The Ohio State University

Working Papers in Linguistics No. 56

Varia

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Autumn 2001

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MORPHOLOGICALLY COMPLEX PREDICATES IN JAPANESE AND WHAT THEY TELL US ABOUT GRAMMAR ARCHITECTURE

Domenic Cipollone[1]

Abstract

In this paper we take a fresh look at an old problem, the syntax and semantics of Japanese causatives. We demonstrate some seldom-noted similarities causatives bear to other Japanese morphologically complex predicates and argue why these similarities are important. Following a survey and critique of past analyses, we conclude that the principle of compositionality is at the root of the deficiencies of these analyses. We thus propose a modified, slightly non-compositional version of Manning *et al*.'s (1999) analysis, similar in spirit to Minimal Recursion Semantics (Copestake *et al*. 1995, 1999). We conclude with some discussion of possible replacements for compositionality.

1 Introduction

Complex predicates in general and Japanese complex predicates in particular have always "fallen between the cracks" of linguistic analysis. Sentences containing them are

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[1] I wish to thank Bob Levine, Carl Pollard and especially Bob Kasper for comments and advice on earlier versions of this paper. All remaining errors are mine.

Cipollone, Domenic 2001. Morphologically Complex Predicates in Japanese and What They Tell Us About Grammar Architecture. *OSUWPL 56, 1–52*.

more than simple sentences and less than complex sentences, exhibiting properties of both. In the Japanese case, any analysis of complex predicates must touch on a very broad spectrum of the grammar of Japanese, from morphology and phonology to syntax and semantics. Each of these modules of the grammar has its own perspective on the properties of complex predicates, and difficulties arise when these perspectives conflict.

In this paper we will examine a number of the properties of Japanese complex predicates, with an eye towards isolating and remedying these inter-module conflicts. In doing so we will pay special attention to module interface issues, eventually calling into question the principle of compositionality. In fact, we view this paper as being less about Japanese complex predicates than about grammar architecture. That is, we will ultimately be concerned with macro-level issues of how a grammar should be organized. Japanese complex predicates are in effect used as a case study to motivate discussion of these larger goals.

Along the way to discussing grammar architecture we will also present a new analysis of the Japanese causative construction, one of the most-debated constructions in the Japanese syntax and semantics literature. For this reason we will concentrate on the causative and past analyses of it in sections 2 and 3. We will move on to presenting data from a number of other morphologically complex predicates (MCPs) in section 4. A novelty of our approach to the causative is that we explicitly recognize that it is simply one of a number of MCPs which share a range of unusual properties, and not the lone misfit it has been almost universally portrayed as. Section 5 shows how, in one way or another, the principle of compositionality has been a factor in the failings of previous approaches to the causative. Section 6, then, presents an analysis which demonstrates how the admission of a small amount of non-compositionality allows for a much more straightforward treatment of the causative and the other MCPs. We consider possible replacements for compositionality in section 7, proposing a new principle of "Naturalness" as a constraint on the global structure of a grammar. Finally, section 8 offers some closing thoughts and further comments on the principle of Naturalness.

Our approach owes a special debt to Manning *et al.*'s (1999) treatment of the causative. Not only do we appropriate much of their analysis wholesale in constructing our own analysis, we share their view of the importance of the Lexical Integrity Hypothesis (LIH). The LIH is Bresnan & Mchombo's (1995) formal expression of the old idea that morphological processes and syntactic processes should be strictly separated. The LIH requires that morphological processes deal only with units below the word level (i.e., morphemes), while syntactic processes deal only with whole words and have no access to smaller units of meaning. This creates a very restricted interface between morphology and syntax, in effect a sort of filter through which only entire, isolated words can pass in either direction. We will be in the position to provide some arguments for the LIH in sections 5.1 and 7.2, but until that point we ask the reader to bear with our insistence on preserving the LIH.

2 The Japanese causative construction

We start our discussion by introducing the Japanese causative construction. The proper analysis of the Japanese causative has long been a thorn in the side of syntacticians due to properties it has which, when viewed from the standpoint of more commonplace constructions, appear to be mutually inconsistent. The basic tension is between properties which make causative predicates appear lexical and properties which make them appear non-lexical. Most analyses, including the one we will eventually propose, have latched onto one or the other groups of properties as somehow more basic, then attempted to explain the other properties via special mechanisms.

2.1 Basic data

In each of the following examples we give a sentence involving a monomorphemic intransitive, transitive or ditransitive predicate, then two sentences involving the causative version of that same predicate with the causer "Hanako". There are in Japanese two different particles, *-o* and *-ni*, which can be used to mark the causee in a causative construction. However, as (2b) and (3b) demonstrate, when the verb is (di)transitive, the accusative particle *-o* is not available as an option. This phenomenon is known as the "double *-o* constraint" and is attributed to Harada (1973).[2]

(1) a. Taroo-ga it-ta
Taroo-NOM go-PAST
'Taroo went.'

b. Hanako-ga Taroo-o ik-ase-ta
Hanako-NOM Taroo-ACC go-CAUSE-PAST
'Hanako made Taroo go.'

c. Hanako-ga Taroo-ni ik-ase-ta
Hanako-NOM Taroo-DAT go-CAUSE-PAST
'Hanako made Taroo go.'

(2) a. Taroo-ga miruku-o non-da
Taroo-NOM milk-ACC drink-PAST
'Taroo drank milk.'

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[2] The choice between *-o* and *-ni* in those sentences which allow it is not arbitrary. It is often claimed (Matsumoto (1996), Uda (1994), Shibatani (1973)) that *-o*-marked causees are interpreted as being coerced in an adversarial way to do something, while this sense is often absent from sentences with *-ni*-marked causees. Matsumoto (1996) claims a four-way distinction defined by the use of *-o* versus *-ni* and a "coercive" versus a "permissive" interpretation.

b. *Hanako-ga Taroo-o miruku-o nom-ase-ta
Hanako-NOM Taroo-ACC milk-ACC drink-CAUSE-PAST
'Hanako made Taroo drink milk.'

c. Hanako-ga Taroo-ni miruku-o nom-ase-ta
Hanako-NOM Taroo-DAT milk-ACC drink-CAUSE-PAST
'Hanako made Taroo drink milk.'

(3) a. Taroo-ga Ken-ni hon-o age-ta
Taroo-NOM Ken-DAT book-ACC give-PAST
'Taroo gave a book to Ken.'

b. *Hanako-ga Taroo-o Ken-ni hon-o age-sase-ta
Hanako-NOM Taroo-ACC Ken-DAT book-ACC give-CAUSE-PAST
'Hanako made Taroo give a book to Ken.'

c. Hanako-ga Taroo-ni Ken-ni hon-o age-sase-ta
Hanako-NOM Taroo-DAT Ken-DAT book-ACC give-CAUSE-PAST
'Hanako made Taroo give a book to Ken.'

As these sentences show, causative predicates are created through suffixation of the morpheme *-(s)ase* to a verb stem. There is in general no restriction on what verbs can be made into causatives.

Having seen the basic form causative sentences take, we now turn to various properties of the causative. These properties fall naturally into two groups: those which are most directly compatible with an analysis in which causatives are treated as lexical items, and those which *prima facie* support treating the causative morpheme *-(s)ase* and the verb stem as separate syntactic elements. Later we will see how these two groups of seemingly contradictory properties give rise to two diametrically opposed groups of analyses.

2.2 Properties which make the causative look lexical

There are good reasons for believing that causative predicates are lexical and not composed of two separate words. Manning *et al.* (1999) (henceforth MSI) present a barrage of arguments (both their own and those of previous researchers) which argue for the lexical status of causatives. The strongest of these are repeated here, along with those of some other researchers. While not every argument is unassailable, the sheer bulk of the evidence points convincingly towards the lexical status of the causative.

2.2.1 Allomorphy

There are at least two morphological reasons for believing that causative predicates are lexical. The first of these is the fact that the causative suffix *-(s)ase* has two different manifestations, the distribution of which is conditioned by the end of the preceding verb stem. This strongly suggests that *-(s)ase* is a morpheme with two allomorphs, meaning that it is a true affix and that therefore the entire verb stem+*(s)ase* complex is a single lexical unit. The following examples demonstrate this distribution.

(4) a. tabe-sase-ru
eat-CAUSE-NPAST

b. ki-sase-ru
wear-CAUSE-NPAST

c. ake-sase-ru
open-CAUSE-NPAST

(5) a. nom-ase-ru
drink-CAUSE-NPAST

b. kak-ase-ru
write-CAUSE-NPAST

c. waraw-ase-ru
laugh-CAUSE-NPAST

As these examples show, *-(s)ase* appears as *-sase* after vowel-final stems and *-ase* after consonant-final stems.

2.2.2 Reduplication

Reduplication of verb stems is commonly used in Japanese to denote repetition of an action or action taken to an extreme degree. Crucially, verb stem+*(s)ase* complexes can be reduplicated, while *-(s)ase* alone cannot.

(6) a. gohan-o tabe tabe
rice-ACC eat eat
'eating rice repeatedly'

b. ?gohan-o tabe-sase tabe-sase
rice-ACC eat-CAUSE eat-CAUSE
'causing someone to eat rice repeatedly'

c. *gohan-o tabe-sase sase
rice-ACC eat-CAUSE CAUSE

MSI take this to show that *tabe-sase* must be formed in the lexicon, since reduplication is a lexical process.

2.2.3 Subject honorification

Japanese has a construction in which a verb may be converted into a new verb, the subject of which is interpreted as being deserving of respect or honor. These honorific forms are infelicitous when used to describe the actions of a person socially equal or inferior to the speaker. Thus we have sentences such as those in (7).

(7) a. Sensei-ga imooto-ni purezento-o o-okuri-ni naru
teacher-NOM (my) younger sister-DAT present-ACC send (HON)
'The teacher will (honorably) send (my) younger sister a present'

b. #Imooto-ga sensei-ni purezento-o o-okuri-ni naru
(my) younger sister-NOM teacher-DAT present-ACC send (HON)
'(My) younger sister will (honorably) send the teacher a present'

Crucially, the affixal wrapper *(g)o-*[ ]*-ni naru* cannot be used to make *-(s)ase* alone into an honorific form.

(8) a. Sensei-ga imooto-ni hon-o o-yom-ase-ni naru
teacher-NOM (my) younger sister-DAT book-ACC read-CAUSE (HON)
'The teacher will make (my) younger sister read a book

b. *Sensei-ga imooto-ni hon-o yomi o-sase-ni naru[3]

MSI take this as evidence that causative predicates are formed lexically and can therefore not be split apart by syntactic processes like subject honorification. Interestingly, Gunji (1999) takes data from subject honorification and reaches quite different conclusions, as will be shown later.

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[3] The form *yomi* is a nominalized form of *yom-* 'to read'. The sequence *yom o-sase-ni naru* would be ruled out on phonological grounds, as *yom* is not a possible Japanese word.

2.2.4 The potential

One way in which Japanese expresses modal possibility (*can do X, be able to do X*) is through a verbal suffix, *-(rar)e*.[4] The compound formed by suffixation of *-(rar)e* to the verb stem is referred to as the *potential form*. Potentials have the peculiar property of in many cases allowing the obligatorily *-o*-marked direct object of their base verbs to be marked with either *-o* or *-ga*, the particle normally reserved for subjects.[5] This is shown in (9).

(9) a. Imooto-wa miruku-o/*-ga nom-u
sister-TOP milk-ACC/*-NOM drink-NPAST
'(My) younger sister drinks/will drink milk.'

b. Imooto-wa miruku-o/-ga nom-e-ru
sister-TOP milk-ACC/-NOM drink-POT-NPAST
'(My) younger sister can drink milk.'

As shown in (10), potential forms of causatives also have this property, arguing that the causative is already a contiguous lexical item by the time the potential morpheme *-(rar)e* is introduced.

(10) a. Okaasan-wa imooto-ni miruku-o/*-ga nom-ase-ru
mother-TOP sister-DAT milk-ACC/*-NOM drink-CAUSE-NPAST
'(My) mother makes/will make (my) younger sister drink milk.'

b. Okaasan-wa imooto-ni miruku-o/-ga nom-ase-rare-ru
mother-TOP sister-DAT milk-ACC/-NOM drink-CAUSE-POT-NPAST
'(My) mother can make (my) younger sister drink milk.'

If *-(s)ase* were an independent verb which simply selected a clausal complement, then it would be difficult to explain how the marking possibilities of one of the arguments inside that complement could be modified by *-(rar)e*, which would have to be analyzed as either a suffix on *-(s)ase* or a higher-up independent verb.[6]

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[4] There are several common regional/speech register-related variants. *-(rar)e* is the standard form most often used in the media. There is a separate periphrastic construction, *...koto-ga dekiru*, which does not involve derivational morphology and which may generally be used interchangeably with the potential form described here.

[5] Although certain "double *-ga*" verbs take *-ga*-marked objects lexically, e.g., *John-ga furansugo-ga/*-o wakaru* 'John understands French'. Note that the periphrastic potential *...koto-ga dekiru* does not license this case-marking alternation.

[6] The technology of argument attraction (Hinrichs & Nakazawa (1989), Kathol (1995), etc.) would permit such an analysis, however. The arguments of the verb stem would simply become arguments of *-(s)ase* , where they would be accessible to the influence of *-(rar)e*. Gunji (1999) introduces argument attraction for certain cases of scrambling, but does not give an analysis of the potential or its case-marking possibilities. MSI also use a form of argument attraction, but at the lexical formation level and not at the syntactic level.

2.2.5 Question-answer pairs

MSI present futher evidence for the lexicality of the causative from the domain of question-answer pairs. In general, questions in Japanese can be answered either by a form of *hai/iie* ‘yes/no’ or by repeating the verb of the question in either affirmative or negative form.[7] Furthermore, in exchanges such as ((11),(12)), in which the questions are of biclausal structures, only the matrix verbs are repeated in the answers.

(11) a. A: [Taroo-ga ik-u yoo ni] shi-ta ka?
Taroo-NOM go-NPAST (COMP) do-PAST QUES
‘Have (you) arranged for Taroo to go?’

b. B: Shi-ta (yo)
do-PAST EMPH
‘Yes, I have’ lit. *‘Did.’*

(12) a. A: [Taroo-ga it-te kure-ru yoo ni] tanon-da ka?
Taroo-NOM [go-GER give-NPAST (COMP)] ask-PAST QUES
‘Have (you) asked Taroo to go?’

b. B: Tanon-da (yo)
ask-PAST EMPH
‘Yes, I have’ lit. *‘Asked.’*

We may then ask what happens in the case of a causative. It turns out that the entire causative predicate, and not only *-(s)ase* , must be repeated in order to give a felicitous answer.

(13) a. A: Taroo-o ik-ase-ta ka?
Taroo-ACC go-CAUSE-PAST QUES
‘Have (you) caused Taroo to go?’

b. B: ik-ase-ta (yo)
go-CAUSE-PAST EMPH
‘Yes, I have’ lit. *‘Caused to go.’*

c. B: *(S)ase-ta (yo)
CAUSE-PAST EMPH

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[7] There is no all purpose auxiliary like the English *did, do* and *will* in *I did/do/will (not)*.

If *-(s)ase* were a matrix verb selecting a clause, then we would expect it to be a possible answer. The fact that it is not implies either that *-(s)ase* is not a clause-selecting verb or that it is an unusual clause-selecting verb which patterns differently from other such verbs with respect to question-answer pairs. The first explanation seems more straightforward and natural.

2.2.6 Blocking by lexical causatives

Miyagawa (1980, 1989) presents a unique argument that causative predicates are lexically-formed. Miyagawa's point of departure is the large number of lexical causatives in Japanese; that is, verbs with causative meanings which have clearly not undergone any derivational processes (except, possibly, diachronically). Examples are *koros-u* 'to kill', *ake-ru* 'to open (something)' and *nuras-u* 'to make wet'. The existence of these lexical causatives can either block the formation of morphologically complex causatives with putatively identical meanings or, more often, forces these complex causatives to take on specialized interpretations. For example, *sin-ase-ru* 'to cause to/let die' cannot be used to describe an act of direct murder as *koros-u* can, but can only be used when indirectly causing death or when failing to intervene as someone is dying. Similarly, *ak-ase-ru* 'to cause (something) to/let (something) open' cannot be used to describe the act of opening a door, but only acts such as watching idly as a door blows open without attempting to close it again.

On the assumption that such semantic blocking and meaning shift can only happen in the lexicon, Miyagawa argues that the interaction between lexical and complex causatives demonstrates the wordhood of causative predicates. As MSI note, however, it is not completely clear that this assumption is correct, and so the fascinating data Miyagawa presents must be treated warily.

2.3 Properties which make the causative look non-lexical

We now turn to those properties of the causative which have led many researchers to believe, despite the weight of evidence presented in the previous section and the intuition of most Japanese speakers, that it is in fact best analysed as composed of two syntactically separate predicates. It is worth noting that this group of properties is of a more semantic nature, while those of the previous section were largely syntactic and morphological.

2.3.1 Adjunct scope

Possibly the most problematic data for a lexical view of the causative comes from adjunct and quantifier scoping. We deal first with adjuncts.

When modifying causatives adjuncts can, in a general and productive way, take semantic scope over either the predicate expressed by the verb stem or the entire causative predicate.[8] In syntactic terms, given standard assumptions, adjuncts can take scope over individual morphemes in a complex verb. This is demonstrated in example (14).

(14) a. Suzuki-sensei-ga Taroo-ni gakkoo-de hashir-ase-ta
Suzuki-teacher-NOM Taroo-DAT school-LOC run-CAUSE-PAST
Wide scope: *'At school, Suzuki-sensei made Taroo run'*
Narrow scope: *'Suzuki-sensei made Taroo [run at school]'*

b. Hanako-ga Taroo-ni hooki-de yuka-o hak-ase-ta
Hanako-NOM Taroo-DAT broom-INSTR floor-ACC sweep-CAUSE-PAST
Wide scope: *'With/using a broom, Hanako made Taroo sweep the floor (by hitting him with it, etc.)'*
Narrow scope: *'Hanako made Taroo [sweep the floor with a broom]'*

This is entirely unexpected given the data seen in the last section. Since adjuncts are normally assumed to take scope at syntactic nodes, an analysis of these sentences would appear to need to split the verb stem and *-(s)ase* into two separate syntactic entities. In other words, these data seem to demand a non-lexical analysis.

2.3.2 Quantifier scope

Parallel to the adjunct data, we also find that quantifiers can take scope over both the complex predicate as a whole and just the verbal stem in causatives.

(15) a. Sensei-ga gakusei-ni san-satsu-no hon-o yom-ase-ta
teacher-NOM students-DAT three-volumes-GEN book-ACC read-CAUSE-PAST
Wide scope: *'There were three books that the teacher made the students read'*
Narrow scope: *'The teacher caused there to be three books that the students read'*

b. watashi-wa nanninka-no tomodachi-o suupaa-ni ik-ase-ru
I-TOP a few people-GEN friends-ACC grocery store-to go-CAUSE-NPAST
Wide scope: *'There are several (particular) friends who I will make go to the grocery store'*
Narrow scope: *'I will make several friends go to the grocery store'*

Again, since quantifiers are normally assumed to take scope over syntactic nodes, these data are highly problematic for a lexical view of the causative.

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[8] Matsumoto (1996) notes that with some kinds of causatives (i.e., permissive vs. coercive causatives) and under some interpretations verb-stem scope is not possible. This, however, does not change the fact that it is *often* possible.

2.3.3 *Jibun* binding

Jibun ‘self’ has a complex and not fully understood set of conditions as to what can serve as its antecedent. Subjects, however, can virtually always serve as antecedents, while non-subject antecedents are rare. As shown in (16), *jibun* can bind to either causers *or* causees in causative constructions.

(16) a. Hanako$_i$-ga Taroo$_j$-ni jibun$_{i/j}$-no shashin-o mi-sase-ta
Hanako-NOM Taroo-DAT self-GEN photo-ACC see-CAUSE-PAST
‘Hanako$_i$ made Taroo$_j$ see her$_i$/his$_j$ picture.’

b. Hanako$_i$-ga Taroo$_j$-ni jibun$_{i/*j}$-no shashin-o mise-ta
Hanako-NOM Taroo-DAT self-GEN photo-ACC show-PAST
*‘Hanako$_i$ showed Taroo$_j$ her$_i$/*his$_j$ picture.’*

Note that (16b) differs only from (16a) in employing the lexical causative *mise-ru* ‘to show’ rather than the morphologically complex causative *mi-sase-ru* ‘to cause to see’. The meanings are thus almost identical, yet the binding patterns differ.

This data makes both causers and causees in morphologically complex causative constructions look like subjects at some level, suggesting a biclausal structure with the causer as the higher subject and the causee as the subject of the embedded clause. While the vagueness of *jibun*’s binding conditions renders this argument less forceful than the preceding ones, it is still a phenomenon which is difficult to explain if the causative verb is treated as syntactically indistinguishable from a standard monomorphemic verb in which such binding ambiguities are absent.

2.3.4 Subject honorification

Gunji (1999) presents an intriguing argument for the non-lexicality of the causative by reference to subject honorification. Gunji examines causatives formed from the honorific forms of verbs. (Note that this is different from MSI, who consider the honorific forms of causatives). Gunji notes that, as seen in (17), it is the causee and not the causer who is interpreted as being honored in these sentences.

(17) a. Ken-ga Suzuki-sensei-o o-aruki-ni nar-ase-ta
Ken-NOM Suzuki-teacher-ACC HON-walk-HON-CAUSE-PAST
‘Ken made Prof. Suzuki (honorably) walk.’

b. #Suzuki-sensei-ga Ken-o o-aruki-ni nar-ase-ta
Suzuki-teacher-NOM Ken-ACC HON-walk-HON-CAUSE-PAST
#*‘Prof. Suzuki made Ken (honorably) walk.’*

In order to preserve the otherwise solid generalization that verbs enclosed by the *(g)o-[ ]-ni nar-* wrapper mark the subject as honored, it is necessary to consider the causee to be in some sense a subject. Gunji, assuming that in the HPSG framework to be a subject means to be an initial element on a SUBCAT list, concludes that there are two SUBCAT lists involved, one for the honorific verb stem and one for *-(s)ase* .

3 Past analyses of the causative

The fact that causative predicates look in some ways lexical and in other ways non-lexical has given rise to two major camps of analyses, those that take the sentential structure of causatives to be monoclausal and those that assume it is biclausal. There is in addition a third camp of analyses which are in some sense mono-/bi-clausal hybrids. In this section, we present a representative sample of past analyses, each of which will be found to be unsatisfactory in some way. In section 5, we will present some comparative analysis of the problems these analyses face. By isolating the common difficulties with past approaches we hope to find a way to cut the Gordian knot and thereby break through to a new, more satisfying approach.

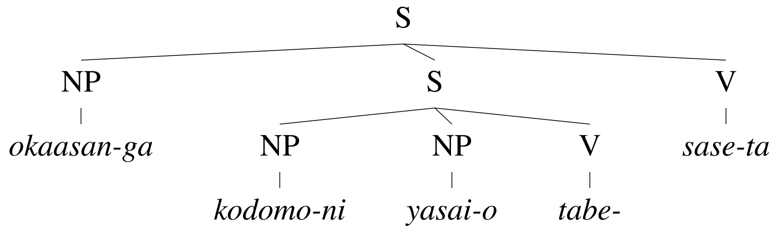
3.1 Biclausal analyses

The majority of past generative analyses of the Japanese causative have been biclausal in nature. That is, most have latched onto the evidence suggesting that the causative is non-lexical, while downplaying the conflicting evidence. As a result, such analyses have worked from the assumption that *-(s)ase* is an independent syntactic entity which takes as a complement a sentence headed by the verb stem.

The classic examples of the biclausal approach are Kuroda (1965, 1981), Kuno (1973) and Shibatani (1973). The particular differences between these analyses and the dozens of similar analyses they have engendered are not relevant for our purposes, and are in any case slight. What is important is the general form these analyses take. A typical causative sentence such as (18) would under these approaches be given a syntactic structure similar to that in (19).

(18)	okaasan-ga	kodomo-ni	yasai-o	tabe-sase-ta
	mother-NOM	child-DAT	vegetables-ACC	eat-CAUSE-PAST
	'The mother made the child eat the vegetables'			

(19)



The various approaches might differ over fine syntactic points such as whether or not the clauses should have VP nodes, but such disagreements are not important to the current discussion. All biclausal approaches take *-(s)ase* to be a verb in its own right, and this is where the issue lies.

The general problem with the biclausal approach is that it is overly simplistic in ignoring or marginalizing the significant evidence for the lexical status of the causative. It exploits the convenient fact that Japanese is syntactically a head-final language, meaning that general principles would force *-(s)ase* , if construed as an independent verb, to immediately follow the verb stem in all cases. This fact, however, is neither evidence for nor against the biclausal approach.

In order to establish the biclausal approach as correct, one would have to either (a) argue quite convincingly that *-(s)ase* is a lexical item despite the evidence against its being so; or (b) explicitly reject the Lexical Integrity Hypothesis (LIH) as an appropriate constraint on grammar architecture. No analysis has done either of these. The closest has been Kuroda's (1981) weak claim that *-(s)ase* is not a bound morpheme at all. He bases this claim on the existence of the well-formed causative verb *sase-ru* 'to cause to do'. However, as pointed out in Kitagawa (1986) and Miyagawa (1989), this word is really nothing more than the causative form of the irregular verb *su-ru* 'to do'. It is thus a standard morphologically complex verb, analyzed as *s-ase-ru*. As further support for this, note that *su-ru* also takes the irregular stem *s-* in the passive form *s-are-ru* 'to be done', formed from the passive morpheme *-(r)are*.

In summary, it is safe to view the classical biclausal analyses as first attempts at wrestling with the odd properties of the Japanese causative. They were made in a time when grammar writers allowed themselves much less technical machinery, meaning that they had no real choice but to use clausal distinctions to capture scope facts. As we will see, the addition of more flexible grammar technology will allow our theories to be faithful to more of the empirical facts.

3.2 Monoclausal analyses

The common thread binding the group of monoclausal analyses together is the assumption that predicates such as *tabe-sase-ru* 'to cause to eat' are formed in the lexicon and that the body of data pointing to the biclausal analysis, to the extent that it is acknowledged, is to be explained via other special mechanisms.

3.2.1 Miyagawa (1980, 1989)

The main substance of Miyagawa's arguments were presented above under "Blocking by lexical causatives" in section 2.2.6. Unfortunately, while he argues strongly for a lexical treatment of the causative, he does not attempt to provide an explanation for any of the major pieces of evidence in support of the biclausal analysis. He in fact hardly even mentions this evidence. His analysis must therefore be regarded as highly incomplete at best.

3.2.2 Manning, Sag & Iida (1999)

MSI present a monoclausal analysis, couched in HPSG, which makes use of a mixed bag of tricks in covering those phenomena which would seem to discredit a monoclausal approach. Their philosophical stance is nicely summed up in the following quote:

> "Although an analysis of causatives in terms of complex syntactic structures has frequently been adopted in an attempt to simplify the mapping to semantic structure, we believe that motivating syntactic structure based on perceived semantics is questionable because in general a syntax/semantics homomorphism cannot be maintained without vitiating syntactic theory (Miller 1991)."

They are also rigidly committed to preserving the LIH. Since MSI's approach is the closest to the one we will eventually propose, we will present it in relative detail. This is as much to be sure the parts we will adopt are adequately explained as it is to highlight the parts we will later argue against.

MSI introduce or borrow a range of formal grammatical devices in constructing their analysis of the causative. We will look at each of these in turn. Note that, because they are presenting an essentially monoclausal analysis, they do not need to do anything special to handle the evidence for the lexicality of the causative. It is the evidence for non-lexicality that they must deal with. Their challenges specifically include (a) word-internal adjunct scope; (b) word-internal quantifier scope; (c) *jibun* binding; and (d) subject honorification. They treat only the first three in their paper, as they do not mention Gunji's (1999) subject honorification argument (presented here in section 2.3.4). We first present their method of forming causative predicates and then move on to show how they tackle (a-c) above.

MSI state that their basic analysis of Japanese causatives is compatible with a lexical-rule treatment, but that they instead choose to implement it in the 'type-based' approach to morphology developed in Riehemann (1993, 1995). Because nothing hinges on the particulars of this rather complex type-based approach and because it can be readily translated into a lexical rule approach, we will present it in that form.[9]

MSI in effect use a lexical rule of the following form:

(20) **Causative Formation Lexical Rule (CFLR):**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4}\left\langle \text{PRO}_j \mid \boxed{5} \right\rangle \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \textsf{causative-morph}\left(\boxed{1}\right) \\ \text{SUBJ} & \left\langle \boxed{6}\text{NP}_i \right\rangle \\ \text{COMPS} & \left\langle \boxed{7}\text{NP}_j \mid \boxed{5}\right\rangle \\ \text{ARG-ST} & \left\langle \boxed{6}, \boxed{7}, \boxed{4}\textit{list}\right\rangle \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{CONTENT}|\text{NUC} & \begin{bmatrix} \textit{cause-rel} & \\ \text{ACTOR} & i \\ \text{UNDERGOER} & j \\ \text{EFFECT} & \boxed{2}\end{bmatrix}\end{bmatrix}$$

There are two unusual points to note about this lexical rule.[10] The first is the element 'PRO' on the ARG-ST list of the left hand side. According to MSI, this PRO "designates a special type of element that is associated with the subject of the basic stem [and is] coindexed with some member of the (outer) ARG-ST list in accordance with fundamentally semantic principles similar to those outlined for English control constructions in Sag and Pollard (1991)". PRO, then, is the SYNSEM value of a kind of NP which does not surface syntactically but is coindexed with a surfacing element which controls it in some way.

The second feature of (20) which deserves mention is the nested ARG-ST list on the right hand side of the rule. This is, in fact, the core of MSI's treatment of the *jibun*-binding facts, our (c) above. Since in their system binding operates by reference to ARG-ST lists, giving causatives nested ARG-ST lists in effect makes them biclausal for the purposes

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[9] In their system there is a hierarchy of types from which particular words (multiply) inherit. For instance, the base form of the verb *buy* inherits from types *stem*, *verb-stem*, *strict-transitive*, *active-stem*, and *undergoer-stem*. Each type carries with it its own set of constraints. The conjunction of these five types gives us the core of the familiar lexical entry for *buy*:

$$\begin{bmatrix} \textit{strict-trans} & \\ \text{HEAD} & \textit{verb} \\ \text{SUBJ} & \left\langle \boxed{1} \right\rangle \\ \text{COMPS} & \left\langle \boxed{2} \right\rangle \\ \text{ARG-ST} & \left\langle \boxed{1}\text{NP}_i, \boxed{2}\text{NP}_j \right\rangle \\ \text{CONTENT}|\text{NUC} & \begin{bmatrix} \textit{buy-rel} & \\ \text{ACTOR} & i \\ \text{UNDERGOER} & j \end{bmatrix} \end{bmatrix}$$

[10] Actually, three. The NEW-QSTORE feature will be discussed later.

of binding. The biclausality, however, is isolated to the ARG-ST list and does not affect the whole of the grammar. Note that, although they do not specifically mention it, this embedded ARG-ST might also be used to address problem (d) above. That is, Gunji's subject honorification argument could be avoided if, instead of taking subjects to be initial SUBCAT elements, they were taken to be initial ARG-ST elements. In a causative both the causer and the causee would then qualify as subjects, and thus potential honorees. We will not attempt to work out the details of such an analysis here, however.

Now that we have seen how MSI deal with (c), we move on to (a), word-internal adjunct scope. Following Miller (1991) and van Noord & Bouma (1994), among others, word-internal adjunct scope is handled in MSI via (the equivalent of) an adjunct addition lexical rule (AALR) which generates "pre-scoped" verbs. Crucially, the application of the AALR is not ordered with respect to the application of the CFLR. One may, for instance, apply the CFLR first and then the AALR second, producing a causative which will later be modified by an adjunct interpreted with wide scope. Alternatively, simply switching the order of application gives the adjunct narrow scope. The AALR might be formulated as follows:

(21) **Adjunct Addition Lexical Rule (AALR):**[11]

$$\begin{bmatrix}\text{HEAD} & \textit{verb}\\ \text{CONTENT} & \boxed{1}\\ \text{ARG-ST} & \boxed{2}\end{bmatrix} \Longrightarrow \begin{bmatrix}\text{CONTENT} & \boxed{3}\begin{bmatrix}\text{NUC}|\text{ARG}\ \boxed{1}\end{bmatrix}\\ \text{ARG-ST} & \boxed{2}\circ\left\langle \text{ADV}\begin{bmatrix}\text{CONT}\ \boxed{3}\end{bmatrix}\right\rangle\end{bmatrix}$$

The crucial thing to note here is that the pre-scoped lexical items created by this rule actually *subcategorize for* adverbs in precisely the same way that they do for objects and other arguments. This is so because in their system a further constraint effectively splits the ARG-ST list into SUBJ and COMPS valence lists, meaning that this adverb will end up on the COMPS list as an argument.[12]

There are serious questions as to whether this unorthodox treatment of adjuncts can be as easily and safely adopted as MSI imply it can be. We will defer addressing such questions until section 5.2, however, where they will be dealt with in detail. For the time being, it will suffice to note our general skepticism towards the approach. There are simply too many reasons to keep a syntactic distinction between adjuncts and arguments to justify casually conflating them for the sake of one particular Japanese verbal construction.

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[11] '$\circ$' denotes list concatenation.

[12] In MSI's type-based morphology the type *stem*, of which all verbs are subtypes, is subject to this constraint:

$$\textit{stem} \Longrightarrow \begin{bmatrix}\text{SUBJ} & \boxed{1}\\ \text{COMPS} & \textsf{compression}\left(\boxed{2}\right)\\ \text{ARG-ST} & \boxed{1}\circ\boxed{2}\end{bmatrix}$$

compression() is a bracket-erasing function which takes a possibly-embedded ARG-ST list and outputs a flat list with the same members except any occurences of PRO, which are deleted. They also state that "an independent constraint guarantees that a stem's SUBJ value is a singleton list".

Finally, we present an overview of MSI's treatment of problem (b) above, that of word-internal quantifier scope. MSI adopt a version of Pollard & Yoo's (1998) theory of quantifier scope, which is in turn based on the technique of "Cooper storage" introduced in Cooper (1983). The reader is referred to Pollard & Yoo (1998) for the full complexities of this theory, but in essence Pollard & Yoo propose a refined version of Cooper storage in which stored quantifiers are inherited from head daughters only, rather than from all daughters as in previous approaches. They also move the Q(UANTIFIER)-STORE feature to SYNSEM|LOCAL from SYNSEM|NONLOCAL, its location in Pollard & Sag (1994). This move solves a number of serious problems in Pollard & Sag's analysis related to the interaction of quantifiers with raising and extraction.

Pollard & Yoo's theory, however, has one shortcoming: it allows quantifier retrieval to occur at too many nodes, resulting in spurious analyses for many sentences. These spurious analyses spring up in cases where there are multiple verbally-headed phrasal nodes which may serve as retrieval sites, but where the choice among these nodes does not result in scope differences. MSI propose to repair this flaw while at the same time allowing for word-internal quantifier scope by lexicalizing quantifier scoping. That is, all quantifiers in their system are retrieved at lexical heads and not at phrasal nodes. This move eliminates the non-determinism of the retrieval process (aside from the inherent non-determinism of choosing a particular quantifier scoping).

MSI implement their lexical quantifier retrieval in such a way that it interacts with the CFLR to allow word-internal quantifier scope with causatives. This is accomplished by using a verbal head's ARG-ST list as a sort of intermediary between the two processes. Quantifier retrieval is technically formulated as a constraint on type *stem* of the following form:

(22) **Quantifier Amalgamation Constraint:**[13]

$$\mathit{stem} \Longrightarrow \begin{bmatrix} \text{ARG-ST} & \boxed{1} \\ \text{QSTORE} & \mathsf{merge\text{-}quants}\left(\mathsf{toplevel}\left(\boxed{1}\right)\right) \uplus \boxed{2} \ominus \boxed{3} \\ \text{NEW-QSTORE} & \boxed{2} \\ \text{CONTENT} & \begin{bmatrix} \text{QUANTS} & \mathsf{order}\left(\boxed{3}\right) \end{bmatrix} \end{bmatrix}$$

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[13] Notation:

- toplevel() is a function that takes a possibly-embedded ARG-ST list and returns all unembedded elements.
- merge-quants() is a function that takes a list of *synsem* values and returns the union of their CONTENT|QUANTS values.
- $\uplus$ behaves like normal set union if its arguments are disjunct sets, and is undefined otherwise.
- $\ominus$ is set difference.
- order() takes a set and nondeterministically returns a list which is an ordering of that set.

This complicated-looking constraint says something rather simple: a *stem* (which may or may not be embedded within a larger complex, as the base verb of a causative is) may choose to retrieve any number of quantifiers from the top level of its own ARG-ST list, as well as any quantifiers passed up from any *stem*s below it via the NEW-QSTORE feature.[14] The unretrieved quantifiers are left in QSTORE to be passed up the tree.

We are now in a position to explain the precise role of NEW-QSTORE, first introduced in the CFLR. Before a causative is built, the base stem retrieves zero or more of the quantifiers contributed by its arguments and leaves the rest in its QSTORE set. The CFLR, then, passes these "leftovers" up to the newly-produced causative form, making them available in its NEW-QSTORE. In this respect NEW-QSTORE is a highly restricted form of Pollard & Yoo's (1998) RETRIEVED feature, which has otherwise disappeared from MSI's theory of quantifier scope.[15]

MSI's theory thus answers all of the challenges for a monoclausal analysis while still remaining monoclausal. It accomplishes this mostly via ARG-ST gymnastics; i.e., it refashions the ARG-ST list into a mini-biclausal structure and uses it as the relevant level of representation for dealing with phenomena which make the causative look non-lexical.

We will adopt most of MSI's analysis as is when presenting our own analysis in section 6. However, as mentioned above, we take issue with their treatment of adjuncts and so will eventually propose a modification of their theory. We realize it might be felt after reading up to this point that the introduction of so much new theoretical machinery is ill-justified if done solely for the purpose of treating the causative. Section 4 will show, however, that this machinery is in fact needed in order to capture a much wider range of data. The empirical motivation for MSI's modifications will thus be strengthened considerably.

3.3 Hybrid analyses

There are a number of analyses which posit syntactic ambiguity for the causative, or else different layers of analysis in which the causative is sometimes a single word, sometimes not. We will refer to these collectively as "hybrid" analyses.

3.3.1 Kitagawa (1986)

Kitagawa (1986) proposes a transformational account in which affix raising is used to account for the dual nature of the causative. Specifically, the verb stem and *-(s)ase* begin at D-structure as a complex V^0 consituent and remain so at S-structure. This move captures

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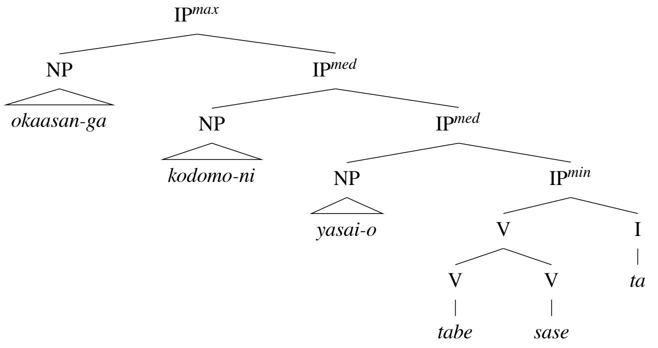
[14] Only the top level of the ARG-ST list is used because any embedded lists will correspond to arguments of lower *stem*s, and these stems will have already had their chances to retrieve quantifiers.

[15] NEW-QSTORE is attributed to Przepiórkowski (1997).

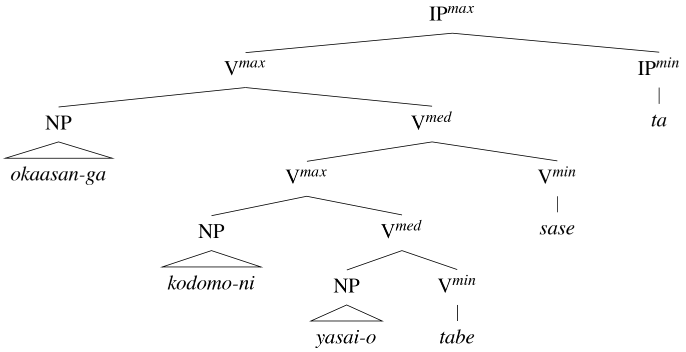
the lexical-like properties of the causative. The non-lexical-like properties are analyzed by having *-(s)ase* undergo affix movement on the way to LF, meaning that the causative is effectively biclausal at that level of representation. Sentence (18), repeated as (23) below, then has the S-structure and LF representations in (24).

(23) okaasan-ga kodomo-ni yasai-o tabe-sase-ta
mother-NOM child-DAT vegetables-ACC eat-CAUSE-PAST
'The mother made the child eat the vegetables'

(24) a. **S-structure:**



b. **LF:**



It initially appears that this approach offers a solution to the dilemma posed by the causative (at least within its set of theoretical assumptions), but a closer look reveals problems. Note that this approach effectively merges both syntax and (at least verbal) morphology into one structure. While this alone would not result in an abandonment of the Lexical Integrity Hypothesis if some sort of boundary were maintained between the two parts of the tree, further note that to derive the LF in (24b) *-(s)ase* would have to move out of the V domain and further up the tree. In doing so, it effectively crosses the morphology-syntax boundary. This movement, then, is a classic example of syntactic interference in the domain of morphology. This undesirable feature is enough to lead us to search for a more satisfactory resolution of the causative's conflicting properties.

3.3.2 Uda (1994)

Uda's (1994) HPSG study of Japanese complex predicates looks at causatives in terms of (a) coercive vs. permissive interpretation and (b) *-o*-marking vs. *-ni*-marking of the causee. It has usually been claimed in the past (Kuno (1973), Shibatani (1973)) that these two dimensions are one and the same, with *-o*-causatives being interpreted as coercive and *-ni*-causatives being interpreted as permissive. Uda, however, presents evidence to the contrary, arriving at an analysis which posits traditionally monoclausal structures for *-o*-causatives and traditionally biclausal structures for *-ni*-causatives. Specifically, causative verbs which take *-o*-marked causees are derived by a lexical rule, while a version of *-(s)ase* which can only take *-ni*-marked causees exists as an independent lexical item to be used in biclausal structures.

Uda's approach appears to be adequate for the data she considers, but she does not address any of the main problems under consideration here.[16] From our perspective, in fact, her analysis seems to adopt the worst of both worlds, giving some causatives a monoclausal analysis which cannot handle the difficult adjunct and quantifier scope data, as well as violating the Lexical Integrity Hypothesis with other causatives by treating some occurrences of *-(s)ase* as an independent word. Her willingness to explore a merger of two long-competing camps of analyses is commendable, but unfortunately, the results are not compelling.

3.3.3 Gunji (1999)

Gunji's (1999) analysis of the causative employs a linearization scheme (Dowty (1996), Reape (1996), Kathol (1995)), with the attendant separation of the grammar into tectogrammatical and phenogrammatical levels. He acknowledges the significant morphophonological evidence arguing for the lexical status of the causative, while also claiming that the data demand a biclausal treatment to effectively capture all the observed patterns. He adopts a linearization analysis in order to be able to incorporate both views simultaneously. Specifically, he treats the monoclausal-like features in the phenogrammar, while handling the biclausal-like features in the tectogrammar.

The linearization approach to grammar architecture holds that there are two largely independent levels of syntactic representation—the *tectogrammar*, in which constituency information is captured (typically by means of some form of phrase structure grammar), and the *phenogrammar*, in which linear ordering constraints are captured. This is a more radical loosening of the relation between syntactic structure and linear order than, for example, the traditional notion of separating ID (immediate dominance) constraints from LP (linear precedence) constraints. Unlike ID/LP grammars, the linearization approach does

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[16] She does mention adjunct scope briefly, but restricts her discussion to the interpretation of subject-oriented adverbs like *wazato* 'purposefully'. Such phenomena bear more in common with *jibun*-binding than with our core word-internal adjunct scope phenomena.

not require that words which form a constituent at the tectogrammatical level be contiguous at the phenogrammatical level. In fact, a linearization grammar could provide for a very constrained tectogrammar and a completely unconstrained phenogrammar, resulting in a language for which any permutation of the words in a given sentence would be given the same syntactic structure. (This may even be correct or close to correct for languages like Warlpiri).

In Gunji's system *-(s)ase* is an independent lexical item which selects a verb stem and inherits all of its arguments. The particular method of selection, however, is unconventional: selection occurs via the SYNSEM|VALENCE|ADJACENT feature, rather than the SUBCAT feature (which is still present, also located under SYNSEM|VALENCE). He then provides two new universal principles, the Adjacent Feature Principle and the Morphophonological Principle, which together ensure that selection via the ADJACENT feature results in a close morphophonological bond between selector and selectee. These principles act to fuse *-(s)ase* to its argument, making the internal structure of the complex predicate impenetrable at the phenogrammatical level. Crucially, however, *-(s)ase* and the verb stem remain separate at the tectogrammatical level, making word-internal adjunct/quantifier scope possible. Since both *-(s)ase* and the verb stem maintain separate SUBCAT lists, an account of the *jibun*-binding and subject honorification data is also straightforward.

By taking this approach, Gunji can be seen as effectively doing in HPSG what Kitagawa (1986) did in transformational grammar. Both treat the causative by appealing to two different levels of syntactic representation, and to accomplish this both need to "merge" morphology into the syntax. The argument in the previous section against Kitagawa's approach, then, also applies to Gunji—both abandon the LIH and propose ad hoc systems of morphology in order to capture the properties of the causative. Gunji goes even further—confronted with purported evidence for both the monoclausality and biclausality of causatives, he simply adopts enough extra grammar technology to simultaneously permit both styles of analysis in virtually unmodified forms.

The linearization approach is motivated by the need to account for discontinuous constituency, *not* by the need to account for unusual interactions between morphology, syntax and semantics. Gunji has shown that adding linearization machinery to his JPSG system can do the job of accounting adequately for the causative. What he has not done is provide justification for the blurring of the boundaries between the various subparts of the grammar his move engenders. Simply because the structure of Gunji's theory allows internal morphological information to be easily accessed by the syntax and semantics does not mean that it *should* be.

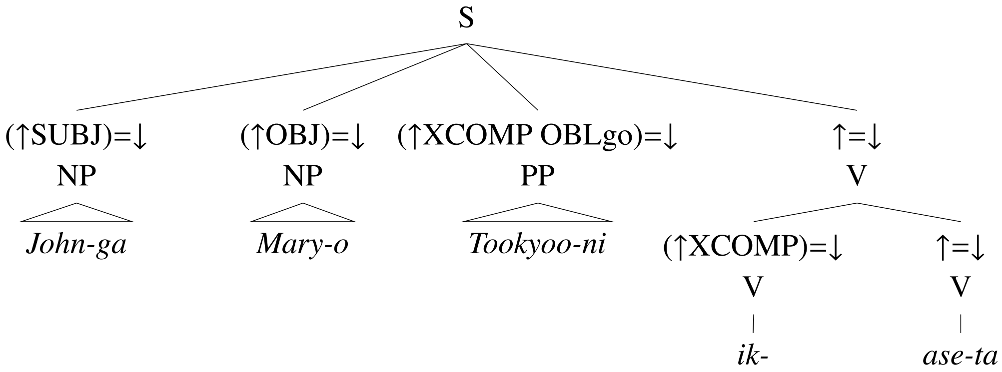
3.3.4 Matsumoto (1996)

Matsumoto (1996) is a study, couched in LFG, of the notion of wordhood. Matsumoto considers four levels of representation; (lexical-)semantic structure, argument (a-)structure, functional (f-)structure and constituent (c-)structure. His main claim is that each of these levels provides its own criteria for wordhood, and that a given construction may qualify as a word at constituent structure, for instance, while failing to be one at functional structure. In this way wordhood is claimed to be a more complex and multi-layered notion than has been generally assumed.

He considers a wide range of Japanese verbal constructions, categorizing each as words or non-words at the various levels of representation. Causatives are split into two groups, with those that are interpreted permissively given “biclausal” (“non-word”) f-structures and those which are interpreted coercively given “monoclausal” (“word”) f-structures. It is not clear, however, what c-structures he assumes for causatives, as he only gives an example of the c-structure of a permissive causative, shown in (25).

(25) a. John-ga Mary-o Tookyoo-ni ik-ase-ta
John-NOM Mary-ACC Tokyo-to go-CAUS-NPAST
‘John let Mary go to Tokyo’

b.



Matsumoto does not concern himself directly with question of reconciling the clear morphophonological integrity of the causative with its syntactic/semantic properties, as this is not directly relevant to his specific task of testing different kinds of syntactic wordhood. His work is therefore not immediately comparable to the other theories we have considered. We introduce his approach, however, because we will be coming back to it later in this paper. In particular, Matsumoto’s treatment not only of the causative, but also of a large range of other Japanese complex predicates is similar in spirit to what we will present in section 4. The analysis we propose in section 6.1 also bears some similarities to his approach.

3.4 General commentary on past analyses

The various shortcomings of these analyses might be forgivable to greater or lesser degrees if it were assumed that the Japanese causative is simply a fringe construction which is outside the bounds of what one normally has to deal with in a syntactic/semantic theory.

That is, if the causative could be likened to a highly idiosyncratic structure like an idiom, which nearly everyone agrees needs special treatment. But this is not the case. The causative, it turns out, is simply one of a number of morphologically complex predicates in Japanese which share many of the same unusual properties. What has been missing from analyses of the causative up to this point is a perspective which places the causative in the context of these other morphologically complex predicates (MCPs). The next section aims to do just this.

4 Other MCPs

Japanese is typically classified as an agglutinative language, and nowhere in the grammar is this more evident than in the verbal system. While there is no verbal agreement with either subjects or objects, there are a number of derivational and inflectional morphemes which may be added to verb stems, nearly all in the form of suffixes.[17] In this section we present a number of complex predicates formed by the addition of derivational suffixes. Note that to be a complex predicate in our terminology requires the presence of two semantic predicates, one taking the other as an argument. Therefore, not all verbs arrived at by suffixation are MCPs.[18]

Our purpose here is to remove as much as possible of the aura of mystery surrounding the Japanese causative. While some unusual features of the causative, namely the *jibun*-binding and subject honorification facts, do appear to be unique to that construction, the more troubling and initially surprising adjunct and quantifier scope facts are not. In fact, word-internal scope of adjuncts and quantifiers will be shown to be in many cases the default state of affairs with MCPs rather than an exotic option available only in special cases.

We are not the first to notice many of the following facts. In particular, Matsumoto (1996) presented the adjunct scope and some of the quantifier scope properties of a large range of MCPs in his study of the notion of wordhood. We believe we are the first, however, to recognize the significance of this data to the resolution of the decades-old debate over the causative, as well as to a number of fundamental questions about what architectual assumptions grammar writers can and should make.[19]

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[17] Like many other agglutinative languages, Japanese is head-final syntactically, but head-initial morphologically.

[18] Some examples of verb forms which are morphologically complex but not MCPs include: the reciprocal (e.g., *tasuke-aw-* ‘to help each other’ from *tasuke-* ‘to help’), the provisional (e.g., *ik-eba* ‘provided (I) go’ from *ik-* ‘to go’), and the conditional (e.g., *owat-tara* ‘if/when (I) finish’ from *owar-* ‘to finish’).

[19] There are some similarities between our claim that the Japanese causative is best viewed as just one of a number of other MCPs and the extensive theory of predicates in Ackerman & Webelhuth (1998). Ackerman & Webelhuth provide a wide range of cross-linguistic evidence to support their claim that the notion of “predicate” deserves to be recognized as a theoretical entity. They exert the majority of their effort in showing how such a uniform cross-linguistic generalization can be maintained in the face of the enormous variety particular languages exhibit in the syntactic, semantic and morphological expression of predicates. They concentrate their attention especially on complex predicates, which they take to include not only semantically

We will not present individual arguments for the lexical status of each of the following MCPs. It will suffice to note that all involve bound morphemes, some with multiple allomorphs.[20]

4.1 The potential: *-(rar)e*

The potential construction was introduced in section 2.2.4 when it was noted that the case-marking alternation it licenses for the base verb's object may be used to argue for the lexicality of the causative. We now show that the potential also shares two surprising features of the causative: it allows both adjuncts and quantifiers to take word-internal scope over the base verb.

Adjunct scope:

(26) a. Hanako-ga piano-o hontoo-ni hik-e-ru
Hanako-NOM piano-ACC truly play-POT-NPAST
Wide scope: *'Hanako truly can play the piano'*
$truly'(possible'(play'(Hanako', piano')))$

b. Hanako-ga piano-o joozu-ni hik-e-ru
Hanako-NOM piano-ACC skillfully play-POT-NPAST
Narrow scope: *'Hanako can play the piano skillfully'*
$possible'(skillfully'(play'(Hanako', piano')))$

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complex predicates as in the present paper, but also otherwise simple predicates marked for tense, mood, aspect, etc.

The similarity to the present approach arises from the fact that Ackerman & Webelhuth concentrate their attention on complex predicates (including the causative) and build a general theory which handles all predicates in a uniform manner. The difference is that they have far loftier goals than we do—rather than build a grand unified theory of predicates, or even a theory of Japanese predicates, we are simply trying to provide an analysis which acknowledges and accounts for several phenomena related to the class of Japanese MCPs. Note also that Ackerman & Webelhuth do not deal with our core topic, the problem of word-internal adjunct and quantifier scope, in Japanese or any other language.

[20] Prima facie counterexamples are *niku-* 'hard to', *yasu-* 'easy to' and *na-* 'not', which can stand on their own. However, all have different meanings as independent words, making this argument untenable. *niku-* means 'hateful', *yasu-* means 'inexpensive' and *na-* means 'to not exist', (i.e., it is the irregular negative form of the verb *ar-* 'to exist'). There is no doubt a diachronic link between these meanings and the morphemes' MCP meanings, but they must be regarded as synchronically distinct.

Quantifier scope:

(27) a. watashi-wa [san-satsu-no hon]$_{NP}$-o yom-e-ru
I-TOP [3-volumes-GEN book]-ACC read-POT-NPAST
Wide scope: *'There are three (particular) books which I can read (...the rest I cannot.)'*
$\exists 3x|_{book'(x)}[possible'(read'(I', x))]$
Narrow scope: *'I can (generally) read three books (...before starting to get sleepy.)'*
$possible'(\exists 3x|_{book'(x)}[read'(I', x)])$

Quantifiers in Japanese can in many cases be "floated", or liberated from the NPs they would normally be associated with and allowed to scramble among other sentential constituents. It is a fascinating fact that such floating generally results in sentences which have *only* narrow scope. This is shown in (28).

(28) a. [hon]$_{NP}$-o san-satsu yom-e-ru
[book]-ACC 3-volumes read-POT-NPAST

b. san-satsu [hon]$_{NP}$-o yom-e-ru
3-volumes [book]-ACC read-POT-NPAST

c. $possible'(\exists 3x|_{book'(x)}[read'(pro, x)])$
$^{*}\exists 3x|_{book'(x)}[possible'(read'(pro, x))]$ **(wide scope impossible)**

Furthermore, although with non-floated quantifiers it is usually possible to get wide scope, narrow scope seems to be preferred in most cases.[21] These patterns also appear to hold with the other MCPs to be presented below. As they are orthogonal to the main point we wish to make, however, we will restrict our attention in this paper to non-floated quantifiers such as those in (27).

We have shown that the potential allows word-internal scope of adjuncts and quantifiers just as the causative does, but what about the *jibun* binding and subject honorification facts presented in 2.3.3 and 2.3.4? It turns out that these arguments have no analogues involving the potential since it does not introduce a new argument comparable to the causee in a causative construction. We will find the same to be true for all of the MCPs to follow. Still, to the extent that they are comparable, the potential and the other MCPs introduced here appear to behave identically to the causative.

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[21] It is not entirely clear to me why this is the case, but it would seem to be the result of a conventional implicature related to the extensive use of demonstratives in normal conversation. Japanese maintains three distance distinctions in its demonstratives for deictic purposes, and furthermore uses these same demonstratives pervasively to maintain discourse structure. It would therefore be unusual to encounter a wide-scope usage of a quantifier without an accompanying demonstrative (e.g., to talk about particular books one would normally say something like 'these three books' or 'those three books'). The absence of a demonstrative, as in the examples above, may bias the listener towards the narrow-scope interpretation.

4.2 The desiderative: *-ta*

We now move on to another MCP, the desiderative, expressed by suffixation of the morpheme *-ta*. The desiderative is the equivalent of the English *I want to X*, where *X* is the state of affairs expressed by the base verb plus its arguments. Unlike the other morphemes considered so far, *-ta* attaches to a verb stem to form an *adjectival* rather than a new verb stem as with *-(s)ase* and *-(rar)e*. However, this difference in syntactic category is negligible because Japanese adjectivals have "built-in" copulas and can be employed in just the same way verbs are. Examples of typical desiderative sentences are given in (29). Note that 'RYK' in the glosses refers to the *ren'yookei* inflection of the verb. The RYK form is infinitival and frequently serves as the stem for derivational morphemes. It can also stand on its own to represent a kind of "coordination" of verbally-headed constituents.[22]

(29) a. watashi-wa hashir-i-ta-i
I-TOP run-RYK-DESID-NPAST
'I want to run'

b. watashi-wa kono hon-o/-ga yom-i-ta-i
I-TOP this book-ACC/-NOM read-RYK-DESID-NPAST
'I want to read this book'

There is another case alternation to note here: for transitive verbs *-ta* licenses the base verb's accusative-marked direct object to be optionally marked with *-ga*, just as we saw with the potential.

The morpheme *-ta* is specifically restricted in most instances to expressing desires of the speaker. This is a linguistic reflection of a facet of Japanese culture: it has traditionally been socially discouraged to make direct claims about the mental states of others. Comments about others are therefore usually made in a roundabout way by saying that a person "appears to" want to do something, or "seems to" like something. Japanese thus has a separate MCP for expressing the desires of others, formed by suffixing *-tagar* 'looks like (s)he wants to X' to a verb stem.[23]

Further note that *-ta* cannot be used in expressing a speaker's desire that someone else perform a particular action (as in '*I want Mary to lend me her car*'). Such desires are instead expressed via a periphrastic construction involving an adjective (*hoshii* 'to be

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[22] Alternatively we may simply analyze the desiderative as having two allomorphs, *-ta* and *-ita*, since the RYK form is identical to the verb stem in vowel-final cases and is constructed by adding *-i* to the verb stem in consonant-final cases. The traditional analysis, however, is that the verb appears in the RYK form before *-ta* and other morphemes such as *-niku* 'hard to', *-yasu* 'easy to', *-oe/owar* 'finish', *-naos* 're(do)', *-tsuzuke* 'continue' and many others. It is also the form seen in verbal compounds, such as *ukemi* 'passivity' (from *uke-* 'to receive (RYK)' and *mi* 'body') and *torishimaru* 'to control/direct' (from *tori-* 'to take (RYK)' and *shimaru* 'to close off')

[23] The situation is identical in Korean.

wanted') predicated of a nominalized sentence. ('*Mary's lending me her car is wanted (by me)'*).

Now we may consider the interaction of the desiderative with adjuncts and quantifiers. It will come as no great surprise by now that, despite appearing to be every much a lexical item as the causative, adjuncts and quantifiers can still get word-internal scope with desideratives.

Adjunct scope:

(30) a. watashi-wa Tookyoo-ni zettai-ni ik-i-ta-i
I-TOP Tokyo-to absolutely go-RYK-DESID-NPAST
Wide scope: *'I absolutely want to go to Tokyo'*
$absolutely'(want'(I', go'(I', Tokyo')))$

b. watashi-wa Tookyoo-ni hikooki-de ik-i-ta-i
I-TOP Tokyo-to airplane-INST go-RYK-DESID-NPAST
Narrow scope: *'I want to go to Tokyo by airplane'*
$want'(I', by'(airplane', go'(I', Tokyo')))$

Quantifier scope:

(31) a. watashi-wa [san-satsu-no hon]$_{NP}$-o yom-i-ta-i
I-TOP [3-volumes-GEN book]-ACC read-RYK-DESID-NPAST
Wide scope: *'There are three (particular) books which I want to read (...but no others.)'*
$\exists 3x|_{book'(x)}[want'(I', (read'(I', x))]$
Narrow scope: *'I want there to be three books that I read (...I don't want to read four.)'*
$want'(I', \exists 3x|_{book'(x)}[read'(I', x)])$

It appears that we have found yet another example of a causative-like MCP. Consequently, the initially strange properties of the causative are proving to be less and less unusual as we show how much of the grammar of Japanese they affect.

4.3 The negative: *-(a)na*

Sentences in Japanese are generally negated by suffixation of the negative morpheme *-(a)na* onto the matrix verb. The resulting MCP is categorially an adjectival like the desiderative. Typical negative sentences are shown in (32).

(32) a. watashi-wa hashir-ana-i
I-TOP run-NEG-NPAST
'I will not/do not run'

b. watashi-wa kono hon-o yom-ana-i
I-TOP this book-ACC read-NEG-NPAST
'I will not/do not read this book'

Negative MCPs straightforwardly admit word-internal adjunct and quantifier scope.

Adjunct scope:

(33) a. Taroo-wa hon-o hotondo yom-ana-i
Taroo-TOP books-ACC almost read-NEG-NPAST
Wide scope: *'Taroo almost never reads books'*
$almost'(not'(read'(Taroo', books')))$

b. Taroo-wa hon-o hayaku yom-ana-i
Taroo-TOP books-ACC quickly read-NEG-NPAST
Narrow scope: *'Taroo doesn't read books quickly'*
$not'(quickly'(read'(Taroo', books')))$

Quantifier scope:

(34) a. watashi-wa [san-satsu-no hon]$_{NP}$-o yom-ana-i
I-TOP [3-volumes-GEN book]-ACC read-NEG-NPAST
Wide scope: *'There are three (particular) books which I do not read (...I do read others.)'*
$\exists 3x|_{book'(x)}[not'(read'(I', x))]$
Narrow scope: *'There are not three books that I (will) read (...there are only two.)'*
$not'(\exists 3x|_{book'(x)}[read'(I', x)])$

On reflection it is not surprising that MCPs involving *-(a)na* are penetrable to adjunct and quantifier scope, as there are no generally equivalent syntactic constructions for expressing simple negation, and it would be shocking to find that Japanese could never get narrow scope with respect to negation.

4.4 Tough constructions: *-niku* & *-yasu*

The two most familiar "fronted" tough constructions in English, *X is hard to Y* and *X is easy to Y*, correspond in Japanese to MCPs built from the adjectival-forming suffixes *-niku* and *-yasu*. The examples in (35) are typical.

(35) a. (watashi-ni totte) kono hon-ga yom-i-niku-i
(I-DAT according to) this book-NOM read-RYK-HARD-NPAST
'This book is hard (for me) to read'

b. (watashi-ni totte) yakisoba-ga tsukur-i-yasu-i
(I-DAT according to) yakisoba-NOM make-RYK-EASY-NPAST
'Yakisoba is easy (for me) to make'

Along with promoting the embedded verb's object to matrix subject, an English tough adjective also arguably contributes an optional argument (the NP complement of *for*) corresponding to the embedded verb's subject. Such is not the case, however, in Japanese. The Japanese equivalent of the English *for* phrase[24] is the *-ni totte* adverbial, which is a general-purpose phrase meaning "according to" or "from the standpoint of". Thus, Japanese tough constructions must be viewed as strictly valence-reducing and not valence-shifting predicates like English tough constructions.

Finally, we see that tough constructions, too, are penetrable to adjunct and quantifier scope.

Adjunct scope:

(36) a. piano-ga totemo hik-i-niku-i
piano-NOM very play-RYK-HARD-NPAST
Wide scope: *'The piano is very hard to play'*
$very'(hard'(play'(pro, piano')))$

b. piano-ga joozu-ni hik-i-niku-i
piano-NOM skillfully play-RYK-HARD-NPAST
Narrow scope: *'The piano is hard to play skillfully'*
$hard'(skillfully'(play'(pro, piano')))$

Quantifier scope:

(37) a. [san-satsu-no hon]$_{NP}$-ga yom-i-niku-i
[3-volumes-GEN book]-NOM read-RYK-HARD-NPAST
Wide scope: *'There are 3 (particular) books which are hard to read (...others are easy.)'*
$\exists 3x|_{book'(x)}[hard'(read'(pro, x))]$
Narrow scope: *'Three books are hard to read (...at one sitting.)'*
$hard'(\exists 3x|_{book'(x)}[read'(pro, x)])$

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[24] If *for* is really a preposition and not a complementizer!

We have now amassed a body of evidence showing just how unremarkable the adjunct and quantifier scope facts surrounding the causative are.[25] The scope facts were only remarkable in the way they collide with our normal assumptions about what the interfaces between semantics, syntax and morphology should be like.

5 The role of compositionality

Had we stopped at the end of section 3 and not seen the data in section 4, then we might have had to grudgingly conclude that, while the common treatment of *-(s)ase* as a separate syntactic entity is unsatisfactory, the only technically viable alternative (MSI) is problematic in other ways. We noted in section 3.2.2 that MSI's treatment of adjuncts leaves much to be desired. Impressionistically, MSI's analysis also seems to introduce too much new grammar technology to be justifiably motivated solely by the causative. Given no additional empirical data, then, it might be better to accept a violation of the LIH for one isolated construction than to radically change the grammar framework in an attempt to maintain the LIH across the board.

Section 4 demonstrates, however, that the problematic phenomena extend far beyond the causative and are in fact present in a whole class of constructions. This new information should force us to reconsider our evaluation of past analyses. In particular, it swings the pendulum away from the LIH-violating analyses and towards MSI's analysis, since the new data provides a broader motivation for their LIH-preserving technology.

In this section, we will be focusing on a factor which, upon examination, can be seen to be at the root of both the abandonment of the LIH and MSI's questionable treatment of adjuncts. This factor is the principle of compositionality. We will show that it is impossible to adopt the LIH while simultaneously assuming strict compositionality *and* maintaining a syntactic distinction between adjuncts and arguments. Only two of these three assumptions may be made at a time. MSI takes the first two, while virtually all other analyses take the last two. We hope to show that it is really the first and third which should be adopted, meaning that we will propose an analysis of MCPs which gives up strict compositionality.

5.1 Compositionality vs. Lexical Integrity

First we will consider the conflicting demands that the assumptions of strict compositionality and of the Lexical Integrity Hypothesis put on the grammar writer. We start off by noting that, given the undeniable evidence for the lexical status of the causative, it seems clear that all analyses of the causative which treat *-(s)ase* as a syntactic entity violate the LIH. This includes all the "biclausal" and "hybrid" analyses presented in section

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[25] Although we have not been able to address the *jibun* binding or subject honorification facts directly.

3.[26] It may or may not be the case that all of these theoreticians consciously realized that they were violating the LIH. It seems likely, however, that if any of them had been able to produce two equally successful analyses, one assuming the LIH and one violating it, s/he would have chosen the analysis with the LIH. This is so because, other things being equal, it is always advantageous to keep the "boundaries" between the subparts of the grammar as clean and restrictive as possible, and the LIH is nothing more than an enforcement of a strict boundary between syntax and morphology.

The fact that the LIH has usually not been assumed in analyses of the causative should then be seen as a red flag of sorts, warning us that something subtle is amiss. This is particularly the case since most theoreticians do not explicitly argue against the LIH, but instead quietly introduce mechanisms which permit syntactic interference in the domain of morphology.

We propose that the reason the LIH is often not a feature of analyses of the causative is that the desire to preserve strict compositionality is given higher priority. Specifically, the LIH is ruled out because of the interaction between compositionality and the traditional assumption that adjuncts syntactically combine with their arguments via adjunction structures (transformational grammar) or the adjunct-head schema (HPSG) and semantically take scope over the entire content of their syntactic arguments.

This assumption is clearly the primary reason that *-(s)ase* has usually been claimed to be a separate syntactic element in the past. Strict compositionality requires that the meaning of a syntactic node be a function solely of the (entire) meanings of its immediate subnodes. Meanings are monolithic—their inner structures are not accessible to further manipulation. The analysis of verbal adjuncts as semantic functors taking the meanings of verbal nodes is highly restricted, then, if strict compositionality is assumed. In particular, adjuncts may not "reach inside" the meaning of a syntactic node which contains multiple predicates and modify only one.

This assumption, then, clashes with the LIH because, in order to capture the MCP data, it requires that both *-(s)ase* and the verb stem each have their own syntactic nodes. A single word consisting of multiple syntactic nodes is, however, directly prohibited by the LIH.

It turns out to be not only MCPs which face this dilemma, however. Dowty (1979) presents several classes of examples from English in which there is scope ambiguity with clearly monomorphemic verbs. Examples are given in (38).

(38) a. The Sheriff of Nottingham jailed Robin Hood for four years.

b. John closed the door again.

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[26] This is arguable in the case of Kitagawa's and Gunji's analyses, as both interleave morphology and syntax. It is not clear that either truly has a division between morphology and syntax at all, and so the nature of the interface between them is cloudy.

In (38a) there are two possible interpretations, one in which the act of jailing took four years and one in which the jailing was more or less instantaneous, but Robin Hood's incarceration lasted for four years. In the latter interpretation the PP *for four years* scopes into the monomorphemic verb *jail*, giving a semantics along the lines of

(39) $\textbf{CAUSE}'(s, \textbf{for-four-years}'(\textbf{BE-IN-JAIL}'(r)))$

where *jail* is taken to be representable as

(40) $\lambda y.\lambda x.\textbf{CAUSE}'(x, \textbf{BE-IN-JAIL}'(y))$

Similarly, in (38b) we have *again* taking scope inside of *close* under the reading in which the door has been closed in the past, but John has never before done the closing. Here we have something like

(41) $\textbf{CAUSE}'(j, \textbf{again}'(\textbf{BE-CLOSED}'(d)))$

Matsumoto (1996) acknowledges these examples but downplays them as very unusual and highly restricted, as only a small class of adverbs can get multiple scopes when modifying the verbs Dowty talks about. While Matsumoto appears to be correct in his characterization, he is nonetheless not justified in simply ignoring the phenomenon, since it is clearly not something as restricted as an idiom. Dowty's examples are productive within a certain sphere. In any case, the verbs in these examples cannot, without reverting to something like Generative Semantics, be argued in any reasonable way to be analyzable as multiple syntactic nodes. Therefore, some mechanism that does not rely on syntactic nodes as domains for adjunct/quantifier scope must in any case be devised. Through such a mechanism we could maintain the LIH in the morphologically complex cases as well.

5.2 Compositionality vs. the adjunct/argument distinction

MSI's approach is the only past analysis of the causative which avoids the problems with the LIH noted in the previous section. However, the way in which MSI maintain the LIH introduces other problems. Recall that it was the interaction of compositionality with the traditional syntactic structure for adjuncts which led to the abandonment of the LIH in other past approaches. MSI's way around this is to give a non-traditional treatment of adjuncts (the Adjunct Addition Lexical Rule (AALR) described in section 3.2.2) which allows the LIH to be preserved without clashing with compositionality. The result of this non-traditional treatment is that verbal adjuncts become syntactically indistinguishable from verbal arguments. We hope to show in this section that this is an undesirable result.

To understand MSI's motivation for treating adjuncts as complements, consider the task they faced in attempting to avoid the problems of the previous section. They are explicitly committed to the LIH, meaning that MCPs for them are single syntactic nodes. They also assume strict compositionality, which means that adjuncts may not "reach inside" the meanings of fully-formed MCPs to get narrow scope. Their only course of action, then, is to let adjuncts get narrow scope by combining with the verb stem before *-(s)ase* and the other suffixes have been attached. This commits them to handling adjunct scope in the lexicon, via lexical rules or similar mechanisms. But a verb which has been "pre-modified" in the lexicon cannot be used in a syntactic structure without the presence of an adjunct to flesh out the placeholder contributed by the AALR. This requirement is tantamount to subcategorization. Adverbial modification, then, moves from being a syntactically optional process to being a lexically optional but syntactically obligatory process.

The idea of collapsing the syntactic treatments of adjuncts and arguments has gathered steam in the HPSG literature over the last half decade. The general sense seems to be that the initially rather shocking idea is actually quite intuitive and makes the analyses of a number of constructions more straightforward. MSI argues, along with Abeillé & Godard (1994), van Noord & Bouma (1994) and Kim & Sag (1995) that lexical rules such as the AALR are merely the HPSG analogues of the harmless functor/argument-reversal type-raising rules in the Lambek Calculus and other more sophisticated categorial systems. Given two adjacent categories A/B and B, for instance, such a rule might raise the argument B to the type (A/B)\A in order to make it into the functor. Such rules provably never alter the set of strings which can be generated by a particular categorial grammar, nor the semantics assigned to those strings.

The reality, however, is that phrase structure grammar is not as parallel to categorial grammar as proponents of the adjuncts-as-arguments approach would have us believe. There are a number of syntactic phenomena which are sensitive specifically to the distinction between adjuncts and arguments, and it is unclear how these phenomena could be captured in a framework which neutralizes this distinction. We present several cases which appear to be problematic for any adjuncts-as-arguments analysis.

5.2.1 Lasnik & Saito (1984), Fukui (1988)

One distinction between adjuncts and arguments can be seen in the behavior of the Japanese word *naze* 'why'. First consider the following two questions.

(42) a. Taroo-ga nani-o te-ni ire-ta no
Taroo-NOM what-ACC obtain-PAST QUES
'What did Taroo obtain _?'

b. Taroo-ga naze sore-o te-ni ire-ta no
Taroo-NOM why that-ACC obtain-PAST QUES
'Why did Taroo obtain that (thing) _?'

These show that, unsurprisingly, Japanese allows question words to appear in simple sentences both as verbal arguments and as verbal adjuncts. The situation changes, however, when we embed the sentences in (42) inside complex NPs. Lasnik & Saito (1984) and Fukui (1988) both discuss such cases. Lasnik & Saito (1984) give the following contrast:

(43) a. [$_{NP}$ [$_{S'}$ Taroo-ga nani-o te-ni ire-ta] koto]-o sonnani okotteru no
Taroo-NOM what-ACC obtain-PAST fact-ACC so much be angry-NPAST QUES
Lit., *'What are you so angry about the fact that Taroo obtained _?'*

b. *[$_{NP}$ [$_{S'}$ Taroo-ga naze sore-o te-ni ire-ta] koto]-o sonnani okotteru no
Taroo-NOM why that-ACC obtain-PAST fact-ACC so much be angry-NPAST QUES
Lit., *'Why are you so angry about the fact that Taroo obtained that (thing) _?'*

Here we see that the argument question word *nani* 'what' can be accessed by a higher verb from inside a complex NP, while the adjunct *naze* cannot. In an adjuncts-as-complements analysis, it is unclear how this distinction would be captured, short of somehow tagging complements which originated as adjuncts and conditioning grammaticality in these cases on the absence of an "adjunct tag".

5.2.2 Yamashita (1992)

Yamashita (1992) presents a set of sentences which demonstrate that extraction from relative clauses is restricted to verbal arguments in Japanese.

(44) a. John-ga [[kodomo-ga batto-de garasu-o wat-ta] to] nagei-ta
John-NOM child-NOM bat-INST glass-ACC broke COMP regret-PAST
'John regretted that the child broke the glass with the bat'

b. [[John-ga [[kodomo-ga batto-de e_i wat-ta] to] nagei-ta] garasu$_i$]-wa taka-katta
John-NOM child-NOM bat-INST e_i broke COMP regret-PAST glass$_i$-TOP costly-PAST
'The glass that John regretted that the child broke with the bat was expensive'

c. [[John-ga [[e_i batto-de garasu-o wat-ta] to] nagei-ta] kodomo$_i$]-wa kare da
John-NOM e_i bat-INST glass-ACC broke COMP regret-PAST child$_i$-TOP him COP
'He's the child that John regretted broke the glass with the bat'

d. *[[John-ga [[kodomo-ga e_i garasu-o wat-ta] to] nagei-ta] batto$_i$]-wa kore da
John-NOM child-NOM e_i glass-ACC broke COMP regret-PAST bat$_i$-TOP this COP
'This is the bat that John regretted that the child broke the glass (with)'

In (44a), we have a biclausal sentence involving a sentential complement containing three NPs, two of which (*kodomo* ‘child’ and *garasu* ‘glass’) are arguments of the embedded verb *watta* ‘broke’ and one of which (*batto* ‘bat’) is an instrumental adjunct. (44b,c) show that the verbal arguments may be extracted and made into complex NP heads, while (44d) shows that the adjunct may not be extracted in this way. Yet it is not the case that adjuncts cannot be extracted in general, as (45) shows.

(45) [[kodomo-ga e$_i$ garasu-o wat-ta] batto$_i$]-wa kore da
child-NOM e$_i$ glass-ACC broke bat$_i$-TOP this COP
‘This is the bat that the child broke the glass (with)’

Again, without some syntactic distinction between the three NPs in the embedded sentence in (44a) there would seem to be no way to express this contrast.

5.2.3 Principle C sensitivity to adjunct/argument distinction

Moving to English, the syntactic distinction between adjuncts and arguments can be demonstrated by examining the properties of cataphora. In both (46) and (47) below we see that R-expressions inside verbal complements cannot be coindexed with preceding pronouns in object positions, while R-expressions inside verbal adjuncts can.

(46) a. *You can’t tell them$_i$ that the twins$_i$ are being offensive.

b. You can’t say anything to them$_i$ without the twins$_i$ getting offended.

(47) a. *I told them$_i$ about the twins’$_i$ *birthday*.

b. I only get them$_i$ presents on the twins’$_i$ *birthday*.[27]

These data, while not from Japanese, still speak to the claim that collapsing the syntax of adjuncts and arguments does not change the expressive power of the grammar, as such a collapse seems to rob the binding theory of a distinction upon which it relies.

5.2.4 Kasper & Calcagno (1997)

Kasper & Calcagno (1997) present several criticisms of the adjuncts-as-arguments approach. Most relevant for our purposes here are two claims: (a) that parsing is complicated significantly by the addition of the AALR; and (b) that some linear order differences

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[27] Italics here represent contrastive stress.

between adjuncts and arguments are difficult or impossible to express when the syntactic distinction between them is erased.

We first consider the task of parsing a sentence using a grammar which handles all verbal adjuncts via the AALR. Assume that there are several verbal adjuncts present. In order to fit these into the parse, the modified verbs will have to undergo the AALR once for each of their associated adjuncts. But the AALR is a form of zero derivation, meaning that the phonological form of the verbs provides the parser with no information whatsoever as to how many times or even whether they have undergone the AALR. Consequently, the parser must scan the sentence searching for "leftover" constituents and trying to create places for them in the subcategorization frames of the verbs. Kasper & Calcagno note that there is in principle no bound on how far the parser might need to look. They illustrate this with the following sentence.

(48) Mike realized the fact that the Cubs were never going to win the World Series [at an early age].

In (48) the adjunct *at an early age* modifies the matrix verb *realized*, yet it is separated by a distance of 14 words, including two intervening verbs.

Contrast this process with the standard case in which an adjunct-head schema is used for each adjunct. Here there is no zero derivation, and so the phonological form of the words present completely determine their selectional properties (modulo lexical ambiguity). There may of course still be nondeterministic choices to be made about which of several possible verbs an adjunct should modify, but there will be no uncertainty as to the subcategorization frames of the verbs themselves.

This is not an indictment of the *feasibility* of parsing grammars containing the AALR, as the task of parsing a given sentence is clearly decidable. The issue lies in the dramatic increase in nondeterminism that the move to the AALR carries with it. From the parsing point of view, then, standard grammars are clearly preferable to grammars which merge the syntax of adjuncts and arguments.

We now move on to Kasper & Calcagno's argument that that adjuncts-as-arguments approach does not appear to be capable of handling some issues related to linear order. They first note that in sentences such as those in (49) verbal adjuncts in English can precede the verb with precisely the same meaning as when they follow the verb (and its complements).

(49) a. Everyone carefully painted an egg.

b. Everyone painted an egg carefully.

The adjuncts-as-arguments approach would have to devise an explanation for the fact that complements which originated as adjuncts can sometimes precede the verb, while "real" complements never can. Alternatively, if *carefully* were to be given different syntactic analyses in these two sentences, then the fact that their meanings are identical would need to be explained.

In connection with this, Kasper & Calcagno point out that verbs such as *treat* which subcategorize lexically for adverbs present real problems for the adjuncts-as-arguments approach. Consider the sentences in (50).

(50) a. Sandy treated/criticized her students harshly.

b. Sandy harshly *treated/criticized her students.

The verb *treat* subcategorizes for an adverb, while *criticize* does not. In (50a), then, both *her students* and *harshly* are "real" complements of *treat*, while *harshly* is added to the *criticize*'s COMPS list by the AALR. The end result, however, is that both verbs have identical COMPS lists of the form [COMPS <NP, ADVP>]. How then, can the contrast in (50b) be explained? Even if some mechanism for allowing adverbial complements to appear before the verb were devised, there is no obvious way for the grammar to distinguish between immobile, lexically selected adverbs and mobile, AALR-added adverbs, although the next section outlines an approach which may be able to handle this data.

5.2.5 A possible counterargument

Bouma *et al.* (to appear) (BMS) propose a modification of the basic AALR approach which seems at first glance to solve the preceding problems quite nicely. Building on the now-accepted separation of selectional properties into a set of VALENCE lists and an ARG(UMENT)-ST(RUCTURE) list (for lexical items), BMS introduces a third list, DEPS, which moderates the interaction of the previous two.

The DEPS list is canonically identical to the ARG-ST list, but may contain additional elements. These additional elements are interpreted as being selected by the head in a syntactic sense but not in a lexical sense. Adjuncts, then, appear on the DEPS list of the head they semantically modify, and by general principles, also on the COMPS list. Since they are not inherent lexical arguments of the head, however, they are absent from the ARG-ST list. What this means is that adjuncts can be treated as complements while at the same time being distinguishable from "true" complements. It then becomes technically possible to address the issues raised in sections 5.2.1, 5.2.2 and 5.2.3. BMS further make a distinction in English between verbal adjuncts which follow the verb they modify and those which precede it. The former are selected under their analysis, while the latter combine via the standard adjunct-head schema. This approach, then, neatly solves the serious problems raised in section 5.2.4 as well. It would seem, then, that an adjuncts-as-arguments approach may truly be viable and that our objections are misplaced.

There is, however, at least one further argument against treating adjuncts as arguments which appears to be impossible to explain away using BMS's approach.[28] Take a simple sentence such as the following:

(51) Kim found a solution in exactly two hours.

Since *in exactly two hours* is a postverbal adverbial in (51), BMS treat it as a complement of the verb *found*. Consider, then, the effect of replacing the simple verb phrase with a coordination:

(52) Kim discovered the problem, found a solution and posted her results in exactly two hours.

In this case *in exactly two hours* applies not to any of the conjuncts individually, but to the entire three-part event. This sentence is not problematic for the traditional view of adjuncts—*in exactly two hours* would simply combine with the syntactic node covering the coordinate structure in just the same way as it would combine with the VP *found a solution* in (51). BMS's approach, however, breaks down in the face of VP coordinate structures such as this.

The issue is that in a coordinate VP there is no DEPS list which can host an adverbial with scope over the entire VP. In (52) each of the three verbal heads have DEPS lists, but adding an adverbial to any of them would incorrectly give the adverbial narrow scope. Even if one were to assume a right node raising structure with the adverbial complement *in exactly two hours* simultaneously satisfying the subcategorization requirements of all three verbs, the semantics would still be wrong because predicating *in exactly two hours* of all three actions individually is not the same as predicating it of their conjunction.

One might then argue that, since BMS does not eliminate the adjunct-head schema from their system, (52) might in fact be analyzable as a traditional adjunction structure despite the uncomfortable similarity to (51). But even this approach is untenable because in BMS's system only adjuncts which appear on DEPS lists are extractable, and *in exactly two hours* is extractable, as shown below.

(53) a. In how much time did Kim discover the problem, find a solution and post her results _?

b. It was in exactly two hours that Kim discovered the problem, found the solution and posted her results _.

Any attempt to treat the problematic examples as adjunction structures, then, undermines their own claim that adjuncts in such structures cannot be extracted. This is a fundamental

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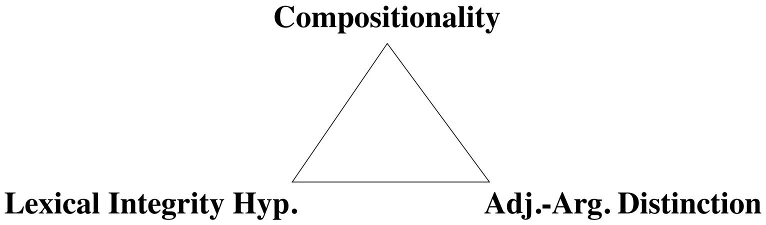
[28] Thanks to Bob Levine for pointing the following data out to me.

problem with BMS's approach, one that does not appear to be addressable without heavily modifying their theory, perhaps beyond recognition. We thus let our criticisms of the adjuncts-as-arguments approach stand.

5.3 A trio of mutually inconsistent assumptions

Let us now pause to take stock of what we have seen. Section 5.1 demonstrated how assuming strict compositionality and keeping a syntactic distinction between adjuncts and arguments forces one to give up the LIH when faced with data from MCPs. Section 5.2 showed that assuming strict compositionality and the LIH forces one to conflate adjuncts and arguments. Visually, then, we have a situation like that in (54).

(54)



These three assumptions are such that any two of them (any side of the triangle, so to speak) may be simultaneously adopted, but not all three. We have not yet shown that it is possible to construct an analysis which assumes the LIH and the adjunct/argument distinction but excludes compositionality. As hinted earlier, however, this sort of analysis is precisely what we will propose in section 6. Before doing so, though, we need to determine that it is actually compositionality that we wish to do away with.

We argued in the previous section that the adjunct/argument distinction is syntactically real, and that therefore MSI's AALR-based approach is unacceptable. We will be assuming in our analysis, then, the adjunct/argument distinction plus either the LIH or compositionality. We turn now to the choice between these last two. Both are constraints on the interfaces between subparts of the grammar. They are constraints of different types, however. The LIH enforces a strict boundary between syntax and morphology in order that the processes which go on in either subpart need have no relation whatsoever to those which occur in the other. Compositionality, on the other hand, enforces a lockstep coordination of syntactic and semantic processes. When viewed from this angle it is not immediately clear which is preferable, but there are several reasons to think that it is the LIH, and not compositionality, which should be maintained.

One argument for keeping the LIH is that a grammar without the LIH allows the syntax to overlap with the morphology by, in effect, permitting some "apples" (morphemes) to be treated along with the "oranges" (whole words) while leaving other morphemes to be handled by strictly morphological processes. This kind of overlap runs counter to the original motivation for making morphology and syntax separate subparts of the grammar, however. Word formation processes in a particular language do not in general follow the same rules that sentence formation processes in that language do. Japanese is a perfect example of this, being a strictly head-final language syntactically but a primarily head-initial language morphologically.

Note that in a grammar without compositionality there is no similar contamination of either syntax or semantics. The only apparent drawback is an unwelcomely large degree of freedom in associating syntactic structures with meanings. We may choose to impose other, less strict constraints on the syntax-semantics interface, however—giving up compositionality does not mean throwing up our hands completely. We will discuss possible alternatives to compositionality in section 7.

A second argument for the LIH over compositionality is that the LIH is grounded in directly-observable data (sequences of sounds), while compositionality is a constraint on two levels of abstraction. This is not to claim that syntax and semantics are not real in some relevant sense and that therefore compositionality is pointless. We simply note that the LIH enforces a closer tie to the empirical data than compositionality, as both the syntax and semantics offer "wiggle room" which may be exploited in order to maintain a one-to-one linkup. In our current situation, in which we must give up either the LIH or compositionality, we should thus be inclined to preserve the LIH.

Finally, an argument against keeping compositionality is the fact that, as Zadrozny (1994) and Lappin & Zadrozny (2000) show, the notion of compositionality itself is formally vacuous. Zadrozny (1994) proves that, given a syntax and a semantics (a set of meanings for all syntactically valid expressions), that semantics can be encoded compositionally. Zadrozny not only demonstrates this by, e.g., giving a compositional semantics for several English idioms, but he also gives a mathematical proof of his claims. This result means that compositionality is technically not a constraint on anything, despite over a century of intuitions to the contrary.

In section 7.1 we will discuss Zadrozny's proposal for a move from compositional semantics to what he calls "systematic" semantics. For now, however, we have enough evidence to conclude that the optimal approach for our MCP data is one which assumes the adjunct/argument distinction and the LIH but *not* compositionality. We now move on to presenting a simple example of such an approach.

6 A slightly non-compositional analysis

Our goal in this section will be to provide an example of how the MCP data can be captured by the admission of the smallest possible amount of non-compositionality. Although we are not aware of any specific problems, we are not necessarily advocating the following as the best overall analysis for Japanese. In particular, we do not consider the impact of our analysis on phenomena other than MCPs. We merely wish to demonstrate that allowing a small crack in compositionality is enough to make a straightforward and more satisfying treatment of MCPs possible.

6.1 The analysis

As noted previously, we take Manning *et al.* (1999) as the base of our analysis. Our strategy will be to replace the AALR with a standard treatment of adjuncts, thereby reinstating the adjunct/argument distinction. Our main task is then to provide a treatment of the word-internal adjunct/quantifier scope facts which does not violate the LIH. This will be accomplished via a highly restricted form of structured meanings.[29] In particular, we will be exploiting the fact that β-reduction in the λ-calculus is meaning-preserving and allowing reference to both reduced and unreduced λ-expressions in the semantics. For example, then, we will distinguish CONTENT values of the form $\lambda p[cause'(x, p)](run'(y))$ from those of the form $cause'(x, run'(y))$, even though the former β-reduces to the latter. The result of this change will be that in the unreduced case the internal structure of the complex predicate's semantics will be preserved to allow for word-internal modification or quantifier retrieval. Note that only unreduced λ-expressions of the form $\lambda p[\psi(p)](\cdot)$ where p is a variable over propositions (soas) are allowed. We do not provide for arbitrary λ-expressions.

The technical details of our restricted λ-calculus are straightforward. We simply replace all CONTENT values of type *psoa* with lists of elements of a new type, *psoa-abstract*, with appropriate features as in (55).

$$(55)\quad \begin{bmatrix} \textit{psoa-abstract} \\ \textsc{lambda}\ \textit{var(psoa)} \vee \textit{none} \\ \textsc{psoa}\ \textit{psoa} \end{bmatrix}$$

*psoa-abstract*s with LAMBDA values of type *psoa* represent λ-abstracts over *psoa*s, while those with LAMBDA equal to *none* are the equivalent of simple *psoa*s. A list of *psoa-abstract*s is interpreted as a chain of functional application. Thus (56) is the feature-structure encoding of the λ-expression $\lambda p[not'(p)](\lambda q[cause'(j, m, q)](run'(m)))$ corresponding to the semantics of *John-wa Mary-ni hashir-ase-na-i* 'John won't make Mary run'.

$$(56)\quad \left\langle \begin{bmatrix} \textsc{lambda}\ \boxed{1} \\ \textsc{psoa}|\textsc{nuc}\ \begin{bmatrix} \textit{not-rel} \\ \textsc{arg}\ \boxed{1} \end{bmatrix} \end{bmatrix}, \begin{bmatrix} \textsc{lambda}\ \boxed{2} \\ \textsc{psoa}|\textsc{nuc}\ \begin{bmatrix} \textit{cause-rel} \\ \textsc{causer}\ j \\ \textsc{causee}\ \boxed{3}\,m \\ \textsc{effect}\ \boxed{2} \end{bmatrix} \end{bmatrix}, \begin{bmatrix} \textsc{lambda}\ \textit{none} \\ \textsc{psoa}|\textsc{nuc}\ \begin{bmatrix} \textit{run-rel} \\ \textsc{runner}\ \boxed{3} \end{bmatrix} \end{bmatrix} \right\rangle$$

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[29] A structured meaning can be thought of as having two parts, a model-theoretic denotation and some record of how the expression in question was constructed. This is in contrast to standard Montagovian semantics, in which meanings preserve no such record. They were first explored by Lewis (1972) in the context of searching for a solution to problems arising from intensionality. See Cresswell (1985) for an overview.

The fully β-reduced expression $not'(cause'(j,m,run'(m)))$ would then be encoded as follows:

(57)
$$\left\langle \begin{bmatrix} \text{LAMBDA}\ \textit{none} \\ \text{PSOA}|\text{NUC} \begin{bmatrix} \textit{not-rel} \\ \text{ARG}|\text{NUC} \begin{bmatrix} \textit{cause-rel} \\ \text{CAUSER}\ j \\ \text{CAUSEE}\ \boxed{1}\, m \\ \text{EFFECT}|\text{NUC} \begin{bmatrix} \textit{run-rel} \\ \text{RUNNER}\ \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\rangle$$

Intermediate forms such as $\lambda p[not'(cause'(j,m,p))](run'(m))$ may also be represented in this fashion.

The utility of this encoding is that embedded *psoa*s may be easily accessed for the purposes of modification. A typical modifier in this setup has the following form.

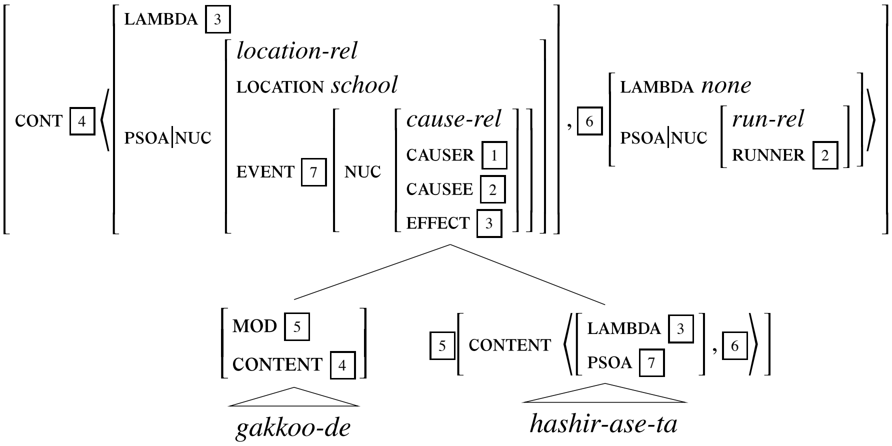
(58) **Typical modifier:**

$$\begin{bmatrix} \text{MOD} \begin{bmatrix} \text{CONTENT}\ \boxed{1} \circ \left\langle \begin{bmatrix} \text{LAMBDA}\ \boxed{2} \\ \text{PSOA}\ \boxed{3} \end{bmatrix} \right\rangle \circ \boxed{4} \end{bmatrix} \\ \text{CONTENT}\ \boxed{1} \circ \left\langle \begin{bmatrix} \text{LAMBDA}\ \boxed{2} \\ \text{PSOA}\ \mathsf{modify}\left(\boxed{3}\right) \end{bmatrix} \right\rangle \circ \boxed{4} \end{bmatrix}$$

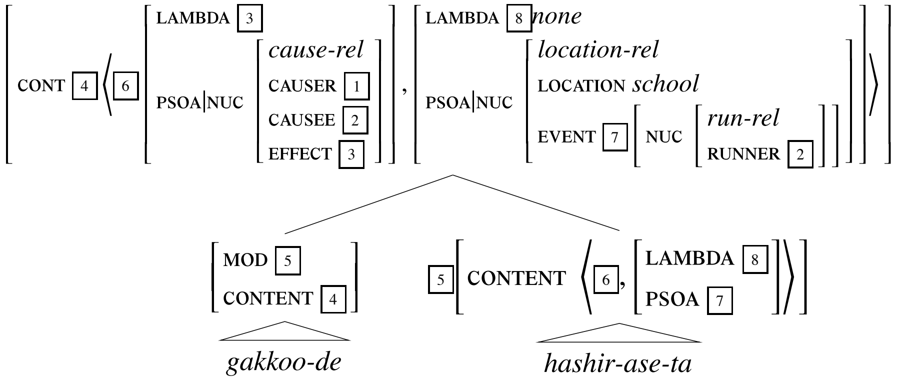
The effect of (58) is to allow the modifier to “pluck out” any *psoa* on its argument’s CONTENT list and modify it individually.

As a concrete example, take the ambiguous sentence *John-wa Mary-ni gakkoo-de hashir-ase-ta* ‘John made Mary run at school’. (59) shows the two possible CONTENT values resulting from the combination of the adjunct *gakkoo-de* with the verb *hashir-ase-ta*.

(59) a.



b.



(59a) corresponds to the wide-scope reading, while (59b) is the word-internal, narrow-scope reading.

Note that a lexical item need not undergo any form of derivation in order to have a "penetrable" (non-singleton) CONTENT list. While MCPs will get their CONTENT values this way, monomorphemic verbs subject to word-internal scope such as Dowty's examples from section 5.1 will have lexically-specified CONTENT lists of length two or more. The vast majority of verbs, however, will have singleton CONTENT lists.

We now consider quantifier scope. A slight modification to MSI's system is all that is needed to adapt it to our new architecture. Recall that MSI make reference to the Quantifier Amalgamation Constraint in (60) (=(22)).

(60) **MSI's Quantifier Amalgamation Constraint:**

$$\textit{stem} \Longrightarrow \begin{bmatrix} \text{ARG-ST} & \boxed{1} \\ \text{QSTORE} & \textsf{merge-quants}\left(\textsf{toplevel}\left(\boxed{1}\right)\right) \uplus \boxed{2} \ominus \boxed{3} \\ \text{NEW-QSTORE} & \boxed{2} \\ \text{CONTENT} & \begin{bmatrix} \text{QUANTS} & \textsf{order}\left(\boxed{3}\right) \end{bmatrix} \end{bmatrix}$$

Because CONTENT in our system is list-valued, we must modify (60) to make it type-compatible. Two possibilities present themselves. Either we apply all the retrieved quantifiers to the first element on the CONTENT list, or we allow for non-deterministic distribution throughout the entire list. While the second option might initially sound more attractive, it is in fact unnecessary because the other mechanisms in MSI's system already provide enough non-determinism to get all necessary interpretations. We thus take the simpler deterministic approach. This gives us the revised constraint in (61).

(61) **Revised Quantifier Amalgamation Constraint:**

$$\textit{stem} \Longrightarrow \begin{bmatrix} \text{ARG-ST} & \boxed{1} \\ \text{QSTORE} & \textsf{merge-quants}\left(\textsf{toplevel}\left(\boxed{1}\right)\right) \uplus \boxed{2} \ominus \boxed{3} \\ \text{NEW-QSTORE} & \boxed{2} \\ \text{CONTENT} & \left\langle \begin{bmatrix} \text{PSOA|QUANTS} & \textsf{order}\left(\boxed{3}\right) \end{bmatrix} \mid \boxed{4} \right\rangle \end{bmatrix}$$

The last necessary modification to MSI's analysis relates to the Causative Formation Lexical Rule (CFLR).[30] MSI directly embed the verb stem's CONTENT under the *cause-rel* contributed by *-(s)ase* , as shown in (62) (=(20)).

(62) **MSI's Causative Formation Lexical Rule (CFLR):**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4}\left\langle \text{PRO}_j | \boxed{5}\right\rangle \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \text{causative-morph}\left(\boxed{1}\right) \\ \text{SUBJ} & \left\langle \boxed{6}\text{NP}_i\right\rangle \\ \text{COMPS} & \left\langle \boxed{7}\text{NP}_j | \boxed{5}\right\rangle \\ \text{ARG-ST} & \left\langle \boxed{6}, \boxed{7}, \boxed{4}\textit{list}\right\rangle \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{CONTENT}|\text{NUC} & \begin{bmatrix} \textit{cause-rel} & \\ \text{ACTOR} & i \\ \text{UNDERGOER} & j \\ \text{EFFECT} & \boxed{2} \end{bmatrix} \end{bmatrix}$$

Our only modification is to make the CONTENT of the causative resulting from application of this rule penetrable to later modification. The revised lexical rule is as follows.

(63) **Revised Causative Formation Lexical Rule (CFLR):**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4}\left\langle \text{PRO}_j | \boxed{5}\right\rangle \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \text{causative-morph}\left(\boxed{1}\right) \\ \text{SUBJ} & \left\langle \boxed{6}\text{NP}_i\right\rangle \\ \text{COMPS} & \left\langle \boxed{7}\text{NP}_j | \boxed{5}\right\rangle \\ \text{ARG-ST} & \left\langle \boxed{6}, \boxed{7}, \boxed{4}\textit{list}\right\rangle \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{CONTENT} & \left\langle \begin{bmatrix} \text{LAMBDA} & \boxed{8} \\ \text{PSOA}|\text{NUC} & \begin{bmatrix} \textit{cause-rel} & \\ \text{ACTOR} & i \\ \text{UNDERGOER} & j \\ \text{EFFECT} & \boxed{8} \end{bmatrix} \end{bmatrix} | \boxed{2} \right\rangle \end{bmatrix}$$

This is the full extent of the modifications needed to restore the adjunct/argument distinction to MSI's analysis. To conclude our presentation we give lexical rules for generating several of the MCPs not dealt with by MSI.

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[30] We again remind the reader that MSI do not actually use lexical rules, but instead assume a complex type-driven morphology driven by multiple inheritance. Our lexical rule presentation can be straightforwardly adapted to their system.

(64) **The Potential Formation Lexical Rule:**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4}\left\langle \text{NP}_i \middle| \boxed{5} \right\rangle \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \text{potential-morph}(\boxed{1}) \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4} \\ \text{CONTENT} & \left\langle \begin{bmatrix} \text{LAMBDA} & \boxed{6} \\ \text{PSOA}|\text{NUC} & \begin{bmatrix} \textit{capable-rel} & \\ \text{ABLE} & i \\ \text{ACTION} & \boxed{6} \end{bmatrix} \end{bmatrix} \middle| \boxed{2} \right\rangle \end{bmatrix}$$

(65) **The Negative Formation Lexical Rule:**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4} \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \text{negative-morph}(\boxed{1}) \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4} \\ \text{CONTENT} & \left\langle \begin{bmatrix} \text{LAMBDA} & \boxed{5} \\ \text{PSOA}|\text{NUC} & \begin{bmatrix} \textit{not-rel} & \\ \text{ARG} & \boxed{5} \end{bmatrix} \end{bmatrix} \middle| \boxed{2} \right\rangle \end{bmatrix}$$

(66) **The Desiderative Formation Lexical Rule:**

$$\begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{PHON} & \boxed{1} \\ \text{CONTENT} & \boxed{2} \\ \text{QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4}\left\langle \text{NP}_i \middle| \boxed{5} \right\rangle \end{bmatrix} \Longrightarrow \begin{bmatrix} \text{PHON} & \text{desiderative-morph}(\boxed{1}) \\ \text{NEW-QSTORE} & \boxed{3} \\ \text{ARG-ST} & \boxed{4} \\ \text{CONTENT} & \left\langle \begin{bmatrix} \text{LAMBDA} & \boxed{6} \\ \text{PSOA}|\text{NUC} & \begin{bmatrix} \textit{want-rel} & \\ \text{WANTER} & i \\ \text{WANTED-SOA} & \boxed{6} \end{bmatrix} \end{bmatrix} \middle| \boxed{2} \right\rangle \end{bmatrix}$$

These are nothing more than simple variants of the CFLR.

Next we consider some similarities this maximally-simple analysis bears to two other approaches to the syntax/semantics interface, one general and one specifically designed for MCPs.

6.2 Parallels to Minimal Recursion Semantics

Minimal Recursion Semantics (MRS) is a flat semantic representation developed in Copestake *et al.* (1995, 1999), primarily for use with HPSG. MRS was originally designed for practical reasons, motivated by the desire for a semantic framework with the properties of computational tractability and underspecifiability. Despite its applied origins, however, it appears to be a sufficiently expressive framework for purely theoretical work as well.

MRS is "flat" in the sense that no embedding of any kind is permitted. Instead of embedding, MRS makes use of "handles" which, as their names suggest, allow semantic elements to "grab onto" other elements. This opens the door to underspecification of scopal relations, since quantifiers, their restrictions and their nuclear scopes are all on the same par, differentiated only by how they are threaded together via their handles. As an example, consider the following simplified mimimal recursion structure for the sentence *Every dog chases some white cat*.[31]

(67) $$\left\langle \begin{bmatrix} \textit{every-rel} \\ \textsc{hndl}\ \boxed{1}\textit{handle} \\ \textsc{bound-var}\ \boxed{2} \\ \textsc{restr}\ \boxed{3} \\ \textsc{body}\ \textit{handle} \end{bmatrix}, \begin{bmatrix} \textit{dog-rel} \\ \textsc{hndl}\ \boxed{3} \\ \textsc{inst}\ \boxed{2} \end{bmatrix}, \begin{bmatrix} \textit{chase-rel} \\ \textsc{hndl}\ \boxed{4} \\ \textsc{arg}1\ \boxed{2} \\ \textsc{arg}2\ \boxed{5} \end{bmatrix}, \begin{bmatrix} \textit{some-rel} \\ \textsc{hndl}\ \boxed{6} \\ \textsc{bound-var}\ \boxed{5} \\ \textsc{restr}\ \boxed{7} \\ \textsc{body}\ \textit{handle} \end{bmatrix}, \begin{bmatrix} \textit{white-rel} \\ \textsc{hndl}\ \boxed{7} \\ \textsc{inst}\ \boxed{5} \end{bmatrix}, \begin{bmatrix} \textit{cat-rel} \\ \textsc{hndl}\ \boxed{7} \\ \textsc{inst}\ \boxed{5} \end{bmatrix} \right\rangle$$

This structure simultaneously encodes both possible scopes for this sentence. This is so because the BODY features of both quantifiers are uninstantiated, meaning that (subject to some restrictions) they may be interpreted as taking any of the other handles in the list. If *every* were to be unambiguously given wide scope, then the structure in (67) would be instantiated as in (68).

(68) $$\left\langle \begin{bmatrix} \textit{every-rel} \\ \textsc{hndl}\ \boxed{1}\textit{handle} \\ \textsc{bound-var}\ \boxed{2} \\ \textsc{restr}\ \boxed{3} \\ \textsc{body}\ \boxed{6} \end{bmatrix}, \begin{bmatrix} \textit{dog-rel} \\ \textsc{hndl}\ \boxed{3} \\ \textsc{inst}\ \boxed{2} \end{bmatrix}, \begin{bmatrix} \textit{chase-rel} \\ \textsc{hndl}\ \boxed{4} \\ \textsc{arg}1\ \boxed{2} \\ \textsc{arg}2\ \boxed{5} \end{bmatrix}, \begin{bmatrix} \textit{some-rel} \\ \textsc{hndl}\ \boxed{6} \\ \textsc{bound-var}\ \boxed{5} \\ \textsc{restr}\ \boxed{7} \\ \textsc{body}\ \boxed{4} \end{bmatrix}, \begin{bmatrix} \textit{white-rel} \\ \textsc{hndl}\ \boxed{7} \\ \textsc{inst}\ \boxed{5} \end{bmatrix}, \begin{bmatrix} \textit{cat-rel} \\ \textsc{hndl}\ \boxed{7} \\ \textsc{inst}\ \boxed{5} \end{bmatrix} \right\rangle$$

Our analysis of MCPs represents, in effect, a highly conservative MRS-style approach. Due to their flat structures, both approaches allow limited non-compositional access to embedded semantic material. MRS, however, is a much greater departure from conventional semantics than our approach, for several reasons. First, unlike MRS, our approach does not rule out semantic embedding. MRS is thus more extreme in *requiring* flat semantic representations. Second, relative order is crucially important in our lists, while it is irrelevant for MRS—list data structures are used only as substitutes for multisets. Also, because the order of our elements completely determines their intended interpretation, there is no need for anything corresponding to handles. Finally, our system does not permit the underspecification of scopal relations as MRS does.

Our approach is thus a less radical departure from compositional semantics than MRS, the development of which is actively progressing within the mainstream HPSG community. This suggests that many of the ideas in this paper, while rarely discussed explicitly, are not incompatible with ideas found in other current research.

6.3 Parallels to Matsumoto (1996)

We briefly note an apparent similarity of our approach to Matsumoto's (1996) treatment of causatives. Matsumoto groups causatives into a number of categories, among them

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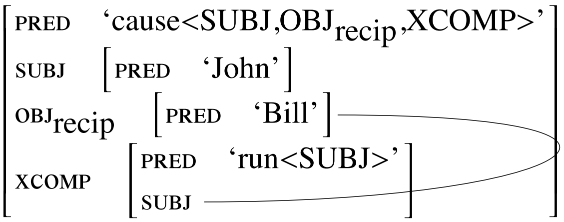
[31] This represents only the LZT (LISZT) value of the structure. It omits the top handle, the local top handle and the handle constraints.

"persuasive" and "coercive" causatives. He presents data which shows, among other things, that word-internal adjunct scope is much more restricted in coercive causatives than it is in persuasive causatives. In his most explicit example, for the pair of causatives in (69) he gives the f-structures in (70).

(69) a. John-wa Biru-ni hashir-ase-ta **[persuasive causative]**
John-TOP Bill-DAT run-CAUSE-PAST
'John made Bill run'

b. John-wa Biru-o hashir-ase-ta **[coercive causative]**
John-TOP Bill-DAT run-CAUSE-PAST
'John made Bill run'

(70) a.



b.

$$\begin{bmatrix} \text{PRED} & \text{`cause-to-run<SUBJ,OBJ>'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{`John'} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{`Bill'} \end{bmatrix} \end{bmatrix}$$

To encode the fact that persuasive causatives readily allow word-internal adjunct scope, Matsumoto gives them "biclausal" f-structures, while coercive causatives get "monoclausal" f-structures in which some form of predicate fusion has occurred. This is highly reminiscent of our "penetrable" and "non-penetrable" CONTENT lists.

Although Matsumoto's formal treatment is not spelled out in enough detail to make any sort of systematic comparision to our approach, this example does suggest that his thinking is along the same lines as ours. Thus, we see again that our style of analysis is not fully unprecedented.

7 What replaces compositionality?

We have argued that compositionality, at least in its strictest form, is an undesirable feature of any analysis of MCPs in Japanese. This claim is not made lightly. Most formal semanticists have historically been loath to so much as consider abandoning strict compositionality, the main reason being that there is no other clear candidate for a constraint on the syntax/semantics interface. Our claim thus comes with the responsibility of offering alternatives to compositionality, since it is clearly not the case that syntax and semantics are entirely independent of each other. There must be a constraint or constraints linking them in some fashion.

While we will draw no strong conclusions in this section, we would like to present two possible alternative constraints on the syntax/semantics interface. Determining which constraint is the best is far beyond the scope of this paper.

7.1 Zadrozny's (1994) notion of "systematicity"

As mentioned in section 5.3, Zadrozny (1994) presents a proof of the formal vacuity of compositionality as a constraint on the syntax/semantics interface. That is, given any grammar and any set of meanings to be assigned to expressions generated by that grammar, a function may be constructed which assigns the meanings compositionally. This result initially appears to imply that theoreticians since Frege have been fundamentally mistaken about the need for compositionality.

It turns out, however, that compositionality becomes non-vacuous if we shift our conception of it and take a compositional analysis to be not only one which assigns unique meanings to syntactic items based solely on the arrangement and meanings of their parts, but one which in addition requires the meaning assignment function to be of a certain class F of homomorphisms from the syntax to the semantics. Zadrozny refers to homomorphisms which belong to F as *F-systematic*. This move makes it possible to distinguish between syntax/semantics pairs which have a compositional (systematic) encoding and those which do not.

While Zadrozny's work clears up the notion of compositionality, it raises the new question of what class F of homomorphisms from syntax to semantics is appropriate for human language. Zadrozny offers some speculation about possible values for F, but the question is largely left for future research.

Our analysis as it stands will fail to be F-systematic under any conception of F, as our syntax/semantics relation fails to be a function (and hence a homomorphism). This can be seen in cases such as the *John made Mary run at school* examples in (59). In order to make systematicity relevant to our approach, we would have to move to something like set-valued meanings, where all scoping options are simultaneously available for ambiguous expressions. In the next section, though, we present another possible approach which is compatible with our analysis.

7.2 Principle of "Naturalness"

We sketch here a methodological principle of grammar architecture we refer to as "Naturalness" which addresses the issue of replacing compositionality but is more general, touching all aspects of linguistic analysis. Naturalness is a principle of common sense which lays constraints on all inter-module interfaces within a grammar. The basic idea is that the interfaces between modules should be as straightforward and as restrictive as possible *without* being so restrictive that they require locally unmotivated distinctions to be made or locally motivated distinctions to be erased in certain areas of the grammar in order to permit particular analyses in other areas. In other words, the internal organization of a particular module of the grammar should never be made secondary to the interfaces which link that module to other modules.

To illustrate, recall from section 5.1 that most analyses of the causative are forced to treat *-(s)ase* as a lexical item because of the (usually implicit) desire to maintain compositionality and the adjunct/argument distinction. This is a non-Natural state of affairs, because a morphology-internal matter (whether or not *-(s)ase* is a bound or free morpheme) is subjugated in these analyses to the desire to maintain a compositional syntax/semantics interface. Similarly, recall from section 5.2 that MSI are forced to abandon the adjunct/argument distinction in order to maintain compositionality and the LIH. This is also non-Natural because the issue of whether or not adjuncts and arguments pattern with each other is a syntax-internal question, but the decision to conflate them is made primarily in order to maintain compositionality.

Our analysis, on the other hand, is fully Natural. By adopting the LIH we enforce a Natural relationship between the morphology and the syntax. By preserving the adjunct/argument distinction via a loosening the syntax/semantics interface we respect the syntactic nature of the distinction. The focus therefore shifts in this conception of grammar architecture from maintaining restrictive interfaces at all costs to delineating appropriate modules, working out the most appropriate internal structure for those modules, and then finally designing interfaces which are as restrictive as possible.

Note that Naturalness suffers from the same problem that Zadrozny's "systematicity" does, in that the notion of an interface which is "as restrictive as possible" requires significant elaboration. We will, however, not address the issue here, leaving the task to future research.

8 Conclusions and further research

In this paper, we have reconsidered the decades-old debate over the proper treatment of Japanese causatives and brought new evidence to bear on the issue, namely, the existence of a much larger class of MCPs with properties like the causative. We have examined the conflicting demands placed on the grammar writer by the various possible methodological assumptions and have taken the unprecedented and near-heretical step of coming out against compositionality. We have given an existence proof of a minimally non-compositional analysis and noted that it bears certain similarities to other current linguistic research, suggesting that it is not as radical as it might initially appear. Finally, we offered some speculation as to what grammatical constraint might replace compositionality, suggesting that the notion of Naturalness might be the answer.

The path from here, as we see it, is to seek out constructions with difficult properties like those of Japanese MCPs in other languages. (A good place to start would be the syntactically similar Korean.) Once identified, it should be determined whether architectural principles such as compositionality have colluded to produce non-Natural standard analyses of these constructions. If so, new, Natural analyses should be proposed. If enough of these problematic constructions were identified and reanalyzed, there may emerge a higher understanding of how grammars should be structured. At the very least, it would be a way of illuminating the effect of the principle of Naturalness and determining whether or not it is a worthy replacement for compositionality.

We hope to have shown here that questioning compositionality is not always a destructive activity, but may sometimes help to illuminate otherwise puzzling phenomena. The resolution to other unresolved analytical debates may lie, like this one, just over the fence that separates compositional approaches from the "forbidden" non-compositional ones. A fresh attitude towards compositionality may be all that is necessary to breathe some new life into otherwise dead areas of linguistic analysis.

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ARGUMENT COMPOSITION AND LINEARIZATION: KOREAN COMPLEX PREDICATES AND SCRAMBLING

Sun-Hee Lee

Abstract

This paper deals with the formation of complex predicates and some interesting scrambling facts in Korean. First, we extend the notion of complex predicates to include various noun-verb combinations by providing syntactic and semantic evidence. Within the HPSG framework, we then propose a general schema based on argument composition, which can be used for different types of complex predicates. Furthermore, in opposition to Chung (1998)'s approach using argument composition for scrambling phenomena, we argue that linearization constraint is better to account for various permutation possibilities in Korean.[1]

1 Introduction

Within the framework of Head-driven Phrase Structure Grammar, there have been various proposals on complex predicate (or CP) constructions in Korean; Chung (1998),

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[1] I would like to thank Carl Pollard, Bob Kasper, and Bob Levine for their valuable comments and help. All errors and shortcomings are, of course, mine.

Lee, Sun-Hee. 2001. Argument Composition and Linearization. *OSUWPL* 56, 53–78.

Bratt (1996), and Ryu (1993) analyzed each different kinds of CP construction. Chung (1998) proposed that an auxiliary verb and its preceding verb form a CP. Bratt (1996) extended the notion of a CP to combinations of a verb and the causative *hata*. Instead of verbal complexes, Ryu (1993) analyzed the combination of a noun and the light verb *hata*, so-called verbal noun construction as a CP. While maintaining different points of view in classifying CPs, all three researches utilized argument composition as the licensing mechanism of CPs.[2]

In this paper, we will focus on the formation of noun-verb CPs by extending Ryu's (1993) notion of verbal noun constructions. In requiring syntactic arguments, a verbal noun[3] functions as the main verbal or adjectival predicate of a sentence in Korean. A verbal noun combines with a small group of verbs, which lack the semantic properties normally associated with main predicates. In particular, those verbs have traditionally been called light verbs or function verbs. We refer to various combinations of a verbal noun and a verb in terms of noun-verb CPs as in (1)

(1) John-i ku saken-ul cosa-lul ha-yess-ta
John-Nom that accident-Acc investigation-Acc do-Past-Ending
'John did an investigation of that accident.'

In example (1), *cosa-lul* (investigation-Acc) and *hata* form a single unit at the level of syntax even though they do not morphologically form a word. This combination exhibits some distinctive properties as one syntactic unit, so the notion of CPs can be applied to include these noun-verb complexes in Korean. This issue will be discussed in section 2.

In this study, we will provide an analysis of Korean CPs by presenting a revised version of Chung's (1998) Gov-Head schema. The schema will utilize argument composition mechanism as in Chung (1998), who extends its notion to license various word order facts. We, however, oppose to Chung's flat structure approach based on argument composition. Instead we will argue that a linearization model provides a more systematic explanation for scrambling facts in Korean. We will specify how the domain union of linearization theory based on Reape (1996) can be used for various scrambling phenomena not only within simplex clauses but also within complex clauses with an embedded clause.

The organization of this paper is as follows. In section 2, we briefly compare the previous analysis of Korean CPs and discuss various characteristics of noun-verb CPs. In section 3, we will explain the formation of CPs by providing a revised Gov-Head schema, which percolates the VALENCE feature of a noun into a higher phrasal category. This schema includes verbal CPs as well as noun-verb CPs. Section 4 deals with scrambling phenomena in Korean within a linearization model. A linearization approach provides a more succinct answer for both sentence internal and long-distance scrambling than Chung's (1998) argument composition approach.

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[2] Argument composition was proposed by Hinrichs & Nakayama (1994).

[3] A great amount of verbal nouns in Korean originally come from Chinese or some foreign languages. For example, English verb "study" is adopted in Korean by taking the format of "study-Acc + do"

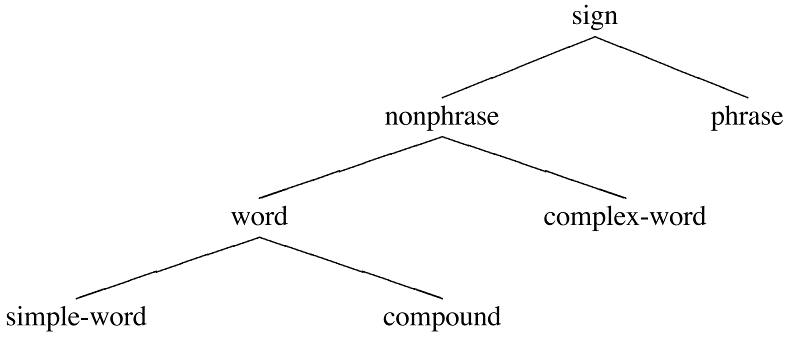
2 Complex Predicate Constructions

2.1 Formation of CPs

In general, the term CP has been used in reference to the broad range of predicates including both syntactic combinations of words and morphological combinations of a stem with various affixes. In this paper, however, we restrict the use of the term , CP to the former. A CP is considered to have a single argument structure and to work as a single unit at the syntactic level, even though its components do not morphologically form a single word.

Focusing on the lexical compositional properties of CPs, Chung (1998) and Bratt (1996) discuss the formation of the Korean verbal complex within the HPSG framework. Chung (1998) analyzes certain auxiliary verb constructions as CPs using argument composition, as proposed by Hinrichs & Nakayama (1994). He introduces a new sort, *non-phrase*, with two subsorts *word* and *complex-word* into the sort hierarchy as in (2), which subsumes various kinds of CPs.

(2)



Bratt (1996) argues that a combination of a verb and the causative verb *hata* form a CP like an auxiliary verb construction. Even though she uses argument composition, her analysis of CPs is different from Chung (1998) as follows: First, Chung does not include the causative *hata* construction[4] among the verbal complexes. Instead he analyzes the dative causative *hata* constructions as VP-complement structures and argues that they have flat structures derived by a lexical rule as follows.[5]

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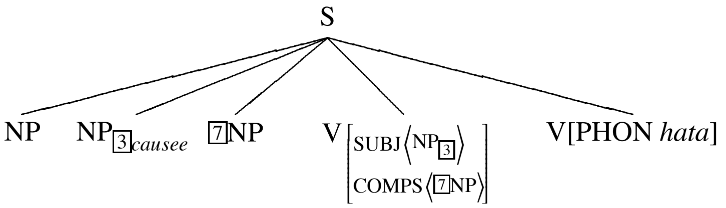
[4] There are two types of the causative *hata* in Korean; the first takes an NP with the accusative case {-lul} while the latter takes an NP with the dative case {-eykey}. Besides the causative verb *hata* constructions, the same form *hata* works as a light verb, which combines with a verbal noun. We will see these examples in section 2.2. The verb *hata* works as a proform for general verbs like the verb *do* in English.

[5] We slightly modify here some of the notations in the lexical rule that Chung (1998) provides. Note that Chung considers *hata* to be a control verb but not a component of a CP.

(3)
$$\begin{bmatrix} \text{CAT}\,|\,\text{VAL} & \begin{bmatrix} \text{SUBJ}\langle \text{NP}_{\boxed{1}} \rangle \\ \text{COMPS}\ \boxed{2}\langle \text{NP}_{\boxed{3}} \rangle \oplus \left\langle \text{VP}\begin{bmatrix}\text{SUBJ}\langle \text{NP}_{\boxed{3}}\rangle\end{bmatrix} : \boxed{4} \right\rangle \end{bmatrix} \\ \text{CONT}\ \boxed{5} & \begin{bmatrix} \text{RELN x} \\ \text{ARG1}\ \boxed{1} \\ \text{ARG2}\ \boxed{3} \\ \text{SOA-ARG}\ \boxed{4}\end{bmatrix}\end{bmatrix} \Longrightarrow \begin{bmatrix} \text{CAT}\,|\,\text{VAL} & \begin{bmatrix} \text{SUBJ}\langle \text{NP}_{\boxed{1}} \rangle \\ \text{COMPS}\ \boxed{2} \oplus \left\langle \text{V}\begin{bmatrix}\text{SUBJ}\langle \text{NP}_{\boxed{3}}\rangle \\ \text{COMPS}\ \boxed{6}\end{bmatrix} : \boxed{4} \right\rangle \oplus \boxed{6} \end{bmatrix} \\ \text{CONT}\ \boxed{5} & \end{bmatrix}$$

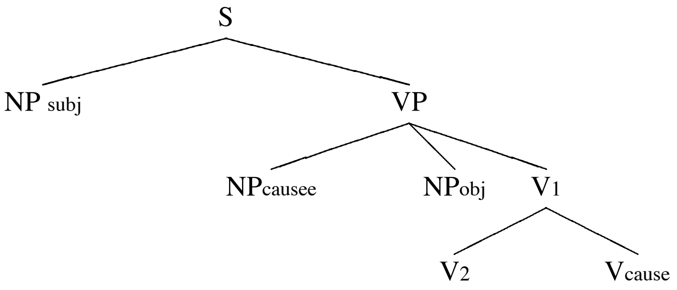
The input to the above lexical rule is a lexical entry with a controller NP and a VP complement in the COMPS list of a governing verb. Argument Composition as introduced by Hinrichs & Nakayama (1994) allows syntactic composition of two predicates in the input and structure sharing of their arguments via the operation append(⊕).[6] Through argument composition, the unsaturated arguments of the argument predicate are introduced into the argument structure of the selecting predicate. Based on this, the clause headed by *hata* causative verb has the canonical structure allowing free word order variation as in (4).

(4)



By contrast, Bratt claims that the causative *hata* forms a verbal cluster with its preceding verb without using a lexical rule. According to her, the canonical structure of the causative constructions can be presented as in (5).

(5)



Second, while Bratt concludes that causatives with dative and accusative case share the same structures, Chung distinguishes two different causative constructions: a control verb construction and a raising construction.[7] .

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[6] A list satistifes the description $D_1 \oplus D_2$ if it is the concatenation of two lists satisfying the description D_1 and D_2 respectively.

[7] Chung claims that the accusative *hata* causatives are more restricted than the dative causatives with respect to scrambling.

Third, with respect to scrambling, Chung argues that clause internal scrambling and long-distance scrambling are explained by the same mechanism of argument composition in Korean. Bratt, however, proposes that clause-bounded scrambling is fundamentally different from long distant scrambling.

When we consider adjunct scope in the causative *hata*-construction, it is hard to support Chung's argument that the causative verb *hata* takes a VP complement. In the following examples, an adverb modifies only the immediately following verb in an embedded S- or VP-complement construction. However, the two different interpretations of (6c) show that the adverb *kakkum* (sometimes) takes scope over not only the immediately following verb but also the whole causative verbal complex.

(6) a. John-i [$_S$ Mary-ka chayk-ul kakkum ilke-yahan-tako] malhayssta
John-Nom Mary-Nom book-Acc sometimes read-must-Comp said
'John said that Mary should read a book sometimes.'

b. John-i Mary-eykey [$_{VP}$ chayk-ul kakkum ilk-ulako] seltukhayssta
John-Nom Mary-to book-Acc sometimes read-Ending persuaded
'John persuaded Mary to sometimes read a book.'

c. John-i Mary-eykey chayk-ul kakkum [ilk-key hayessta]
John-Nom Mary-Dat book-Acc sometimes read-Ending caused
1. 'Sometimes John caused Mary to read a book.'
2. 'John caused Mary to sometimes read a book.'

Further evidence that the adverb modifies not only the immediately following predicate but also the whole cluster is that the occurrence of an adverb is semantically restricted by the whole verbal cluster. Consider the example (7).

(7) John-i Mary-lul han sikan-maney kippu-key hayessta
John-Nom Mary-Acc one hour-in be happy-Ending caused
'John caused Mary to be happy in an hour.'

In Korean, the adverbial phrase *han sikan man-ey*, the correspondent of the time adverbial *in an hour*, modifies only telic predicates which specify the end point of the

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1. Mary-ka ku chayk-ul ilk-key John-eykey hayessta
Mary-Nom that book-Acc read-Ending John-to caused
'Mary caused John to read the book.'

2. *Mary-ka ku chayk-ul ilk-key John-ul hayessta
Mary-Nom that book-Acc read-Ending John-Acc caused
'Mary caused John to read the book.'

There seems to be a difference between an accusative NP and others in Korean. We are not sure whether we must distinguish two causatives according to the case marker of an NP or not. Since this is not one of main concerns of this paper, we will not discuss it further.

event. Although the adjective *kipputa* (be happy) is stative, and therefore is not a telic predicate, the adverbial *han sikan man-ey* appears in (7). This suggests that it modifies the event of causing Mary to be happy as a whole. Thus, the adverbials in the causative *hata* constructions can modify either the causative relation or the lower verb's semantic relation. This is hard to explain without accepting the verbal complex analysis of the lower verb and the causative verb *hata*. In addition, the sentence adverb scope undermines the claim that the causative *hata* takes a VP as its argument. In general, a sentential adverb of a matrix predicate does not occur among the elements of the embedded S or VP as in (8b) and (9b), but it can intervene between the embedded verb and its argument as in (10b).

(8) a. tahaynghi, John-i [$_S$ Mary-ka chayk-ul ilk-key] hayessta
fortunately John-Nom Mary-Nom book-Acc read-Ending caused
'Fortunately, John caused Mary to read a book.'

b. *John-i [$_S$ Mary-ka, tahaynghi, chayk-ul ilk-key] hayessta
John-Nom Mary-Nom fortunately book-Acc read-Ending caused
'Fortunately, John caused Mary to read a book.'

c. *John-i [$_S$ Mary-ka chayk-ul, tahaynghi, ilk-key] hayessta
John-Nom Mary-Nom a book fortunately read-Ending caused
'Fortunately, John caused Mary to read a book.'

(9) a. tahaynghi, John-i Mary-ul [$_{VP}$ chay-ul ilk-key] seltukhayessta
fortunately John-Nom Mary-Acc book-Acc read-Ending persuaded
'Fortunately, John persuaded Mary to read a book.'

b. *John-i Mary-ul [$_{VP}$ chay-ul, tahaynghi, ilk-key] seltukhayessta
John-Nom Mary-Acc book-Acc fortunately read-Ending persuaded
'Fortunately, John persuaded Mary to read a book.'

(10) a. tahaynghi, John-i Mary-eykey chayk-ul ilk-key hayessta
fortunately John-Nom Mary-Dat book-Acc read caused
'Fortunately, John caused Mary to read a book.'

b. John-i Mary-eykey chayk-ul, tahaynghi, ilk-key hayessta
John-Nom Mary-Dat book-Acc fortunately read-Ending caused
'Fortunately, John caused Mary to read a book.'

2.2 Verbal Noun Constructions as CPs

In addition to auxiliary verb constructions and the causative *hata* constructions, there are some combinations of a noun and a verb which have been classified as CPs in Korean.

(11) a. John-i ku saken-ul cosa-ul ha-yess-ta
John-Nom that accident-Acc investigation-Acc do-Past-Ending
'John did an investigation of that accident.'

b. John-i ku saken-uy cosa-lul ha-yess-ta
John-Nom that accident-Gen investigation-Acc do-Past-Ending
'John did an investigation of that accident.'

(12) a. John-i kutul-kwa hyepsang-ul ha-yess-ta
John-Nom them-with negotiation-Acc do-Past-Ending
'John made a negotiation with them.'

b. John-i kutul-kwa-uy hyepsang-ul ha-yess-ta
John-Nom them-with-Gen negotiation-Acc do-Past-Ending
'John made a negotiation with them.'

In the given examples, the underlined elements are required by *cosa* (investigation) and *hyepsang* (negotiation), and not by *hata*. This kind of argument-predicate relationship is supported by the examples of (11b) and (12b); the elements can be realized under the NP by taking a genitive case marker. A notable point is that the underlined elements are realized directly under the VP in (11a) and (12a). If the arguments were located in the sister position of the verbal noun, we would expect topicalization, or pseudocleft formation to be prohibited like normal elements under NPs as follows.

[topicalization]

(13) a. ku saken-un John-i cosa-lul ha-yess-ta
that accident-Top John- Nom investigation-Acc do-Past-Ending
'As for that accident, I did an investigation.'

b. kutul-kwa-nun John-i hyepsang-ul ha-yess-ta
them-with-Top John-Nom negotiation-Acc do-Past-Ending
'As for with them, John made a negotiation.'

[pseudocleft]

(14) a. John-i cosa-lul ha-n kes-un ku saken-ita
John-Nom investigation-Acc do-Rel what-Top that accident-Copular
'What John did an investigation was that accident'

b. John-i hyepsang-ul ha-n kes-un kutul-kwa-ita
John-Nom negotiation-Acc do-Rel what-Top them-with-Copular
'Who John made a negotiation with was them.'

Morphologically, nominal argument takes genitive case only under an NP in Korean as in the following examples.

(15) a. Yenghuy-ka chingwu-uy oppa-lul salanghanta
Yenghuy-Nom friend-Gen brother-Acc loves
'Yenghuy loves her friend's brother.'

b. *chingwu-nun Yenghuy-ka oppa-lul salanghanta
friend-Top Yenghuy-Nom brother-Acc loves
'As for a friend, Yenghuy loves her brother.'

c. *Yenghuy-ka oppa-lul salangha-nun kes-un chingwu-ita
Yenghui-Nom brother-Acc loves-REL who-Top friend-copula
'It is her friend whose brother Yenghuy loves.(lit)'

The accusative case 'ul/lul' and the postposition *wa/kwa* (with) in (11a) and (12a) show that the underlined arguments come directly under the VP node of the sentence. In the given examples, the argument structure of the CP is mainly inherited from the nominal component, the combining noun has been called a verbal noun. Besides the verb *hata* has been considered to take a functional role by accompanying a tense or aspect marker and completing a sentence while it does not semantically restrict the arguments of a sentence as other predicates. In this respect, the verb *hata* is similar to auxiliary verbs, so has been called a light verb in contrast with other verbs (heavy verbs).[8]

The verbal noun constructions have been paid much attention in the literature, including Grimshaw & Mester's (1988) proposal of argument transfer, which percolates arguments of the nominal to the light verb, Ahn's (1989) analysis based on a heavy and light verb distinction, and Ryu's (1993) approach within the HPSG framework. Among the various mechanisms for explaining the formation of noun-verb complexes, Ryu (1993) uses argument composition, following the idea of Hinrichs & Nakayama (1994).[9] Similarly, Lee

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[8] Especially in generative grammar including Grimshaw & Mester (1988) and Ahn (1989).

[9] Instead of argument composition, he actually uses the term 'argument transfer' but there is not much difference.

(1993) uses theta-role raising to V-bar within the GB framework.[10] Even though it has not been noticed in many previous approaches on CPs, there are many other verbs which can be combined with verbal nouns besides the light verb *hata*. Let us consider the following examples.

(16) a. John-i ku saken-ul cosa-lul machi-ess-ta
John-Nom that accident-Acc investigation-Acc finish-Past-Ending
'John finished the investigation of that accident.'

b. John-i ku saken-uy cosa-lul machi-ess-ta
John-Nom that accident-Gen investigation-Acc finish-Past-Ending
'John finished the investigation of that accident.'

(17) a. John-i kutul-kwa hyepsang-ul kkuthnay-ess-ta
John-Nom them-with negotiation-Acc end-Past-Ending
'John ended the negotiation with them.'

b. John-i kutul-kwa-uy hyepsang-ul kkuthnay-ess-ta
John-Nom them-with-Gen negotiation-Acc end-Past-Ending
'John ended the negotiation with them.'

Moreover, there are some combinations of a verbal noun and a verb in which the verb cannot be substituted for by the verb *hata*.

(18) a. Na-nun nay salm-ey hoyuy-lul nukki-ess-ta
I-Top my life-in skepticism-Acc feel-Past-Ending
'I felt a skepticism in my life.(lit)'

b. Na-nun sulpum-lul nukki-ess-ta
I-Top sorrow-Acc feel-Past-Ending
'I felt sorrow.'

(19) a. Chelswu-ka John-eykey kocangnan sikye-lul swuli-lul mathki-ess-ta
Chelswu-Nom John-to broken watch-Acc repair-Acc entrust-Past-Ending
'Chelswu entrusted the repair of a broken watch to John.'

b. Na-nun John-eykey caysan-ul mathki-ess-ta
I-Top John-to property-Acc entrust-Past-Ending
'I entrusted my property to John.'

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[10] Grimshaw & Mester (1988) also proposes an operation of 'argument transfer' to deal with the syntax of light verb constructions. However, their account is dependent on the notion of 'partial argument transfer', which does not apply to Korean. For this, refer to Lee (1993) and Ryu (1993).

The underlined arguments *nay salm-ey* (my life-in) and *kocangnan sikye-lul* (broken watch-Acc) are not related to the argument structure of *nukkita* and *mathkita*. Considering this, the combinations of a noun and a verb of (18) and (19) are similar to the light verb *hata* constructions. The arguments of a noun cannot form pseudocleft sentences or be topicalized, while the arguments of a verbal noun can. Pointing out these properties, Lee (1993) suggested that a verbal noun licenses its arguments in VP by constituting a CP construction with a specific verb as in the light verb *hata* constructions.

Adverb scope supports that a verbal noun and its following verb form a single syntactic unit. In general, adverbs of manner and degree tend to immediately precede their modifying verbal categories. In the above sentences, they precede the verbal nouns[11]

(20) a. Na-nun ku saken-ul chelcehi cosa-lul ha-yess-ta
I-Top that accident-ul thoroughly investigation-Acc do-Past-Ending
'I did an investigation of that accident thoroughly.'

b. Na-nun ku saken-ul cosa-lul chelcehi ha-yess-ta
I-Top that accident-ul investigation-Acc thoroughly do-Past-Ending
'I did an investigation of that accident thoroughly.'

(21) a. Na-un nay salm-ey khukey hoyuy-lul nukki-ess-ta
I-Top my life-in greatly skepticism-Acc feel-Past-Ending
'I greatly felt a skepticism in my life.'(lit)

b. Na-nun nay salm-ey hoyuy-lul khukey nukki-ess-ta
I-Top my life-in skepticism-Acc greatly feel-Past-Ending
'I greatly felt a skepticism in my life' (lit)

There are some adverbs that are morphologically related to the adjectives modifying verbal nouns as we see in (20) and (21).

(22) Na-nun ku saken-ul chelcehan cosa-lul ha-yess-ta
I-Top that accident-ul thorough investigation-Acc do-Past-Ending
'I did a thorough investigation of that accident.'

(23) Na-nun salm-ey khun hoyuy-ul nukki-ess-ta
I-Top life-in great skepticism feel-Past-Ending
'I felt a great skepticism in my life.'(lit.)

The adverbs like *chelcehakey* and *khukey* do modify nouns in Korean. The morphological correspondence between an adverb and an adjective suggests that these modifiers are semantically related to the verbal noun rather than to the verbs.

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[11] This, however, is not a strong evidence since those adverbs commonly precede objective NPs in Korean.

3 Argument Composition

In this section, we will discuss the formation of CPs. Following Chung (1998) and Bratt (1996), we basically assume argument composition for the noun-verb CP constructions. Argument Composition refers to the mechanism that *a*ttracts the arguments of the complement to the valence list of the head.

To deal with verbal noun CPs, Ryu (1993) adopted the structure sharing mechanism but he did not propose a new schema capturing the formation of a CP. Instead, he uses the head-complement schema for the general combinations of a head and its complements. With this schema, CPs cannot be differentiated from general object and verb combinations.[12] Furthermore, his Head-Comp schema allows partial structure sharing of arguments similar to Grimshaw & Mester's argument transfer, so it incorrectly licenses the following ungrammatical examples.

(24) a. *John-i tosekwan-ey [$_{NP}$ chayk-uy pannap-ul] ha-n-ta
John-Nom library-to book-Gen return-Acc do-Pres-Ending
'John returns the book to the library.'

b. *John-i Mary-eykey [$_{NP}$ kkoch-uy senmwul-ul] ha-n-ta
John-Nom Mary-to flower-Gen present-Acc do-Pres-Ending
'John presents flowers to Mary.'

Chung (1998) also proposed the Gov-Head schema licensing verbal CPs.[13] According to Chung (1998),however, only nonphrasal categories are allowed to appear as a governed element, so we cannot explain the fact that a governed element can be modified by an adverb or an adjective as follows.

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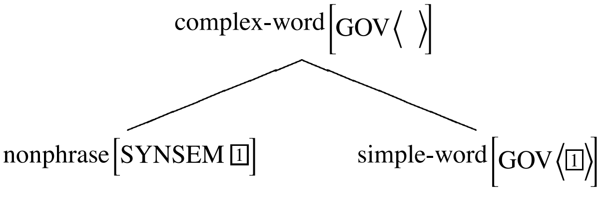
[12] In addition, Ryu includes *sikhita* (to cause), *toyta* (to become) in the same category with *hata*. According to him, these verbs derive causative or passive CPs from verbal nouns and cause a change in grammatical function at the level of the syntax without depending on a lexical rule. The notion of grammatical function change here is, however, not clear to me. Even though Ryu categorized some verbs causing grammatical function change as function verbs, empirically many verbs form a CP both verbal nouns. The arguments of the noun can appear directly under the VPs as we have already seen in the previous section.

[13] Chung (1998) proposes the Gov-Head schema and demonstrates how it works for auxiliary verb complex predicates in Korean. With this schema, however, we cannot fully explain the formation of CPs including the causative verb *hata* or verbal nouns.

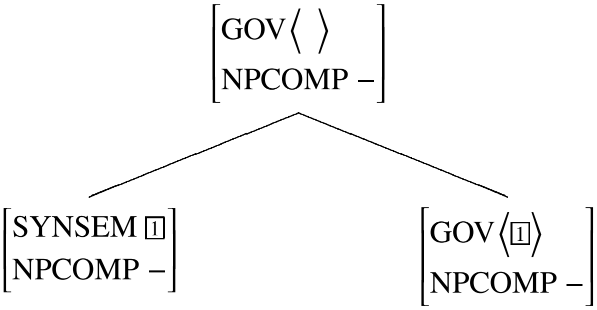


(25) John-i Mary-eykey [[ppalli ka-key] hayessta]
John-Nom Mary-to fast go-Ending made
'John made Mary go fast.'

(26) John-i ku saken-ul [[chelcehan cosa-lul] hayessta]
John-Nom that accident-Acc thorough investigation-Acc did
'John did thorough investigation of that accident.'

In order to correctly capture the formation of a verbal noun construction, we propose to revise the Gov-Head schema proposed by Chung (1998) to license a new type of syntactic structure working as a single unit at the level of syntax as in (27).

(27)



For the revised schema, we assume two features, GOV(ERNMENT) and NPCOMP. GOV feature takes either an empty list or a singleton list containing a governee's SYNSEM value. This captures the syntactic relationshipt between a governee, a verbal noun and a head, the following verb. We can use the NPCOMP feature in order to capture adjunct modification of a governed element. NPCOMP is the feature which Hinrichs and Nakazawa (1994) use for recording whether a verbal projection (or, in the present setting a verbal noun projection) has yet discharged any nominal arguments. In case an argument of a verbal noun is realized within the verbal noun phrase by taking the genitive case, a verbal noun and the following verb are a syntactic combination which is formed by the Head-Comp/Head-Subject schema. Thus, a verbal noun in this case takes an [NPCOMP +] and its combination with the following predicate does not form a CP.

The ungrammatical examples like(24) can be excluded from CPs because the Gov-Head schema does not apply for noun-verb combinations. The Gov-Head schema works as a syntactic schema not only for noun-verb CPs but for other CPs as well, including auxiliary verbs and causative constructions.[14] In verbal noun constructions, the combining

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[14] With respect to scrambling, there is some difference among the three types of CPs since auxiliary verb constructions do not allow intervention of adjuncts between a verb and the following auxiliary verb. This can be treated in terms of morphological properties of auxiliary verbs. In Korean, all the auxiliary verbs immediately follow main predicates, so they have been assumed to form morphosyntactic constructions according to traditional grammar. Here, we attribute the prohibition of adjuncts in auxiliary verb constructions to the property of AUX in Korean, as explained in section 4.

verb syntactically subcategorizes for the preceding verbal noun via the GOV feature just as an auxiliary verb or the causative verb *hata* does. When we consider the head final linear ordering and the fact that case marking of a verbal noun depends on the combining verb in Korean, we can conclude that the final verb functions as the head. The lexical entries of the light verb *hata* and a verbal noun *cosa* can be provided as in the following examples.

(28) *hata* 'do'

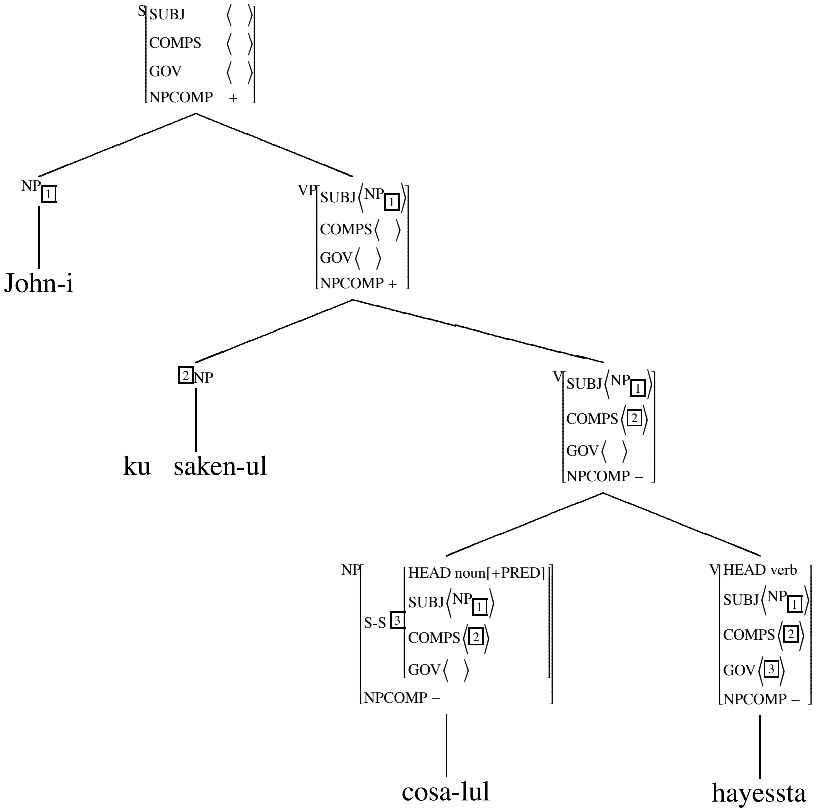
$$\left[\begin{array}{ll} \text{S-S} & \left[\begin{array}{ll} \multicolumn{2}{l}{\text{HEAD verb}\left[\text{bse}\right]} \\ \text{VAL} & \left[\begin{array}{ll} \multicolumn{2}{l}{\text{SUBJ}\left\langle \boxed{1} \right\rangle} \\ \multicolumn{2}{l}{\text{COMPS}\left\langle \boxed{2} \right\rangle} \\ \text{GOV } \boxed{4} & \left[\begin{array}{ll} \multicolumn{2}{l}{\text{HEAD NOUN}\left[\text{+PRED}\right]} \\ \text{VAL} & \left[\begin{array}{l} \text{SUBJ}\left\langle \boxed{1} \right\rangle \\ \text{COMPS}\left\langle \boxed{2} \right\rangle \\ \text{GOV}\left\langle\ \right\rangle \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right] \\ \multicolumn{2}{l}{\text{NPCOMP} -} \end{array}\right]$$

(29) *cosa* 'investigation'

$$\left[\begin{array}{ll} \boxed{4}\text{S-S} & \left[\begin{array}{ll} \text{HEAD} & \text{noun[+PRED]} \\ \text{VAL} & \left[\begin{array}{l} \text{SUBJ}\left\langle \text{NP} \right\rangle \\ \text{COMPS}\left\langle \text{NP} \right\rangle \\ \text{GOV}\left\langle\ \right\rangle \end{array}\right] \end{array}\right] \\ \multicolumn{2}{l}{\text{NPCOMP} -} \end{array}\right]$$

Based on this schema, argument composition allows arguments of the verbal noun to become arguments of the CP. These provide the following structure for the verbal noun CP constructions.

(30)



The lexical entry of *hata* shows that it subcategorizes for the verbal noun *cosa* (investigation)and allows the inheritance of arguments through argument composition. Lexical specification of a verbal noun and the light verb *hata* brings two separate lexical items together at the syntactic level through the Gov-Head schema. This mechanism explains how two independent categories function as a single syntactic unit.

4 Linearization with respect to Scrambling

Even though Korean is generally considered to be a free word order language, some specific restrictions exist. As is well-known, an argument cannot appear in the position where it follows its head. This phenomenon appears in noun-verb complex constructions, too.

(31) a. John-i secem-eyse ku chayk-ul kwuip-ul ha-yess-ta
John-Nom bookstore-at that book-Acc purchase-Acc do-Past-Ending
'John purchased that book at the bookstore.'

b. John-i ku chayk-ul secem-eyse kwuip-ul ha-yess-ta
John-Nom that book-Acc bookstore-at purchase-Acc do-Past-Ending
'John purchased that book at the bookstore.'

c. *John-i secem-eyse kwuip-ul ku chayk-ul ha-yess-ta
John-Nom bookstore-at purchase-Acc that book-Acc do-Past-Ending
'John purchased that book at the bookstore.'

As in (31), the complement NP *ku chayk-ul* (that book) cannot follow its head *kwuip* (purchase). This fact can be explained by the following LP constraint, which is needed to explain the head-final property of Korean.

(32) a. $X < [\text{COMPS } \alpha \oplus \langle X \rangle \oplus \beta]$

b. $X < [\text{GOV } \langle X \rangle]$

The property of free word order in Korean can be found not only among the elements in a simple sentence but also in a complex sentence containing an embedded VP or S complement.

(33) a. John-i Mary-eykey ku chayk-ul ilk-ulako seltukhayssta
John-Nom Mary-to that book-Acc read-Comp persuaded
'John persuaded Mary to read that book .'

b. John-i ku chayk-ul Mary-eykey ilk-ulako seltukhayssta
John-Nom that book-Acc Mary-to read-Comp persuaded

c. ku chayk-ul, John-i Mary-eykey ilk-ulako seltukhayssta
that book-Acc John-Nom Mary-to read-Comp persuaded

(34) a. John-i Mary-ka hakyo-eyse nolko iss-tako sayngkakhayssta
John-Nom Mary-Nom school-at be playing-Comp thought
'John thought Mary is playing at the school.'

b. hakkyo-eyse John-i Mary-ka nolko iss-tako sayngkakhayssta
school-at John-Nom Mary-Nom playing-Comp thought

c. John-i hakkyo-eyse Mary-ka nolko iss-tako sayngkakhayssta
John-Nom school-at Mary-Nom be playing-Comp thought

Considering that the subject of the embedded clause changes its position and the matrix subject does not appear in the embedded clause, we can identify that it is the element of the embedded phrase or clause which changes its canonical position.[15] In order to capture this property, Chung (1998) provides a flat structure analysis. According to him, the elements of the embedded VP or S are freely ordered unless a specific LP constraint applies.

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[15] In case of (34b), it is hard to tell what is the element that changes it canonical position. In general, a focused or topicalized element occupies the sentence initial position out of its canonical position in Korean.

He, furthermore, proposes a lexical rule using argument composition for a verb forming a complex sentence. As an output of the lexical rule, flat structures are licensed. The flat structure analysis, however, requires less realistic VP or S as an input of the lexical rule, which does not exist any more in the output structure. With the application of the lexical rule, all the elements inside of the VP or S-complement appear among the elements of the matrix predicate, so we cannot find the embedded VP or S in the outputs. The elements of the embedded VP or S, however, form a constituent in the output structure since they can be replaced by an anaphoric verb phrase *kulehkey hata* (do so) or *kulaysssta*(did so).

(35) a. John-i Mary-eykey ku chayk-ul ilk-ulako seltukhayss- ta
John-Nom Mary-to that book-Acc read-Comp persuaded-Ending
'John persuaded Mary to read that book.'

b. John-un Tom-eykey-to kulehkey ha-lako seltukhayss-ta
John-Top Tom-to-also do so-Comp persuaded-Ending
'John also persuaded Tom to do so.'

(36) a. John-i Tom-eykey Mary-ka ku chayk-ul ilkess-tako malhayss-ta
John-i Tom-to Mary-Nom that book-Acc read-Ending told-Ending
'John told Tom that Mary read that book.'

b. John-i Jim-eykey-to kulayss-tako malhayss-ta
John-Nom Jim-to-also (she) did so-Comp told-Ending
'John also told to Jim that (she) did so '

In (35) and (36), *kulehkey ha-lako* (do so-Comp) replaces the VP *ku chayk-ul ilk-ulako* (read that book) and *kulayss-tako* ((she) did so-Comp), the whole S. The flat structure approach is hard to capture this kind of phrasal constituency. Chung's lexical rule takes a phantom S or VP only in the input structure, but by going through the application of the rule, it does not exist in the output structure. Thus, it is hard to explain why there is some evidence of syntactic combinations of a noun and a verb. Another defect of the argument composition approach is that it does not explain the asymmetric distribution of adjuncts in S- and VP-complement structures, as Chung (1998) himself admits.[16]

(37) a. Mary-ka ilcwuil ceney [$_S$ John-i ku proceyhthu-lul kkuthnay-yahan-tako] malhayssta
M-Nom one week ago J-Nom the project-Acc finish-must-Comp told
'One week ago, Mary said that John had to finish the project'

b. Mary-ka [$_S$ John-i ku proceykthu-lul kkuthnay-yahan-tako] ilcwuil ceney malhayssta
M-Nom J-Nom that project-Acc finish-must-Comp one week ago told

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[16] According to Chung, argument composition gives a flat structure for a sentence containing an S-complement. By this mechanism, he argues that scrambling out an S-complement can be accounted for. He also argues that an adjunct of the matrix head verb may occur any place in a sentence once the argument composition rule is applied. He argues that an adjunct of a complement verb is attracted to the ADJT list of a matrix verb instead of COMPS list unless something else is said.

c. *Mary-ka [S John-i ilcwuil ceney ku proceykthu-lul kkuthnay- yahan-tako] malhayssta
M-Nom J-Nom one week ago that project-Acc finish-must-Comp told

d. *Mary-ka [S John-i ku proceykthu-lul ilcwuil ceney kkuthnay- yahan-tako] malhayssta
M-Nom J-Nom that project-Acc one week ago finish-must-Comp told

The adjunct modifying the matrix predicate in (37a) cannot intervene among the elements of the embedded sentence as in (37c) and (37d). However, it still modifies the martrix predicate when it follows the embedded clause as in (37b). In contrast, an adjunct modifying the embedded predicate scrambles out of the embedded sentence as we have already seen in (34).[17] In order to explain this asymmetry, Chung proposes the following Interpretive Principle which requires that the adjunct be semantically dependent on the embedded predicate in a certain structure.[18]

(38) *Interpretive Principle* : Suppose (i) that Y is an NP[nom], (ii) that X is the first verb following Y, and (iii) that Z is any constituent occurs between Y and X. Then Z cannot be a semantic dependent (semantic argument or functor) of a verb superordinate to X.

This restriction excludes the ungrammatical examples of (37c) and (37d). However, this assumption is rather ad hoc since it requires a configurational restriction to block ungrammatical examples. Moreover, this kind of configurational restriction is not enough to cover the fact that the same phenomenon exists in VP-complement constructions, even though Chung argues that it does not.

(39) a. John-i Mary-eykey [VP ku chayk-ul nayil ilk-ulako] seltukayssta
John-Nom Mary-to that book-Acc tomorrow read-Comp persuaded
'John persuaded Mary to read the book tomorrow'

b. John-i nayil Mary-eykey [VP ku chayk-ul ilk-ulako] malhaysstta
John-Nom tomorrow Mary-to that book-Acc read-Comp persuaded
'John persuaded Mary to read the book tomorrow.

(40) a. tahaynghi John-i Mary-ekey [VP chong-ul patak-ey noh-ulako] seltukhayssta
fortunately John-Nom Mary-to gun-Acc floor-on put-Comp persuaded
'Fortunatly, John persuaded Mary to put the gun on the floor.'

b. *John-i Mary-eykey [VP chong-ul patak-ey tahanghi noh-ulako] seltukhayssta
John-i Mary-to gun-Acc floor-on fortunately put-Comp persuaded
'Fortunately, John persuaded Mary to read the book loudly.'

Since Chung's interpretive principle does not include the configuration of the VP, it does not explain the contrast in (39) and (40).[19] In addition, the same asymmetry can be

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[17] The sentences (34a) and (34b) are ambiguous, so the adverb can be interpreted to modify a matrix verb as well as the embedded verb.

[18] Refer to p.203 in Chung (1998).

[19] Even though topicalization and preposing are common phenomena in Korean, they are not applicable to two more elements. Thus, it is hard to claim that two elements are simultaneously scrambled in (40b).

found not only in adjuncts but also in arguments in the embedded S or VP constructions as follows.

(41) a. Mary-ka Tom-eykey [S John-i ku proceykthu-lul kkuthnay-yahanta-ko] malhayssta
M-Nom T-to J-Nom that project-Acc finish-Must-Comp told
'Mary told Tom that John must finish the project.'

b. ku proceykthu-lul, Mary-ka Tom-eykey [S John-i kkuthnayya-hanta-ko] malhayssta
that probject-Acc M-Nom T-to J-Nom finish-must-Comp told

c. Mary-ka, ku proceykthu-lul, Tom-eykey [S John-i kkuthnay-yahanta-ko] malhayssta
M-Nom that probject-Acc T-to J-Nom finish-must-Comp told

d. *Mary-ka [S John-i, Tom-eykey , ku proceykthu-lul kkuthnay-yahanta-ko] malhayssta
M-Nom J-Nom T-to that project-Acc finish-must-Comp told

e. *Mary-ka [S John-i ku proceykthu-lul, Tom-eykey, kkuthnay-yahanta-ko] malhayssta
M-Nom J-Nom that project-Acc Tom-to finish-must-Comp told

As we see in (41b)and (41c), the argument of the embedded S *ku proceykthu-lul* (that project-Acc) appears among the elements of the matrix predicate *malhata* (told). However, the argument of the matrix predicate *Tom-eykey* (Tom-to) cannot intersperse among the elements of the embedded clause as in (41d) and (41e). It can be argued that an element(or elements) of the embedded predicate move out of the embedded clause. However, this claim can be reputed by the fact that the subject of the embedded clause precedes it; the subject of an embedded predicate has been known not to scramble out of the embedded clause in Korean. The fact that the embedded subject *John-i* precedes *Tom-eykey* shows that the element of the matrix predicate appears in noncanonical position.[20]

We, thus, argue that it is the sentencial adverb which goes through scrambling. However, it is not easy to determine which element appears in noncanonical position in the following example.

i. John-i Mary-ekey chong-ul tahanghi patak-ey noh-ulako seltukhayssta
John-Nom Mary-to gun-Acc fortunately floor-on put-Comp persuaded
'Fortunately, John persuaded Mary to put the gun on the floor.'

We can provide two kind of structures for the sentence as follows.

ii. John-i Mary-eykey chong-ul tahaynghi [VP t patak-ey noh-ulako] seltukhayssta
John-i Mary-to gun-Acc fortunately floor-on put-Comp persuaded

iii. John-i Mary-eykey t [VP chong-ul tahaynghi patak-ey noh-ulako] seltukhayssta
John-i Mary-to t gun-Acc fortunately floor-on put-Comp persuaded

In the given example, the adverb *tahaynghi* (fortunately) modifies the matrix sentence. If it is analyzed to have the structure of (ii), it is not compatible with the asymmetric facts in scrambling into an S or VP argument. In (i), we can observe that pause or pitch accent frequently appears with *chong-ul* (gun-Acc) but not with *tahaynghi* (fortunately). Putting pause or pitch accent is a common phenomenon among the elements which occur in noncanonical position. In other words, it suggests that it is the element of the embedded VP which undergoes the scrambling.

[20] Even though most elements can be topicalized by taking topic marker *un/nun* occurring in the sentence initial position in Korean, the embedded subject is hard to topicalize. It also cannot be used as a head noun of a relative clause. This supports that the embedded subject does not intersperse among the elements of the matrix predicate in (i).

In summary, Chung's interpretive rule only deals with the scrambling of the modifiers of the embedded predicate, so it is not enough to explain the scrambling asymmetry between an embedded VP or S and a matrix clause. By depending on argument composition, we need to assume several interpretive rules to deal with the same kind of scrambling asymmetry, which is not a desirable situation.

In order to handle the scrambling phenomena systematically, we propose that Reape-style linearization theory is more naturally applicable than the analysis based on argument composition. By accepting a fundamental dissociation between syntactic structure and linear order, a systematic explanation can be provided for various constituent orders and moreover, the asymmetric behavior of adjuncts in long distance scrambling can be handled without introducing the hypothesis of intermediate flat structures. While the formation of CPs is accounted for by argument composition, word order variation can be effectively handled by using the linearization model (Dowty (1996), Reape (1996), Pollard Carl & Kasper (1993), Kathol (1995)).

The linearization approach makes a basic distinction between tectogrammatical and phenogrammatical structure. Tectogrammatical structure involves grammatical-function based, compositional structure of a sentence, while phenogrammatical structure involves the actual form of the words in a string with a particular ordering. Dowty proposes that discontinuous syntactic phenomena can be correctly described by LP principles but not by hierarchical structures based on phrase structure trees.

Reape (1996) introduces the phenogrammatical notion of word order domains, which involves the actual ordering of words in sentences. Tectogrammatic combinations can appear as discontinuous or non-adjacent elements. Reape restricts word order through domain union. Domain union is a sequence union relation of two DOM values, which represent linear order information, ∪ <> (A, B, C) where C is the result of sequence unioning A and B and contains all and only the elements of them. Thus, the relative order of elements of any daughter domain must be the same as that of its mother domain. Adapting Reape's idea for representing information about linear order, Pollard Carl & Kasper (1993) propose that DOM features do not take signs as their values but rather a grouping of PHON and SYNSEM attributes. In Kathol (1995) this type of grouping is referred as to DOM(AIN)-OBJ(ECT), rather than NODE as in Pollard Carl & Kasper (1993). We also follow Calcagno (1993) in assuming that words are specified for a word order domain, so that every sign (phrasal and lexical) bears a DOM feature.[21]

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i. *John-un Mary-ka Tom-eykey [ku proceykth-lul kkuthnay-yahan-tako] malhayssta.
John-Top Mary-Nom Tom-to that project-Acc finish-must-Comp told
'Mary told Tom that John must finish the project.'

ii. *Mary-ka Tom-eykey [ku proceykth-lul kkuthnay- yahan-tako] malha-n John
Mary-Nom Tom-to that project-Acc finish-must-Comp told-Rel John
'John who Mary told Tom that must finish the project.'

[21] Reape assumes that a DOM is appropriate only for phrasal signs. Extending Pollard, Levine & Kasper's (1993) idea, Calcagno points out that once DOM is defined on all signs, we can constrain the order of elements in a DOM value by more general constraints on signs. The ID schemata mediate between tectogrammatical

Through the feature DOM, phenogrammatical information is encoded. Kathol (1995), furthermore, argues that a domain object, which contains linear order information projected from a sign, is associated with that sign by the compaction relation.

(42)
$$\text{compaction}\left\langle \begin{bmatrix} \text{sign} \\ \text{SYNSEM } \boxed{1} \\ \text{DOM}\left\langle [\text{PHON}\boxed{2}], ..[\text{PHON } \boxed{n}] \right\rangle \end{bmatrix}, \begin{bmatrix} \text{dom-obj} \\ \text{SYNSEM } \boxed{1} \\ \text{PHON } \boxed{2}\circ,...\circ\boxed{n} \end{bmatrix} \right\rangle$$

According to Kathol, instead of having a separate DOM-OBJ attribute containing SYNSEM and PHON values, we can map a sign's SYNSEM value directly on the corresponding domain object. The PHON value of the domain objects corresponds to the concatenation of the PHON values of all the elements in the sign's domain. With the notion of compaction, we can easily explain the reason why the element of the matrix predicate does not intervene among the elements of the embedded VP or S as we observed (41d) and (41e). Since the embedded S or VP is compacted by combining with its head verb, the element of the matrix predicate cannot be inserted into it. Compaction, however, is too restrictive to fully license scrambling possibilities in Korean. This kind of element insertion into a higher domain while other elements are compacted together can be explained by replacing the notion of compaction with partial compaction as proposed in Kathol (1995). Intuitively, partial compaction allows designated domain objects to be liberated into a higher domain, while the remaining elements of the source domain are compacted. The definition of partial compaction is provided as follows.

(43)
$$(\text{p-compaction } \boxed{1}, \boxed{2}, \boxed{3}) \equiv$$
$$\boxed{1} : \begin{bmatrix} \text{sign} \\ \text{SYNSEM } \boxed{4} \\ \text{DOM } \boxed{6} \end{bmatrix} \wedge \boxed{2} : \begin{bmatrix} \text{dom-obj} \\ \text{SYNSEM } \boxed{4} \\ \text{PHON } \boxed{7} \end{bmatrix} \wedge \text{shuffle}(\boxed{5}, \boxed{3}, \boxed{6}) \wedge \text{join}_{\text{PHON}}(\boxed{5}, \boxed{7})$$

In long-distance scrambling constructions as in (41b) - (41c), the designated element of the embedded clause becomes liberated into the higher domain, while the remaining elements are compacted into a single domain object through partial compaction. In general, the liberated element receives focus interpretation by accompanying pause or pitch accent. This mechanism licenses scrambling of an element out of an embedded S or VP. In contrast, an element of the matrix predicate does not scramble into the embedded S or VP, which is already compacted together as in (41d) and (41e).

Now let us consider how this kind of phenogrammatical information can be encoded. Instead of using distinct Head-Subject and Head-Complement Schema, Kathol

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notion and phenogrammatical information by way of the DOM attribute.

uses a binary Head-Argument Schema for licensing particular combinations of signs.[22] Moreover, he proposes a Head-Argument Composition Relation dispensing with phrase structure-based analysis using the DTRS attribute in favor of relation based syntactic combination.

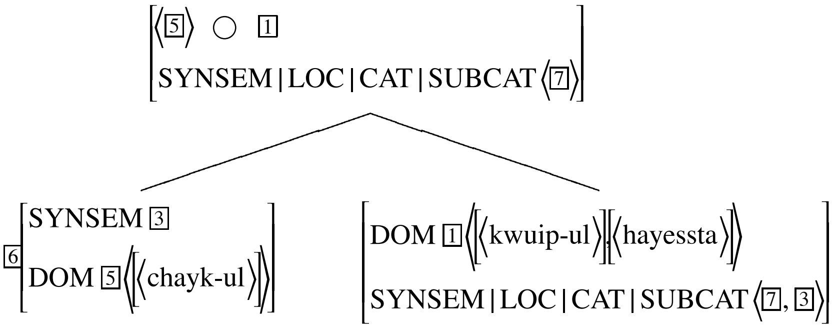
(44) The ternary relation HEAD-ARGUMENT COMPOSITION holds of three signs M, H, and A if and only if:

1. M's SYNSEM | LOCAL | CAT | COMPS is token-identical to H's SYNSEM |LOCAL | CAT | COMPS value minus A's SYNSEM value.
2. M's DOM value is a sequence union of H's DOM value and < Ca> , where Ca is the p-compaction of A.

Adopting the above Head-Argument Composition Relation for syntactic combination of a head and its complements including subjects in Korean, we drop the TOPO feature from the constraint, which is introduced for languages like German. According to this rule, the domain of the mother is the sequence union of the domain of the head daughter with the singleton list containing the compaction of the argument. Through compaction and sequence union, essentially a shuffle operator, arbitrary permutations of a domain can be licensed unless LP constraints are provided. The combination of a CP and its complement can be licensed by Head-Argument Composition as follows.

(45) a. John-i chayk-ul kwuip-ul ha-yess-ta
John-Nom book-Acc purchase-Acc do-Past-Ending
'John purchased a book.'

b.



For licensing the combination of a verbal noun and a head verb in the above structure, we need another Composition Relation. On the basis of the Gov-Head schema, which has been presented in the previous chapter, the Gov-Head Composition Relation can be given as follows.

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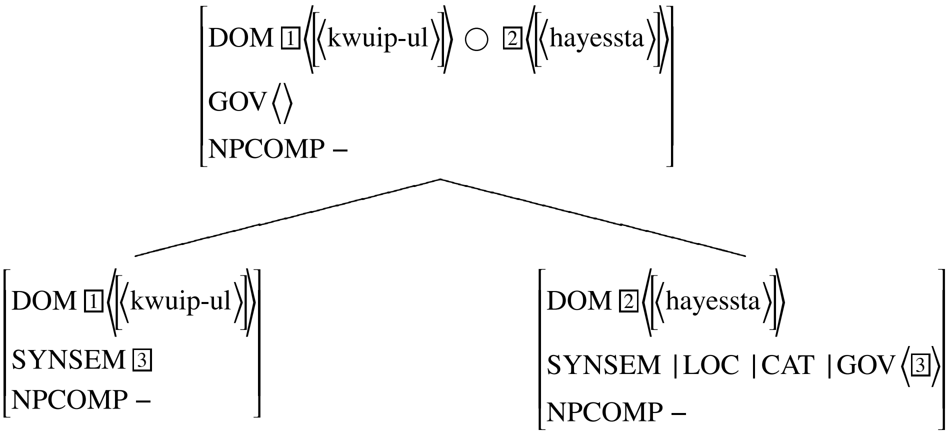
[22] Kathol (1995) argues for this general combinatorial system in order to avoid the differences in the argument structures of finite and nonfinite verbs posited by Kiss and others, and to avoid positing different representations of subjects of fronting constructions in German. For this, refer to Kathol (1995) ch.5 and ch.7. This is not directly relevant to this paper, however.

(46) A sign M is licensed in a Gov-Head Composition Relation, provided there exist two signs G(overnee) and H(ead), such that:

1. M's SYNSEM | LOCAL | CAT | GOV value is token-identical to H's SYNSEM | LOCAL | CAT | GOV value minus G's SYNSEM value
2. M, G, H's NPCOMP values are −.
3. M's DOM value is the append of H's DOM value with G's DOM value.

This relation licenses the following local composition of a verbal noun and a head in (47).

(47)



Depending on the above relational constraints, the following sentences are licensed.

(48) a. DOM < [*kuchayk* − *ul*], [*John* − *i*], [*kwuip* − *ul*], [*hayessta*] >

b. DOM < [*kuchayk* − *ul*], [*John* − *i*], [*kwuip* − *ul*], [*hayessta*] >

c. *?DOM < [*John* − *i*], [*kuchayk* − *ul*], [*hayessta*], [*kwuip* − *ul*] >

d. *DOM < [*John* − *i*], [*kwuip* − *ul*], [*kuchayk* − *ul*], [*hayessta*] >...

As we see in the above examples, there are some restrictions on the permutations. Following Chung (1998) and Calcagno (1993), we can exclude the ungrammatical examples of (48c) and (48d) by the Head Final Constraint. This holds for the governed elements of CPs such as verbal nouns or other verbs as well as arguments. We need the following constraint for the immediate precedence between a verb and an auxiliary verb in Korean.[23]

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[23] In auxiliary verb construction, delimiters can intervene between a predicate and the following auxiliary verb. This kind of insertion is commonly found in complex or compound word constructions. It is attributed to the morpho-syntactic property of delimiters in Korean. Thus, it does no harm for the LP constraint.

(49) $X \ll {}_{V}\begin{bmatrix}\text{AUX} & + \\ \text{COMPS} & \langle X \rangle\end{bmatrix}$

Now let us consider adjuncts interspersed among complements. For the syntactic combination of a head and an adjunct, we need another relational constraint of Head-Adjunct Composition Relation similar to the Head-Argument Composition Relation.

(50) The ternary relation Head-Adjunct Composition holds of three signs, M, H and A if and only if:

1 H's SYNSEM value is token identical to A's SYNSEM | LOCAL | CAT | MOD value.

2 M's DOM value is a sequence union of H's DOM value and < CA >, where CA is the compaction of A.

Based on the Head-Adjunct Composition Relation, the following DOM value of the phrase containing an adjunct phrase and its head is licensed.

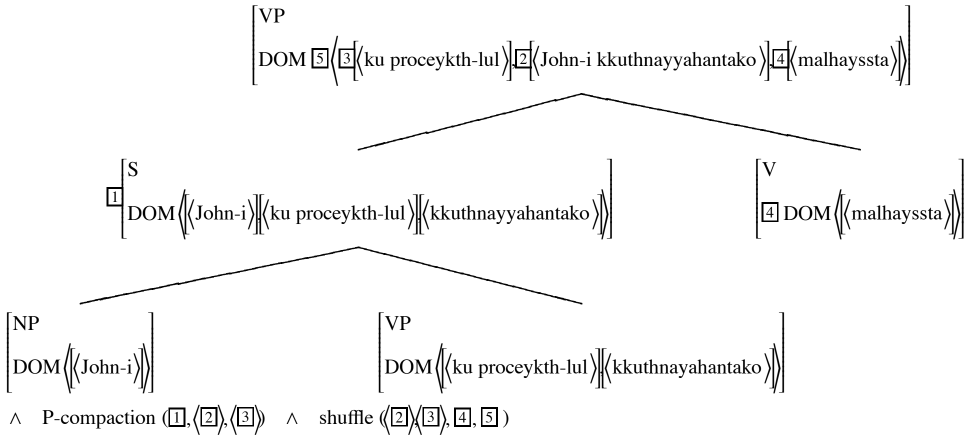
(51) a. secem-eyse chay-ul kwuip-ul ha-yess-ta
bookstore-at book-Acc purchase-Acc do-Past-Ending
'(I) purchased a book at the book store.'

b. $\left\langle \begin{bmatrix}\text{PHON secem-eyse} \\ \text{SYNSEM } \alpha\end{bmatrix}, \begin{bmatrix}\text{PHON chayk-ul} \\ \text{SYNSEM } \beta\end{bmatrix}, \begin{bmatrix}\text{PHON kwuip-ul} \\ \text{SYNSEM } \gamma\end{bmatrix}, \begin{bmatrix}\text{PHON hayessta} \\ \text{SYNSEM } \delta\end{bmatrix} \right\rangle$

Within a linearization model, we can provide the following structure for the example containing an element, which scrambles out of the embedded S argument. We repeat the example (41c) in (52).

(52) a. Mary-ka ku proceykth-lul Tom-eykey [S John-i kkuthnay-yahan-tako] malhayssta
Mary-Nom that project-Acc Tom-to John-Nom finish-must-Comp told
'Mary told Tom that John must finish that project.'

b.



As shown in (52), the embedded sentence becomes compacted when it combines with the verbal head while the focused element *ku proceykth-lul* (that project-Acc) is scrambled out of it. In other words, the focused element is inserted into the domain of the matrix VP. The rest of the embedded clause *John-i kkuthnayyahantako* (John-Nom finish-must-Comp) is compacted together forming a single list when it combines with the verb *malhyassta*(told).

In case the list of liberated domain objects is empty, however, the domain object of the sign is totally compacted to a single list. In that case no element of the matrix verb intervene among the compacted elements. This correctly captures the asymmetry in long distance scrambling between the elements of the matrix and the embedded clauses. Partial compaction involves Focus or Topic interpretations. Therefore, the exact mechanism introducing this sort of compaction relation should be more carefully investigated by considering various pragmatic sort of information; however, we leave this subject for future study.

5 Conclusion

In this paper, we examined various kinds of CPs in Korean and tried to draw some generalizations based on the similarities among them. The combination of a verbal noun and a verb shows various properties of CPs. Especially, adverb scope can be used as one of the identifying tools for a CP in Korean both verbal and noun-verb complex. A CP is formed by an argument composition mechanism, as proposed by Hinrichs & Nakayama (1994). We have shown that the syntactic coherence of a CP can be captured by Gov-Head schema licensed by the lexical properties of a verbal noun and the following verb. We argue that while argument composition captures the properties of CPs, it is not quite appropriate to explain various scrambling facts as Chung (1998) proposes. His flat structure analysis based on argument composition does not fully explain long-distance scrambling without rather arbitrary interpretive rules. By using the linearization model, we claim that scrambling facts can be more systematically explained. This approach enhances the explanatory power of the theory by providing proper empirical generalizations for distinct syntactic phenomena. Long-distance scrambling phenomena, however, are entangled with complicated pragmatic factors such as focus or topic interpretations, which remains as an important subject for future study.

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GEORGIAN AGREEMENT WITHOUT EXTRINSIC ORDERING

Thomas W. Stewart, Jr.

Abstract

Accounts of Georgian morphological agreement marking on verbs have been frustrated by systematic deviations from regular morphemic behavior (co-occurrence restrictions and the so-called ‘inversion’ construction). A theory of inflection which does not assume the morpheme (e.g. Paradigm Function Morphology (PFM; Stump 1991, 1993, 2001)) permits the ready formal expression of some recalcitrant aspects of the distribution of agreement markers, but not all. By expanding the database somewhat and by capitalizing on independently motivated resources available within PFM, an approach is put forward here which shows the Georgian facts to fully respect rule ordering based wholly on proper subset exclusion (PFM’s *Pāṇinian Determinism Hypothesis*), without resorting to extrinsically imposed stipulations.

1. Introduction

Agreement marking in Georgian has raised a number of analytical questions for morphologists and syntacticians. The distribution of two major sets of agreement markers casts doubt on an analysis of the markers in terms of sign-like morphemic units.

Morphemes can be defined as minimal units of form that may be associated with meaning in a language. Morpheme-based theories of morphology traditionally emphasize

STEWART, THOMAS. 2001. Georgian Agreement without Extrinsic Ordering. *OSUWPL* 56, 107–133.

the sign-like qualities of these units, and claims are encountered that both free and bound morphemes are listed in the lexicon, albeit with different subcategorization restrictions (e.g., Selkirk 1982). It follows from a theory of meaningful pieces that morphologically complex words may be built up out of discrete morphemes, and perhaps exhaustively so. For this reason, morphosemantic mismatches, i.e. relations other than one-to-one between form and meaning (Stump 1991), are challenges to morphemic theory.

Georgian presents two clear mismatches which run contrary to a morphemic assessment of agreement marking. One is the so-called 'inversion' construction (Harris 1981, 1984; cf. Hewitt 1983), in which markers more usually associated with logical objects are, under certain conditions, systematically used to mark logical subjects (see Tables in section 2). The other mismatch is the disjunctive relation which apparently exists between certain pairs of markers (Anderson 1986), such that although multiple markers are semantically motivated in a given verb, only a subset of these markers may appear.

The structure of this paper is the following: section 2 presents example paradigms from Georgian conjugation classes and subclasses, in the interest of presenting the distribution of the different sets of argument markers where only one argument is present. This is followed by a critical presentation of recent accounts of the phenomenon. Section 3 builds on this discussion by describing the marker co-occurrence patterns. Notable accounts of the disjunctivity are summarized. Section 4 recasts portions of a recent treatment of Georgian disjunctivity in Paradigm Function Morphology (PFM, Stump 2001), and the conclusion is drawn that Stump incorporates a weakening assumption—the introduction of *expansion schemata*—that is not required given the broader data set considered here. An alternative PFM analysis is offered in section 5, holding more closely to independently motivated assumptions already present in the theory without expansion schemata. This analysis draws on the 'inversion' facts as well as the disjunctivity facts, and thereby provides a more integrated account of Georgian agreement. Section 6 presents conclusions and a summary.

2. The 'Inversion' Construction

Georgian is traditionally described as having four conjugations. Within certain of these conjugations, subclassifications may be made on the basis of inflectional behavior. Differences in semantic and valence also pattern broadly with the conjugation classification, and so there is strong motivation, both formal and functional, for these classes.

(1) Georgian conjugation classes: semantic characteristics (Cherchi 1999:16-17)

Class 1	generally transitive (e.g., 'do', 'complete', 'see', 'kill')
Class 2	generally intransitive or passive (e.g., 'be written', 'die')
Class 3	atelic activities (e.g., 'sing', 'cry', 'dance', 'swim')
Class 4	emotions, perceptions, states, possession (e.g., 'be ashamed')

Classes 3 and 4 are by and large formally homogeneous, and so will be exemplified with one paradigm each. Class 1 may be divided into ‘strong’ (1*s*) and ‘weak’ (1*w*) paradigms, based on the presence of a phonologically reduced stem alternant in Series I (i.e., Present and Future tense) forms. Class 2, on the other hand, has three clear subcategories, here called 2*i*, 2*d*, and 2*x*, which differ more substantially in their affixal morphology. A full account of Georgian verb morphology is beyond the scope of this paper, but the following examples give some indication of the patterning of the argument markers in the different conjugations.

To simplify matters slightly, it will be seen that for the most part, ‘inversion’ involves a choice in the set of argument markers between the following (a dash indicates the lack of overt exponence):

(2)	1sg.	2sg.	3sg.	1pl.	2pl.	3pl.
“*v*-set”	*v-*	—	*-s*	*v-…-t*	*-t*	*-en*
“*m*-set”	*m-*	*g-*	—	*gv-*	*g-…-t*	—

It will be seen that there is more going on than this, especially in the case of 3rd person marking, but the markers as given in (2) are sufficient to describe the conditions under which ‘inversion’ obtains. This conditioning may be described as follows:

(3) The *m*-set of markers is used to realize the logical subject iff
  (i) the verb lexeme belongs to the fourth conjugation, or
  (ii) (a) the verb lexeme belongs to the first or third conjugation, and
    (b) the verb form is Evidential[1], i.e., “Apparently, s.o. (has) VERB-ed”.

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[1] See the Appendix for the full set of morphosyntactic features and the permissible values of each.

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
vaketeb	**v**aketebdi	**v**aketebde
aketeb	aketebdi	aketebde
aketeb**s**	aketebd**a**	aketebde**s**
vaketeb**t**	**v**aketebdi**t**	**v**aketebde**t**
aketeb**t**	aketebdi**t**	aketebde**t**
aketeb**en**	aketebd**nen**	aketebd**nen**
Future	*Conditional*	*Future Subjunctive*
ga**v**aketeb	ga**v**aketebdi	ga**v**aketebde
gaaketeb	gaaketebdi	gaaketebde
gaaketeb**s**	gaaketebd**a**	gaaketebde**s**
ga**v**aketeb**t**	ga**v**aketebdi**t**	ga**v**aketebde**t**
gaaketeb**t**	gaaketebdi**t**	gaaketebde**t**
gaaketeb**en**	gaaketebd**nen**	gaaketebd**nen**
	Aorist	*Optative (Aorist Subj.)*
	ga**v**akete	ga**v**aketo
	gaakete	gaaketo
	gaaket**a**	gaaketo**s**
	ga**v**akete**t**	ga**v**aketo**t**
	gaakete**t**	gaaketo**t**
	gaakete**s**	gaaketo**n**
	Evidential Indicative	*Evidential Subjunctive*
	ga**m**iketebia	ga**m**eketa
	ga**g**iketebia	ga**g**eketa
	ga**u**ketebia	gaeketa
	ga**gv**iketebia	ga**gv**eketa
	ga**g**iketebia**t**	ga**g**eketa**t**
	ga**u**ketebia**t**	gaeketa**t**

TABLE 1

Class I Strong

ket ‘do’

TABLE 2

Class I Weak

šal ‘hear’

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
všli	**vš**lidi	**vš**lide
šli	**š**lidi	**š**lide
šli**s**	**š**lid**a**	**š**lide**s**
všli**t**	**vš**lidi**t**	**vš**lide**t**
šli**t**	**š**lidi**t**	**š**lide**t**
šli**an**	**š**lid**nen**	**š**lid**nen**
Future	*Conditional*	*Future Subjunctive*
ga**vš**li	ga**vš**lidi	ga**vš**lide
ga**š**li	ga**š**lidi	ga**š**lide
ga**š**li**s**	ga**š**lid**a**	ga**š**lide**s**
ga**vš**li**t**	ga**vš**lidi**t**	ga**vš**lide**t**
ga**š**li**t**	ga**š**lidi**t**	ga**š**lide**t**
ga**š**li**an**	ga**š**lid**nen**	ga**š**lid**nen**
	Aorist	*Optative (Aorist Subj.)*
	ga**vš**ale	ga**vš**alo
	ga**š**ale	ga**š**alo
	ga**š**al**a**	ga**š**alo**s**
	ga**vš**ale**t**	ga**vš**alo**t**
	ga**š**ale**t**	ga**š**alo**t**
	ga**š**ales	ga**š**alo**n**
	Evidential Indicative	*Evidential Subjunctive*
	ga**miš**lia	ga**meš**ala
	ga**giš**lia	ga**geš**ala
	ga**uš**lia	gae**š**ala
	ga**gviš**lia	ga**gveš**ala
	ga**giš**lia**t**	ga**geš**ala**t**
	ga**uš**lia**t**	gae**š**ala**t**

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
vixatebi	**v**ixatebodi	**v**ixatebode
ixatebi	ixatebodi	ixatebode
ixateb**a**	ixatebod**a**	ixatebode**s**
vixatebi**t**	**v**ixatebodi**t**	**v**ixatebode**t**
ixatebi**t**	ixatebodi**t**	ixatebode**t**
ixatebi**an**	ixatebod**nen**	ixatebod**nen**
Future	*Conditional*	*Future Subjunctive*
gamo**v**ixatebi	gamo**v**ixatebodi	gamo**v**ixatebode
gamoixatebi	gamoixatebodi	gamoixatebode
gamoixateb**a**	gamoixatebod**a**	gamoixatebode**s**
gamo**v**ixatebi**t**	gamo**v**ixatebodi**t**	gamo**v**ixatebode**t**
gamoixatebi**t**	gamoixatebodi**t**	gamoixatebode**t**
gamoixatebi**an**	gamoixatebod**nen**	gamoixatebod**nen**
	Aorist	*Optative (Aorist Subj.)*
	gamo**v**ixate	gamo**v**ixato
	gamoixate	gamoixato
	gamoixat**a**	gamoixato**s**
	gamo**v**ixate**t**	gamo**v**ixato**t**
	gamoixate**t**	gamoixato**t**
	gamoixat**nen**	gamoixato**n**
	Evidential Indicative	*Evidential Subjunctive*
	gamo**v**xatul**v**ar	gamo**v**xatuliqavi
	gamoxatul**x**ar	gamoxatuliqavi
	gamoxatul**a**	gamoxatuliq**o**
	gamo**v**xatul**v**ar**t**	gamo**v**xatuliqavi**t**
	gamoxatul**x**ar**t**	gamoxatuliqavi**t**
	gamoxatul**an**	gamoxatuliqv**nen**

TABLE 3

Class 2i

xat ‘be painted’

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
vketdebi	**v**ketdebodi	**v**ketdebode
ketdebi	ketdebodi	ketdebode
ketdeb**a**	ketdebod**a**	ketdebode**s**
vketdebi**t**	**v**ketdebodi**t**	**v**ketdebode**t**
ketdebi**t**	ketdebodi**t**	ketdebode**t**
ketdebi**an**	ketdebod**nen**	ketdebod**nen**
Future	*Conditional*	*Future Subjunctive*
ga**v**ketdebi	ga**v**ketdebodi	ga**v**ketdebode
gaketdebi	gaketdebodi	gaketdebode
gaketdeb**a**	gaketdebod**a**	gaketdebode**s**
ga**v**ketdebi**t**	ga**v**ketdebodi**t**	ga**v**ketdebode**t**
gaketdebi**t**	gaketdebodi**t**	gaketdebode**t**
gaketdebi**an**	gaketdebod**nen**	gaketdebod**nen**
	Aorist	*Optative (Aorist Subj.)*
	ga**v**ketdi	ga**v**ketde
	gaketdi	gaketde
	gaketd**a**	gaketde**s**
	ga**v**ketdi**t**	ga**v**ketde**t**
	gaketdi**t**	gaketde**t**
	gaketd**nen**	gaketd**nen**
	Evidential Indicative	*Evidential Subjunctive*
	ga**v**ketebul**v**ar	ga**v**ketebuliqavi
	gaketebul**x**ar	gaketebuliqavi
	gaketebul**a**	gaketebuliq**o**
	ga**v**ketebul**v**ar**t**	ga**v**ketebuliqavi**t**
	gaketebul**x**ar**t**	gaketebuliqavi**t**
	gaketebul**an**	gaketebuliqv**nen**

TABLE 4

Class 2d

ket-deb ‘be done’

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
vkvdebi	**v**kvdebodi	**v**kvdebode
kvdebi	kvdebodi	kvdebode
kvdeb**a**	kvdebod**a**	kvdebode**s**
vkvdebi**t**	**v**kvdebodi**t**	**v**kvdebode**t**
kvdebi**t**	kvdebodi**t**	kvdebode**t**
kvdebi**an**	kvdebod**nen**	kvdebod**nen**
Future	*Conditional*	*Future Subjunctive*
mo**v**kvdebi	mo**v**kvdebodi	mo**v**kvdebode
mokvdebi	mokvdebodi	mokvdebode
mokvdeb**a**	mokvdebod**a**	mokvdebode**s**
mo**v**kvdebi**t**	mo**v**kvdebodi**t**	mo**v**kvdebode**t**
mokvdebi**t**	mokvdebodi**t**	mokvdebode**t**
mokvdebi**an**	mokvdebod**nen**	mokvdebod**nen**
	Aorist	*Optative (Aorist Subj.)*
	mo**v**kvdi	mo**v**kvde
	mokvdi	mokvde
	mokvd**a**	mokvde**s**
	mo**v**kvdi**t**	mo**v**kvde**t**
	mokvdi**t**	mokvde**t**
	mokvd**nen**	mokvd**nen**
	Evidential Indicative	*Evidential Subjunctive*
	mo**v**mkvdar**v**ar	mo**v**mkvdariqavi
	momkvdar**x**ar	momkvdariqavi
	momkvdar**a**	momkvdariq**o**
	mo**v**mkvdar**v**ar**t**	mo**v**mkvdariqavi**t**
	momkvdar**x**ar**t**	momkvdariqavi**t**
	momkvdar**an**	momkvdariqv**nen**

TABLE 5

Class 2x

kvd ‘die’

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
vtamašob	**v**tamašobdi	**v**tamašobde
tamašob	tamašobdi	tamašobde
tamašob**s**	tamašobd**a**	tamašobde**s**
vtamašob**t**	**v**tamašobdi**t**	**v**tamašobde**t**
tamašob**t**	tamašobdi**t**	tamašobde**t**
tamašob**en**	tamašobd**nen**	tamašobd**nen**
Future	*Conditional*	*Future Subjunctive*
vitamašeb	**v**itamašebdi	**v**itamašebde
itamašeb	itamašebdi	itamašebde
itamašeb**s**	itamašebd**a**	itamašebde**s**
vitamašeb**t**	**v**itamašebdi**t**	**v**itamašebde**t**
itamašeb**t**	itamašebdi**t**	itamašebde**t**
itamašeb**en**	itamašebd**nen**	itamašebd**nen**
	Aorist	*Optative (Aorist Subj.)*
	vitamaše	**v**itamašo
	itamaše	itamašo
	itamaš**a**	itamašo**s**
	vitamaše**t**	**v**itamašo**t**
	itamaše**t**	itamašo**t**
	itamaše**s**	itamašo**n**
	Evidential Indicative	*Evidential Subjunctive*
	mitamašnia	**m**etamaša
	gitamašnia	**g**etamaša
	utamašnia	etamaša
	gvitamašnia	**gv**etamaš_a
	gitamašnia**t**	**g**etamaš_a**t**
	utamašnia**t**	etamaš_a**t**

TABLE 6

Class 3

tamaš ‘play’

Indicative		Subjunctive
Non-past	Past	
Present	*Imperfect*	*Present Subjunctive*
mɣviʒavs	**m**ɣviʒavda	**m**ɣviʒavdes
gɣviʒavs	**g**ɣviʒavda	**g**ɣviʒavdes
ɣviʒavs	ɣviʒavda	ɣviʒavdes
gvɣviʒavs	**gv**ɣviʒavda	**gv**ɣviʒavdes
gɣviʒav**t**	**g**ɣviʒavda**t**	**g**ɣviʒavde**t**
ɣviʒav**t**	ɣviʒavda**t**	ɣviʒavde**t**
Future	*Conditional*	*Future Subjunctive*
meɣviʒeba	**me**ɣviʒeboda	**me**ɣviʒebodes
geɣviʒeba	**ge**ɣviʒeboda	**ge**ɣviʒebodes
eɣviʒeba	eɣviʒeboda	eɣviʒebodes
gveɣviʒeba	**gve**ɣviʒeboda	**gve**ɣviʒebodes
geɣviʒeba**t**	**ge**ɣviʒeboda**t**	**ge**ɣviʒebode**t**
eɣviʒeba**t**	eɣviʒeboda**t**	eɣviʒebode**t**
	Aorist	*Optative (Aorist Subj.)*
	meɣviʒa	**me**ɣviʒos
	geɣviʒa	**ge**ɣviʒos
	eɣviʒa	eɣviʒos
	gveɣviʒa	**gve**ɣviʒebos
	geɣviʒa**t**	**ge**ɣviʒebo**t**
	eɣviʒa**t**	eɣviʒebo**t**
	Evidential Indicative	*Evidential Subjunctive*
	mɣviʒebia	**m**ɣviʒoda
	gɣviʒebia	**g**ɣviʒoda
	ɣviʒebia	ɣviʒoda
	gvɣviʒebia	**gv**ɣviʒoda
	gɣviʒebia**t**	**g**ɣviʒoda**t**
	ɣviʒebia**t**	ɣviʒoda**t**

TABLE 7

Class 4

ɣviʒ ‘be awake’

The inconsistency of the match between logical ("initial" in Relational Grammar (RG)) grammatical relations and their formal markers constitutes a problem for an analysis based on classical morphemes because we have not simply an alternative phonological shape associated with a constant meaning (garden-variety allomorphy), but rather an apparent systematic substitution of forms which are canonically associable with a contrasting meaning. It is for this reason that Harris (1981, 1984) analyzes 'inversion' as a sequence of RG syntactic operations.

Anderson (1992:155-56) claims that there are no clearly syntactic attributes of 'inversion', that linear word order is unaffected, regardless of marker type, and thus that 'inversion' is a phenomenon restricted to inflectional morphology. Despite this rejection of Georgian 'inversion' as syntax proper, Anderson proposes a solution based on movement. Movement applies here not to syntactic units but rather covertly to Anderson's abstract level of layered morphosyntactic representations (MSRs). The manipulation of MSRs essentially 'tricks' the inflectional component into giving the desired results, because the word formation rules (WFRs) introducing the affixes are stated so as to apply blindly to particular layers of MSR structure, i.e., the same MSR on different layers will license the application of different WFRs. This approach will thus give rise to the introduction of a featurally equivalent, but formally potentially distinct exponent. Despite their ability to cover the facts, MSR transformations have little independent motivation in the rest of Anderson's theory.

3. Disjunctivity in Georgian agreement marking

The second morphosemantic mismatch to be found in Georgian agreement marking is a systematic formal underdetermination of verbs having particular combinations of two or more arguments. As seen in the paradigms in section 2, the two major sets of argument markers are as given in (2), repeated in (4):

(4)	1sg.	2sg.	3sg.	1pl.	2pl.	3pl.
"*v*-set"	*v-*	—	*-s*	*v-…-t*	*-t*	*-en*
"*m*-set"	*m-*	*g-*	—	*gv-*	*g-…-t*	—

Any analysis in which words are built up through a compilation of meaningful pieces (morphemes) or through the application of strictly information-increasing rules (as in Articulated Morphology, Steele 1995) would lead to the prediction that, all else being equal, the following distribution of markers in verb forms with two arguments should hold (assuming somewhat arbitrarily, but not crucially, that subject markers would appear consistently 'outside of' direct object markers):

(5) An “idealized” paradigm[2] for the present tense of *xedav*, ‘see’

DO Subj.	1sg.	2sg.	3sg.	1pl.	2pl.	3pl.
1sg.		**V**-**g**-xedav	**v**-xedav		**V**-**g**-xedav-**t**	**v**-xedav
2sg.	**m**-xedav		xedav	**gv**-xedav		xedav
3sg.	**m**-xedav-**s**	**g**-xedav-**s**	xedav-**s**	**gv**-xedav-**s**	**g**-xedav-**t**-**S**	xedav-**s**
1pl.		**V**-**g**-xedav-**t**	**v**-xedav-**t**		**V**-**g**-xedav-**T**-**t**	**v**-xedav-**t**
2pl.	**m**-xedav-**t**		xedav-**t**	**gv**-xedav-**t**		xedav-**t**
3pl.	**m**-xedav-**en**	**g**-xedav-**en**	xedav-**en**	**gv**-xedav-**en**	**g**-xedav-**T**-**en**	xedav-**en**

Affixes which are predicted (i.e., semantically motivated) but which do not actually occur are given as capitals in (5)[3]. From (5) it can be seen that those forms which are not as one would predict are all and only those in which two prefixal markers and/or two suffixal markers are semantically motivated.

These facts are summarized by Cherchi (1999:43, citing Aronson 1990:169-70) as the following set of stipulations:

(6) **Rule 1**: First person subjects cannot occur with first person objects. Second person subjects cannot occur with second person objects.

Rule 2: The 2nd person object marker *g*- overrides the 1st person subject marker *v*-.

Rule 3: Only one -*t* suffix can occur in a given inflected verb form.

Rule 4: The 3rd person singular subject suffix -*s* is overridden by the plural object suffix -*t*.

Rule 5: The 3rd person plural subject suffix -*en* overrides the plural object suffix -*t*.

Carmack (1997) suggests that Georgian disjunctivity can be reduced to the operation of an information-based blocking mechanism. This account claims that, assuming a maximum of one prefix and one suffix in any given verb form, the information contained in the combination of markers which appears is more than any possible alternative (contextually appropriate) combination. Carmack proposes a calculation process for information content in morphemes (320) which allows a principled decision to be made. Although such a mechanism does give correct results much of the time, and it may capture some diachronic tendencies of how such a system developed, it is rather implausible as part of a synchronic grammar. The failure of a plural suffix -*t* to accompany

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[2] Shaded cells correspond to combinations of like (non-3rd) person values; the object arguments in these combinations are realized by a periphrastic construction rather than by an affix on the verb itself.

[3] An across-the-board ban on geminate consonants in Georgian makes the case of the competing -*t* suffixes for SU[1pl.]/DO[2pl.] moot.

the 1st person plural object prefix *gv-* in an otherwise unsuffixed form is accommodated by Carmack with an appeal to analogy, blocking the redundant marking of plurality (320, 323). If maximizing information is the driving force, however, a *-t* suffix ought to appear in such cases whenever it is not specifically pre-empted by *-s* or *-en*. The generalization that a 1st person plural object correlates only with the *gv-* prefix is missed in this account.

Halle and Marantz (1993:116-20) propose an analysis within their theory of Distributed Morphology (DM) whereby all the morphosyntactic features of the arguments in a Georgian clause are compiled in a (pro-)clitic cluster, immediately preceding the verb stem. They further propose that this collection of features is subject to morphological operations of *fission*, *fusion*, and *merger*, which create the necessary terminal nodes as part of DM's post-syntactic level of Morphological Structure (MS, located between SS and PF in the standard "T-model" of the grammar). The nodes created are of exactly the right number and end up in exactly the right positions with respect to the verb stem, by means of as many morphological operations as necessary.

There is, however, neither distributional nor phonological evidence to support the claim that the agreement markers are clitics rather than ordinary affixes. The motivation for DM's assumption of a clitic cluster, it would seem, is to have a structurally isolated 'workspace' in which to hash out the necessary node creation, deletion, combination, and sequencing, independent of the rest of verbal inflection. Even with this considerable expressive license, however, DM is left with no non-stipulative account of the disjunction between pairs of affixes. Halle and Marantz are left to assume a version of the *Elsewhere Condition* (Anderson 1969, 1986, 1992; Kiparsky 1973), whereby competition between any two items (in DM, morphemes) is resolved in favor of the more specific competitor. The lexical entries for the morphemes *g-* and *v-* as defined in Halle and Marantz (1993:119) are as follows:

(7) a. [+2], DAT ↔ /g-/
    b. [+1] ↔ /v-/

Assuming the EC, (7a) should precede and exclude (7b), the correct precedence relation. The problem, however, is that they tie the definition to dative case, which would seem to be at odds with the 'inversion' facts. If case must be ignored, Halle and Marantz (1993:120) are prepared to invoke extrinsic ordering of application, that is, the result of the disjunctive application is simply stipulated and does not follow from any other principles. Once this device is added to an already considerable arsenal of manipulations, the DM model is rendered nearly, if not completely, unfalsifiable.

The latter two assumptions, i.e. the EC and extrinsic ordering, are explicitly borrowed into DM from the work of Anderson (1986, 1992). Anderson makes the assumption that "[r]ules may be organized (by stipulation) into disjunctive blocks, corresponding (roughly) to the traditional notion of *position class*" (1986:3). Position classes (to be discussed further within PFM, below) are defined with respect to linear order and co-occurrence facts, i.e. purely distributionally. Membership in one of

Anderson's WFR-blocks and the disjunctivity which follows is not principled or predictable in this way, but rather may be stipulated,

> For instance, of two descriptively adjacent rules, one might be a rule of prefixation and the other of suffixation. Such rules could potentially be stipulated to be disjunctive on the present approach, giving complementarity between structurally non-equivalent forms (4, fn. 3).

This move opens the range of possibilities in a way that no predictions are possible—for most any given set of observations, the linguist has the power to stipulate a rule ordering to obtain the desired effects. This lack of falsifiability must be seen as an excess, since it allows for many more types of interactions than are actually observed.

In the case of Georgian, where a WFR prefixing *g-* apparently preempts a WFR prefixing *v-*, the solution for Anderson is to assume that these rules belong to the same disjunctive block and that the rule prefixing *g-* is simply ordered ahead of the rule prefixing *v-* by stipulation, since the Elsewhere Condition as conceived of in Anderson (1986, 1992) does not favor one over the other on grounds of morphosyntactic specificity. This would seem to be only marginally more explanatory than the bald rule set of Aronson (1990) given in (6) above. While it is an advance for a theory to have an explicit acknowledgement of disjunctivity, the power involved in Anderson's approach to rule block formation and extrinsic ordering is a high price for a weak position.

4. Georgian agreement in Paradigm Function Morphology

Most recently, Stump (2001:69-73, 83-86) has taken on Georgian agreement as a testing ground for the strong Pāṇinian Determinism Hypothesis (PDH), a fundamental assumption of his Paradigm Function Morphology (PFM) approach to inflection:

> According to the [PDH], all override relations within a realization-rule block are determined by a universal principle; the possibility is excluded that such relations might ever be stipulated on a language-specific basis (62).

This assumption is therefore very much at odds with Anderson's take on extrinsic ordering, and also with Halle and Marantz's (1993) position (in addition to a number of other conflicting assumptions there). The realization-rule blocks referred to in the preceding are inflectional rules in PFM which license the presence of a certain inflectional exponent in a certain linear position or 'slot'. In this way, PFM rule blocks much more closely reflect the traditional morphological notion of a position class than do their analogues in Anderson's theory.

The PDH states more specifically that the narrowest applicable rule in a rule block overrides the application of all other applicable rules in that block (Stump 2001: 22-24). Narrowness is determined with respect to a set-theoretic relation between the morphosyntactic feature-value sets realized by each of the rules so compared, on the one hand, or between the set of lexemes to which the rules are applicable. In the former case, the narrowest rule realizes an extension of the features realized by any other applicable rule (it is therefore more specific). In the latter case, by contrast, the narrower lexeme class is a proper subset of those lexemes to which any other rule is applicable (ms. p. 77). Narrowness thus depends on a combination of these two dimensions. Applicability is assessed similarly with respect to particular pairings of lexical roots and full sets of morphosyntactic feature values—rules are applicable iff they do not conflict with the lexeme class of the root, and they realize a proper subset of the feature values in the full set.

PFM encounters a problem in Georgian based on the following proposed block of realization rules[4] (Stump 2001:70):

(8) a. $RR_{\mathrm{pref},\ \{\mathrm{AGR(su)}:\{\mathrm{PER}:1\}\},\ V}(<X, \sigma>) \quad =_{\mathrm{def}} <vX', \sigma>$
b. $RR_{\mathrm{pref},\ \{\mathrm{AGR(ob)}:\{\mathrm{PER}:1\}\},\ V}(<X, \sigma>) \quad =_{\mathrm{def}} <mX', \sigma>$
c. $RR_{\mathrm{pref},\ \{\mathrm{AGR(ob)}:\{\mathrm{PER}:1,\ \mathrm{NUM}:pl\}\},\ V}(<X, \sigma>) \quad =_{\mathrm{def}} <gvX', \sigma>$
d. $RR_{\mathrm{pref},\ \{\mathrm{AGR(ob)}:\{\mathrm{PER}:2\}\},\ V}(<X, \sigma>) \quad =_{\mathrm{def}} <gX', \sigma>$

Since these rules belong to the same rule block, the PDH predicts that no two of these rules should qualify as the narrowest applicable rule in any context, i.e. there can be no ‘ties’, for this would entail an arbitrary, and therefore unprincipled, ‘tiebreaker’ stipulation. Rules (8b, c, and d) cannot simultaneously apply to the same form because they each realize a different value for the feature {AGR(ob)}. Rule (8a) cannot conflict with either (8b) or (8c) because in Georgian, matching values for {PER} require the use of a periphrastic reflexive construction for one of the arguments. The only potential conflict, therefore, is between rules (8a) and (8d), which, as written, are equally narrow and equally applicable to a verb root (V) paired with any extension of the feature value set {{AGR(su):{PER:1}}, {AGR(ob):{PER:2}}}. Does this indeed falsify the PDH, as Anderson (1986, 1992) and Halle and Marantz (1993) would have it? Must extrinsic ordering be countenanced, even in the more constrained position class rule block of PFM?

Stump’s (2001:72ff) response to this problem is to propose a second mode of realization rule application, as *expansion schemata*. “A realization rule R applying in expanded mode is a rule schema instantiated by each member of a class S_R of rules applying in expanded mode…” (72). For every unexpanded rule in S_R, the set of morphosyntactic feature values mentioned in that rule’s property-set index must be a well-

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[4] PFM is an inferential-realizational theory of inflection. On this approach, morphological exponents are introduced in forms as licensed by the application of realization rules (RRs) which apply to pairings of lexical roots (X) and fully specified sets of morphosyntactic properties (σ) applicable to such roots. RRs bear three (subscript) indices, a *block index*, a *property-set index*, and a *class index*, in that order. These indices play a role in the determination of (1) Applicability and (2) (relative) Narrowness of competing rules within any rule block, as demanded under the PDH. See chapter 2 of Stump (2001) for detailed discussion.

formed extension of the property-set index of the schema. Assuming the following expansion schema in the prefix block for Georgian (arrows around a property-set index indicate expanded application):

(9) $$RR_{\text{pref}, \leftarrow\{\textsc{Agr}(\text{ob}):\{\textsc{Per}:2\}\}\rightarrow, \text{V}}(<X, \sigma>) \quad =_{\text{def}} <gX', \sigma>,$$

this entails that any form which involves the realization of a {PER:2} object argument will show a *g*- prefix and no other prefix. This claim is indeed consistent with the facts: "[w]henever a rule R realizing second-person object agreement competes with another rule, R is the overriding rule" (86).

Stump (2001) argues forcefully that expansion schemata are consistent with the PDH, and that they are formally more constrained, and hence more predictive than a theory which permits extrinsic ordering (73-75). The prediction that allows expansion schemata to escape criticism for being an *ad hoc* crypto-stipulation is that there will be no instances where expansion schemata in the same rule block will come into conflict, and therefore that rules applying in expanded mode will never be overridden when applicable.

This solution is ingenious and considerably more constrained than the competing analyses, but is this new mode of rule application actually motivated by the facts of Georgian? We are left to wonder, "What's so special about {AGR(ob): {PER:2}}?".

The question here is not whether expansion schemata are a valid formal device or not, but rather whether there is a way, within the existing resources of PFM, to gain the same results for Georgian without them. In the following section, I will propose a possible alternative which, while respecting the guidelines and leading ideas (the "what" and "how") of PFM, offers somewhat more insight into the "why."

5. PFM, Georgian, and the "narrowest applicable rule"

Stump's response to the narrowness deadlock between rules (8a) and (8d) was to retool rule (8d) with respect to the property-set index, entailing a considerable augmentation of his rule theory, i.e. the introduction of expansion schemata. Since the Narrower relation is defined with respect to both the property-set and the lexeme class indices of realization rules (Stump 2001:52), I propose that a closer look at the class indices (simply given as V[erb] in the rules in (8)) is in order.

The choice to mark the rules with the class index V was presumably to make the rules as broadly applicable as possible. The conflict can only arise in principle in transitive or ditransitive verbs, and not in intransitives. The rules as stated are not falsified by this fact–since they simply are not both applicable, no arbitration is required (or rather the Pāṇinian well-formedness conditions are satisfied vacuously) in such cases. The use of V, then, is not strictly speaking inaccurate, in that it makes no false predictions[5], but it masks an alternative Narrowness assessment which could prove decisive without introducing otherwise novel machinery.

Lexeme class theory must presuppose a theory of the organization of the lexicon, and entries within that lexicon. It is not the case, however, that there is anything close to general agreement on what the lexicon is like, and in fact, much of generative linguistic theory has gone to considerable lengths to avoid using the lexicon for anything but the most recalcitrant of irregularities (e.g., "…there neither can nor should be a theory directly about [the lexicon]…" (Di Sciullo and Williams 1987:4)). That said, even Di Sciullo and Williams acknowledge that words are eminently categorizable, both derivationally and inflectionally, but they claim that these are aspects of the (undefined and therefore quasi-mystical) "space of words" in a language and not of the "lexicon" *per se* (4).

The sense of "lexicon" that I am interested in here, then, has more in common with the "word space" metaphor for the lexicon than the more traditional "rogue's gallery" conception (present even in Bloomfield (1933)), because our concern is the domain of morphological rules and what can inform them. It should stand to reason that lexeme classes and subclasses to which realization rules might refer will be those which have to do with morphological generalizations, whether morphosyntactic, morphophonological, or more purely morphological (morphomic). Some of the lexeme classes (beyond the major categories of N, V, and A) mentioned in Stump (2001) are the C-stem and Multiple C-stem nominals of Sanskrit (ch. 6), and the four-way division of Truncating and Non-truncating Consonantal and Vocalic verbs of Bulgarian (ch. 2). These classifications are equivalent to inflectional (declension and conjugation) classes, to be distinguished by patterns of inflection within their respective paradigms.

Built into the PFM reliance on override/default relations between realization rules is an implicit acknowledgment of inheritance from class to subclass, i.e., certain generalizations may hold of all verbs in a language e.g., but other facts will apply to certain subclasses to the exclusion of others. Taking inheritance on directly, as is done in Network Morphology (e.g., Corbett and Fraser 1993), or in certain outgrowths of Head-driven Phrase Structure Grammar (HPSG; esp. Riehemann 1997, Kathol 1999, Meurers 2000) will allow a picture of lexeme classification to come through more clearly.

Verbs in general have a minimum of one argument to index, regardless of the morphosyntactic properties associated with that argument in context (the distinction between *valence*, on the one hand, and *argument structure*, on the other). Verbs with a valence of one can index only one argument, and thus no conflict in realization can arise. Georgian verbs of the second conjugation are, as a class, intransitive, and thus have only one argument, all else being equal. The point here is that verbs can safely be said to have one morphosyntactic argument position (MAP, Gerdts 1992, 1993a, 1993b) by default,

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[5] It was also the practice among Sanskrit grammarians (with Pāṇini foremost) to state rules as broadly as possible, within their formalism, including any number of irrelevant environments, just so long as no demonstrable counterexamples were included.

i.e. by virtue of being verbs. Having additional MAPs, then, is a fact about transitive and ditransitive verbs, and not a general fact about the class of verbs. In this way, the ability of a verb to take multiple arguments (understanding arguments to be SU, DO, or IO) is not something to be expected of all verbs, and it is for this reason that it was claimed above that although marking the realization rules in (8) as applying to the lexeme class V is not false, it is misleading with respect to what we can expect from particular classes of verbs, defined by their valence (and, accordingly, their MAPs).

To make this more concrete, we need to consider an interface between syntax and inflection with respect to the set of arguments to be realized on the verb[6]. Gerdts's series of articles offers a bridge between the 'terms' of RG—logical subject (=1), logical direct object (=2), and logical indirect object (=3)—and the inflectional marking patterns which these terms receive under different (morpho-)syntactic conditions. This approach fits together very well with an approach to morphology which assumes the Separation Hypothesis, whereby grammatical function and (morpho-)phonological exponence are in principle distinct. PFM is one such approach to morphology. A MAP, in this sense, corresponds to a system of morphosyntactic marking (here a set of markers on the verb), which although they may be associated with one function canonically, need not be so associated in their every instance, as is the case in Georgian with the so-called 'inversion' construction: a mismatched pattern which occurs in certain tense/mood/aspect combinations for verbs of the first and third conjugations (see Tables 1-2, 6) and categorically for verbs of the fourth conjugation (see Table 7). From this perspective markers are elements of form and not classical linguistic signs, i.e. not *morphemes*. The single argument of an intransitive verb will be its logical subject, its '1'. By default, in Georgian, this term is associated with some member of the "*v*-set" of markers in (4) above, repeated here with amended (MAP-based) labels as (10):

(10)

	MAP A	MAP B
1st singular	*v-*	*m-*
2nd singular	—	*g-*
3rd singular	*-s*	—
1st plural	*v-...-t*	*gv-*
2nd plural	*-t*	*g-…-t*
3rd plural	*-en*	*-t*

To recast this further into PFM terms, i.e., distinguishing prefix-slot exponents from non-prefixes[7], we arrive at (11):

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[6] Case marking on NPs in Georgian is also controversial, and it does not follow one-for-one with the verb inflection patterns described here. Attempts to account for both argument marking and case marking in one fell swoop are bound to miss real generalizations about each.

[7] Any non-prefixal argument index would belong to some other position-based rule block, from which position they cannot affect the distribution of prefixes in any way.

(11) **Prefixes**

	MAP A	MAP B
1st singular	*v-*	*m-*
2nd singular	—	*g-*
3rd singular	—	—
1st plural	*v-*	*gv-*
2nd plural	—	*g-*
3rd plural	—	—

This shows more clearly than ever the limited potential for conflict—exponents in the same row or in the same column cannot compete with each other in principle. It also shows that there is exactly one MAP A prefix, *v-*, which realizes the morphosyntactic property {PER:1}.

The innovation in the present analysis consists in the extension of the abstract indexation of sets of non-stem elements which nevertheless seem to organize themselves into (limited, non-lexemic) paradigms. Stump (2001:184) presents what he calls the *Indexing Autonomy Hypothesis* (IAH), specifically with reference to lexical stems, as follows:

(12) **Indexing Autonomy Hypothesis** (IAH): The determination of a stem's index is in principle independent of the determination of its form.

This hypothesis is designed to address apparent mismatches between a stem's form and its function, or in other words, the fact that a single stem, as a formal element, may be associated in the same paradigm with semantically and/or grammatically unrelated functions. Purely morphological (*morphomic*) indices such as 'strong' or 'weak' (also the Sanskrit 'guṇa', 'vṛddhi' grades) may be assigned to stems on formal grounds, but the use to which these forms are put may vary from one inflectional class to another. The use of MAPs here is meant to be an analogous sort of index for the argument markers of Georgian. The analogy is not meant to go all the way through, of course, since whereas each lexeme of a certain category may have a number of distinct stems, often relatable to one another in morphophonological terms, these argument markers are a small and finite collection, and the MAPs are correspondingly few in number.

What remains is to incorporate this notion into the PFM framework. In the case of stems, PFM separates rules of stem formation, stem indexation, and stem selection, with only the last of these being realization rules proper (block '0' rules). Since we really do not need rules of marker 'formation', and we similarly do not require productive rules of marker indexation, we actually only need to find a way to state the generalization of when to choose from column (MAP) A and when from B.

The default association between grammatical relations and MAPs is direct (adapted from Gerdts 1992:293):

(13)

Grammatical Relations: 1 2 (initial relations in classic RG)

| |

MAPs: A B (final relations in classic RG)

This means that where there is a single argument (verbs with a valence of one) that argument will be realized (at least in part) with the MAP A marker on the verb which matches it for person and number (all else being equal). The empirical prediction, then, is that the only prefixal index that will appear on an intransitive Georgian verb is *v*-, when the 1-term is {PER:1}.

As discussed above, arguments in excess of one are the special case, rather than the default case, among the category of verbs taken as a whole. On this interpretation, it stands to reason that in a non-inverted transitive verb, the non-1-term, i.e., the direct object, will constitute a contribution toward Narrowness. In other words, a second term is only possible with a subset of the class V, in contrast with a first term[8], which every verb has by default (i.e. inherits as members of the category V). Thus any realization rule realizing properties of a second term will be narrower than a rule realizing attributes of a 1-term. This is the implicit Narrowness that the realization rules as presented in (8) disguised. In the only situation where a conflict can arise, namely where the *property-set indices* on the rules in question would seem to be deadlocked, the relative Narrowness of the *class index* carries the day, and the 2-term/MAP B marker *g*- is in fact predicted to override the 1-term marker, under the ordinary definition of Narrowness: *v*- may appear only if the realization rule introducing *g*- is not applicable.

Although the MAPs may seem superfluous under direct association, their value comes to the fore in the so-called 'inversion' construction. MAP association other than that shown in (13) occurs if either:

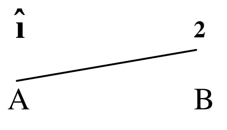
(14) (i) the verb lexeme belongs to the fourth conjugation, or
(ii) (a) the verb lexeme belongs to the first or third conjugation, and
(b) the property set is an extension of {EVID:yes}.

If the conditions of (14) are met, then the 'inversion' construction is used (Harris 1981, 1984).

(15) The 'inversion' construction in MAP terms:

Grammatical Relations:

MAPs:



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[8] Here "first term" is independent of the number of the grammatical role associated with that term under RG assumptions; thus a first term may be a 2-term, as in the RG analysis of the sole argument of unaccusative verbs.

In (15), the 1-term is placed *en chômage* (displaced, indicated by the circumflex diacritic), but there is a question as to whether this is the result of a syntactic operation, or merely the result of a stipulated override mapping of the 2-term onto MAP A, leaving the 1-term to "fend for itself" as it were. A 1-term so preempted in the 'inversion' construction does not simply take over the abandoned MAP B, and in fact a third term or an oblique may take the MAP B marker itself, leaving the 1-term to be marked as a canonical indirect object (=3-term) might.

The nature of the PFM inflectional component is one of static well-formedness conditions that hold of inflected forms which correspond to cells in the inflectional paradigms of the lexemes of a language. From this perspective, there is no place for post-syntactic reordering, even of abstract elements like MSRs. Lexemes and feature-value sets are paired, both in the cells of paradigms and in particular linguistic contexts. Inflected forms of lexemes, *words* in PFM parlance, are the morphophonological input to the phonological component, and as such, they are completely compiled structurally within the lexicon, with only (automatic) allophony and any external sandhi (segmental and/or suprasegmental) left to be resolved.

Since MAP specifications are essentially morphomic indices, it is an error to portray them as morphosyntactic properties on a par with {PER}, {TNS}, {MOOD}, etc., as in the following (cf. (8), above):

(16) $\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}1:\{\textsc{Per}:1,\textsc{Map}:\mathrm{A}\}\},\mathrm{V}}(<X,\sigma>) =_{\mathrm{def}} <vX,\sigma>$
$\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}2:\{\textsc{Per}:1,\textsc{Num}:\mathrm{sg},\textsc{Map}:\mathrm{B}\}\},\mathrm{V}}(<X,\sigma>) =_{\mathrm{def}} <mX,\sigma>$
$\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}2:\{\textsc{Per}:1,\textsc{Num}:\mathrm{pl},\textsc{Map}:\mathrm{B}\}\},\mathrm{V}}(<X,\sigma>) =_{\mathrm{def}} <gvX,\sigma>$
$\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}2:\{\textsc{Per}:2,\textsc{Map}:\mathrm{B}\}\},\mathrm{V}}(<X,\sigma>) =_{\mathrm{def}} <gX,\sigma>$

Even though this use of a putative feature {MAP} would allow the realization rules to be stated generally over the class V without fear of contradiction, it is questionable to place a purely morphological feature side by side with, or in (partial) replacement of, feature values that determine its distribution, e.g., {TNS, MOOD, ASP}. This intermingling of the morphomic and morphosyntactic would actually introduce redundancy into the statement of the rules, since the value of {MAP} is predictable from conjugation class, and in the case of 1st and 3rd conjugation verbs, the value of evidential {EVID} modality.

The realization rules in (17) give the default associations between grammatical relation and a marker selected from the corresponding MAP set:

(17) (a) $\mathrm{RR}_{\mathrm{pref},\{\textsc{Per}:1\},\mathrm{V}}(<X,\sigma>) =_{\mathrm{def}} <vX,\sigma>$
(b) Where α=1 or 3,
$\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}2:\{\textsc{Per}:1,\textsc{Num}:\mathrm{sg}\}\},\mathrm{V}\alpha}(<X,\sigma>) =_{\mathrm{def}} <mX,\sigma>$
(c) Where α=1 or 3,
$\mathrm{RR}_{\mathrm{pref},\{\textsc{Agr}2:\{\textsc{Per}:1,\textsc{Num}:\mathrm{pl}\}\},\mathrm{V}\alpha}(<X,\sigma>) =_{\mathrm{def}} <gvX,\sigma>$
(d) Where α=1 or 3,

$RR_{\text{pref},\{\text{AGR2}:\{\text{PER}:2\}\},V\alpha}(\langle X,\sigma\rangle) \quad =_{\text{def}} \langle gX,\sigma\rangle$

Rule (17a) is stated quite generally, independent of grammatical relation, and since its exponent can appear on verb lexemes of any conjugation, it may be viewed as a default marker which appears to index any {PER:1} argument, just in case no narrower rule in the prefix block is applicable. In this way, since (17a) applies as a relative default, while (17d) applies only to a proper subset of the lexemes to which (17a) may apply, the precedence of (17d) over (17a) is captured without singling out the former as applying in a special, expanded, mode.

In order to incorporate the association shown in (15) into PFM without unnecessary redundancy, it is necessary to treat the MAPs as one would the index 'strong' or 'weak' with respect to stem, a designation which plays only an indirect role in the definition of paradigm functions. The identity of the markers associated with the 2-term under inversion and the 1-term without inversion must be captured. Such systematic syncretism may be handled in PFM by means of *rules of referral* (Stump 1993, 2001:ms. p. 67-68, 82-84), which point the exponence of a property-set toward an independently motivated rule of exponence. The format for a rule of referral is slightly different that that for rules of exponence, because in a sense rules of referral are 'parasitic' on particular rules of exponence. Adding the following rules of referral to the rules of exponence in (17), we approach the full prefix rule block:

(18) (a) $RR_{\text{pref},\{\text{AGR2}\},V4}(\langle\sigma\rangle) \quad =_{\text{def}} \langle\sigma\rangle/\{\text{AGR1}\}$
(b) Where α=1 or 3,
$RR_{\text{pref},\{\text{AGR2},\text{EVID:yes}\},V\alpha}(\langle\sigma\rangle) \quad =_{\text{def}} \langle\sigma\rangle/\{\text{AGR1, EVID:no}\}$

The notation σ/ρ is meant to be interpreted as defining the well-formed property set which is just like σ, except the feature mentioned in ρ is given the value mentioned in ρ in place of any value it may have in σ. Thus, in (18a), in order to realize a 2-term argument on a fourth-conjugation verb, look to what would ordinarily be done to a 1-term argument with the same {PER, NUM} values. Similarly, in (18b), for verbs of the first or third conjugations, in order to realize a 2-term argument in the evidential mode, look to what would ordinarily be done to a 1-term argument with the same {PER, NUM} values in the non-evidential mode.

Rule (18b) is relatively unproblematic, because the class index is held constant throughout. In (18a), however, the referral is from class V4 to V2, perhaps, or equivalently to V1 or V3, provided we restrict our attention to extensions of {EVID:no}. In short, one referral (18b) is *vertical*, i.e., within-paradigm, but the other (18a) is *horizontal*, i.e., across paradigms. It is not clear whether horizontal referrals are to be ruled out in principle, or if they are merely difficult to formalize. If the latter, we are perhaps finished here. If the former, however, it is worth considering alternative formalizations of the MAP generalization in (15), made first in terms of morphological metageneralizations:

(19) (Morphomic) MAP selection rule
Associate a 2-term argument with MAP A.

(20) Morphological metageneralization
(a) If $X \in V4$, then for any RR_{pref} applicable to X, (19) $\in \phi RR$[9].
(b) For any root-feature pairing $<X,\sigma>$, if $X \in V1 \vee V3$, and if σ is an extension of {EVID:yes}, then for any RR_{pref} participating in the definition of $PF<X,\sigma>$, (19) $\in \phi RR$.

This use of morphological metageneralizations departs from their use in Stump (2001:ms. p. 69-74), where they are limited to examples of morphophonological rules. The function of metageneralizations, however—that they are 'rules about rules'—would seem to allow for the possibility of generalizations of this sort to have an analogous place in the grammar.

It may well be that the two conditions for 'inversion' belong to different formal structures (see Janda and Joseph (1986), Stewart (in progress)), that is, that the limited 'inversion' in classes V1 and V3 is better handled with a rule of referral as in (18b), but the categorical 'inversion' in class V4 is better handled with a morphological metageneralization. Since it would portray the formal identity of the MAP B markers to posit a set of realization rules bearing the class index V4 and stating the exponents directly, certainly an account closer to one of the above would be preferable.

6. Conclusions

As stated at the outset, there are two phenomena in Georgian argument indexing that challenge a morpheme-based account, the so-called 'inversion' construction and disjunctivity. The present analysis builds on the best of what has gone before in the treatment of these facts, and in fit of conservatism, an account is developed here which relies on independently motivated formal mechanisms within PFM theory in hopes of arriving at an adequate description of the data.

A call for an explicit theory of lexeme classes is made, with Network Morphology and certain developments of HPSG as possible guides to the characterization of subclasses and inheritance. With a clear and constrained theory of lexeme classification, the relative narrowness of competing realization rules can better be assessed, since there indeed appear to be cases where a comparison of property-set indices alone is inconclusive for the PDH.

Since some version of the Separation Hypothesis is already assumed in a realizational morphological theory such as PFM, it is reasonable to reaffirm the validity of the Hypothesis whenever form-function mismatches seem to arise. The patterning of

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[9] ϕRR is a set of rules constraining the evaluation of a rule RR.

markers in the ‘inversion’ construction shows that the markers are not isomorphic linguistic signs, but rather they are formal elements, deployed for various functions in the synchronic grammar of modern Georgian.

Finally, the goal of this paper was to lend support to the strongest possible version of the PDH, whereby competition between any two applicable rules in the same block is always decided in favor of the narrower competitor. This competition operates in a principled fashion, given a consistent rule format, a distributionally based way to determine block membership, and explicit definitions of both narrowness and applicability. A PFM account need not relax its assumptions to handle the Georgian case. Expansion schemata or extrinsic ordering may yet be needed, but we should resist their premature adoption.

Appendix - Morphosyntactic (MS) Properties in Georgian

Feature	***(abbreviation)***	***Permissible values***
Evidential	(EVID)	yes, no
Aorist	(AOR)	yes, no
Future	(FUT)	yes, no
Mood	(MOOD)	indicative, subjunctive (indic, subj)
Past	(PAST)	yes, no
Agreement		
-‘(Logical) Subject’	(AGR1)	(sets of MS properties)
-‘(Logical) Object’	(AGR2)	(sets of MS properties)
Person	(PER)	1, 2, 3
Number	(NUM)	singular, plural (sg, pl)

Along with these feature-value pairs, the paradigm of the Georgian verb is defined by the following feature *co-occurrence restrictions*:

a. σ is an extension of {EVID:yes}, iff neither {AOR} nor {FUT} are defined.

b. Where α = yes or no, σ is an extension of {FUT:α} iff {EVID:no} and {AOR} is undefined.

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FLEXIBLE SUMMATIVITY: A TYPE-LOGICAL APPROACH TO PLURAL SEMANTICS

Nathan Vaillette

Abstract

This paper explores some theoretical properties of summativity, a generalization of cumulativity. It presents an approach to plural semantics in which summativity can apply not only to lexical predicates, but also to partially saturated predicates. It is shown how this approach can be tied to an explicit type-logical syntax.

1 Introduction

The distinction between distributivity and collectivity has been taken as the starting point for many discussions of the semantics of plural noun phrases (hereafter PNPs). However, as noted early on in (Scha 1981) (also discussed in (Langendoen 1978)), it does not exhaust the possibilities. An example like (1) also exhibits a "neutral" construal, which says that the men can be divided up into groups, each of which lifted the piano, and which put together just add up to the men; but says nothing about how they are divided up. What is interesting about this construal is that it subsumes both the collective and distributive construals, as we shall see in section 4.

VAILLETTE, NATHAN 2001. Flexible Summativity: A Type-Logical Approach to Plural Semantics. *OSUWPL 56, 135–157.*

(1) The men lifted the piano.

A common generalization for a semantics for PNPs extends the distributive/collective distinction to the various argument places of multivalent verbs which can be occupied by plural arguments. For instance, in the following example, we can interpret both arguments distributively (understanding that each teacher marked each exam), interpret the subject collectively and the object distributively (so that all the teachers as a group marked each exam), and so forth.

(2) The teachers marked the exams.

Scha's original treatment in (Scha 1981) was similar, and also allowed the neutral construal as a third possibility for each argument (his C_2 reading). However, (2) also exhibits a construal that Scha called "cumulative": this commits us to all of the teachers marking and all the exams being marked, but to nothing about the "division of labor," i.e. how the teachers relate to the exams (what this exactly amounts to will be spelled out in section 3). What is interesting is that the cumulative construal can't be derived from any combination of distributivity, collectivity, and neutrality of the separate argument places. To see why, given a binary relation R and individuals x and y, say x is "R-involved" with y if x is part of some group g_1 and y is part of some group g_2 such that g_1 stands in the relation R to g_2. It is easy to prove that any reading of "the As R the Bs" derived from any of the nine combinations (of distributivity, collectivity, and neutrality for both of the arguments) requires that each individual in the As is R-involved with each individual in the Bs. The cumulative construal on the other hand breaks this tight connection; this is what makes it (properly) cumulative, by allowing various unconnected relations between parts of groups to "add up" to a relation between groups. This perspective also drives home the point that despite the complexity of some of the classic examples used to illustrate it, there's nothing "exotic" about the cumulative construal. For instance, distributivity and collectivity are too specific, but cumulativity is sufficiently general, to account for the truth of a sentence like *the men lifted the boxes* in the simple situation where each man lifts just one box.

Recall that in the single argument case, the neutral construal subsumed both the collective and distributive ones. The cumulative construal (more accurately, the "generalized cumulative" construal to be defined in section 3) exhibits parallel behavior in the two argument case: it is more general that any of the nine combinations discussed above. Furthermore, we will see in section 3 that when we generalize cumulativity to relations of arbitrary arity, neutrality falls out as just the special instance of it in the unary case.

Because of its generality, it seems evident that cumulativity ought to occupy a special place in any theory of plural semantics. First of all, one should be suspicious of any approach such as (Scha 1981), (Kamp & Reyle 1993) etc. that starts with a simple approach to distributivity, collectivity, and neutrality, but is then forced to adopt additional, complicated mechanisms to account for cumulativity. A more reasonable approach would start with the most general construal and derive the more specific instances by further restrictions. In fact, it is arguable to what degree these restrictions have to be imposed semantically at all. It seems advisable to postulate ambiguity (as opposed to simply vagueness of reference) only where linguistic evidence motivates it, and some semanticists have questioned whether the different construals derivable from restrictions on cumulativity have any such justification to be treated as resolutions of true ambiguity (see especially (Schwarzschild 1991), (Schwarzschild 1996), (van der Does 1993), (van der Does & Verkuyl 1996), and (Verkuyl 1994)). This paper will not attempt to reiterate or evaluate these arguments, but will rather simply take the unambiguity hypothesis as its basis and study its semantic properties and syntactic implementation.[1]

The paper is organized as follows: in section 2, I outline the algebraic approach to plurality introduced in (Link 1983). Section 3 shows how cumulativity (or in a broader sense, "summativity") can be formalized and generalized within this framework and points out what some different approaches to the phenomenon have in common. Section 4 presents the main theoretical claim of this paper (which builds off of (Sternefeld 1998)): that summativity should not be taken as a lexical property of predicates, but rather as a combinatory operation that may apply at different levels of predicate saturation to yield different semantic results. A type-logical syntax/semantics interface is provided in sections 5 and 6, and the derivations of some desired readings are illustrated.

2 Modeling Structures

An obvious way to model groups is with sets. This approach was taken in early work on plural semantics (e.g. (Bennett 1975)) and in much subsequent research. However, this paper will use the algebraic approach introduced in (Link 1983). In this framework, both basic individuals and groups made out of them are of a single semantic type, which has a lattice structure imposed on it. In fact, this structure will be isomorphic to an appropriate kind of set-theoretic lattice, so the algebraic approach does not buy us much in principle. The primary justification that Link notes is the ease with which it can be adapted to the arguably non-well-founded domain of mass term denotations. For our purposes, the only real advantage of this approach is its perspicuity: it is convenient for e.g. the sets of individuals that model predicate or common noun denotations to be kept typographically distinct from the denotations of PNPs. Everything discussed here can be translated straightforwardly into purely set-theoretic terminology.

The algebraic structure that best mimics the part-whole structure the subset relation imposes on sets is a Boolean algebra. However, the operation we most clearly need for linguistic applications is a join which works like set-union to put objects together into groups, and it is unclear that meets and bottom have any role to play. Thus we will follow

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[1] For this reason, I will use the term *construal* in this paper whenever I am not committed to treating the relevant distinction as an ambiguity. The term *reading* is only used where the analysis presented predicts an ambiguity, i.e. where the syntax-semantics interface associates multiple, truth conditionally distinct semantic representations with a single string of words.

(Link 1998) (appendix) in using only semilattices. Nonetheless, the semilattices we want—what Link dubs "plural semilattices"—will be just those that are like the "top half" of a Boolean algebra. The following definitions set the stage:

1 Definition (Join Semilattice)
A *join semilattice* is a poset $L = \langle S, \sqsubseteq_L \rangle$ where any two elements x and y of S have a least upper bound w.r.t. $\sqsubseteq_L$ (written $x \sqcup_L y$).

In what follows, all our semilattices will be join semilattices by default. Semilattices can also be characterized algebraically by viewing join as a binary operation. The conditions on $\sqcup_L$ that ensure a semilattice structure are that it be commutative, associative, and idempotent. $\sqsubseteq_L$ and $\sqcup_L$ then become interdefinable: $x \sqsubseteq_L y \equiv x \sqcup_L y = y$. In what follows, we will leave off the subscripts when it is clear which semilattice is being discussed.

It is easy to prove that in a semilattice, not only every pair of elements but also every non-empty finite set of elements has a least upper bound. *Completeness* extends this property to arbitrary non-empty sets:

2 Definition (Complete Semilattice)
A semilattice $\langle S, \sqsubseteq_L \rangle$ is *complete* if for every non-empty subset S' of S, S' has a least upper bound in S w.r.t. $\sqsubseteq_L$ (written $\bigsqcup_L S'$).[2]

3 Definition (Atom)
Given a join semilattice $L = \langle S, \sqsubseteq_L \rangle$, an *L-atom* is any minimal element of S w.r.t. $\sqsubseteq_L$. We write $u \sqsubseteq_L^{\circ} x$ as an abbreviation for "u is an L-atom and $u \sqsubseteq_L x$" (omitting reference to L when convenient).

This gives us enough machinery to define plural semilattices; the following definition of plural semilattices is taken from (Link 1998) (appendix, p. 376):

4 Definition (Plural Semilattice)
A *plural semilattice* (written PSL) is a complete join semilattice $\langle S, \sqsubseteq \rangle$ that obeys the following conditions:

1. $S \neq \emptyset$. (Non-Emptiness)
2. S has no least element under $\sqsubseteq$. (No Bottom)
3. For every $x \in S$, there is a $u \in S$ s.t. $u \sqsubseteq^{\circ} x$. (Atomicity)
4. For each $x, y \in S$ s.t. $x \not\sqsubseteq y$, there is a $u \sqsubseteq^{\circ} x$ s.t. $u \not\sqsubseteq y$. (A-Separation)
5. For any $X \subseteq S$, for any $u \sqsubseteq^{\circ} \bigsqcup X$, there is a $b \in X$ s.t. $u \sqsubseteq b$. (Sup-Primes)

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[2] Note that some authors use a stricter definition of completeness that requires the existence of $\bigsqcup \emptyset$, and thus of a least element.

As hinted at above, a plural semilattice is just like the "top half" of a Boolean algebra, which itself is like a subset lattice. The following theorem relates plural semilattices and set-theoretic lattices directly:

5 Proposition (PSL Representation Theorem)
For any PSL $\langle S, \sqsubseteq \rangle$ with A the set of its atoms, the function h which maps each $s \in S$ to $\{u \in A \mid u \sqsubseteq^{\circ} s\}$ is a complete join semilattice isomorphism from $\langle S, \sqsubseteq \rangle$ to $\langle \wp(A) \setminus \{\emptyset\}, \subseteq \rangle$. Equivalently, for any non-empty $X \subseteq S$, $h(\bigsqcup X) = \bigcup h[X]$. (For proof, see (Link 1998) appendix p. 381f.).

The last concept we discuss in this section can be used to model what (Quine 1960) calls "cumulative reference."[3] Basically, (the extension of) a predicate P is said to have cumulative reference if whenever P holds of two objects x and y, it holds of their join $x \sqcup y$. More generally, if a cumulatively referring P holds of all of the elements of some set S, it also holds of $\bigsqcup S$. *Algebraic closure* is just a way of minimally extending a predicate P so that it refers cumulatively.

6 Definition ($^{\star}P$)
Given a complete join semilattice $L = \langle S, \sqsubseteq \rangle$ and a $P \subseteq S$, the *algebraic closure of P w.r.t. L* (written $^{\star}P$) is defined as the smallest superset of P which is closed under arbitrary non-empty joins (i.e. $^{\star}P = \bigcap \{Q \supseteq P \mid \forall Q' \subseteq Q(Q' \neq \emptyset \rightarrow \bigsqcup Q' \in Q\})$.[4]

Now we can put these concepts to use in analyzing some plural expressions, following (Link 1983). Assume a domain D of the objects we use to model individuals and groups. The former will be the atoms, the set of which we'll call A; the latter will be the non-atomic elements of D. $[\![-]\!]$ will be the interpretation function mapping expressions of the language to their model-theoretic interpretation.

One kind of PNP can be made from a plural common noun by adding the definite determiner. Let's assume that any singular common noun *CN* denotes a set of individuals, i.e. $[\![CN]\!] \subseteq A$. We want its plural counterpart *CNs* to be true of just those groups that are made up of individuals which of which *CN* holds; this can be expressed by setting $[\![CNs]\!] = {}^{\star}[\![CN]\!]$. Then, we can treat *the CNs* as "all the *CNs* put together," i.e. $[\![\textit{the CNs}]\!] = \bigsqcup [\![CNs]\!]$.

Another way of making PNPs is by conjoining definite NPs, such as proper nouns, or NPs constructed from singular or plural common nouns with the definite determiner. We interpret conjunction as putting its conjuncts' denotations together in a group: for any definite NPs DNP_1 and DNP_2, $[\![DNP_1 \textit{ and } DNP_2]\!] = [\![DNP_1]\!] \sqcup [\![DNP_2]\!]$.

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[3] One should not confuse cumulative reference with cumulativity in the sense used in this paper, though as we will see in the next section, the two are closely related.

[4] The algebraic closure of P in L coincides with the complete sub-semilattice of L generated by P, a more standard notation for which is $[|P|]$. We will use $^{\star}P$ to avoid confusion with the denotation function $[\![-]\!]$.

3 Summativity

In this section, we explore how predicates combine with their plural arguments. We assume that the predicate denotations encode the difference between individual and group action by whether individuals or groups are contained in them. n-place predicates in general denote appropriate subsets of $D^{(n)}$.[5]

With the tools from the previous section, we can formalize various possibilities for combining predicates with arguments. (3) gives the one-argument case with an intransitive verb V. The simplest option is (3a): the collective construal just amounts to the group denoted by the NP inhabiting the predicate. The distributive construal in (3b) on the other hand breaks the NP denotation up into its atomic parts and applies the predicate to each of them individually. The neutral construal can be expressed by (3c): the NP denotation is broken up into subgroups to which the predicate applies. The universal quantification over atomic parts guarantees that the subgroups exhaust the NP denotation, i.e. that their combinded join is just $[\![NP]\!]$.

(3) (a) Collective:
$[\![NP]\!] \in [\![V]\!]$
(b) Distributive:
$(\forall x \sqsubseteq^{\circ} [\![NP]\!])(x \in [\![V]\!])$
(c) Neutral:
$(\forall x \sqsubseteq^{\circ} [\![NP]\!])(\exists g \sqsubseteq [\![NP]\!])(x \sqsubseteq g \wedge g \in [\![V]\!])$

This formulation makes the relationships between the construals easy to understand. The neutral construal associates each atomic part x with some group g it belongs to and applies the predicate to g. The collective construal results from the neutral construal by associating each x with the same group, namely the whole $[\![NP]\!]$. The distributive construal is similarly just the special case of the neutral one where each atomic x is associated with the trivial group x containing just itself.

Now, one way to avoid a proliferation of different combinatoric options is to always combine a predicate with its NP argument by just checking to see if the latter is an element of the former, but first modifing the predicate denotation so that it has the desired properties. Recall that our methodologial assumption is that only the most general construal needs to be represented. Thus, the relevant question is how a predicate P can be modified to yield a new predicate P' which contains $[\![NP]\!]$ if and only if (3c) holds.

This problem has been approached a few different ways in the literature. One line of thought represented by Krifka in (Krifka 1989) and subsequent work links neutrality to cumulative reference—P' should contain just those groups which can be built up out of memebers of P, i.e. ${}^{\star}P$.

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[5] We write $S^{(n)}$ for $S \times \cdots \times S$ (n times).

Another tradition begins with Higginbotham's suggestion in (Higginbotham 1980) that P' contain just those groups that (speaking set-theoretically) can be divided into a partition each of whose cells is in P. For empirical reasons, Gillon found it necessary in (Gillon 1987) to relax the requirement imposed by a partition that its cells not overlap, and reformulated the Higginbotham semantics with the weaker notion of a *cover*. We can define an algebraic notion of cover as follows:

7 Definition (L-Cover)
Given a PSL $L = \langle S, \sqsubseteq \rangle$ and an $a \in S$, an *L-cover of a* is a non-empty set $C \subseteq S$ such that $\bigsqcup C = a$. (We drop reference to L when convenient).

What's interesting is that with the relaxation to covers, the Krifka and Higginbotham approaches become equivalent. The following proposition relates them to each other and to (3c):

8 Proposition
Given a PSL $L = \langle S, \sqsubseteq \rangle$, an $a \in S$, and a $P \subseteq S$, the following three statements are equivalent:

(i) $(\forall x \sqsubseteq^{\circ} a)(\exists g \sqsubseteq a)(x \sqsubseteq g \wedge g \in P)$

(ii) There is an L-cover C of a such that $C \subseteq P$.

(iii) $a \in {}^{\star}P$.

Proof: This equivalence falls out as the special case of proposition 11 below, where $n = 1$. □

Next we discuss the combination of multivalent verbs with their NP arguments. It is at this point that the cumulative reading becomes important. Although this construal is usually associated with Scha, the general truth condition schema in (4a) for a transitive verb TV with plural arguments NP_1 an NP_2 is already to be found in (Langendoen 1978). It says in essence that every atom in the subject did the relation to some atom in the object, and that to every atom in the object was done the relation by some atom in the subject. This captures the general conditions on sentences like *the men talked to the women* in an appealing way. However, the restriction to atomicity in (4a) is rather arbitrary, and in fact only works when the relation is inherently distributive on both argument positions. The need for a generalization of this schema is exemplified by Langendoen's example *the men released the prisoners*. Here, releasing someone is a property a group can have without it's individual members having it (though this property holds less convincingly for being released by someone, *pace* Langendoen). The revision in (4b) requires that every subject atom belongs to some subject subgroup that does the relation to some object subgroup and vice versa.

(4) (a) Cumulative:
$(\forall x \sqsubseteq^{\circ} [\![NP_1]\!])(\exists y \sqsubseteq^{\circ} [\![NP_2]\!])(\langle x, y\rangle \in [\![TV]\!]) \wedge$
$(\forall z \sqsubseteq^{\circ} [\![NP_2]\!])(\exists w \sqsubseteq^{\circ} [\![NP_1]\!])(\langle w, z\rangle \in [\![TV]\!])$

(b) Generalized Cumulative:
$(\forall x \sqsubseteq^{\circ} [\![NP_1]\!])(\exists g_1 \sqsubseteq [\![NP_1]\!])$
$(x \sqsubseteq g_1 \wedge (\exists g_2 \sqsubseteq [\![NP_2]\!])(\langle g_1, g_2\rangle \in [\![TV]\!])) \wedge$
$(\forall z \sqsubseteq^{\circ} [\![NP_2]\!])(\exists g_3 \sqsubseteq [\![NP_2]\!])$
$(z \sqsubseteq g_3 \wedge (\exists g_4 \sqsubseteq [\![NP_1]\!])(\langle g_4, g_3\rangle \in [\![TV]\!]))$

Here we suppress the various construals that derive from the various combinations of distributive, collective, and neutral readings for the two argument places; it is straighforward but tedious to verify that they all entail (4b).

The advantages of an approach which derives the cumulative construal by modifying the relation and then applying it directly to its NP arguments are clearer in the multivalent case than for the derivation of the neutral construal with single argument predicates. It is rather difficult to devise combinatoric rules that put two NPs and a verb together to yield (4b). A DRT treatment of such rules is hinted at in (Kamp & Reyle 1993) and (Reyle 1996), but these rules involve copying of quantificational material into various DRS-boxes in a way that is essentially non-compositional. Referring to the simpler (4a), Sternefeld comments that "[i]t is fairly obvious that [it] cannot be derived from the syntactic structure…by compostional methods…[T]he paraphrase with four quantifiers will always exhibit a kind of 'cross-over effect,' so that the quantifiers get in one another's way, excluding a compositional analysis."

The problem is exacerbated if we make the plausible assumptions that predicates with more than two argument places combine with their arguments in a parallel way, so that e.g. *the men gave the presents to the children* means (5):

(5) (i) Each man belongs to a subgroup of the men that gave some subgroup of the presents to some subgroup of the children, and

(ii) each present belongs to a subgroup of the presents that was given by some subgroup of the men to some subgroup of the children, and

(iii) each child belongs to some subgroup of the children that was given some subgroup of the presents by some subgroup of the men.

The problem is that the general schema for this kind of three-place cumulativity can't be gotten at by first deriving the two-place cumulative meaning for the combination of the predicate with two of its arguments via (4b) and then adding something further; for each argument A, existential quantification over subgroups of *every* other argument must occur within the scope of universal quantification over A's atomic parts. This difficulty increases the desirablity of deriving (4b) and its counterparts at higher arities by modifying the predicate somehow and then simply applying the result to the arguments.

One way to do this is what Krifka calls "summativity" (Krifka 1989). This operation closes an n-ary relation R under (binary) pairwise joins:

(6) $\mathsf{summate}(R) =_{def}$

$$\bigcap\{Q \mid R \subseteq Q \wedge (\forall x_1, \ldots, x_n)(\forall y_1, \ldots, y_n) \\ (\langle x_1, \ldots, x_n\rangle \in Q \wedge \langle y_1, \ldots, y_n\rangle \in Q\ .\rightarrow \\ \langle x_1 \sqcup y_1, \ldots, x_n \sqcup y_n\rangle \in Q)\}$$

The cover approach can get the same result by existentially quantifying over the right kind of pair-cover, in a way introduced in (Schwarzschild 1991).

These approaches are obviously related to the corresponding closure and cover approaches for the one argument place. In fact, one can view the multivalent versions as exactly the same as the one-argument versions if one thinks about the structure that the semilattice structure of the domain D imposes on the domain $D^{(n)}$ of n-tuples of which an n-ary relation is a subset:

9 Definition **($L^{(n)}$)**
Given a complete join semilattice $L = \langle S, \sqsubseteq_L\rangle$ and a natural number $n > 0$, we define *the n-th product of* L to be the order $L^{(n)} = \langle S^{(n)}, \sqsubseteq_{L^{(n)}}\rangle$, where for each $\vec{x}, \vec{y} \in S^{(n)}$, $\vec{x} \sqsubseteq_{L^{(n)}} \vec{y}$ iff for all $i, 0 < i \leq n, \pi_i(\vec{x}) \sqsubseteq_L \pi_i(\vec{y})$. We abbreviate $\sqsubseteq_{L^{(n)}}$ as $\sqsubseteq_n$ whenever L is fixed.[6]

It is easy to prove that the n-th product of any (complete) semilattice is itself a (complete) semilattice. In particular, if L is a PSL, then so is $L^{(n)}$. This follows from the easily proved lemmata in 10:

10 Lemma
For any PSL $\langle S, \sqsubseteq_L\rangle$, the following hold of any $\langle S^{(n)}, \sqsubseteq_n\rangle$:

(i) For all non-empty $R \subseteq S^{(n)}$, the least upper bound of R w.r.t. $\sqsubseteq_n$ (written $\bigsqcup_n R$) exists in $S^{(n)}$: it is the n-tuple $\langle \bigsqcup_L \pi_1[R], \ldots, \bigsqcup_L \pi_n[R]\rangle$.

(ii) For any $\vec{u}, \vec{x} \in S^{(n)}$, $\vec{u} \sqsubseteq^{\circ}_n \vec{x}$ iff for all i $(0 < i \leq n), \pi_i(\vec{u}) \sqsubseteq^{\circ}_L \pi_i(\vec{x})$.

(iii) For all $\vec{x}, \vec{y} \in S^{(n)}$, if $\vec{x} \not\sqsubseteq_n \vec{y}$, then there is some $\vec{u} \sqsubseteq^{\circ}_L \vec{x}$ and some i $(0 < i \leq n)$ s.t. $\pi_i(\vec{u}) \not\sqsubseteq_n \pi_i(\vec{y})$.

(iv) For any $\vec{a} \in S^{(n)}$, any $R \subseteq S^{(n)}$, if $\vec{a} = \bigsqcup_n R$, then there is a $\vec{b} \in R$ s.t. for all i $(0 < i \leq n), \pi_i(\vec{a}) \sqsubseteq_L \pi_i(\vec{b})$.

Recall that Krifka's modification of a unary predicate P was just the algebraic closure of P; it's easy to see that his modification of a higher arity relation, $\mathsf{summate}(R)$, is

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[6] $\vec{x}$ abbreviates the n-tuple $\langle x_1, \ldots, x_n\rangle$, and we write $\pi_i(\vec{x})$ for the i-th projection of $\vec{x}$.

just the algebraic closure of R, but with respect to the product ordering $D^{(n)}$ (the only difference being that (6) above is insufficiently general in that summate only closes a relation under finite, but not arbitrary non-empty joins). In what follows, we use the notation ${}^{\star}_{n}R$ for the upper closure of R w.r.t. $\sqsubseteq_n$; then the general modification we make to an R of any arity n, including 1, is ${}^{\star}_{n}R$. The same kind of generalization can be made for the cover approach: for an R of any arity n, we want $\{\vec{a} \in D^{(n)} \mid \text{there is an } L^{(n)}\text{-cover } C \text{ of } \vec{a} \text{ s.t. } C \subseteq R\}$. This applies equally well for $n = 1$ if we equate the 1-tuple $\langle x\rangle$ with x.

The equivalence of the closure and cover approaches extends to the multivalent case as well. The following theorem shows this, also shows that and that they both are equivalent to the generalization of the cumulativity schema (4b) to arbitrary arities. The proof is given in the appendix.

11 Proposition

Given a PSL $\langle S, \sqsubseteq_L\rangle$, its n-product PSL $\langle S^{(n)}, \sqsubseteq_n\rangle$, an $\vec{a} \in S^{(n)}$, and an $R \subseteq S^{(n)}$, the following three statements are equivalent:

1. $$\bigwedge_{0<k\leq n}\left(\begin{array}{l}(\forall x_k \sqsubseteq_L^{\circ} \pi_k(\vec{a}))\\ \qquad (\exists g_1 \sqsubseteq_L \pi_1(\vec{a}))\ldots(\exists g_n \sqsubseteq_L \pi_n(\vec{a})) :\\ \qquad\qquad (x_k \sqsubseteq g_k\\ \qquad\qquad \wedge \langle g_1,\ldots,g_n\rangle \in R)\end{array}\right)$$
2. There is an $L^{(n)}$-cover C of $\vec{a}$ such that $C \subseteq R$.
3. $\vec{a} \in {}^{\star}_{n}R$.

Despite the equivalence between the closure and cover approaches, their different formulations make them lend themselves differently to certain extensions. For instance, it has proved heuristically fruitful to begin with covers but then consider various stronger notions, such as "pseudo-partitions"; this path is followed in (Verkuyl 1994) and (van der Does & Verkuyl 1996). Another line of thinking introduced in (Schwarzschild 1991) replaces quantification over covers with pragmatic determination. This allows some of the distinctions the summative approach erases to be reintroduced, but in a parsimonious and context-dependent way that is consistent with a treatment of sentences with PNPs as semantically unambiguous. For the remainder of this paper however we will stick to the closure approach and refer to the general phenomenon of algebraic closure over relations of arbitrary arity as "summativity."

What this section has shown is that for any arity n, there exists a general method for associating the combination of an n-place predicate with n NP arguments yielding truth conditions that account for the cumulative construal (and its higher arity generalizations), and of which the distributive, collective, and neutral construals and their various combinations are special subcases. Furthermore, this method ties together two different strands of thought in the study of cumulativity and shows where they converge on the same result.

4 Flexible Summativity

In the previous section, we relied on intuitions about the "basic" denotations of predicates, and derived more complex summative denotations by means of algebraic closure or existential quantification over covers. In this section, we consider what linguistic status these "derived" predicates have.

Some researchers view it as a lexical property of verbs. For instance, (Lasersohn 1995) assumes that certain verbs are inherently algebraically closed. Notice that for these verbs, the intuitive distinction between the "basic" denotation and the derived one is lost, since nothing in the lexicon represents the basic sense. Lasersohn's motivation for lexicalizing summativity comes from his conviction that the cumulative construal is not available for all predicates. However, Bayer argues that although certain sentences seem to require construals stronger than the cumulative one, the same predicates occurring in them can be combined with different arguments in different contexts to allow the weaker construal (Bayer 1996). Thus, it seems possible to preserve the general hypothesis that all predicates allow summativity. Bayer makes this assumption, but still views summativity as a lexical property. It is not clear to me what the motivation for this is. It would seem that we could divorce specific predicate meanings from the general phenomenon of summativity by hanging on to basic predicate denotations and then applying a summativity operator to them. It might seem that there is no empirical difference between these two options. However, I will argue that the nonlexical approach gives us a kind of flexibility that allow us to account for a wider range of data.

Notice that the examples of summativity presented so far have all involved definite noun phrases. An important property that these have is that they are referentially independent, i.e. they don't enter into scope relations that can affect truth conditions. Compare (7a) with example (2), repeated here as (8a). Assume that predicate denotations are basic (not summative). Let's give an existential treatment to numerals as in (8b) following (Link 1983) (*six* being interpreted in a parallel fashion), where $|x|$ is interpreted as the cardinality of the set of atoms under x. Although we haven't discussed an explicit syntax-semantics interface, it should be clear that the only reading we get for (8a) from the machinery presented so far without further assumptions is something like (8c), a cumulative construal exactly parallel to (7b). Since permuting existential quantifiers preserves truth conditions, the two variables x and y are independent of each other, i.e. the choice of a value for one doesn't depend on the choice of a value for the other.

(7) (a) The teachers marked the exams.

(b) $\langle \bigsqcup {}^{\star}[\![\textit{teacher}]\!], \bigsqcup {}^{\star}[\![\textit{exam}]\!] \rangle \in {}^{\star}_{2}[\![\textit{marked}]\!]$

(8) (a) Three teachers marked six exams.

(b) $[\![\textit{three CNs}]\!] = \{Q \subseteq D \mid (\exists x \in [\![\textit{CNs}]\!])(|x| = 3 \land x \in Q)\}$

(c) $(\exists x \in [\![\textit{teachers}]\!])(\exists y \in [\![\textit{exams}]\!])(|x| = 3 \land |y| = 6 \land \langle x, y \rangle \in {}^{\star}_{2}[\![\textit{marked}]\!])$

However, (8c) does not cover all the ways (8a) can be understood. For instance, it can be read as making a claim about not six exams, but eighteen—six per teacher for each of three teachers. Now on this construal, it seems as if the predicate *marked six exams* is being applied to each of the individual teachers in turn, i.e. being interpreted distributively. The existence of such a construal with a concomitant difference in the total cardinality of the object is taken by e.g. (Roberts 1987) as prime evidence that such sentences are in fact ambiguous, not just vague, and that the distributive reading corresponds to one potential disambiguation. I accept the first conclusion, but deny that the data show anything about distributivity *per se*. I argue that the important difference between this construal and the cumulative one lies in the referential dependency of the exams on the teacher. A sentence can be ambiguous as to the dependencies between its NPs i.e. the scopes of its quantifiers, while still remaining vague about the divisions of labor involved. For instance, a sentence could have one reading where the choice of A depends on the choice of B and different one where the choice of B depends on A. At the same time, in the disambiguation where the choice of B depends on the choice of A, once we choose an x from the As, get the dependent choice of y from the Bs, and relate x and y, we still don't need to specify the division of labor that underlies this relation.

The reason this bears on the issue of the locus of summativity is that if we view the summativity operator as not tied to the completely unsaturated lexical predicate, but free to apply to a partially saturated, syntactically derived predicate, we can get just such a representation that specifies dependencies but underspecifies the division of labor. Consider (9a), which by proposition 8 is equivalent to (9b); this analysis of (8a) differs from (8c) in that the quantification over exams occurs within the scope of the closure, i.e. the closure applies not to the lexical predicate *marked* but to the derived one *marked six exams*. Such scope relationships encode the referential dependencies, while the use of summativity (instead of forcing a choice between more specific options like distributivity and collectivity) keeps the division of labor out of the semantics.

(9) (a) $(\exists x \in [\![\mathit{teachers}]\!])(|x| = 3 \wedge x \in {}^\star\{g \in D \mid (\exists y \in [\![\mathit{exams}]\!])(|y| = 6 \wedge \langle g, y\rangle \in [\![\mathit{marked}]\!])\})$

(b) $(\exists x \in [\![\mathit{teachers}]\!])(|x| = 3 \wedge (\forall z \sqsubseteq^\circ x)(\exists g \sqsubseteq x)(z \sqsubseteq g \wedge (\exists y \in [\![\mathit{exams}]\!])(|y| = 6 \wedge \langle g, y\rangle \in [\![\mathit{marked}]\!]))))$

Lastly, note that summativity has no effect when the predicate it yields gets applied to only to singular arguments, so there is no harm in associating summativity with predication in general, not just predication of plurals. This allows us to have a reading for a sentence like *the lawyers hired a secretary* where the choice of secretary is dependent on the choice of lawyer:[7]

(10) $\bigsqcup {}^\star[\![\mathit{lawyer}]\!] \in {}^\star\{x \in D \mid (\exists y \in [\![\mathit{secretary}]\!])(\langle x, y\rangle \in [\![\mathit{hired}]\!]\}$

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[7] Unfortunately, nothing in the account I will give blocks the reverse dependency $(\exists y \in [\![\mathit{secretary}]\!])(y \in {}^\star\{g \in D \mid \langle \bigsqcup {}^\star[\![\mathit{lawyer}]\!], g\rangle \in [\![\mathit{hired}]\!]\})$. This yields a purely collective reading, while our aim is to avoid specifying readings stronger than necessary.

A similar proposal is developed by Sternefeld in (Sternefeld 1998) which allows operators to apply to partially saturated predicates. However, that account differs in both spirit and specifics from the proposal I sketched above and develop more fully in section 6. First of all, the operators Sternefeld applies to these predicates are not restricted to summativity; he also allows the option of using a more specific distributivity operator, which I avoid. Secondly, I will assume that only one summativity operator is used with each predicate, while Sternefeld allows no such restriction. This allows him to represent a neutral–neutral reading of (8a) with two instances of 1-place summativity as in (11), as well as a distributive–distributive one, a distributive–neutral one, etc. However, since all these construals can be derived as special cases of the use of summativity plus scope variation, I do not see the necessity of this option.

(11) $(\exists x \in [\![\mathit{teachers}]\!])(|x| = 3 \wedge x \in {}^{\star}\{g \in D \mid (\exists y \in [\![\mathit{exams}]\!])$
$(|y| = 6 \wedge \in {}^{\star}\{g' \in D \mid \langle g, g' \rangle \in [\![\mathit{marked} \} \;]\!])\})$

Lastly, Sternefeld's syntax-semantics interface makes use of a syntactic level of logical form where these operators can be introduced non-deterministically as "semantic glue" in a way not related to the construction or lexical items used in a sentence. In the next two sections, I will develop a more tightly constrained interface in type-logical grammar that anchors summativity to predication.

5 Overview of Type-Logical Grammar

Type-logical grammar developed out of categorial grammar by focusing on the logical nature of categorial combinatorics. The account developed in this paper presupposes familiarity with the basics of the semantically annotated Lambek calculus, as it is presented in (Carpenter 1997). The sequent rules for this calculus are given in figure 1.

Following the presentation in (Carpenter 1997), this calculus can be extended with a binary connective '$\Uparrow$' to account for *in situ* binding phenomena. A category of the form $A \Uparrow B$ has type $(\mathsf{type}(A) \rightarrow \mathsf{type}(B)) \rightarrow \mathsf{type}(B)$. The application we will be concerned with here is the analysis of some NP expressions as of category $np \Uparrow s$, which occurs in an NP position but can be interpreted as combining with and "quantifying-into" a sentence. For example, assigning *every* the meaning and category $\lambda P \lambda Q. \forall x[P(x) \rightarrow Q(x)] : (np \Uparrow s)/n$ permits a standard Montogovian treatment of universal quantification. Sequent are given in figure 2.

The next extension we will need to make to the Lambek calculus for the purposes of this paper is to incorporate a limited kind of polymorphism. This allows us to manipulate not only constant categories, but also category variables. Polymorphic extensions to the Lambek calculus are discussed in e.g. (Emms 1993) and (Moortgat 1997). The motivation for such an extension is the desire to have a single, unambiguous lexical item be able to take on different categories in different contexts. For example, the word *and* can be used to

$$\frac{}{\alpha\colon A \vdash \alpha\colon A}\ (\text{Ax}) \qquad \frac{\Delta \vdash \alpha\colon A \quad \Gamma, \alpha\colon A, \Gamma' \vdash \beta\colon B}{\Gamma, \Delta, \Gamma' \vdash \beta\colon B}\ (\text{Cut})$$

$$\frac{\Gamma, \pi_1(\alpha)\colon A, \pi_2(\alpha)\colon B, \Gamma' \vdash \beta\colon C}{\Gamma, \alpha\colon A \bullet B, \Gamma' \vdash \beta\colon C}\ (\bullet\ \text{L}) \qquad \frac{\Gamma \vdash \alpha\colon A \quad \Delta \vdash \beta\colon B}{\Gamma, \Delta \vdash \langle \alpha, \beta \rangle\colon A \bullet B}\ (\bullet\ \text{R})$$

$$\frac{\Delta \vdash \beta\colon B \quad \Gamma, \alpha(\beta)\colon A, \Gamma' \vdash \gamma\colon C}{\Gamma, \Delta, \alpha\colon B\backslash A, \Gamma' \vdash \gamma\colon C}\ (\backslash\ \text{L}) \qquad \frac{x\colon A, \Gamma \vdash \alpha\colon B}{\Gamma \vdash \lambda x.\alpha\colon A\backslash B}\ (\backslash\ \text{R})$$

$$\frac{\Delta \vdash \beta\colon B \quad \Gamma, \alpha(\beta)\colon A, \Gamma' \vdash \gamma\colon C}{\Gamma, \alpha\colon A/B, \Delta, \Gamma' \vdash \gamma\colon C}\ (/\ \text{L}) \qquad \frac{\Gamma, x\colon A \vdash \alpha\colon B}{\Gamma \vdash \lambda x.\alpha\colon B/A}\ (/\ \text{R})$$

Figure 1: Sequent rules for the Lambek calculus with semantic annotations

$$\frac{\Delta_1, x\colon B, \Delta_2 \vdash \beta\colon A \quad \Gamma_1, \alpha(\lambda x.\beta)\colon A, \Gamma_2 \vdash \gamma\colon C}{\Gamma_1, \Delta_1, \alpha\colon B \Uparrow A, \Delta_2, \Gamma_2 \vdash \gamma\colon C}\ (\Uparrow \text{L})\ [x \text{ fresh}]$$

$$\frac{\Gamma \vdash \alpha\colon A}{\Gamma \vdash \lambda x.x(\alpha)\colon A \Uparrow B}\ (\Uparrow \text{R})\ [x \text{ fresh}]$$

Figure 2: Sequent rules for $\Uparrow$

conjoin to expressions of category X for (almost) any X. We can capture this by assigning it to the polymorphic category $(\forall X)(X\backslash X/X)$. This universal category can be instantiated to any constant category as needed.

In certain situations, we might want to limit this polymorphism so that the category variable can only be instantiated to certain categories. For instance, say we want a certain expression to be able to act as either a noun or noun phrase. In the system given here, we provide names for classes of categories, e.g. *nominal*, and define the class-membership relation "is a" in the metalanguage, by recursive definition or, as in this case, by simple enumeration:

(12)
- *np* is a *nominal*;
- *n* is a *nominal*;
- nothing else is a *nominal*.

We can now assign an expression to category $(\forall X \leq \ nominal)X$. The restriction that in such a category, X can be instantiated only to *np* or *n*, is implemented in the sequent rule by a side condition. Of course, in the case of a finite category class like this there are simpler ways to deal with category vagueness; the usefulness of bounded polymorphism is more apparent when the relevant class is infinite.

One question that needs to be asked about polymorphic categories is what type their semantic labels should have. This can be answered most satisfactorily in a richer type theory that countenances polymorphic types, such as that of (Cardelli & Wegner 1985). However, for our purposes here we will sidestep this problem by requiring that polymorphic categories always be labeled by syncategorematic semantic terms. For instance, our category for *and* can be labeled by the syncategorematic generalized conjunction symbol of (Partee & Rooth 1983), which has no type of its own, but when combining with two expressions of type τ is evaluated at type $\tau \rightarrow (\tau \rightarrow \tau)$. The rules of proof and use for $(\forall - \leq -)$ thus leave the semantic terms unchanged. Note the resulting calculus no longer exhibits a strict Curry-Howard correspondence between proofs and lambda-terms.

The details are as follows. We assume a denumerable set of category variables, which we write as X, Y, etc. The set of basic categories is now expanded to contain these alongside our atomic category constants. We also assume a set of category class symbols. We add to our recursive definition of complex category the clause (13), and extend our deductive calculus as in figure 3.

(13) If V is a category variable, c is a category class symbol, and A is a category, then $(\forall V \leq c)A$, is a category.

The last extension we will need is a way for selected expressions to escape the strict structural requirements of the Lambek calculus. We introduce a new unary category

$$\frac{\Gamma, \alpha\colon A^{\{B\backslash X\}}, \Delta \vdash \beta\colon B}{\Gamma, \alpha\colon (\forall X \leq T)A, \Delta \vdash \beta\colon B}\ (\forall\mathrm{L}) \qquad [\text{where } B \text{ is a } T]$$

$$\frac{\Gamma \vdash \alpha\colon A}{\Gamma \vdash \alpha\colon (\forall X \leq T)A^{\{X\backslash B\}}}\ (\forall\mathrm{R}) \qquad [\text{where } B \text{ is a } T]$$

Figure 3: Sequent rules for ∀

$$\frac{\Gamma_1, \alpha\colon A, \Gamma_2 \vdash \gamma\colon C}{\Gamma_1, \alpha\colon \triangle A, \Gamma_2 \vdash \gamma\colon C}\ (\triangle\mathrm{L}) \qquad \begin{array}{c} \Gamma_1, \alpha\colon \triangle A, \beta\colon B, \Gamma_2, \vdash \gamma\colon C \\ \hline\hline \Gamma_1, \beta\colon B, \alpha\colon \triangle A, \Gamma_2 \vdash \gamma\colon C \end{array}\ (\triangle\mathrm{P})$$

Figure 4: Sequent rules for △

constructor '△', borrowed from (Morrill 1994), which allows a formula it annotates to undergo permutation. Since we will not need a rule of proof in our applications, only a left rule is shown in figure 4: all it does is eliminate the △ from a formula, with no effect on the semantics.[8]

This concludes the presentation of the type-logical machinery used in this paper. The next section applies it to the syntax-semantic interface for flexible summativity.

6 A Syntax-Semantics Interface

Our goal is to analyze predications of PNPs in such a way that they are associated with a single summativity operator which can apply at any level of predicate saturation. This variability in the behavior of summativity will be modeled using bounded polymorphism and structural permutation.

First we need to add a summativity operator to our semantic representation language. It will be associated with a polymorphic category, since it can combine with a relation of any arity to yield a summative interpretation of that relation. For this reason, it will need to be syncategorematic. The following gives a meta-level definition of a semantic type-class *Erel*, which contains all types of (curried) relations over type *e*. The summativity operator Σ combines with any expression of such a type to yield a new expression of the same type, which is interpreted as the algebraic closure of the denotation of the original expression.

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[8] The double line in the △P rule indicates that it should be read biconditionally.

$$\dfrac{\dfrac{\dfrac{}{y\colon np \vdash y\colon np}\,\text{Ax} \qquad \dfrac{\dfrac{\dfrac{}{x\colon np \vdash x\colon np}\,\text{Ax} \quad \dfrac{}{\phi(y)(x)\colon s \vdash \phi(y)(x)\colon s}\,\text{Ax}}{x\colon np, \phi(y)\colon np\backslash s \vdash \phi(y)(x)\colon s}\,(\backslash\text{L}) \quad \dfrac{}{\gamma\colon s \vdash \gamma\colon s}\,\text{Ax}}{Q\colon np \Uparrow s, \phi(y)\colon np\backslash s \vdash \gamma\colon s}\,(\Uparrow\text{L})}{Q\colon np\Uparrow s, \phi\colon (np\backslash s)/np, y\colon np \vdash \gamma\colon s}\,(/\text{L})}{Q\colon np\Uparrow s, \phi\colon (np\backslash s)/np \vdash \lambda y.\gamma\colon s/np}\,(/\text{R})$$

Figure 5: Quantifier subject + transitive verb; γ abbreviates $Q(\lambda x.\phi(y)(x))$

(14)
- $e \to t$ is an *Erel*;
- If α is an *Erel*, then $e \to \alpha$ is an *Erel*;
- Nothing else is an *Erel*.

(15)
- The degree of $e \to t$ is 1.
- For an *Erel* $e \to \alpha$, the degree of $e \to \alpha$ is 1+ the degree of α.

(16) If ϕ is a wff of type τ and τ is an *Erel* with degree n, then $\Sigma(\phi)$ is a wff of type τ and $[\![\Sigma(\phi)]\!] = \mathsf{curry}({}^{\star}_{n}\mathsf{decurry}([\![\phi]\!]))$.[9]

Next, we define a category class *Everb* that picks out just those verbal categories whose semantic terms are of an *Erel* type; this class will form the restriction of Σ's polymorphic category.

(17)
- $np\backslash s$ is a *Everb*;
- np/s is a *Everb*;
- If α is a *Everb*, then $np\backslash\alpha$ is a *Everb*;
- If α is a *Everb*, then α/np is a *Everb*;
- Nothing else is a *Everb*.

Now, if we give the summativity operator the category of a polymorphic *Everb* modifier, it can combine with a lexical predicate, but also with a lower-arity partially saturated predicate. For instance, if we have a way to combine a subject directly with a transitive verb with category $(np\backslash s)/np$, we can wait till after we do this to apply closure. The derivation in figure 5 shows how we can do this, even when the subject is of a quantifier category. The resulting category is that of a sentence missing an object, to which Σ can apply.

---

[9] Since the closure operator is defined to operate on sets of n-tuples, a curried relation must be decurried to combine with it, and then the result must be re-curried. We could of course eliminate these steps by defining closure directly over curried relations.

$$
\begin{prooftree}
\AxiomC{Assoc}
\AxiomC{}
\RightLabel{Ax}
\UnaryInfC{$x\colon np \vdash x\colon np$}
\AxiomC{}
\RightLabel{Ax}
\UnaryInfC{$y\colon np \vdash y\colon np$}
\AxiomC{}
\RightLabel{Ax}
\UnaryInfC{$\phi(y)(x)\colon s \vdash \phi(y)(x)\colon$}
\RightLabel{(/L)}
\BinaryInfC{$\lambda w.\phi(w)(x)\colon s/np, y\colon np \vdash \phi(y)(x)\colon s$}
\AxiomC{}
\RightLabel{Ax}
\UnaryInfC{$\delta\colon s \vdash \delta\colon s$}
\RightLabel{($\Uparrow$ L)}
\BinaryInfC{$\lambda w.\phi(w)(x)\colon s/np, Q\colon np\Uparrow s \vdash \delta\colon s$}
\RightLabel{(\textbackslash L)}
\BinaryInfC{$x\colon np, \lambda z\lambda w.\phi(w)(z)\colon np\backslash(s/np), Q\colon np\Uparrow s \vdash \delta\colon s$}
\RightLabel{Cut}
\BinaryInfC{$x\colon np, \phi\colon (np\backslash s)/np, Q\colon np\Uparrow s \vdash \delta\colon s$}
\RightLabel{(\textbackslash R)}
\UnaryInfC{$\phi\colon (np\backslash s)/np, Q\colon np\Uparrow s \vdash \lambda x.\delta\colon np\backslash s$}
\end{prooftree}
$$

Figure 6: Transitive verb + quantifier direct object; δ abbreviates $Q(\lambda y.\phi(y)(x))$

Figure 6 shows how an object can also be put together directly with a transitive verb. The step labeled "Assoc" abbreviates the Lambek derivable sequent given in (18).

(18) $\phi\colon (np\backslash s)/np \vdash \lambda z\lambda w.\phi(w)(z)\colon np\backslash(s/np)$.

These derived predicates give us three options for incorporating the summativity operator (in a way to be explained in a moment) to derive four readings for a sentence of the form "$Q_1\colon np\Uparrow s, \phi\colon (np\backslash s)/np, Q_2\colon np\Uparrow s$".

We have a cumulative one in (19a), and the same with reversed scopes in (19b). In these, both quantifiers lie outside the scope of summativity We also have an object dependent reading (19c) and a subject dependent one (19d). This last one is perhaps hardest to get for the relevant sentences, but I do not attempt to account for this asymmetry here.

(19) (a) $Q_1(\lambda x.Q_2(\lambda y.(\Sigma(\phi))(y)(x)))$

(b) $Q_2(\lambda y.Q_1(\lambda x.(\Sigma(\phi))(y)(x)))$

(c) $Q_1(\lambda w.(\Sigma(\lambda x.Q_2(\lambda y.\phi(y)(x))))(w))$

(d) $Q_2(\lambda z.(\Sigma(\lambda y.Q_1(\lambda x.\phi(y)(x))))(z))$

Now we turn to the question of how Σ can get these scopes. Since type-logical grammar is radically lexicalized, the only way to introduce it into a sentence is by association with a lexical item. Since I argued above that summativity should be seen as a property of predication, I propose that it be incorporated lexically as part of the verbal predicate, but in a way that allows it to break free from the predicate. This can be accomplished by taking every lexical predicate we would normally assign some category $\phi\colon C$ and giving it the new category $\langle\phi, \Sigma\rangle\colon C \bullet \vartriangle(\forall X \leq Everb)(X/X)$. For instance, figure 7 shows a sample derivation of a (19c)-type object dependent reading for *three lawyers hired a secretary*, i.e. $\mathbf{three}(\mathbf{law})(\lambda z.\Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z))$ (abbreviated γ in the example). Here *hire*, instead of category **hire**: *tv*, has category ⟨**hire**, Σ⟩: $tv \bullet (\forall X \leq Everb)(X/X)$. The polymorphic part can be dissociated from the predicate as in the first step; since it is marked with $\triangle$, it need not combine directly with *hire*, but can permute to take a different argument as in the next step. When it finds one of some *Everb* category, here a yet-to-be-derived $np\backslash s$, it can lose its $\triangle$, be instantiated to $(np\backslash s)/(np\backslash s)$, and take the $np\backslash s$ as an argument.

7 Conclusion

Summativity has been shown to be a general characterization of the semantics of sentences with plural NPs, from which more specific construals can be derived as special cases. The way summativity is treated in section 3 ties together different traditions of approaching cumulative construals. As shown section 4, letting summativity apply to partially saturated predicates allows quantifier scope ambiguities to be captured in a representation that does not force further disambiguation between subconstruals of the summative one. The fragment in the final sections shows how this flexibility can be tied in a natural way to an explicit syntax.

Although our aim has been to maximize the generality of the analysis, the result may be too general in certain respects. First of all, as noted in footnote 7, the generality of the syntax-semantics interface actually undermines the generality of the semantics by allowing an undesirably specific construal as a combinatoric option. Secondly, as mentioned in section 6, it is not clear that subject dependent readings of the form in (19d) are actually possible. In that case, perhaps they should be ruled out in the syntax-semantics interface itself.

In a related vein, even if we take the most general construal as basic, natural language has mechanisms for forcing stronger readings. For instance, *each* appears to force distributivity, while *together* forces collectivity. It remains to be demonstrated exactly how this strengthening should be incorporated into the analysis given here.

Appendix

12 Proof (of proposition 11)

The definition of ${}^{\star}P$ w.r.t. L is equivalent to the definition of the complete sub-semilattice of L generated by P, which is equivalent, in fact for any arbitrary complete join semilattice L, to $\{x \in S \mid \text{for some } C \subseteq P, C \neq \emptyset, x = \bigsqcup_L C\}$ (see (Link 1998) p. 364 for proof). Since $L^{(n)}$ is complete join semilattice by lemma 10(i), this holds for ${}^{\star}_{n}R$ as well, so 11(ii) and 11(iii) are clearly equivalent. We now show the equivalence of 11(i) and 11(ii). As a preliminary, notice that we can rewrite 11(i) as 12(i) by introducing explicit universal quantification over the k's (the projections of $\vec{d}$) and reducing the multiple existential quantifications over g_i's to a single existential quantification over the whole n-tuple $\langle g_1, \ldots, g_n \rangle$:

Figure 7: Derivation of the object dependent reading for *three lawyers hired a secretary*; γ abbreviates $\mathbf{three}(\mathbf{law})(\lambda z.\Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z))$

(i)

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{}{\mathbf{hire} : tv, \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)) : np_{nom}\backslash s}\,\text{Prev} \quad \dfrac{\text{(see (ii) below)}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma : (np_{nom}\backslash s)/(np_{nom}\backslash s), \lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)) : np_{nom}\backslash s \vdash \gamma : s}\,/\text{L}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma : (np_{nom}\backslash s)/(np_{nom}\backslash s), \mathbf{hire} : tv, \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \gamma : s}\,\text{Cut}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma : \triangle((np_{nom}\backslash s)/(np_{nom}\backslash s)), \mathbf{hire} : tv, \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \gamma : s}\,\triangle\text{L}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \mathbf{hire} : tv, \Sigma : \triangle((np_{nom}\backslash s)/(np_{nom}\backslash s)), \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \gamma : s}\,\triangle\text{P}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \langle \mathbf{hire}, \Sigma \rangle : tv \bullet \triangle((np_{nom}\backslash s)/(np_{nom}\backslash s)), \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \gamma : s}\,\bullet\text{L}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \langle \mathbf{hire}, \Sigma \rangle : \forall X < Everb(tv \bullet \triangle(\mathrm{X}/\mathrm{X})), \mathbf{a}(\mathbf{sec}) : np_{acc} \Uparrow s \vdash \gamma : s}\,\forall\text{L}$$

(ii)

$$\dfrac{\dfrac{}{\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)) : np_{nom}\backslash s \vdash \lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)) : np_{nom}\backslash s}\,\text{Ax} \quad \dfrac{\text{(see (iii) below)}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x))) : np_{nom}\backslash s \vdash \gamma : s}\,\Uparrow\text{L}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma : (np_{nom}\backslash s)/(np_{nom}\backslash s), \lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)) : np_{nom}\backslash s \vdash \gamma : s}\,/\text{L}$$

(iii)

$$\dfrac{\dfrac{\dfrac{}{z : np_{nom} \vdash z : np_{nom}}\,\text{Ax} \quad \dfrac{}{\Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z) : s \vdash \Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z) : s}\,\text{Ax}}{z : np_{nom}, \Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x))) : np_{nom}\backslash s \vdash \Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z) : s}\,\backslash\text{L} \quad \dfrac{}{\mathbf{three}(\mathbf{law})(\lambda z.\Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x)))(z)) : s \vdash \gamma : s}\,\text{Ax}}{\mathbf{three}(\mathbf{law}) : np_{nom} \Uparrow s, \Sigma(\lambda x.\mathbf{a}(\mathbf{sec})(\lambda y.\mathbf{hire}(y)(x))) : np_{nom}\backslash s \vdash \gamma : s}\,\Uparrow\text{L}$$

12(i) $(\forall k, 0 < k \leq n)(\forall x_k \sqsubseteq_L^\circ \pi_k(\vec{d}))(\exists \vec{g}_{x_k} \in S^{(n)})$:
$\pi_1(\vec{g}_{x_k}) \sqsubseteq_L \pi_1(\vec{d}) \wedge \cdots \wedge \pi_n(\vec{g}_{x_k}) \sqsubseteq_L \pi_n(\vec{d})$
$\wedge\ x_k \sqsubseteq_L \pi_k(\vec{g}_{x_k})$
$\wedge\ \vec{g}_{x_k} \in R$

Explicitly quantifying over the projections of $\vec{g}_{x_k}$ and $\vec{d}$, we get 12(ii):

12(ii) $(\forall k, 0 < k \leq n)(\forall x_k \sqsubseteq_L^\circ \pi_k(\vec{d}))(\exists \vec{g}_{x_k} \in S^{(n)})$:
$(\forall i, 0 < i \leq n)(\pi_i(\vec{g}_{x_k}) \sqsubseteq_L \pi_i(\vec{d}))$
$\wedge\ x_k \sqsubseteq_L \pi_k(\vec{g}_{x_k})$
$\wedge\ \vec{g}_{x_k} \in R$

We can pull the mention of R up to the quantification over $\vec{g}_{x_k}$. Finally, by the definition of $\sqsubseteq_n$, we can rewrite the second line of 12(ii) as $\vec{g}_{x_k} \sqsubseteq_n \vec{d}$. This yields 12(iii):

12(iii) $(\forall k, 0 < k \leq n)(\forall x_k \sqsubseteq_L^\circ \pi_k(\vec{d}))(\exists \vec{g}_{x_k} \in R)$:
$\vec{g}_{x_k} \sqsubseteq_n \vec{d}\ \wedge\ x_k \sqsubseteq_L \pi_k(\vec{g}_{x_k})$

11(i) implies 11(ii): Assume 11(i) holds; then 12(iii) above holds. For each $x_k \sqsubseteq_L^\circ \pi_k(\vec{d})$, let $G_{x_k} = \{\vec{g}_{x_k} \in R \mid \vec{g}_{x_k} \sqsubseteq_n \vec{d}$ and $x_k \sqsubseteq_L \pi_k(\vec{g}_{x_k})\}$. 12(iii) just tells us that each such G_{x_k} is non-empty. Furthermore, we know by atomicity that for any k $(0 < k \leq n)$, there is always such an L-atom $x_k \sqsubseteq_L^\circ \pi_k(\vec{d})$, so there is indeed such a G_{x_k}.

For each k $(0 < k \leq n)$, let $D_k = \bigcup_{x_k \sqsubseteq_L^\circ \pi_k(\vec{d})}(G_{x_k})$. Let $C = \bigcup_{0<k\leq n}(D_k)$. Clearly $C \subseteq R$, since each $G_{x_k} \in R$. We claim C is an $L^{(n)}$-cover of $\vec{d}$.

The non-emptiness condition is straightforward to verify, since each D_k is non-empty. Now we must prove that $\vec{d} = \bigsqcup_n C$.

First of all, we show that $\vec{d}$ is an upper bound for C. By the definition of C, we know that for any $\vec{c} \in C$, there is a k $(0 < k \leq n)$ s.t. $\vec{c} \in D_k$. Then, by the definition of D_k, there is an $x_k \sqsubseteq_L^\circ \pi_k(\vec{d})$ s.t. $\vec{c} \in G_{x_k}$; so by the defintion of G_{x_k}, $\vec{c} \sqsubseteq_n \vec{d}$.

Now, to see that $\vec{d}$ is the least upper bound of C, say there were some $\vec{b} \in S^{(n)}$ s.t. for all $\vec{c} \in C$, $\vec{c} \sqsubseteq_n \vec{b}$, but $\vec{d} \not\sqsubseteq_n \vec{b}$. Then by lemma 10(iii) above, there is some $L^{(n)}$-atom $\vec{u}$ s.t. $\vec{u} \sqsubseteq_n^\circ \vec{d}$ and some i $(0 < i \leq n)$ s.t. $\pi_i(\vec{u}) \not\sqsubseteq_L \pi_i(\vec{b})$. We will refer to this $\pi_i(\vec{u})$ as u_i. Since $\vec{u} \sqsubseteq_n^\circ \vec{d}$, $u_i \sqsubseteq_L^\circ \pi_i(\vec{d})$ by lemma 10(ii) above. Pick an arbitrary $\vec{g}_{u_i}$ from G_{u_i}. Since $\vec{g}_{u_i} \in C$, $\vec{g}_{u_i} \sqsubseteq_n \vec{b}$ by assumption. This entails that $\pi_i(\vec{g}_{u_i}) \sqsubseteq_L \pi_i(\vec{b})$, by the definition of $\sqsubseteq_n$. However, by the definition of G_{u_i}, we know that $u_i \sqsubseteq_L \pi_i(\vec{g}_{u_i})$, so $u_i \sqsubseteq_L \pi_i(\vec{b})$. But recall that $u_i = \pi_i(\vec{u})$ and $\pi_i(\vec{u}) \not\sqsubseteq_L \pi_i(\vec{b})$. So there is no such $\vec{b}$, so $\vec{d} = \bigsqcup_n C$. Thus C is an $L^{(n)}$-cover of $\vec{d}$; since $C \subseteq R$, 11(ii) is proven.

11(ii) implies 11(i): Assume 11(ii) holds, i.e. that there is some non-empty $C \subseteq R$ s.t. $\bigsqcup_n C = \vec{a}$. Since $\bigsqcup_n C = \vec{a}$, we know by lemma 10(i) that for each i $(0 < i \leq n)$, $\pi_i(\vec{a}) = \bigsqcup_L \pi_i[C]$. We now show 12(ii), thereby proving 11(i).

Pick an arbitrary k $(0 < k \leq n)$ and assume that $x_k \sqsubseteq_L^\circ \pi_k(\vec{a})$. Then $x_k \sqsubseteq_L^\circ \bigsqcup_L \pi_k[C]$. So by sup-primes, there is a $\vec{g}_{x_k} \in C$ s.t. $x_k \sqsubseteq_L \pi_k(\vec{g}_{x_k})$. Now pick an arbitrary i $(0 < i \leq n)$; since $\pi_i(\vec{g}_{x_k}) \in \pi_i[C]$, $\pi_i(\vec{g}_{x_k}) \sqsubseteq_L \bigsqcup_L \pi_i[C]$, i.e. $\pi_i(\vec{g}_{x_k}) \sqsubseteq_L \pi_i(\vec{a})$. Lastly, since $C \subseteq R$, $\vec{g}_{x_k} \in R$. □

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WEAK OBJECT PRONOUN PLACEMENT IN LATER MEDIEVAL GREEK: INTRALINGUISTIC PARAMETERS AFFECTING VARIATION.

Panayiotis A. Pappas

Abstract

This paper presents some results from an in-depth analysis of the phenomenon of variation in weak object pronoun placement in Later Medieval Greek, focusing on the language-internal parameters that affect the variation. The findings reveal a complex pattern of variation that cannot be fully understood at this stage, and pose interesting questions for further investigation.

1 Introduction

As has already been demonstrated in Pappas (2000, 2001) the pattern of weak object pronoun placement variation in Later Medieval Greek (12th to the 16th century) is a complex phenomenon. Following the Pappas (2000, vol. 54 in this series) discussion of the different effect that οὐ /u/ ‘not’ and ἄν οὐ /ɑn u/ ‘if not’ have on the position of the pronoun (postverbal and preverbal, respectively), the present article is a detailed discussion of several intralinguistic parameters that appear to affect pronoun placement based on the in-depth analysis of the phenomenon presented in Pappas (forthcoming). It will be shown that, contrary to the standard opinion (Mackridge 1993, 1995, Janse 1994,

PAPPAS, PANAYIOTIS A. 2001. Weak Object Pronoun Placement in Later Medieval Greek: Intralinguistic Parameters Affecting Variation. *OSUWPL* 56, 79--106.

1998, Janssen 1998, Horrocks 1997), neither emphasis on the element immediately preceding the verb-pronoun complex, nor the distinction between a focus element and a topic element determine pronoun position with respect to the verb. Furthermore, it is revealed for the first time that in a particular subset of constructions, namely in those cases known as 'doubling pronoun' constructions, the pattern of pronoun placement is markedly different when the 'doubled' element is the adjective ὅλος /olos/ 'all'. Finally, the very intricate matter of pronoun placement with verb-forms other than the indicative and the subjunctive (i.e., the infinitive, the gerund, and the imperative) is examined in detail for the first time, and it is suggested that already in Later Medieval Greek, the imperative patterns more like the gerund than like the indicative, as is the case for Standard Modern Greek.

2 The database

The results presented here were based on the analysis of roughly 8,000 tokens of weak object pronoun placement. The tokens were collected from 27 texts which according to most philologists (cf. Beck 1993, Horrocks 1997) are the best representation of the vernacular of the period. In those cases where more than one manuscript exists for a particular text, only the one that is considered the closest to the original composition was used. When possible, approximately 1500 consecutive lines of text where extracted, and the tokens were manually listed and then coded according to the element that immediately precedes the verb-pronoun (or pronoun-verb) complex, in essence following Mackridge's 1993 categorization of environments.

For the statistical analysis, the JMP 3.2.1 software for Macintosh was used to perform OneWay Anovas. Since the number of observations varies greatly from text to text, the only way the Anova can be successfully carried out is if these observations are transformed into scores that show normal distribution and have constant variance. To do this, I calculated the percentage that each one of these observations (e.g. number of postverbal tokens) constitutes over the total amount (number of postverbal+ number of preverbal) and then took the *arcsin* value of that percentage value. This is standard practice in statistics, and the transformation is known as the *arcsin transformation*. (Woods et al. 1983: 220). In this fashion a score ranging from 0 to 1.57... was entered for each text; if a particular construction did not occur at all in the text, that entry was left blank. These then are the numerical values for which a OneWay Anova was carried out.

In the graphs, the *x* axis lists the factors which are compared, while the *y* axis runs from 0 to 1.57 (the arcsin score). The dark squares represent where a particular text scores; larger squares indicate a score for multiple texts. According to the manual of the JMP software, the diamond-shaped figures are a schematic representation of the mean and standard error for each sample group. The line across the diamond represents the mean of the sample group, while the height of the diamond represents the 95% interval of confidence for each group. The tables labeled Tukey-Kramer HSD are the results of a test sized for all differences among means. As indicated at the bottom of each table, if the number in a cell is positive that means that the difference between the two factors that make up the cell is significant.

3 Results and discussion

3.1 Differentiation within the factor 'reduplicated object'

As was mentioned in the introduction, the presence of the adjective ὅλος affects the pattern of variation associated with the 'doubling pronoun' construction[1]. This is a construction in which an object of the verb has a co-referent weak pronoun. The weak pronoun can co-refer either with a direct object (example (1)) or with an indirect object (example (2)).

(1)	τὸ	διάδημαν	παίρνει	το
	to	ðiaðiman	pεrni	to
	the-Acc sg	crown-Acc sg	takes-3 Pres sg	it-DO sg WP

'The crown, he takes it' (*Belisarios*, 42).

(2)	τοὺς τριακοσίους	ἀφήνω	σας
	tus triakosius	afino	sas
	the three hundred-Acc pl	leave-1 Pres sg	you-IO pl WP
	ἀπὸ	ἑνὸς	φαρίου
	apo	εnos	fariu
	from	one-Gen sg	horse-Gen sg

'To the three-hundred, I leave you each a horse' (*Digenēs*, 1759).

According to Mackridge (1993: 340) in these circumstances the order verb + pronoun is "more or less obligatory". However, as can be seen in Figure 3, in Appendix B, the pattern of pronoun placement that associated with 'doubling pronoun' constructions is significantly different from the pattern associated with other factors which Mackridge has also listed under the "more or less obligatory" category[2]. A closer examination of the data reveals that in most of the instances in which the 'doubling pronoun' appears preverbally, the doubled element is some form of the adjective ὅλος. Of the 118 tokens of the doubling pronoun construction there are 38 in which the element immediately preceding is a form of the adjective ὅλος. Of these 38, 24 show preverbal placement and 14 postverbal placement. If we exclude these tokens from the category of pronoun, there are 65 examples with postverbal placement and 15 examples showing preverbal placement (cf. Appendix A). This new pattern of variation, as it turns out is not

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[1] This construction is usually referred to as 'clitic doubling'. The term, however, makes crucial assumptions about the nature of these elements, which are not justified for LMG. Thus the theory neutral term 'weak object pronoun' is used.

[2] For an in-depth analysis of Mackridge's article, and a thorough description of all aspects of the variation see Pappas (forthcoming).

significantly different from the patterns of variation for the other factors identified under Rule(1)[3], as can be seen in Appendix B.

It is only natural to wonder why the adjective ὅλος should be associated with a pattern of pronoun placement that is the inverse of what we expect for the doubling pronoun construction. One possibility comes from the fact that the same adjective could take a weak pronoun as an argument in a partitive construction. Thus we find in texts examples such as the following:

(3)	ὅλοι oli	τους tus	τὴν tin	γρικοῦσι ɣrikusi
	all-Nom sg	they-PS pl WP	she-DO pl WP	listen-3pl Pres

‘all of them hear it’ (*Rimada*, 642).

In this case it is evident, not only from the accent markings, but also from the context, that τους is not an argument of the verb but of the adjective with a partitive sense. The sentence can be translated as ‘All of them listen to it’.

However, in a sentence like example (4), we know that the weak pronoun is an argument of the adjective and give the translation ‘and he defeated them all’ (*Rimada*, 322) only because there is no accent on τους. The alternative interpretation, though, namely that τους is an argument of the verb, with a translation ‘and all, he defeated them’ is also possible. In fact, there is no reason to believe that this type of construction would be any clearer for listeners of LMG than for contemporary speakers, since the only disambiguating factor would have been the constraint that pronouns must follow the verb. It seems likely then, that, in sentences such as these, τους may have become ambiguous. It could be either a partitive pronoun qualifying the adjective or an argument of the verb.

(4)	καὶ kɛ	ὅλους olus	τους tus	ἐνίκησε ɛnikisɛ
	and	all-Acc pl	they-PS pl WP	win-3sg Past

The crucial aspect of this ambiguity is that the partitive pronoun is of the same gender, number and case as the adjective, as indeed would have been the case for a weak object pronoun. Thus, the shift to constructions with ὅλος in which the pronoun is placed preverbally was most probably based on a four-part analogy, essentially a process in which the speaker/hearer extracted a pattern of matching gender/number/case marking in both the adjective and the pronoun based on the reanalyzed partitive construction (see Figure 1). This yielded constructions such as example (4) above and example (5), in which the ‘doubling pronoun’ appears preverbally.

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[3] The negative adverb οὐ was excluded from this test since it is associated with categorical postverbal placement (see Pappas 2000 and Pappas (forthcoming) for a discussion of pronoun placement associated with οὐ).

(5) ὅλην τὴν ἠξεύρεις
oli tin iksɛvris
all-Acc pl she-DO sg WP know-2sg Pres
‘you know her completely’ (*Gioustos*, 184).

ὅλους : τους
: :
ὅλην : X
X = τήν

Figure 1: Four-part analogy schema for the change in pronoun placement in ὅλος construction.

3.2 The effect of emphasis on pronoun placement

Emphasis is an intralinguistic factor that Mackridge (1993) identifies as affecting the variation of pronoun placement. For him, the difference in pronoun placement between ‘object/adverb’[4], ‘subject’, and ‘temporal expression’[5] is based on the fact that these elements are differently emphasized. His reasoning works as follows: the canonical word order of Later Medieval Greek is SVO, where the subject is covert more often than not. Thus, when an object (or adverb) (example (6)) is fronted it receives special emphasis which allows it to “attract” the pronoun to the preverbal position. Subjects are in a canonical position when they precede the verb and this “…does not necessarily result in its being specially emphasized” (Mackridge 1993: 320), which results in a less robust pattern of preverbal placement associated with preceding subjects. Finally, temporal expressions (example (7)) “…are not normally emphatic in themselves, but tend instead to place emphasis on the following verb…” (ibid: 322), which according to Mackridge weakens the preverbal placement pattern even more.

(6) μανδᾶτον τὸν ἐδῶκα
mandaton ton ɛðoka
message-Acc sg he-IO sg WP give-1sg Past
‘I gave him a message’ (*Poulologos*, 576)

(7) πάλε ἀπομοιράζεις τα
palɛ apomirazis ta
again break up-2sg Pres they-DO pl WP
‘again you break them up’ (*Poulologos*, 395)

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[4] In this study preverbal objects, non-temporal adverbs and prepositional phrases are grouped together under the label ‘fronted constituent’ (see Figure 4 in appendix B).

[5] Mackridge uses the term ‘temporal adverb’ and refers to a few specific lexical items, namely, πάλιν /palin/ ‘again’, εὐθύς /ɛfθis/ ‘immediately’, τότε /totɛ/ ‘then’, and πάντα /panda/ ‘always’. Here, however, the category has been expanded to include all temporal expressions.

The first problem with Mackridge's account is empirical. As can be seen in Figure 4 of appendix B, there is no significant difference between the factors 'subject' and 'temporal expression', and thus we should be looking for ways to explain their similarity not their difference. Moreover, Mackridge's line of reasoning itself is problematic in several ways. To begin with, the argument is circular. While he asserts that it is the emphasized status of fronted objects that "attracts" the pronoun to the preverbal position at the beginning of his analysis, he then interprets the fact of "freer" placement in the case of temporal expressions as an indication that they are not as emphatic as fronted objects, thus explaining the difference in pronoun placement between 'temporal expression' and 'object'. Secondly, in order for the 'attraction' mechanism to work, the 'attracting' element (whether subject, object, or adverb) would have to be a phonological host for the pronoun[6], which is impossible. The pattern of secondary stress accents in LMG (essentially the same as SMG) clearly indicates that the verb is the only available phonological host for the pronoun, and it is difficult to justify how another element which does not bind the pronoun would affect its position. In a similar vein Wanner (1981b: 200) criticizes the use of the term attraction (*attraccâo*) by prescriptivist grammarians in Portuguese; they too employed this vague term as an explanation of variation between preverbal and postverbal placement of 'clitic' pronouns. Wanner writes:

> Attributing proclisis to the presence of particular words is satisfactory only in a framework which does not recognize linguistic structure beyond the level of abstractness of the word, i.e., the typical prescriptive grammar tradition; in addition, it is a confusion of cause and effect.

Finally, if emphasis does indeed 'attract' the pronoun to the preverbal position, full pronoun subjects should be associated with near categorical preverbal placement of the weak pronoun (cf. example (8)). This is expected because, as in any (so-called) 'empty subject' or 'pro-drop' language, full pronoun subjects in Later Medieval Greek should be an indication that there is emphasis placed on the subject—see Haberland and van der Auwera (1993). According to Mackridge's hypothesis that emphasis is associated with preverbal placement, one would expect pronoun placement when the immediately preceding subject is a full pronoun to be significantly more preverbal than the pattern of pronoun placement when the immediately preceding subject is a noun phrase. However, the comparison test between the two patterns shows that there is no significant difference between them (cf. Appendix B).

(8)	ἄλλος	φιλεῖ	τὴν	ἀγαπῶ
	allos	fili	tin	aɣapo
	another-Nom sg	kiss-3sg Pres	Rel. prn-Acc sg	love-1sg Pres
	κ᾽	ἐγὼ	στερεύγομαί	την
	kj	εɣo	stεrεvɣomε	tin
	and	I-Nom sg	to be deprived-1sg Pres	she-DO sg WP

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[6] The necessity of this can be seen in Halpern's (1996) treatment of Bulgarian clitics, in which he assumes that they are uniformly enclitic, despite evidence (Ewen 1979) that they may be at times proclitic.

‘Another man kisses the one I love and I am deprived of her’ (*Katalogia*, 434).

Thus, the emphatic status of the element preceding the verb complex does not seem to affect the placement of the pronoun.

3.3. Topic vs. Focus.

The possibility that discourse constraints may affect the placement of the pronoun, especially in cases where a subject immediately precedes the verb-pronoun complex, has been brought up by Janse in two papers (1994, 1998). There Janse claims that in Cappadocian Greek (which also shows variation between preverbal and postverbal pronoun placement) the pronoun is placed preverbally if the subject (especially subject pronouns) “constitute the information focus of the respective utterances, since they carry new information” (cf. example (9) taken from Janse 1998).

(9)	tis	t	álakse
	who-Nom sg	it-DO pl WP	change-3sg Past
	oɣo	d	álaksa
	I-Nom sg (EMPHATIC)	it-DO pl WP	change-1sg Past

‘—Who changed them?
—I changed them’

However, Janse does not show that being the information focus of an utterance is the necessary and sufficient condition for preverbal placement, since he does not discuss examples with subject pronouns (or nominal subjects for that matter) and postverbal object pronoun placement to show that in these cases the subject is not the information focus of the utterance. Furthermore, it can be shown that in the LMG texts this distinction does not affect the placement of the pronoun; the two passages below come from the same text and have the same interpretation with respect to the Focus/Topic distinction, yet the pronoun is placed postverbally in one and preverbally in the other.

(10)	ὁκάποτ᾽	ἀπεσώσασιν,	ἦλθαν	εἰς	τὸ Μοντόριον
	okapot	apεsosasin	ilθan	is	to montorion
	sometime	finish-3pl Past	come,-3pl Past	to	the Montorion-Acc sg
	ὁ δοὺξ	τοὺς	ἀποδέχθηκεν		
	o ðuks	tus	apoðεxθikεn		
	the duke-Nom sg	they-DO sg WP	receive-3sg Past		

‘In time they finished [their journey], they came to Montorion. /
The duke received them …’ (*Phlōrios*, 303-304).

(11)	καβαλλικεύουν	ἄρχοντες	ὑπάγουν	ς	τὸ παλάτι,
	kavalikεvun	arxondεs	ipaɣun	s	to palati

ride-3pl Pres	lord-Nom pl	go-3pl Pres	to	the palace-Acc sg
κι ὁ βασιλεὺς	ἐδέχθην	τους		
c o vasilεfs	εðεxθin	tus		
and the king-Nom sg	receive-3sg Past	they-DO sg WP		

‘The lords ride, they go to the palace, /
and the king received them…’ (*Phlōrios*, 938-939).

Nevertheless, this distinction between a focus and topic reading could prove useful when examining preverbal objects. As Androulakis (1998)[7] points out, in Standard Modern Greek a preposed object with a focus reading is distinguished by an object that is a topic by the fact that in the latter case a ‘doubling pronoun’ is used.

(12)	τον Νικολή	τον	θαυμάζω	για την υπομονή του
	ton nikoli	ton	θavmazo	ja tin ipomoni tu
	Nikolis-Acc sg/TOP	he-DO sg WP	admire-1sg Pres	for his patience

‘Nikolis, I admire him for his patience’ (Androulakis 1998: 150).

(13)	τον ΝΙΚΟΛΗ	θαυμάζω	για την υπομονή του
	ton nikoli	θavmazo	ja tin ipomoni tu
	Nikolis-Acc sg/FOC	admire-1sg Pres	for his patience

‘It is Nikolis that I admire for his patience’ (Androulakis 1998: 150).

However, it is not certain that this was the case for LMG. In fact, without the necessary prosodic information (i.e. information about sentence stress), this distinction between topic and focus is hard to confirm based on the surrounding context alone. Take for example the following two clauses that appear one after the other in the poem *Thrēnos tēs Kōnstantinoupoleōs*:

(14)	ἐγίνηκε	᾿Αντίχριστος,	τὸν κόσμον	σακτανίζει
	εɣinikε	andixristos	ton kosmon	saktanizi
	became	antichrist	the world-Acc sg	bedevils-3sg Pres
	τὸ γένος	τὸ ῾Ρωμαικὸν	ἐκαταδούλωσέν	το
	to ɣεnos	to romaikon	εkataðulosεn	to
	the race-Acc sg	the Roman-Acc sg	enslave-3sg Past	it-DO sg WP

‘He became the antichrist, he bedevils the world, the Roman race, he enslaved it’ (*Thrēnos*, 601-2).

There do not seem to be any contextual factors that would make the two objects τὸν κόσμον, and τὸ γένος τὸ ῾Ρωμαικὸν different with respect to the focus-topic distinction. Similar examples can be found throughout the corpus. Thus, although there is good reason to believe that the distinction between focus and topic is the reason for the use (or not) of a doubling pronoun in SMG, the same claim cannot be made for LMG.

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[7] See also Warburton (1975), Kazazis & Pentheroudakis (1976), Horrocks (1983), Joseph (1983b), Mackridge (1985), Stavrou (1985), and Philippaki-Warburton (1985).

3.4 Non-finite forms of the verb

It is reasonable to investigate whether or not the status of the verb-form (finite or non-finite) plays a role in the placement of pronouns in Later Medieval Greek as this has been accepted as the determining factor in Standard Modern Greek. There the pronouns appear preverbally (cf. (15) and (16), except when the verb is a gerund (17), or an imperative[8], (18) in which case they appear postverbally.

(15)	τον	είδα
	ton	iða
	he-DO sg WP	see-1sg past

‘I saw him.’

(16)	τον	Αντώνη,	τόν	είδα
	ton	adoni	ton	iða
	the-Acc sg	Anthony-Acc sg	he-DO sg WP	see-1sg past

‘Anthony, I saw him.’

(17) a.	βλέποντάς	το
	vlεpondas	to
	see-gerund	it-DO sg WP

‘Seeing it, …’

b.	Μη	βλέποντάς	το
	mi	vlεpodas	to
	not	see-gerund	it-DO sg WP

‘Not seeing it…’

(18)	δώσε	μού	το
	ðosε	mu	to
	give-2 sg Imper	I-IO sg WP	it-DO sg WP

‘Give me it!’

The fact that the imperative verb-form, and the clearly non-finite gerund both show the same pattern of postverbal pronoun placement, coupled with the observation that the imperative is morphologically marked only for number has been interpreted as an

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[8] Joseph (1978/1990, 1983a), and Nevis & Joseph (1992) mention that the past passive participle may have a weak pronoun argument in some rare cases. The example they cite

δεχόμενός	το
ðεxomεnos	to
accept-Past Pass. Prcle Nom sg	it-DO sg WP

‘Accepting it’.

I did not encounter any such examples in my research of the Medieval texts.

indication that in SMG the imperative is a non-finite form (Joseph 1978/1990, 1983a, 1985, Mackridge 1985, Joseph & Warburton 1987, Horrocks 1990, Nevis & Joseph 1992).

In Later Medieval Greek, on the other hand, there are three clearly non-finite forms, the participle (present active, or perfect passive), the gerund and the infinitive. As in SMG the LMG imperative is marked only for number, although in some texts there are also 3rd person forms of the imperative which are most likely archaisms. In the next sections I examine the position of weak object pronouns with these verb-forms.

3.4.1 Participles

3.4.1.1 The Present Active Participles

These forms show marking for gender, number, and case as in Ancient Greek. There are 8 examples of pronoun placement with present active participle in the database, most of them from *Ptōkhoprodromos*. Some examples are given below.

(19)	ἀτίμως	μοι	λαλοῦσα
	atimos	mi	lalusa
	deceitfully-Adverb	I-IO sg WP	speak-Pres. Act. Prcle

‘speaking to me deceitfully’ (*Ptōkhoprodromos*, I 155).

(20)	ταῦτα	μοι	προσοιποῦσα
	tafta	mi	prosipusa
	this-Acc pl	I-IO sg WP	tell-Pres. Act. Prcle

‘Telling me these things’ (*Ptōkhoprodromos*, I 198).

(21)	καὶ	συνβυθίζουσάν	μϵ
	kɛ	sinviθizusan	mɛ
	and	sink-Pres. Act. Prcle	I-DO sg WP

‘And sinking me’ (*Ptōkhoprodromos*, IV 243).

(22)	καὶ σῶον	σϵ̀	φυλάττων
	kɛ soon	sɛ	filaton
	and safe-Acc sg	you-DO sg WP	keep-Pres. Act. Prcle

‘and keeping you safe’ (*Glykas*, 341).

(23)	τὸν	καταφλέξαντά	σϵ
	ton	katafleksanda	sɛ
	the-Acc sg	burn thoroughly-Pres. Act Prcle	you-DO sg WP

‘The one who burnt you thoroughly’ (*Achilleid*, 1410).

It is generally accepted (Horrocks 1997: 78) that the use of the present active participle in *Ptōkhoprodromos* is an archaizing aspect of his mixed language, and as such I will not be concerned with the relationship between these forms and pronoun placement.

3.4.1.2 Perfect Passive Participles

These are forms in –μένος mostly used as adjectives or as complements of the verb ἔχω [ɛxo] 'I have' in the perfect periphrasis (or its past form εἶχα in the pluperfect periphrasis—so Horrocks 1997: 304). There are only four instances of these constructions with a pronoun, and in all of them the pronoun is placed preverbally before the ἔχω form as in the example (24).

(24)	σὲ	τόπο	ἐπιτήδιο
	sɛ	topo	ɛpitiðio
	in-preposition	place-Acc sg	clever-Acc sg
	τὰ	εἴχασι	βαλμένα
	ta	ixasi	valmɛna
	it-DO sg WP	have-3 pl Past	place-Perf. Pass Prcle

'They had placed them in a clever place' (*Rimada*, 834).

Despite what seems here an obvious incorporation of the perfect passive participle arguments by the ἔχω form, it was not necessary that the two forms be adjacent as can be seen in example (25) where the adverb δῶ can be interpolated between the ἔχω form and the participle.

(25)	τὰ	μοὔχει	δῶ	γραμμένα
	ta	moxi	ðo	ɣramɛna
	which-Rel prn	I-IO sg+have-3sg Pres	here-Adverb	write-Perf. Pass Prcle

'which he has written to me here' (*Rimada*, 716).

3.4.2 Gerunds

These forms, although clearly derived from the above mentioned present active participles, show no gender, number, or case agreement. Instead they vary between a form with final (ς) and one without it. The final (ς) is most likely due to analogical spreading, either from the masculine nominative singular or from the adverbial (ς) (see Horrocks 1997: 229). There are several constructions of a gerund with a weak pronoun argument; they are all found in later texts (15th and early 16th century) and in all of them the pronoun appears postverbally as in (26) and (27):

(26)	ἐγὼ	θωρώντα	σϵ
	εɣo	θoronda	sε
	I-Nom sg	look-Gerund	you-DO sg WP

‘I, looking at you’ (*Rhodos*, 211)

(27)	καὶ	δίνοντάς	τονϵ
	kε	ðinondas	tonε
	and	give-Gerund	he-IO sg WP

‘and giving him’ (*Tribōlēs*, 275)

The unfortunate gap in the data is that there are no instances of a negated gerund (μὴ + gerund) with a weak object pronoun. Such examples would provide crucial information concerning the interaction between the finiteness of the verb-form and pronoun placement (with putative examples such as * ἐγὼ μὴ θωρώντα σϵ indicating that the non-finite verb-forms have postverbal pronouns only). Although no firm conclusion can be reached in their absence, it is my intuition that postverbal pronouns may have been the categorical placement in this context.

3.4.3. Infinitive

3.4.3.1 Articular infinitive

In this type of infinitival construction a definite article is added to the infinitive, which is used either as the complement of a preposition (28) or a verb (29), as a clause with a final sense (30) or as a nominalized adjunct (31) (Horrocks 1997: 98, 280).

(28)	ϵἰς	τὸ	ϵὐϵργϵτῆσαι	σοι
	is	to	εverɣetisε	si
	towards-preposition	the-Acc sg	benefit-Infin.	you-IO sg WP

‘towards benefiting you’ (*Spanos*, 690).

(29)	ἤρξατο	τοῦ	γϵλᾶν	μϵ
	irksato	tu	ɣεlan	mε
	begin-3sg Past	the-Gen sg	laugh-Infin.	I-DO sg WP

‘He began to make fun of me’ (*Ptōkhoprodromos*, I 190).

(30)	χρόνον ... ἀνάλωσα	...τοῦ	ϵὑρϵῖν	σϵ
	xronon ... analosa	... tu	εvrin	sε
	time ... I spent	... the-Gen sg	find-Infin.	you-DO sg WP

‘I spent [much] time in order to find you’ (*Spanos*, 606).

(31)	Τὸ	ἰδϵῖν	τα

to	iðin	ta
the-Acc sg	see-Infin.	it-DO pl WP

"Upon seeing them" (*Digenēs*, 785).

In all of these uses the pronoun is always placed postverbally.

3.4.3.2 Infinitive as the complement of a verb

Despite facing competition from finite complementation constructions (Joseph 1978/1990, Browning 1983, Joseph 1983a, Horrocks 1997) an infinitival complement is still a possibility in the texts of Later Medieval Greek. Most of these appear in the periphrases of the future tense (θέλω 'I want' + infinitive) (ex.(32), conditional (ἤθελα 'I wanted' + infinitive) (ex. (33) and the pluperfect[9] (εἶχα 'I had' + infinitive) (ex. (34), but there are also some examples of a standard infinitival complement (ex. (35).

(32)	θέλεις	μὲ	κοπιάσειν
	θεlis	mε	kopiasin
	want-2sg Pres	I-DO sg WP	tire-Infin.

'Will you tire me?' (*Digenēs*, 1390).

(33)	ὅταν	ἤθελες	δοξασθῆν
	otan	iθεlεs	ðoksasθin
	when	want-2sg Past	glorify-Pass Infin.

'When you would be glorified' (*Digenēs*, 252).

(34)	ἄν	τὄχα	ξεύρειν
	an	toxa	ksεvrin
	if	it-Acc sg. + have-1sg Past	know-Infin

'If I had known it' (*Katalogia*, 321).

(35)	ἐσὺ	τολμᾶς	ὑβρίζειν	με
	εsi	tolmas	ivrizin	mε
	you-Nom sg	dare-2sg Pres	insult-Infin.	I-DO sg WP

'You dare to insult me?' (*Poulologos*, 99).

Mackridge (1993: 338) only discusses the cases of θέλω and ἤθελα periphrases for which he states that "the future and volitive construction + infinitive is quite straightforward as long as one bears in mind that the pronoun attaches itself to θέλω rather than to the infinitive." What Mackridge overlooks in this assumption, however, is

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[9] According to Joseph (1983a:64, 2000), Horrocks (1997:304) the present perfect periphrasis with the present tense of ἔχω 'I have' was modelled on the pluperfect form at a much later time.

that, since the pronouns must appear adjacent to the verb that selects them as arguments, attachment to θέλω implies incorporation of the semantic arguments of the infinitival form as syntactic arguments of the θέλω form (cf. Joseph 1978/1990). And although this may be a possibility for the future constructions (as it was for the ἔχω + passive participle periphrases) there is no evidence that it also occured in volitive constructions. Perhaps, though, Mackridge's mention of "future and volitive construction" is merely a way to avoid the controversy over the meaning of these θέλω + infinitive constructions.

Nonetheless, according to this assumption the contrast between (36) and (37) is explained as follows: in (36) the pronoun attaches to θέλει, and is 'attracted' to the preverbal position by the relative pronoun ὁπoὺ (according to his Rule 2). On the other hand, in (37) the pronoun once again attaches to θέλει, but this time it appears postverbally, because the complex follows immediately after the negative adverb οὐ (Mackridge's Rule 1b).

(36)	ὁπoὺ	μὲ	θέλει	πάρει
	opu	mɛ	θɛli	pari
	which	me-DO sg WP	want-3sg, Pres	take-Infin.

'which will take me' (*Digenēs*, 1769).

(37)	οὐ	θέλει	τὲς	πομείνει
	u	θɛli	tɛs	pomini
	not	want-3sg Pres	it-DO pl WP	suffer-Infin.

'He will not suffer them' (*Rimada*, 1016).

The question of which of the two verbs is the host of the pronoun is important; for if Mackridge is correct that the θέλω form is always the host, then these constructions will have nothing to contribute to our discussion of weak pronoun placement with non-finite verb-forms.

One problematic aspect of Mackridge's analysis concerns the accentuation of the pronoun. If Mackridge is correct that the pronoun attaches to the θέλω form then in those cases in which it appears postverbally, the pronoun should be enclitic to the θέλω form. And if this is true, then one would expect that when the pronoun appears after a three syllable form of θέλω (such as ἤθελα) the rule of secondary stress should take effect, adding an accent to the last syllable of the verb. This prediction, however, is not borne out in the case of θέλω periphrastic constructions, as in example (38), in which we see that the pronoun does not affect secondary stress on ἤθελα.[10]

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[10] There is one other example from *Kallimakhos*, ln 651

λαβεῖν	γυναῖκα	ἤθελέ	με
lavin	ɣinɛka	iθɛlɛ	mɛ
take-Infin.	woman-Acc sg	want-3sg Past	I-DO sg WP

(38)	ὥς	μήρμυκα	καὶ	κώνωπα
	os	mirmika	kɛ	konopa
	like	ant-Acc sg	and	mosquito-Acc sg
	ἤθελα	τὸν	συντρίψειν	
	iθɛla	ton	sindripsin	
	want-1sg Past	he-DO sg WP	crush-Infin.	

“Like an ant and a mosquito I would have crushed him” (*Achilleid*, 1696).

If the pronoun were enclitic to ἤθελα it would be written ἤθελα τον. The fact that in these circumstances the pronoun does not pattern as an enclitic would casts doubt on Mackridge’s statement that the pronoun always attaches itself to the θέλω form. Another argument against Mackridge’s implicit assumption that θέλω future periphrases always involve ‘argument incorporation’ is that the infinitive can in some cases be preposed, as in example (39); such ‘freedom of movement’ is considered as evidence against ‘argument incorporation’ (cf. Abeille & Godard 1996).

(39)	εὕρεῖν	τὴν	θέλω
	ɛvrin	tin	θɛlo
	find-Infin.	she-DO sg WP	want-1sg Pres

‘I will find her’ (*Phlōrios*, 267).

If this were true, the pronoun in these cases should remain both the semantic and syntactic argument of the infinitive, which in turn means that the pronoun would be ‘enclitic’ and according to the system of written accents an ‘enclitic’ pronoun is not written with an accent. In this research, out of the 10 instances of a future periphrasis with a preposed infinitive, 8 of them have a written accent on the pronoun. Thus instances such as (39) may be an indication that the pronoun is attached to the θέλω form, and subsequently that ‘argument incorporation’ has taken place, despite the counterevidence provided by the preposed infinitive. The two non-conforming examples are:

(40)	ἐγὼ	δώσει	τες	ἤθελα
	ɛɣo	ðosi	tɛs	iθɛla
	I-Nom sg	give-Infin.	she-DO pl WP	want-1sg Past

‘I would have given them’ (*Rimada*, 1270).

This is a troubling example, however. First of all, it seems to have a volitional meaning—Pichard translates it as “voulait m’epouser”—and this makes the separation between the Infinitive and its object pronoun surprising. Moreover, the infinitive is in the first hemistich while the rest of the VP is in the second hemistich (see chapter 6 for more details about the meter of the poetry). Thus, this construction is extraordinary for a variety of reasons, and basing conclusions on it is not recommended.

(41)	χαρίσει	του	τὴν	θέλω
	xɑrisi	tu	tin	θεlo
	grant-Infin.	he-IO sg WP	she-DO sg WP	want-1sg Pres

‘I will grant her to him’ (*Lybistros*, 2510).

Example (41) is particularly telling because if one were to adhere to what the written accents indicate, then the IO του and the DO τὴν do not form a cluster, as the IO attaches to the infinitive and the DO to θέλω. This is indeed quite surprising and casts serious doubt as to whether the written accents can be trusted as a guide at this intersection of two highly volatile constructions: weak pronoun placement and the future periphrasis construction.

On the other hand, the data do confirm the view that from the perspective of pronoun placement it seems as if the pronoun is attached to the θέλω form, as Mackridge has asserted. Appendix A presents the results of coding the tokens of θέλω periphrasis with a weak object pronoun, according to the character of the immediately preceding element, namely whether it is associated with preverbal or postverbal placement, or it is somewhat neutral towards placement. Thus, ‘postverbal environment’, includes factors such as ‘initial’, ‘co-ordinating conjunction’, ‘doubling pronoun’, ‘οὐ’ and so forth; in ‘preverbal placement’ factors ‘function word’ and ‘fronted constituent’ are included, whereas ‘neutral’ (for lack of a better term) includes ‘subject’ and ‘temporal expression’[11]. As the table shows, in θέλω periphrases with a ‘postverbal environment’ the pronoun is placed between θέλω and the infinitive 42 out of 44 times; in ‘preverbal environments’ the pronoun appears to the left of θέλω 35 out of 39 times, while in ‘neutral environments’ there are 8 post-θέλω tokens and four pre-θέλω tokens.

The only clear evidence is that ‘argument incorporation’ happens at least sometimes, i.e. when the pronoun appears to the left of θέλω. In the absence of any conclusive evidence concerning the host of pronouns that appear between the θέλω form and the infinitive, it seems more straightforward to adopt the idea that all the periphrastic tense constructions involve some type of ‘argument incorporation’ mechanism, but note that this seriously challenges the notion that such mechanisms lead to a strong linear adjacency requirement.

With respect to true complement infinitives, it can be said that these constructions are rare, and appear mostly in texts before the 14th century (*Digenēs*, *Ptōkhoprodromos*, *Spaneas*, *Glykas*, *Poulologos*, *Moreas*). The specific verbs found with an infinitive complementizer in the corpus are ἀρχίζω /ɑrxizo/ ‘I begin’, (ἠ)μπορῶ /imboro/ ‘I am able to’, ἐλπίζω /εlpizo/ ‘I hope’, θαρρῶ /θɑro/ ‘I dare’, and τολμῶ /tolmo/, also “I dare”. There are 10 examples, and in 7 of them the pronoun appears after the infinitive as in example (35) above and (42):

(42) ἤρξατο εὔχεσθαί του

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[11] For a full description of what these categories include, see Pappas (forthcoming).

irksato	ɛfxɛsθɛ	tu
begin-3sg Past	wish-Infin.	he-IO sg WP

‘she began to wish him …’ (*Digenēs*, 810).

However, since these constructions seem to be archaisms (note the use of the ‘-σθαι’ infinitive in (42)), it may also be that the pattern of pronoun placement associated with them is also archaic.

The evidence available from the LMG texts does not lead to any clear conclusions about the placement of pronouns that are arguments of non-finite verb-forms. It seems though, that texts from before the 14th century have both a wider range of non-finite forms and variation between preverbal and postverbal pronoun placement in association to them. In texts dating after the 14th century, if the thorny issue of periphrastic tenses is put aside, the available non-finite verb-forms are gerunds and articular infinitives which are basically semantically equivalent; and the placement of the pronouns in this context is robustly postverbal. When these facts are compared with the situation in SMG (cf. examples (15)-(18)) it is clear that at least the beginning of the partition of weak pronoun placement according to the finiteness of the verb-form is found in 14th century texts. Now that the evidence for the uncontroversially non-finite forms has been established, an examination of pronoun placement with the imperative is in order.

3.4.4 Imperative

When the verb is in the imperative form the placement of the weak object pronoun seems to vary in much the same way that it does for the finite verb-forms, the indicative and the subjunctive. Mackridge (1993: 330) is convinced of this as he emphatically states that:

> It must be stressed that Rule 3 is valid as much for the imperative as for finite forms of the verb:

(43)	Αλλα	μὲ	εἰπὲ[12]
	ala	mɛ	ipɛ
	other-Acc pl	I-DO sg WP	say-2sg Imper

‘Tell me something else’ (*Digenēs*, 670)

(44)	τρεῖς ἴγκλες	μοῦ	τὸ	ἴγκλωσε
	tris iŋglɛs	mu	to	iŋglosɛ
	3 saddle straps	I-IO sg WP	it-DO sg WP	strap on-Imp sg

‘Strap it [the horse] for me, three saddle straps’ (*Digenēs*, 800)

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[12] Mackridge only gives the Greek text but I included the broad transcription and translation, for readers not familiar with the language.

> The placement of the pronoun before an imperative is absolutely standard in such circumstances in texts from the twelfth to the fifteenth centuries, irrespective of geographical provenance; it is found not only in the Escorial *Digenes Akrites* but in Ptochoprodromos, the Chronicle of the Morea, and practically every other text in which the imperative is used.

The textual evidence, however, does not support the characterization "absolutely standard". Before delving into the details, though, one must consider how an accurate comparison between the finite forms and the imperative forms can be conducted. First, the environments in which either a finite form or an imperative form could appear need to be separated from the rest. As such, all environments listed in Mackridge's Rule (2)—essentially relative pronouns, mood markers and *wh*-phrases—must be excluded, since the imperative cannot appear in those contexts. Next, from Rule (1) one must exclude the negative adverb οὐ because the imperative does not have a directly negated form (instead μή plus the subjunctive is used), as well as the conjunction ὅτι. Thus, the environments[13] in which pronoun placement can be compared based on the verb-form are represented by the following factors: 'initial', 'co-ordinating conjunction', 'reduplicated object', 'fronted constituent', 'subject', and 'temporal expression'.

As was done in the previous section these environments can be grouped into three categories according to the effect that they have on pronoun placement when the verb-form is indicative or subjunctive. Thus, there is 'preverbal environment', containing factor 'fronted constituent', 'postverbal environment', containing factors 'initial', 'co-ordinating conjunction', and 'reduplicated object', and 'neutral environment' which contains factors 'subject' and 'temporal expression'.

Cataloguing the data according to these groups reveals that there is a difference between the placement of the pronoun with finite verb-forms on the one hand, and imperative verb-forms, on the other. Except for factor 'initial', however, the number of tokens is too small for an investigation of the effect of the other factors, and comes from a limited amount of texts (only 10 for 'fronted constituent', for example) so the results, presented in detail in the appendix, are suggestive, not conclusive. Nonetheless, the patterns observed are remarkably different.

For instance, when there is a fronted constituent with a finite verb the pronoun appears preverbally 898 out of 988 times. In the case of the imperative, however, this only happens 15 out of 32 times. Even as a suggestive result, these numbers do not in any way confirm Mackridge's intuition that whether the verb is in the imperative or indicative/subjunctive form does not affect the placement of the pronoun. Similarly, for the factor 'subject' we find no preverbal pronouns if the verb-form is imperative, yet for the finite verb-forms, an immediately preceding subject is associated with preverbal placement 334 out of 464 times. Finally, for 'temporal expression' we have 8 preverbal

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[13] Since the imperative in LMG appears only in the 2nd sg. and pl. forms with rare, highly stylized, and presumably conciously archaizing uses of the 3rd sg. or pl. it would seem appropriate to exclude all non-2nd person forms from the finite verb-form database. It is, however, a reasonable assumption that the person of the verb-form does not affect the placement of the weak object pronoun, and so it is not necessary to do so.

instances out of 24 when the verb-form is imperative but 86 preverbal instances out of 149 for a finite verb-form.

It seems that although preverbal pronoun placement is possible with imperative verb-forms, it is extremely restricted, especially when compared to the situation with the indicative and subjunctive on the one hand, and the pattern associated with the gerunds on the other. Contrary to Mackridge's observation, then, the imperative—with respect to weak object pronoun placement—behaves more like the gerund than the finite verb-forms.

4 Conclusion

The in-depth examination of variation in LMG pronoun placement presented here has provided concrete evidence for several unexpected results. These were:

a) the association of the adjective ὅλος in 'doubling pronoun' construction with preverbal pronoun placement, an effect that has not been noticed before,
b) the fact that neither emphasis of the preverbal element nor the distinction between topic and focus affects pronoun placement,
c) the inability to disambiguate the pattern of pronoun position in the periphrastic tenses, no matter how detailed or in depth the analysis, and
d) the ambiguous status of the imperative verb-form which, with respect to pronoun placement at least, patterns almost like the gerund but not entirely so.

Of course, as observations, the above statements do not provide explanations for the pattern of pronoun placement in LMG; rather they pose more and increasingly difficult questions that must be answered in order for the phenomenon to be understood. That task, which includes an examination of the extralinguistic parameters affecting variation, as well as the diachronic development of weak object pronoun position from Early Medieval to Early Modern Greek, is undertaken in Pappas (forthcoming) to which the reader is referred.

APPENDIX

A. Raw Counts

Red. Object	with ὅλος		without ὅλος	
Text↓	PRE V	POST V	PRE V	POST V
Digenēs	1	5	0	4
Ptōchoprod.	1	1	0	1
Glykas	0	0	0	0
Spaneas	0	1	0	1
Kallimakhos	0	3	0	3
Lybistros	2	10	1	7
Achilleid	0	6	0	6
Belisarios	0	1	0	1
Thrēnos Kon.	0	6	0	6
Poulologos	2	7	1	6
Paidiophr.	0	6	0	6
Physiologos	0	1	0	1
Spanos	1	0	1	0
Aitōlos	5	0	1	0
Moreas	0	1	0	1
Tokkoi	5	4	2	2
Rimada	8	4	3	4
Gioustos	4	4	0	3
Depharanas	2	0	1	0
Tribōlēs	2	0	0	0
Phalieros	1	1	1	1
Homilia	1	0	1	0
Apokopos	0	1	0	0
Apollōnios	0	4	0	2
Phlōrios	2	5	1	4
Rhodos	2	3	2	1
Katalogia	0	5	0	5
Total	39	79	15	65

Table 1: Raw counts concerning the interaction between the presence of ὅλος and pronoun placement in the ‘doubling pronoun’ construction.

Envrn.→	Preverb Environ.		Postverb Environ.		Neutral Environ.	
Text↓	PRE V	POST V	PRE V	POST V	PRE V	POST V
Digenēs	5	0	0	1	0	0
Ptōchoprod	1	0	0	0	0	0
Glykas	1	0	0	2	1	0
Spaneas	0	0	0	0	0	0
Kallimakhs	1	0	0	2	0	0
Lybistros	4	0	0	4	1	2
Achilleid	3	0	0	3	0	2
Belisarios	0	0	0	1	0	0
Thrēnos	0	0	0	0	0	1
Poulologos	1	0	0	3	0	0
Paidiophr.	0	0	0	0	0	0
Physiologos	0	0	0	0	0	0
Spanos	0	0	0	0	0	0
Aitōlos	0	1	0	0	0	0
Moreas	4	0	0	0	0	0
Tokkoi	3	0	2	2	1	0
Rimada	4	0	0	4	1	2
Gioustos	3	0	1	2	0	0
Depharanas	1	0	1	1	0	0
Tribōlēs	1	0	0	1	0	0
Phalieros	7	1	0	1	0	0
Homilia	0	0	0	0	0	0
Apokopos	0	0	0	2	0	0
Apollōnios	1	0	0	1	0	0
Phlōrios	1	0	0	4	0	0
Rhodos	1	1	0	1	0	0
Katalogia	2	0	0	2	0	0
Total	44	3	4	37	4	7

Table 2: Raw counts concerning the interaction between θέλω periphrastic constructions and pronoun placement.

Envrn.→	Preverb Environ.		Postverb Environ.		Neutral Environ.	
Text↓	PRE V	POST V	PRE V	POST V	PRE V	POST V
Digenēs	2	0	1	21	1	1
Ptōchoprod	2	4	0	46	3	4
Glykas	1	2	0	40	2	4
Spaneas	0	0	1	10	0	2
Kallimakhs	0	0	0	17	0	1
Lybistros	0	0	0	40	0	3
Achilleid	1	1	0	16	1	0
Belisarios	0	0	0	4	0	0
Thrēnos	5	1	0	7	0	1
Poulologos	0	0	0	8	0	0
Paidiophr.	0	0	0	0	0	0
Physiologos	0	0	0	0	0	0
Spanos	1	0	0	24	0	3
Aitōlos	0	0	0	4	0	0
Moreas	0	0	0	4	0	0
Tokkoi	0	0	0	1	0	0
Rimada	0	3	0	11	0	0
Gioustos	0	3	0	14	0	0
Depharanas	2	1	0	4	0	0
Tribōlēs	0	0	0	3	0	0
Phalieros	0	0	0	26	1	3
Homilia	0	0	0	4	0	0
Apokopos	0	0	0	7	0	0
Apollōnios	0	0	0	6	0	0
Phlōrios	1	2	0	26	0	2
Rhodos	0	0	0	9	0	0
Katalogia	0	0	0	18	0	1
Total	15	17	2	263	8	25

Table 3: Raw counts concerning the interaction between imperative verb-form and pronoun placement.

B. Results of OneWay ANOVA

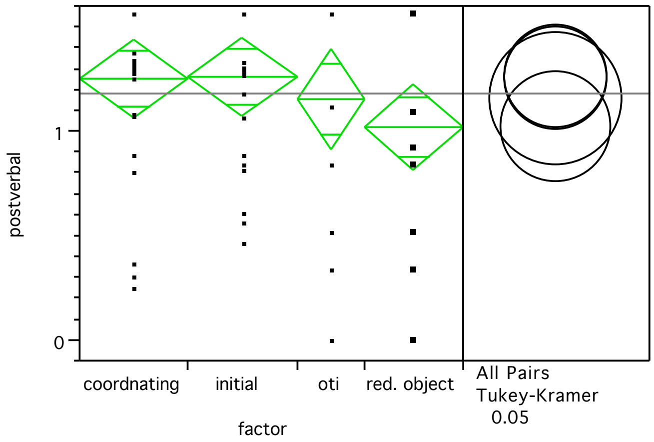

Figure 2: Comparing factors in Mackridge’s Rule (1); tokens with ὅλος excluded from factor ‘reduplicated object’.

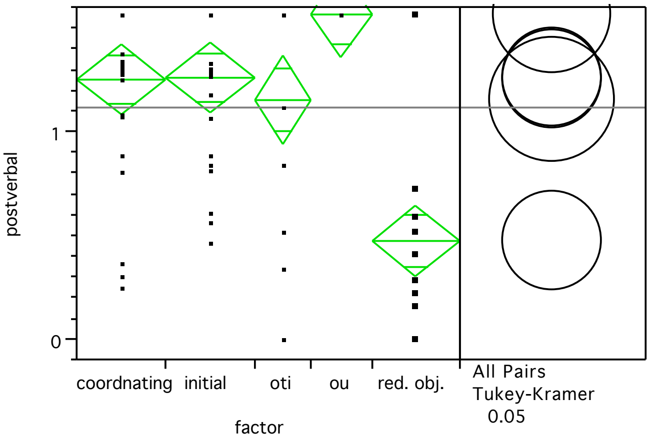

Figure 3: Graph of Anova with ὅλος tokens included in factor ‘reduplicated object’.

Abs(Dif)-LSD	initial	coordnating	ὅτι	red. object
initial	-0.36507	-0.35725	-0.3151	-0.14235
coordnating	-0.35725	-0.36507	-0.32291	-0.15017
oti	-0.3151	-0.32291	-0.46537	-0.29721
red. object	-0.14235	-0.15017	-0.29721	-0.38814

Positive values show pairs of means that are significantly different.
Table 4: Comparisons for all pairs using Tukey-Kramer HSD (when ὅλος is excluded) q*=2.61939

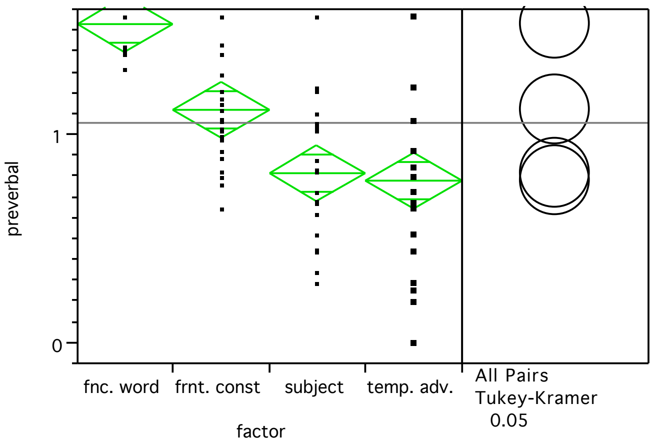

Figure 4: Comparing factors associated with preverbal placement (Mackridge's Rules 2, 3, 4, & 5).

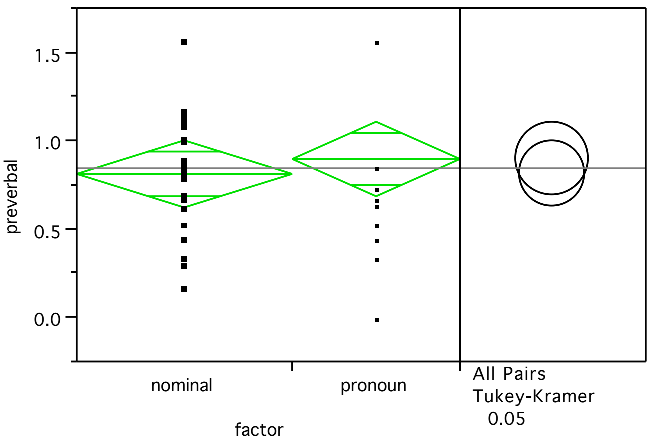

Figure 5: Comparing pronominal vs nominal subjects.

Abs(Dif)-LSD	pronoun	nominal
pronoun	-0.31015	-0.20641
nominal	-0.20641	-0.27202

Positive values show pairs of means that are significantly different.

Table 5: Comparisons for all pairs in pronoun vs. nominal subjects using Tukey-Kramer HSD, q*=2.01540.

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AN EMPIRICAL EVALUATION OF SENTENCE PROCESSING MODELS: CENTER EMBEDDINGS IN HINDI

Shravan Vasishth

Abstract

Data from Hindi center-embedding constructions (CECs) are used to evaluate three sentence processing models: Joshi's Embedded Pushdown Automaton (EPDA), Gibson's Syntactic Prediction Locality Theory (SPLT), and Lewis' Interference and Confusability Theory (ICT). The SPLT and ICT (but not the EPDA) are found to correctly predict several processing facts about Hindi. However, the experimental results also reveal a problem for these two current, wide-coverage theories: neither model appears to be able to account for differences in reading time observed at noun phrases in Hindi CECs. A sentence processing model is proposed in an accompanying article (see (Vasishth & Kruijff 2001) in this volume) that can in principle be integrated with the ICT to provide a unified account of processing difficulty in the languages investigated.

1 Introduction

Several cross-linguistically applicable models of sentence processing have been proposed over the last decade that attempt to account for processing difficulties experienced by humans. Center-embedding constructions (described below in detail) have been

Vasishth, Shravan. 2001. An empirical evaluation of sentence processing models: Center embeddings in Hindi. *OSUWPL* 56, 159–181.

a centerpiece, so to speak, of these models. In this chapter, I discuss the predictions of three models using center embeddings in Hindi, and show that these models make several incorrect predictions regarding the Hindi data. In response to this gap between the data and the existing theories, Vasishth and Kruijff present a model of processing (see the article accompanying this one (Vasishth & Kruijff 2001)); this model can account for the Hindi data, as well as the existing set of data available for Dutch, German, and Japanese center embeddings.

I begin by describing the performance issues relating to center embeddings in general. Then I present three models of sentence processing (developed by Joshi, Gibson and Lewis) and their respective predictions for Hindi. Finally, I evaluate these models using new experimental data from Hindi.

2 What are center embeddings and why are they interesting?

Center-embedding constructions (CECs) involve sentences in which linguistic material is embedded inside another clause. An example is the center embedding (1a), which has one embedded clause. Chomsky & Miller (1963), among others, have observed that double center embeddings like (1b), which have two embedded clauses, are more difficult for English native speakers to process than single embeddings (1a) or right-embedded constructions like (1c).

(1) a. The rat [that the cat chased] ate the malt.
b. The rat [that the cat [that the dog chased] killed] ate the malt.
c. The dog chased the cat [that killed the rat [that ate the malt]].

A widely-held view is that limitations on human working memory[1] impose strong constraints on the processing of complex structures like CECs. The assumption is that the noun phrases must be temporarily stored in working memory until verbal information clarifies the sentence structure. Two wide-coverage theories of sentence processing, Gibson's Syntactic Prediction Locality Theory (SPLT) (Gibson 1998; Babyonyshev & Gibson 1999), and Lewis' Interference and Confusability Theory (ICT) (Lewis 1998), specifically appeal to working memory constraints in explaining the processing of syntactic structures like CECs. Joshi's Embedded Pushdown Automaton (EPDA) does not appeal to working memory constraints directly, but it does rely on the notion of temporary storage of material. Gibson and Lewis' models are able to account for many processing facts in languages such as Dutch (Kaan & Vasić 2000), German (Bach *et al.* 1986), Japanese (Nakatani *et al.* 2000), and Korean (Uehara & Bradley 1996), and Joshi's can do the same for a smaller range of languages.

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[1] I assume that working memory, or short-term memory, is "...a short-duration system in which small amounts of information are simultaneously stored and manipulated in the service of accomplishing a task" (Caplan & Waters 1999).

Clearly, many other languages need to be investigated before theories of sentence processing can claim truly universal coverage (as these models aspire to do). This is the motivation for studying the processing of CECs in Hindi.[2] This is a useful language to investigate since it has certain properties not seen in previously studied languages. We look at these properties next. Consider first the single center embedding in example (2):

(2) Siitaa-ne Hari-ko [kitaab(-ko) khariid-ne-ko] kahaa
Sita-erg Hari-dat book(-acc) buy-inf told
'Sita told Hari to buy the book.'

Here, the ergative case marker *-ne* marks the agent,[3] and the other noun phrases (NPs) are marked by the oblique case marker *-ko*, regardless of the NP's grammatical role as indirect or direct object. However, case marking on the direct object (*kitaab*) is optional: when present, it marks the NP as specific, and when absent, the NP could be specific or non-specific (Mohanan 1994).

For example, in a sequence of utterances like (3), the direct object *kitaab* cannot have case marking when it is not salient in the discourse (3a), but can have it once it has been mentioned (3b).

(3) a. Siitaa aura Hari-ne dukaan mẽ ek kitaab dekhii
Sita and Hari-erg shop in one book saw
'Sita and Hari saw a book in a shop.'
b. Sita-ne Hari-ko [kitaab(-ko) khariid-ne-ko] kahaa
Sita-erg Hari-dat book-acc buy-inf told
'Sita told Hari to buy the book.'

The interesting fact for us is that, in example (2), if *-ko* case marking is present on the direct object (*kitaab*), the second and third NPs will have phonologically the same suffix. This is interesting because previous research on adjacent similarly case-marked NPs in Japanese and Korean CECs Uehara & Bradley (1996); Lewis & Nakayama (1999) have shown that nominative case marking on adjacent NPs results in increased processing difficulty, presumably due to working memory overload (this is discussed in detail below). However, it is an open question whether case markings other than nominative affect processing similarly.

Hindi also has rather free word order in general; there is only one constraint on the 5! orders for the single center embedding in (2): the direct object of the most deeply

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[2] Hindi, also known as Urdu, or Hindi-Urdu, is an Indo-Aryan language spoken primarily in South Asia; it has about 424 million speakers in India (source: 1991 Census of India, www.censusindia.net), and about 10 million in Pakistan (source: www.sil.org).

[3] Hindi is a split-ergative language, with an ergative-absolutive case marking system in the perfective aspect.

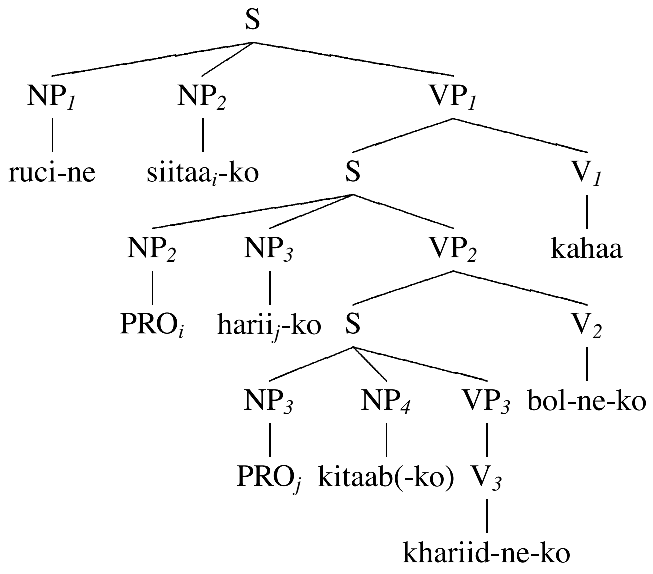

Figure 1: Example (5)

embedded verb must not appear to the right of this verb, as the following example shows (unlike analogous English sentences like *The cat the dog bit died*, examples like (4a) are very natural in Hindi and occur quite frequently in a large text corpus (Vasishth *et al.*)).

(4) a. Siitaa-ne Hari-ko [kitaab khariid-ne-ko] kahaa
Sita-erg Hari-dat book buy-inf told
'Sita told Hari to buy a/the book.'
b. * Siitaa-ne Hari-ko [khariid-ne-ko kitaab] kahaa
Sita-erg Hari-dat buy-inf book told
'Sita told Hari to buy a/the book.'

This near-absence of constraints on word order turns out to be very useful in evaluating the existing models of sentence processing, as we shall presently see.

A third property of Hindi center embeddings is that these are control constructions. That is, the structure of a double embedding like (5) is as shown in Figure 1 (single embeddings have a similar structure).

(5) Ruci-ne Siitaa-ko [Hari-ko [kitaab(-ko) khariid-ne-ko] bolne-ko] kahaa
Ruci-erg Sita-dat Hari-dat book(-acc) buy-inf tell-inf told
'Ruci told Sita to tell Hari to buy the book.'

That is, the indirect object of a clause at a given level (matrix or embedded) obligatorily controls a PRO in subject position in the clause embedded within it. The syntax of these constructions is discussed in detail elsewhere (Vasishth in progress).

These three properties (phonologically similar case marking with dative and accusative case, relatively free word order, and center embeddings being control constructions) become relevant as we look at Hindi CECs to test the predictions of the EPDA, SPLT, and ICT. I will show that the SPLT and ICT can only partly account for the Hindi processing facts and that the EPDA fails almost completely. Specifically, Gibson's SPLT can only partly account for certain reading time differences for NPs. On the other hand, Lewis' ICT appears to be noncommittal about NP reading time differences: it assumes that the primary source of processing difficulty for CECs occurs in the retrieval stage,[4] as NPs stored in working memory are retrieved and integrated with information about the verb. However, findings from self-paced reading experiments presented in this paper (see Section 4) indicate an additional, earlier, more prominent source of processing difficulty in the NP encoding/storage[5] stage. On this basis, I argue that working-memory related constraints on parsing are affected by both encoding and retrieval.

Let us now turn to the three sentence processing models in question.

3 Three models of sentence processing

3.1 Joshi's Embedded Pushdown Automaton (1990)

Joshi (Joshi 1990) presents a computational model of processing based on the results of (Bach *et al*. 1986); the latter paper showed that Dutch crossed dependencies were easier to process for native Dutch speakers than German nested dependencies are for native German speakers. Examples of crossed Dutch and nested German dependencies are shown below:

(6) a. Jan Piet Marie zag laten zwemmen
Jan Piet Marie saw make swim

'Jan saw Piet make Marie swim.'
NP1 NP2 NP3 V1 V2 V3

b. …dass Hans Peter Marie schwimmen lassen sah
…that Hans Peter Marie swim make saw

'…that Hans saw Peter make Marie swim.'
NP1 NP2 NP3 V3 V2 V1

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[4] By 'retrieval' I mean the *process* of integration of NP information with a verb.

[5] I use the term 'encoding' to refer to the stage preceding storage of NPs in working memory whereby the NPs are converted into some representational form suitable for storage. Gathercole & Baddeley (1993) present a discussion relating to the working memory processes assumed here.

The Dutch CECs are called "crossed" because of the fact that the dependencies between the verbs and the subjects form crossing chains (NP1 NP2 NP3 V1 V2 V3), and the German CECs are nested since the pattern is NP1 NP2 NP3 V3 V2 V1.

(Bach *et al*. 1986) "...show that the pushdown automaton (PDA) cannot be the universal basis for the human parsing mechanism" (Joshi 1990). The problem for the PDA is that in the case of German, NP3 and the immediately following V3 can combine together, but there is no way to tell where that structure belongs until one gets to the end of the sentence, and so this structure (and, similarly, the NP2-V2-(NP3-V3) sub-structure) has to be stored until a higher structure becomes available. By contrast, in Dutch, the sub-structures can be built and integrated incrementally.

Joshi proposes a PRINCIPLE OF PARTIAL INTERPRETATION to overcome this problem with PDAs. As he puts it (Joshi 1990:4-5):

1. The structure should be a properly integrated structure with respect to the predicate-argument structure (i.e., only predicates and arguments that go together should be integrated: *ad hoc* packaging of predicates and arguments is disallowed), and there should be a place for it to go, if it is expected to fit into another structure (i.e., the structure into which it will fit must have been popped already).
2. If a structure which has a slot for receiving another structure has been popped, then the structure that will fill this slot will be popped next.

Joshi then develops an embedded PDA (EPDA) and shows that it can handle the Dutch and German processing facts. The significance of this is that EPDAs are equivalent to the syntactic formalisms TAGs, HPSG, and CCG, all of which are capable of providing syntactic analyses for crossed and nested dependencies.

In the following discussion of Joshi's model, I assume that the reader has a working knowledge of PDAs (see, e.g., (Hopcroft & Ullman 1979:107-124) for details). In an EPDA, the pushdown store is a sequence of stacks, and new stacks may be created above or below (to the left or right) of the current stack. The specific behavior of EPDAs described below is based on (Joshi 1990).

1. **Stack head**: This is always at the top symbol of the top stack. If the stack head ever reaches the bottom of a stack, then the stack head automatically moves to the top of the stack below (or to the left) of the current stack, if there is one.
2. **Transition function** δ': Given an input symbol, the state of the finite control and the stack symbol, this specifies (a) the new state; (b) whether the current stack is pushed or popped; and (c) new stacks to be created above or below the current stack.

   δ'(input symbol, current state, stack symbol) =
   (new state, $sb_1, sb_2, \ldots, sb_m$, push/pop on current stack, $st_1, st_2, \ldots st_n$)

where $sb_1, sb_2, \ldots, sb_m$ are the stacks introduced below the current stack, and $st_1, st_2, \ldots st_n$ are the stacks introduced above it.

Note that during each move, push/pop is carried out on the current stack, and pushes on the newly created stack(s).

Next, I illustrate processing of the Dutch crossed dependency sequence: NP1 NP2 NP3 V1 V2 V3 with the figure below showing the various states. The column "Stack sequence" contains the newly created stacks, "Stack" is the stack we begin with, and the column "Pop action" shows how the interpretation is incrementally built up. Finally, "No. of (input) items" lists a number that Joshi uses as a complexity measure to account for the difference in processing Dutch and German– this just involves adding up the total number of input items in the EPDA at each move, and looking at the largest number (in the Dutch case, 3).

Input head at	Stack sequence			Stack	Pop action	No. of items
NP1						0
NP2				NP1		1
NP3				NP1 NP2		2
V1				NP1 NP2 NP3		3
V1			NP3	NP1 NP2		3
V1		NP3	NP2	NP1		3
V1	NP3	NP2	NP1			3
V2		NP3	NP2		V1(NP1,S1)	2
V3			NP3		V2(NP2,S2)=S1	1
					V3(NP3)=S2	0

Figure 2: EPDA processing of Dutch dependencies

The way this proceeds is as follows. First, NP1 is read in and pushed on to the current stack, the same goes for NP2 and NP3. Then NP3, NP2, and NP1 are successively popped out of the current stack and pushed into sequences of stacks at the left of the current stack. Then, each NP is popped out of the EPDA and incrementally builds up the predicate-argument structures starting with V1 up to V3. The complexity never goes beyond 3.

The problematic German case (problematic for PDAs), where the order of NP and V sequences is NP1 NP2 NP3 V3 V2 V1 is handled as shown below. In each case, V^*n is a possibly underspecified structure encoding V*n* and its argument(s) (NP*n* and possibly also S). That is, V^*3 = V1(NP3), V^*2= V2(NP2,S2), and V^*1= V3(N1,S1). Note that the maximum number of input items in this case is 6, higher than that in Dutch crossed dependencies.

Input head at	Stack sequence	Stack	Pop action	No. of items
NP1				0
NP2		$\boxed{\text{NP1}}$		1
NP3		$\boxed{\text{NP1 NP2}}$		2
V3		$\boxed{\text{NP1 NP2 NP3}}$		3
V3	$\boxed{V^*3}$	$\boxed{\text{NP1 NP2}}$		4
V3	$\boxed{V^*3}\boxed{V^*2}$	$\boxed{\text{NP1}}$		5
V3	$\boxed{V^*3}\boxed{V^*2}\boxed{V^*1}$			6
V2	$\boxed{V^*3}\boxed{V^*2}$		V1(NP1,S1)	4
V1	$\boxed{V^*3}$		V2(NP2,S2)=S1	1
			V3(NP3)=S2	0

Figure 3: EPDA processing of German dependencies

Joshi also discusses the case of mixed dependencies in German, where the sequences are like NP1 NP2 NP3 V1 V3 V2. The complexity measure for this kind of dependency is claimed to be intermediate between that for crossed and nested dependencies (presumably due to the larger number of total steps involved in mixed dependencies). In such a case, the EPDA behaves exactly like that for nested dependencies in German until we reach V1. Then it must behave like the EPDA for crossed dependencies. A schematic view is shown below:

Input head at	Stack sequence	Stack	Pop action	No. of items
NP1				0
NP2		$\boxed{\text{NP1}}$		1
NP3		$\boxed{\text{NP1 NP2}}$		2
V1		$\boxed{\text{NP1 NP2 NP3}}$		3
V1	$\boxed{\text{NP3}}$	$\boxed{\text{NP1 NP2}}$		3
V1	$\boxed{\text{NP3}}\boxed{\text{NP2}}$	$\boxed{\text{NP1}}$		3
V1	$\boxed{\text{NP3}}\boxed{\text{NP2}}\boxed{\text{NP1}}$			3
V3	$\boxed{\text{NP3}}\boxed{\text{NP2}}$		V1(NP1,S1)	2
V2	$\boxed{\text{NP3}}\boxed{\text{V3}}\boxed{\text{NP2}}$			3
	$\boxed{\text{NP3}}\boxed{\text{V3}}$		V2(NP2)=S1	2
	$\boxed{\text{NP3}}$		V3(NP)	1
			NP3	0

Figure 4: EPDA processing of German mixed dependencies

One point to note here is that when V3 is popped out, its argument (NP) is uninstantiated. This only gets instantiated when NP3 is popped out in the final move. Another important point: when the input head is at V2, the preceding V3 has been inserted to the left of NP2 by creating a new stack behing the stack holding NP2, and inserting V2 into this new stack. These moves are allowed by the EPDA and accord with the PPI.

3.2 Predictions of the EPDA model for Hindi CECs

Joshi's account raises some interesting questions for Hindi center-embedding constructions. Recall the issue of specificity marking on the direct object, i.e., minimal pairs like the following:

(7) a. Siitaa-ne Hari-ko [kitaab khariid-ne-ko] kahaa
Sita-erg Hari-dat book buy-inf told
'Sita told Hari to buy a/the book.'
b. Siitaa-ne Hari-ko [kitaab-ko khariid-ne-ko] kahaa
Sita-erg Hari-dat book-acc buy-inf told
'Sita told Hari to buy the book.'
c. Siitaa-ne Hari-ko [Ravi-ko [kitaab khariid-ne-ko] bol-ne-ko] kahaa
Sita-erg Hari-dat Ravi-dat book buy-inf tell-inf told
'Sita told Hari to tell Ravi to buy a/the book.'
d. Siitaa-ne Hari-ko [Ravi-ko [kitaab-ko khariid-ne-ko] bol-ne-ko] kahaa
Sita-erg Hari-dat Ravi-dat book-acc buy-inf tell-inf told
'Sita told Hari to tell Ravi to buy a/the book.'

Consider now the parses for (7a,b):

Input head at	Stack sequence	Stack	Pop action	No. of items
NP1-ne				0
NP2-ko		NP1-ne		1
NP3-$\emptyset$/-ko		NP1-ne NP2-ko		2
V2		NP1-ne NP2-ko NP3		3
V1	V^*2	NP1-ne		4
	V^*2		V1(NP1-ne,S1)	3
			V2(NP2-ko,NP3)=S1	0

Figure 5: Hindi examples (7a,b)

Based on Table 5, it is easy to see that the EPDA predicts the following for Hindi center embeddings:

- No difference in processing difficulty at NP3 with respect to specificity-marking.
- No difference in processing difficulty at V2 in both sentences.

- Greatest difficulty at final (matrix) verb.

I will presently show that none of these preductions are borne out.

3.3 Concluding remarks regarding the EPDA model

Consider again the Dutch vs. German constrast. Bach et al. showed that Dutch crossed dependencies are easier to process for Dutch native speakers, but German nested dependencies are harder for German native speakers. The EPDA models moment by moment processing difficulty (Joshi, personal communication), so it would predict that the highest processing cost is at the innermost verb in both the Dutch and German cases, since in the EPDA the most time is spent there and the number of items present in the EPDA at this point is the largest. However, experimental work has shown that this is not true, at least not for Dutch (Kaan & Vasić 2000): in Dutch, as in Hindi, the most costly region seems to be at the final NP.

Moreover, in the EPDA, structure building does not begin until the verbs are reached; until that point, the NPs are simply stored in the stack. NPs, however, generate predictions (see, e.g., (Scheepers *et al*. 1999), and references cited therein), they are not just merely stored in a temporary buffer (presumably EPDA is intended to model working memory). Gibson's SPLT, discussed next, addresses this issue of incremental processing and predictions at the NPs.

In sum, there are several empirical problems in the EPDA model: the inability to predict moment by moment reading times correctly for Hindi and Dutch (there are no reading time studies for German CECs, as far as I know), and the assumption of simple storage of the NPs before the verbs are encountered.

3.4 Gibson's Syntactic Prediction Locality Theory (1998/1999)

Gibson's syntactic prediction locality theory (SPLT) (Gibson 1998; Babyonyshev & Gibson 1999) has a somewhat different processing cost metric than the EPDA. The SPLT has two cost components: INTEGRATION COST and MEMORY COST. Integration cost is the distance between the head-to-be-integrated (e.g., an NP) and the head to which it connects in the current structure (e.g., a verb). This is quantified in terms of the number of discourse referents separating the two heads. Memory cost is the number of all required syntactic heads at a given point. The memory cost for each predicted syntactic head h increases as linguistic material not matching h is processed. The prediction of the top-level predicate (matrix verb) is assumed to be cost-free (since most utterances are headed by a predicate), and for all required syntactic heads other than the top-level predicate, memory cost $M(n) = n$, where n is the number of new discourse referents processed since that syntactic head was initially predicted.[6]

I illustrate the model's predictions by giving a derivation for Hindi double embeddings.[7] In (8), case marking or the absence thereof on NP3 is indicated by ∅ (no case marking) and *-ko*. In this discussion, I focus on the memory cost alone for ease of exposition; since integration cost is a function of memory cost in the SPLT, the relative processing costs that interest us remain the same.

(8) NP1-ne NP2-ko NP3-ko NP4-∅/ko V3-inf V2-inf V1

Here, the predicted slowest point during real-time processing is over NP4, and no difference between the two variants (NP4-∅ versus NP3-*ko*) is predicted.

Prediction	NP1-ne	NP2-ko	NP3-ko	NP4-∅/ko	V3	inf2	V2	inf1	V1
V1	0	0	0	0	0	0	0	0	0
V2	-	M(0)	M(1)	M(2)	M(2)	M(2)	*	-	-
Inf1	-	M(0)	M(1)	M(2)	M(2)	M(2)	M(2)	*	-
V3	-	-	M(0)	M(1)	*	-	-	-	-
Inf2	-	-	M(0)	M(1)	M(1)	*	-	-	-
	—-	—-	—-	—-	—-	—-	—-	—-	—-
	0	0	2	6	5	4	2	0	0

Figure 6: Processing of (8)

However, I will presently show that the slowest reading time is over the final NP only if it has *-ko* marking. Thus, the predictions of the SPLT appear to be only partly correct.

3.5 Lewis' Interference and Confusability Theory (1998/1999)

This model treats parsing as a short-term memory task. In the context of center-embedding constructions, the central idea is that retrieval at a verb of an NP during real-time processing is affected by two factors: (i) positional confusability; and (ii) retroactive interference (RI) and proactive interference (PI).

Positional confusability is the probability of correctly retrieving an NP from among a list of NPs seen up to a given point. For example, if NP1 NP2 NP3 NP4 is the list of NPs seen so far, and if NP3 is to be retrieved, the probability of correct retrieval will decrease if NP3 and NP4 are similarly case marked. This decrease in probability is due to

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[6] Only finite verbs introduce discourse referents in this model (Gibson, personal communication).

[7] I follow Babyonyshev and Gibson's derivation for Japanese center-embeddings and assume that the oblique postpositions/case markers for the embedded verbs are also predicted during real time processing; however, nothing hinges on this assumption.

the assumption that item-recall is with respect to the end-points (the first and last item) of a list (independent motivation for this assumption comes from the psychology literature, e.g., (Henson 1999)). If an end-point NP is similar to the item being recalled (in our case, 'similar' means similarly case marked), then the probability of correct retrieval decreases. Conversely, if the end-point NP is dissimilarly case marked compared to the NP to be retrieved, the probability of correct retrieval increases (i.e, positional confusability is reduced).

Pro- and retroactive interference are defined as follows. Proactive interference (PI) occurs when the retrieval of an NP that suffers from interference by an NP or NPs preceding the NP to be retrieved. Retroactive interference (RI) is the opposite: the retrieval of an NP suffers from interference from items that follow the NP. There is a great deal of evidence in the psychology literature for PI and RI in intertrial list recall (see, e.g., (Müller & Pilzecker 1900) and (Keppel & Underwood 1962) for some of the earliest findings). It is an assumption of the model that PI and RI occur *within* a list of NPs (see (Humphreys & Tehan 1998), which provides independent evidence for proactive interference within trials).

I now illustrate the model's behavior.

(9) $\phi_1\phi_2\ldots\phi_n X\rho_1\rho_2\ldots\rho_m Y$

If Y is the current word (a verb), and a syntactic relation needs to be established between a constituent projected from Y and a constituent headed by a prior word X (a noun), the total amount of interference at Y depends on the number of similar items intervening between X and Y (RI) and the number of similar items preceding X (PI). 'Similarity' is understood to be syntactic similarity, which is determined by the structural role to be assigned to X. For example, if X is to be assigned the structural position of subject, then RI occurs due to all $\rho_1\rho_2\ldots\rho_m$ which could also fill subject positions, and PI occurs due to all $\phi_1\phi_2\ldots\phi_n$ which could also fill subject positions. In addition, positional confusability increases if X and ρ_m or ϕ_1 (i.e., one of the end points) is similar to X. The total amount of retrieval difficulty at Y is the sum of the two kinds of interference and positional confusability. For ease of exposition, I assign simple numerical values to each component of processing cost: e.g., if there are two elements causing RI, then RI=2, if one end-point is increasing positional confusability (POS), then POS=1, etc. In the actual computational implementation, the costs are not necessarily simple integer values.

The predictions for Hindi CECs illustrate the model's operation. The pattern in (10a) is predicted to be easier than (10b).

(10) a. NP1-ne NP2-ko NP3-ko NP4-∅ V3 V2 V1
b. NP1-ne NP2-ko NP3-ko NP4-ko V3 V2 V1

The following tables illustrate how the model works. In each table, the first column lists the item to be retrieved (X in the template above) at a particular verb Y, with the items

$\rho_1\rho_2\ldots\rho_m$ intervening between X and Y, and the items $\phi_1\phi_2\ldots\phi_n$ preceding X. For each Y the Figure lists the cost of RI and PI, and the uparrow (⇑) indicates the item(s) involved in causing RI or PI at retrieval.

Retrieved item	NP1-ne	NP2-ko	NP3-ko	NP4-∅	V3	V2	V1
NP3-ko	ϕ_1	ϕ_2	X	ρ_1	Y		
					POS=0		
					RI=0		
	⇑	⇑			PI=2		
NP2-ko	ϕ_1	X	ρ_1	ρ_2		Y	
						POS=0	
			⇑			RI=1	
	⇑					PI=1	
NP1-ne	X	ρ_1	ρ_2	ρ_3			Y
							POS=0
		⇑	⇑				RI=2
							PI=0

Figure 7: Processing of (10a)

Retrieved item	NP1-ne	NP2-ko	NP3-ko	NP4-ko	V3	V2	V1
NP3-ko	ϕ_1	ϕ_2	X	ρ_1	Y		
					POS=1		
				⇑	RI=1		
	⇑	⇑			PI=2		
NP2-ko	ϕ_1	X	ρ_1	ρ_2		Y	
						POS=1	
	⇑		⇑	⇑		RI=2	
						PI=1	
NP1-ne	X	ρ_1	ρ_2	ρ_3			Y
							POS=1
		⇑	⇑	⇑			RI=3
							PI=0

Figure 8: Processing of (10b)

Here, the retrieval of a subject at a verb results in the other underlying subjects causing RI or PI.

In the next section I show that Lewis' model correctly predicts increased retrieval difficulty at the innermost verb. However, there is another dimension of processing difficulty in such sentences: encoding difficulty of the NPs increases if similarly case-marked NPs are adjacent to each other. Lewis' model is agnostic about processing difficulties at NPs and is thus unable to account for this fact.

We turn now to the experimental evidence from Hindi.

4 Center embeddings in Hindi: Three experiments

The second author of these notes (Vasishth) conducted three experiment to evaluate various predictions of these three models. These experiments were conducted at Jawaharlal Nehru University, New Delhi, India during September 2000. The research was funded partly through the project, “Establishing Ohio State as a Major Center for Language Processing Research, Ohio State Center for Cognitive Science, Department of Linguistics, and Department of Computer and Information Science” and partly by the Department of Linguistics, The Ohio State University (OSU), and was conducted in accordance with the human subjects research protocol number 80B0433 specified by the Human Subjects Institutional Review Board, OSU.[8]

4.1 Experiment 1

4.1.1 Method and materials

Experiment 1 had a 2×2 factorial design, the two factors being level of embedding (single or double; compare (11a,b) and (11c,d)), and absence or presence of case marking on the final NP (compare (11a,c) and (11b,d)). In the test sentences, all but the final NPs were proper names; the final NP was always an inanimate common noun, such as ‘book’ or ‘letter’. This was a paper questionnaire where subjects were asked to rate each sentence on a scale from 1 (completely unacceptable) to 7 (completely acceptable).

(11) a. Siitaa-ne Hari-ko [kitaab khariid-ne-ko] kahaa
Sita-erg Hari-dat book buy-inf told
‘Sita told Hari to buy a/the book.’

b. Siitaa-ne Hari-ko [kitaab-ko khariid-ne-ko] kahaa
Sita-erg Hari-dat book-acc buy-inf told
‘Sita told Hari to buy the book.’

c. Siitaa-ne Hari-ko [Ravi-ko [kitaab khariid-ne-ko] bol-ne-ko] kahaa
Sita-erg Hari-dat Ravi-dat book buy-inf tell-inf told
‘Sita told Hari to tell Ravi to buy a/the book.’

d. Siitaa-ne Hari-ko [Ravi-ko [kitaab-ko khariid-ne-ko] bol-ne-ko] kahaa
Sita-erg Hari-dat Ravi-dat book-acc buy-inf tell-inf told
‘Sita told Hari to tell Ravi to buy a/the book.’

---

[8] All comparisons presented hereafter have $p < .05$, unless otherwise stated.

Four lists were prepared in a counterbalanced, Latin Square design, and 32 fillers were inserted between 16 target sentences in pseudorandomized order. The fillers consisted of eight examples of four syntactic structures: relative clauses, medial gapping constructions, simple declaratives, and sentences with that-clauses (all the stimuli and fillers are available from the author on request). Fifty-three native speakers of Hindi participated in the experiment. Nineteen of these were Hindi-speaking students at the Ohio State University, and were paid 5 US Dollars each for completing the questionnaire; the remaining thirty-four were undergraduate and graduate students at Jawaharlal Nehru University, New Delhi, India, and were paid 80 Indian Rupees each (approximately 1.7 US Dollars).

4.1.2 Predictions

This experiment tested the following predictions:

- Acceptability will decrease with increasing level of embedding. All three models predict this.
- Lewis' model predicts that direct-object marking will result in reduced acceptability, but Gibson's and Joshi's models predict that the direct object marking will have no effect on acceptability.

4.1.3 Results

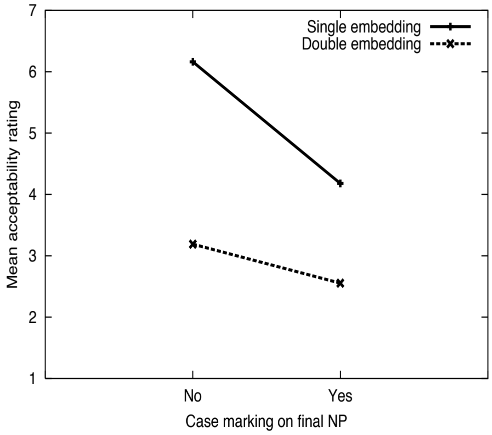

Figure 9: Results of Experiment 1

As Figure 9 shows, the results indicate that increasing the amount of embedding reduces acceptability ((11c,d) were less acceptable than (11a,b)), as predicted by Joshi's, Gibson's, and Lewis' models. However, case marking on the final NP also results in reduced acceptability ((11b), (11d) were less acceptable than (11a), (11c) respectively), which Lewis' model predicts, but Joshi's and Gibson's do not. The details of the statistical analysis are as follows: A repeated measures analysis of variance (ANOVA) was done for subject (F1) and item (F2) means, with level of embedding and presence or absence of case marking on the final NP as the within-subject factors. The mean rating for sentences like (11a) was significantly higher (mean: 6.162) than that for sentences like (11b) (mean: 4.179), F1(1,52) = 130.969, rating for sentences like (11c) was significantly higher (mean: 3.189) than for sentences like (11d) (mean: 2.553), F1(1,52) = 13.447,

4.2 Experiment 2

4.2.1 Method and Materials

This was a noncumulative self-paced moving window reading task (Just *et al*. 1982); exactly the same materials were used as for Experiment 1 (see examples (11) for the four conditions).

A G3 laptop Macintosh running PsyScope (Cohen *et al*. 1993) was used to present the materials to subjects. Forty-six native speakers of Hindi participated in the experiment; no subjects from Experiment 1 participated in this experiment. The task was to press the space key in order to see each successive word; each time the key was pressed, the previous word would disappear. Reading time (msec) was taken as a measure of relative momentary processing difficulty. A yes/no comprehension question was presented after each sentence; these were meant to ensure that subjects were attending to the sentences.

4.2.2 Predictions

This experiment tested the following predictions:

- Reading time at the innermost verb would be slower in examples like (11a,c) than in examples like (11b,d). This was based on Lewis' interference theory, which states that the probability of correct retrieval of the final NP decreases as its positional confusability with an adjacent NP increases.

- Reading time would be slowest either at (i) the last NP (SPLT), or (ii) the innermost verb (EPDA). Prediction (i) is based on the SPLT, as discussed in Section 3.4. Prediction (ii) comes from the fact that in the EPDA processing of examples like (11b,d) will proceed as in German center embeddings (see Figure 3), with a highest cost of 7 at the innermost *verb* (since there is one more NP than in the German example in Figure 3).

- The EPDA and SPLT both predict that reading time over the last NP will be unaffected by whether the NP has case marking or not.

4.2.3 Results

Residual reading time were calculated for each region by subtracting from raw reading times each participant's predicted reading time for regions with the same numbers of characters; this in turn is calculated from a linear regression equation across all of a participant's sentences in the experiment (Ferreira & Clifton 1986; Trueswell *et al*. 1994). This was done in order to factor out the effect of word length on reading time. However, the raw reading times gave identical results to the ones discussed below.

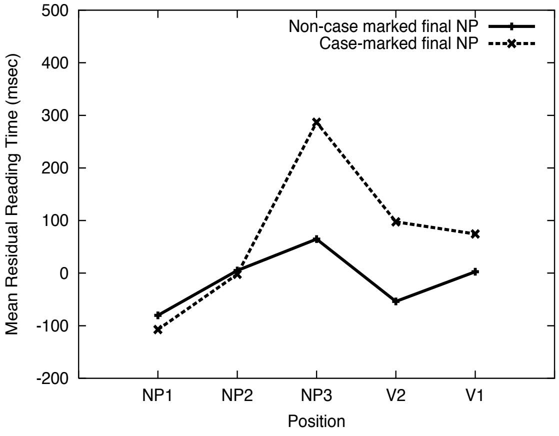

Figure 10: Single Embeddings

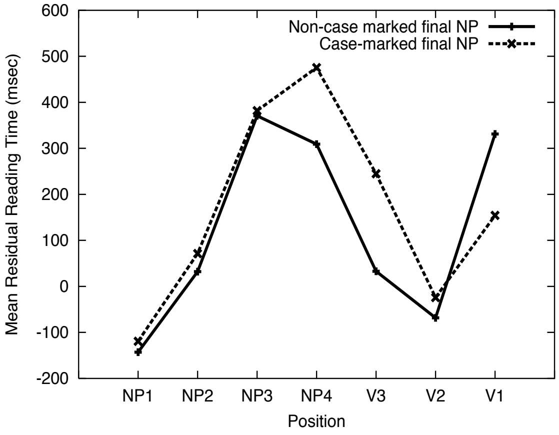

Figure 11: Double Embeddings

As shown in Figures 10 and 11, the results indicate that (a) reading time (RT) increases at the second of two adjacent similarly case-marked NPs; (b) RT remains slow if two *-ko* marked NPs are followed by a third *-ko* marked NP; (c) RT is faster if a non-case-marked NP (rather than a case-marked NP) follows a *-ko* marked NP; (d) RT at the innermost verb is slower if the last NP is case marked than when it isn't; and (e) the slowest RT is in the region of the final NP, particularly if it is case marked.

Thus, the first prediction (Lewis' model), that RTs would be slower at the innermost verb in sentences with case-marked final NPs than in sentences with non-case-marked final NPs, was borne out.[9] The second prediction (Gibson's model's), that the slowest RT would be at the final NP was partly confirmed, and Joshi's model's prediction that the slowest RT would be at the innermost verb, was disconfirmed. The third prediction (Gibson's and Joshi's models'), that RT at the last NP would be unaffected by case marking, was disconfirmed.

Thus, Lewis' and Gibson's models make several correct predictions. However, both models are unable to capture some of the Hindi facts: Lewis' ICT makes no predictions for the NP reading times,[10] and Gibson's model cannot account for the different RTs on the final case-marked vs. non-case-marked NPs. Thus, it is clear that encoding/storing NPs is a component of processing that neither model can account for.

I propose to extend Lewis' model so that it can account for encoding and retrieval difficulty; this is discussed in (Vasishth & Kruijff 2001). I choose to augment Lewis' model rather than Gibson's because the former makes no assumptions about the encoding component of processing and it is straightforward to incorporate the ideas set forth in (Vasishth & Kruijff 2001), which provides a fairly robust account of difficulty due to encoding processes.

We now consider another aspect of Lewis' model. Recall that Lewis identifies two sources of retrieval difficulty: positional confusability and interference (Section 3.5). In experiment 2, there was no way to distinguish between the two. In experiment 3 below, I attempt to find evidence for positional confusability. I use the fact that positional confusability predicts that processing will improve if similarly case-marked NPs are made non-adjacent, by, e.g., scrambling. I therefore tested this prediction in Experiment 3 by manipulating adjacency.

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[9] It is possible that the longer reading time at the innermost verb is due to spillover to the verb region from processing difficulty at the NPs. I intend to investigate this question further in future research.

[10] Lewis (personal communication) informs me that this claim is incorrect; Lewis' ICT does indeed make predictions for NP reading times. However, at the time of writing this I do not possess a description of the precise predictions made by the ICT.

4.3 Experiment 3

4.3.1 Method and Materials

This was an offline acceptability rating task similar in design to Experiment 1. The test sentences were single embeddings; one factor was presence or absence of case-marked final NPs, and the other factor was scrambled (NP2-**ko** NP1-*ne* NP3(-**ko**)) or unscrambled (NP1-*ne* NP2-**ko** NP3-(**ko**)) first and second NPs (see examples (12a,b)).

Participants were given a paper questionnaire and asked to rate each sentence on a scale of 1 (completely unacceptable) to 7 (completely acceptable). Sixty-seven native speakers of Hindi participated; none had participated in the earlier experiments. There were 16 test items and 32 fillers.

(12) a. siitaa-ne hari-ko kitaab khariid-ne-ko kahaa
Sita-erg Hari-dat book buy-inf told
'Sita told Hari to buy a/the book.'

b. hari-ko siitaa-ne kitaab khariid-ne-ko kahaa
Hari-dat Sita-erg book buy-inf told
'Sita told Hari to buy a/the book.'

c. siitaa-ne hari-ko kitaab-(ko) khariid-ne-ko kahaa
Sita-erg Hari-dat book-acc buy-inf told
'Sita told Hari to buy the book.'

d. hari-ko siitaa-ne kitaab-(ko) khariid-ne-ko kahaa
Hari-dat Sita-erg book-acc buy-inf told
'It was Hari who Sita told to buy the book.'

The conditions (12a) and (12b) were included to establish whether scrambled sentences are in general less acceptable than unscrambled ones when presented out of context. It is well-known that scrambled sentences (presented out of context) are less acceptable in languages like English, German, Finnish, and, Hungarian, (see (Hyönä & Hujanen 1997) for a discussion and references). We would therefore expect scrambled sentences (in null contexts) to be involve some processing cost. One key question is whether positional confusability has a greater cost compared to the processing cost of scrambling. If increasing positional confusability has a higher relative cost than scrambling, we will have evidence consistent with the confusability theory.

4.3.2 Predictions

Scrambling was expected to result in reduced acceptability; in addition, adding case marking to the final NP in a scrambled sentencs is predicted by Lewis' confusability theory to result in a smaller decrease in acceptability than when case marking is added to the final NP in unscrambled sentences. That is, the unscrambled order NP1-*ne* NP2-**ko** NP3 is predicted to be more acceptable than the scrambled order NP2-**ko** NP1-*ne* NP3, and the reduction in acceptability when an NP sequence like NP1-*ne* NP2-**ko** NP3-**ko** is scrambled to NP2-**ko** NP1-*ne* NP3-**ko** should be smaller than the case where a sequence like NP1-*ne* NP2-**ko** NP3 is scrambled to NP2-**ko** NP1-*ne* NP3. This is because the confusability theory predicts that in a sequence like NP2-**ko** NP1-*ne* NP3-**ko** there will be less retrieval difficulty at a verb since the two *-ko* marked NPs are no longer adjacent and are at the two ends of the list of NPs (as discussed in Section 3.5, the two ends of the NP-list are the indexing positions for recalling items in a list).

4.3.3 Results

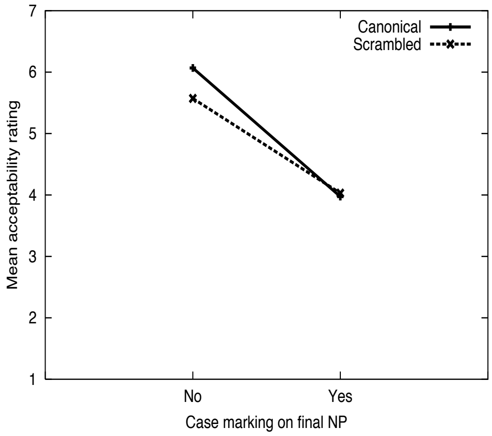

Figure 12: Experiment 3 results

Results showed that items with two *-ko* marked NPs were less acceptable (replicating findings in Experiment 1). Furthermore, as predicted by Lewis' model, scrambling sentences with two *-ko* marked NPs resulted in a smaller decrease in acceptability than scrambling sentences with only one *-ko* marked NP; i.e., there was an interaction between the factors (F1(1,66)= 7.5).

4.4 Discussion

Consistent with Lewis' theory of positional confusability, reducing similarity of adjacent NPs resulted in a smaller decrease in acceptability. Thus, the data suggest that Lewis' ICT is completely able to account for the retrieval-related processing facts for Hindi, and that the two key components in the ICT play a role in accounting for the data.

5 Conclusion

I empirically evaluated three sentence processing models and showed that Lewis' model makes the best predictions for the Hindi data. I also show that Lewis' model appears to be unable to predict all the processing facts in Hindi. In other work (Vasishth & Kruijff 2000), I propose a model of encoding that can be incorporated into Lewis' sentence processing theory.

An important point is that although the EPDA model clearly fails for Hindi center embeddings, this is not so clear for Gibson's model. Recall that all the sentences in all the experiments were presented out of context, and since we were manipulating specificity of the NP, it is possible that subjects were unable to "accommodate" the specific referent. If this was indeed the source of processing difficulty, then the SPLT's predictions may turn out to be correct if the sentences are presented with appropriate preceding context. Experiments are currently in progress to determine whether this is the case.

Acknowledgments

This research was funded by the Department of Linguistics and the Department of Computer and Information Science, OSU. The experiments were conducted at Jawaharlal Nehru University, New Delhi, India; I thank Professors Ayesha Kidwai, and R. S. Gupta, and Aarti Venkataraman for logistical help. Without their cooperation, this research would have been very difficult to carry out. I am also grateful to Chris Brew, Michael Dickey, David Dowty, Edward Gibson, Martin Jansche, Aravind Joshi, Edith Kaan, Keith Johnson, Neal Johnson, Brian Joseph, Ruth Kempson, Marcus Kracht, Bob Levine, Richard Lewis, Edson Miyamoto, Mineharu Nakayama, Gerald Penn, Shari Speer, and Hans Uszkoreit. Parts of this paper were presented at the CUNY 2001 sentence processing conference at the University of Pennsylvania, at a talk in the Department of Computational Linguistics and Phonetics, The University of Saarland, Germany, and at the 13th European Summer School for Logic, Language, and Information held at Helsinki, Finland; thanks go to the audiences at these venues for their comments and suggestions. Any errors are my sole responsibility. The author's email address is vasishth@ling.ohio-state.edu.

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SENTENCE PROCESSING AS ABDUCTION+DEDUCTION

Shravan Vasishth and Geert-Jan M. Kruijff

Abstract

A sentence processing model is presented, based on abductive and deductive inference. We show that the model makes correct predictions for an array of data involving Dutch, German, Japanese, and Hindi center-embedding constructions. It has comparable or better empirical coverage with respect to several other theories of sentence processing, and can be integrated into an existing wide-coverage model, Lewis' Interference and Confusability Theory, to obtain an integrated theory of working memory constraints on human language processing.

1 Introduction

A well-known fact about English (Chomsky & Miller 1963) is that center-embedded constructions (CECs) like (1a) are more difficult for humans to process than right-embedded constructions like (1b).

(1) a. The salmon [that the man [that the dog chased] smoked] fell off the grill.
b. The dog chased the man [that smoked the salmon [that fell off the grill]].

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Such CECs occur in several languages, such as Dutch, German, Japanese, and Hindi, as the following examples demonstrate.

(2) a. (dat) Aad Jantje de lerares de knikkers liet helpen opruimen
that Aad Jantje the teacher the marbles let help collect
'(that) Aad let Jantje help the teacher collect the marbles.' (Kaan & Vasić 2000)

b. (dass) die Männer haben Hans die Pferde füttern lehren
that the men have Hans the horses feed teach
'(that) the men have taught Hans to feed the horses.' (Bach *et al.* 1986)

c. Keiko-ga Tadashi-ga Kenji-o kiraida-to omotteiru
Keiko-nom Tadashi-nom Kenji-acc hates-comp thinks
'Keiko thinks that Tadashi hates Kenji.' (Uehara & Bradley 1996)

d. Siitaa-ne Hari-ko kitaab khariid-ne-ko kahaa
Sita-erg Hari-dat book buy-inf-acc said
'Sita told Hari to buy a/the book.' (Vasishth 2001)

Several experimental studies have investigated Dutch, German, Japanese, and Hindi (see, for example, (Bach *et al.* 1986), (Kaan & Vasić 2000), (Lewis 1998), (Babyonyshev & Gibson 1999), (Uehara & Bradley 1996), and (Vasishth 2001)), and as a result we now have a body of interesting, empirically determined facts about relative difficulties in processing these kind of sentences, and reading time differences during real-time processing.

Two theories that address the question of a cross-linguistically robust account of CEC processing are: Gibson's (Gibson 1998) Syntactic Prediction Locality Theory (SPLT), based on integration cost and memory cost; and Lewis' (Lewis 1998) Interference and Confusability Theory (hereafter, ICT), which relies on constraints on working memory during comprehension.[1] These theories make correct predictions for several languages, but are unable to account for all the processing difficulties in Hindi CECs. This is discussed in detail in (Vasishth 2001) (this volume), which showed that (i) although the ICT can account for processing difficulty of verbs, it is unable to account for differences in processing nouns; and (ii) the SPLT, whose complexity metric relies on the number of discourse referents introduced in a sentence, cannot account for some key Hindi processing facts.

Lewis' ICT focuses on processing difficulty at verbs, and makes the correct predictions for the processing of verbs in all the languages under consideration; however, it is less clear what the predictions are of the ICT for processing difficulty at nouns. One possibility is to add the metric proposed in this paper to the ICT; this has the advantage of maintaining the wide coverage of the ICT and of extending it to account for the Hindi data. We propose the abductive-inference based model as such an addition to the ICT.

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[1] This is by no means an exhaustive list of theories relating to sentence processing– we choose to discuss these two theories because they have wide empirical coverage for the questions we address here.

The structure of the paper is as follows. Section 2 outlines the main proposal: an algorithm, a complexity metric, and the relationship between the two; Section 3 illustrates the operation of the model by giving several derivations for the Dutch, German, Japanese, and Hindi facts; and Section 4 concludes the paper.

2 Processing as abduction+deduction: The main proposal

The processing model we propose for explaining the complexity of center-embedded constructions is based on a combination of *abduction* and *deduction*.[2].

The basic idea is as follows. We assume that we have a grammar, $\mathcal{G}$, for a particular natural language, $\mathcal{L}$. $\mathcal{G}$ defines what types of functional categories (or predicate-valency frames) we can encounter in $\mathcal{L}$, and how these functions can combine with their arguments. Throughout this paper we will assume that $\mathcal{G}$ is a categorial grammar, and that the basic types of functional categories can be derived directly from $\mathcal{G}$'s lexicon.

We can extract the list of types of functional categories from $\mathcal{G}$'s lexicon. Disregarding the specific words that each of these functional categories have been assigned to in the lexicon, we can consider this list essentially as providing us with schemas elucidating how words (of particular categories) can be combined. For example, the intransitive verbs give us the schema $f(NP)$, the transitive verbs $f(NP1, NP2)$, and so on. We regard this list as our collection of *hypothesis formers*, $\mathcal{H}$. We employ $\mathcal{H}$ in the following way.

When we process a sentence, we do so by starting at the beginning of the sentence, and proceeding word by word towards the end of the sentence.[3] In center embeddings, we encounter NPs before we see a verb. These NPs are arguments for one or more verbs. The NPs that we have encountered at a given point during real-time processing result in unconscious abductive inferences about the possible completion of the sentence (i.e., about the kind of schema or schemas that will apply). The model relies on the assumption that a greater number of abductive inferences will result in increased processing difficulty due to an processing overload on human working memory.[4]

Put differently, whenever we encounter a word that is believed to be an argument of an as yet unseen verb (function), we assume a *hypothetical* function that would *explain* the occurrence of that word as a (projected) argument. For example, if we encounter a noun in nominative case before we have encountered a verb, we hypothesize a verbal category that would take a noun in nominative case as its argument. It is our list $\mathcal{H}$ that provides us with

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[2] Abduction has been discussed in the context of semantic interpretation in previous work; see, e.g., Jerry R. Hobbs & Martin (1993), Strigin (1998). Note that the abductive-inference theory we present is intended to be a model of human cognitive processes, not a practical, real-life parser for natural language applications. Perhaps our model can be extended for such applications, but our goals here are different.

[3] Computers do not necessarily have to do so - for example when using head-corner parsing algorithms.

[4] We assume that working memory, or short-term memory, is "...a short-duration system in which small amounts of information are simultaneously stored and manipulated in the service of accomplishing a task" (Caplan & Waters 1999).

the possible hypothesis-candidates, since $\mathcal{H}$ includes all the (basic) types of functions that we can conceivably encounter, given $\mathcal{G}$.

Subsequently, whenever the parser encounters a verb, it tries to match a hypothesized function or functions against the actual functional category of the verb. If there is a match, or if the verbal category subsumes the hypothesized function,[5] then we can instantiate the hypothesis as the encountered verbal category, and compose the verb with the noun as its argument.[6]

Abduction, then, is understood here as the kind of unconscious and instantaneous reasoning we use to advance a hypothetical function as the best explanation for the occurrence of an argument, acting on the assumption that we are trying to process a grammatical sentence. Deduction is used in the Categorial Grammar sense, as the means to subsequently try to *compose* an actually encountered function and any available, suitable argument(s). The account of processing *complexity* arises from the number of hypotheses currently active, and how difficult it is to match them against the functional categories of observed words.

In the next subsections we discuss the notion of abduction in some more detail; then we present the algorithm and the complexity metric, and the relationship between them.

2.1 Abduction

The contemporary understanding of abduction, as a third form of logical reasoning next to deduction and induction (cf. (Josephson & Josephson 1996)), is usually traced back to its discussion by the American logician, Charles S. Peirce (Kruijff 1995; Kruijff 1998). Peirce defined abduction as the following kind of inference:

> *A surprising phenomenon O is observed;*
> *but if H were to be the case, then O would follow as a matter of course.*
> *Therefore, there is reason to believe that H.*

Thus, whereas (intuitively speaking) deduction derives a consequence from given axioms, and induction establishes a rule or generalization, abduction proposes an *explanation* for a *surprising* observation.

The surprise is the key, here. Being surprised means that either (a) we did not expect to observe (anything like) O at all, or (b) we did expect to make some observation, but it was not O. On (a), our knowledge is incomplete, whereas on (b), our knowledge is in some way incorrect. Either way, we do not at that time have sufficient knowledge to create

---

[5] (by "subsumes" we mean, "is more inclusive than but not inconsistent with"; see (Shieber 1986:14-16) for a precise definition.

[6] By the term "compose" we simply mean putting a function and its argument together.

a hypothesis explaining O- if we knew all along that O would happen, then why are we surprised?[7] Peirce's claim was that only through abduction could we obtain genuinely new knowledge (on the assumption we would let ourselves be surprised, and acknowledge that fact).

Here, as in artificial intelligence research in general, we take in a substantially weaker (but more workable) position. We assume that we have at our disposal all hypothesis formers that could be possibly abduced. For our application, the list is assumed to be the smallest one given a grammar/lexicon - the set $\mathcal{H}$ discussed above. We assume that $\mathcal{H}$ is finite and closed.[8] These are all reasonable assumptions since $\mathcal{H}$ cannot have any redundant hypothesis formers (having been created from the grammar rules), and the list of schemas extracted from the grammar will be finite (if this were not so, the set of grammar rules would have to infinite).

$\mathcal{H}$ is created on the basis of a compilation of the lexicon (by compilation we do not mean the creation of the lexicon; rather, given a lexicon, a set of procedures, described in detail in (Kruijff 1999), are applied to it in order to compile out information present in the lexicon). In a lexicalist approach like Categorial Grammar, the lexicon determines how words can be put together. Structural rules, like the those in Multi-Modal Logical Grammar (MMLG) (Moortgat 1997), only vary the order in which words occur grammatically.[9]

The compilation of the lexicon is based on a procedure proposed for linear logic in (Hepple 1998), and extended in (Kruijff 1999) to cover a larger range of multiplicative resource logics used in MMLG. Originally, compilation was proposed for the purposes of efficient chart parsing with Lambek-style grammars, in order to overcome problems with earlier approaches (e.g., (Hepple 1992) and (König 1990)). The result of the procedure is a set of first-order functions to represent categories (i.e., there are no higher-order formulas).

Once we have a compiled version of the lexicon, we abstract away from individual words, and retain the different functional categories that are defined. Taken together, these functional categories make up $\mathcal{H}$. The list of hypothesis formers $\mathcal{H}$ is assumed to be partially ordered by a simplicity criterion: simpler structures appear before the more complex ones. Examples of the simplicity criterion: monoclausal structures are simpler than biclausal ones, the intransitive-verb based hypothesis is simpler than the ditransitive verb-based hypothesis. This assumption is not arbitrary; it is based on experimental evidence from (Yamashita 1997), which showed that (Japanese) subjects prefer to complete sentences with verbs that are simpler (i.e., verbs that result in monoclausal structures) rather than more complex ones. We take this result to indicate that simpler structures are more

---

[7] For that reason, Peirce advanced the idea that a hypothesis is created by a "guessing instinct" because we cannot rely on reasoning from our knowledge as such. In this context it is perhaps interesting to note that Peirce was not alone in postulating a fundamental role for something like a "guessing instinct" in logic. Gödel took the same line– cf. (Parsons 1995), and the brief comparison between Gödel's ideas and Peirce's in (Kruijff 1997).

[8] This is not to confused with the fact that the set of sentences is infinite.

[9] Moortgat's term for MMLG is Multimodal categorial grammar. We follow the terminology used in Kruijff (2001).

accessible than more complex ones, and model this assumption by the partial ordering (the ordering is partial because it is possible that there is no way to specify relative simplicity between a given pair of hypotheses). We leave aside the issue of precisely defining the ordering criteria for the moment.[10]

2.2 Some definitions

Next, we define some terms that we use in the proposed algorithm.

> **Abducible structure(s)**: An ABDUCIBLE STRUCTURE is a hypothesis based on the information available so far; no more hypotheses are selected than are justified by the information available up to a certain point (this will be made precise presently).

New information results in the replacement of previous hypotheses. Abduced *functions* f_i are part of the abducible structures that are taken from $\mathcal{H}$, and thus posit the presence of a word with a particular syntactic category. For example, in Japanese, if only a nominative NP (we represent this as $NP[nom]$) has appeared so far, $f_i(NP[nom])$ is a syntactic hypothesis that says: an intransitive verb f_i with the nominative NP will give a sentence.[11]

Note that although a nominative case marked NP is in principle consistent with an infinite set of possible continuations, our model allows for the selection of only those hypotheses from the hypothesis formers $\mathcal{H}$ that are *minimally consistent* with the nominative NP. We define minimal consistency as follows:

> **Minimal consistency**:
>
> There are two cases: (i) only a list of NPs has been seen so far, (ii) a list of NPs and a verb, or only a verb, has been seen so far.
>
> (i) If only a list of NPs has been seen so far: A list of hypotheses H', $H' \subset H$, is minimally consistent with a given list of nouns NPs iff each hypothesis $h \in H'$ is able to take the NP's as arguments without positing any new, unseen arguments.

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[10] Lewis (personal communication) informs me that Uehara has found that Japanese subjects prefer two clauses over one in incomplete sentences beginning with two nominative-case marked NPs; in Japanese, this sequence could be continued either with a stative verb or a bi-clausal structure. The simplicity criterion given here wrongly predicts that the stative verb (monoclausal structure) is ordered before the biclausal one. It is likely that the simplicity criterion is an oversimplification, and that a more sophisticated set of decision criteria are needed (such as frequency of certain syntactic structures) in order to determine the ordering. I leave this question open for future research.

[11] The subscript on f is merely a notational device used in the derivations in Section 3 for improving readability.

(ii) A list of hypotheses H', $H' \subset H$, is minimally consistent with a verb, or a given list of nouns NPs and a verb, iff each hypothesis $h \in H'$ is able to take any of the seen NP's as arguments (given the valency-frame of the verb that has been seen); if the verb requires any new, unseen argument(s) and/or is an argument of another as-yet-unseen verb f_i, the unseen argument(s) and/or the function f_i are posited. Any unseen arguments that the function f_i would require are also posited.

An example illustrating the first clause above of minimal consistency is as follows. Suppose that, during the course of processing a Japanese sentence, we have seen only one nominative NP so far. In that case, a hypothesis satisfying minimal consistency is $f_i(NP[nom])$, and one *violating* minimal consistency is: $f_i(NP[nom], x)$, where x is a hypothesized, new, unseen NP. By contrast, if, after we see the first nominative NP, we see a second nominative NP, the minimally consistent hypotheses are now $f_i(NP1[nom], NP2[nom])$, where f_i is a stative verb, and $f_{i+1}(NP1[nom], f_{i+2}(NP2[nom]))$, i.e., a center-embedded structure.

The second clause of minimal consistency can be exemplified as follows. Suppose we are processing a sentence in Japanese, and we first see a verb V1 like *itta-to*, 'said[past]-complementizer'. Here, the hypothesis will be $f_i(x, V1(y, z))$; since V1 is necessarily an embedded verb (due to the presence of the complementizer), there is a function f_i (with some subject NP x) that takes a clause headed by V1 as an argument, and V1 takes as-yet-unseen arguments y and z.

There is some psychological motivation for the minimal consistency constraint. Yamashita (Yamashita 1997) has conducted Japanese sentence completion tasks where she presented subjects with incomplete sentences containing only a series of NPs which they were asked to complete. She found that subjects tended to use verbs that subcategorized only for the NPs present, but not verbs that would require adding new, unseen NPs. The first author of this paper obtained a similar result for Hindi in a pilot study.[12]

Turning next to the issue of processing verbs after the nouns have been seen, the model uses a process of matching the verb to the hypothesized function or functions, in the manner defined below.

> **Matching**: A verb V MATCHES with a function f_i iff V has a valency that is identical with that of f_i.
>
> An NP can MATCH with a posited NP argument iff its case marking, person, number, gender, and other information, is consistent with that of the posited argument.

With these definitions in place, we turn next to the algorithm, based on which the complexity metric is defined.

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[12] Of course, it is still an open question whether completion preferences relate to parsing preferences.

2.3 The algorithm

The processing algorithm works as follows.

Init: Set the queue data structure $\mathfrak{S}$ to $\emptyset$, set the scanning pointer to position 0.

Scan: Scan the next word w_i, moving the pointer to the next position.

Lookup: Lookup the scanned word w_i in the lexicon of $\mathcal{G}$.

Process: This is the main part of the algorithm.

```
if $\mathfrak{S} = \emptyset$ then
    check the category $\mathsf{C}$ of $w_i$:
    if C is a function category $\mathsf{C}$ then
        $\mathfrak{S} = \mathfrak{S} \cup \{\mathsf{C}\}$
    else
        $\mathfrak{S} = \mathbf{abduce}(\mathcal{H}, \mathsf{C}, \mathfrak{S})$
    end if
else $\{\mathfrak{S} \neq \emptyset\}$

    if the category of $w_i$ is a function category $\mathsf{C}$ then
        $\mathfrak{S} = \mathbf{deduce}(\mathsf{C}, \mathfrak{S})$
        or (failing that) $\mathfrak{S} = \mathfrak{S} \cup \{\mathsf{C}\}$
    else {C is not a function category $\mathsf{C}$}
        $\mathfrak{S} = \mathbf{deduce}(\mathsf{C}, \mathfrak{S})$
        or failing that $\mathfrak{S} = \mathbf{abduce}(\mathcal{H}, \mathsf{C}, \mathfrak{S})$
        If the latter step fails, or we arrive at the latter step
        and $w_i$ is the last word in the sentence, then FAIL.
    end if
end if
```

$\mathfrak{S} = \mathbf{deduce}(\mathbf{C}, \mathfrak{S})$:

Given a category C and a structure $\mathfrak{S}$, if C is an argument then try to combine it with a hypothesis or function in $\mathfrak{S}$, starting with the outermost hypothesis/function first (FIFO). Else, C is a function, and try to match it against a hypothesis h in $\mathfrak{S}$, such that C is either equal to h or subsumes it. Failing all that, throw an exception stating that the word with category C cannot be combined with anything in the structure.

$\mathfrak{S} = \mathbf{abduce}(\mathcal{H}, \mathbf{C}, \mathfrak{S})$: Given a list of possible hypotheses $\mathcal{H}$, a category C, and a structure $\mathfrak{S}$, find the minimally consistent hypothesis (or hypotheses) h in $\mathcal{H}$ that takes C as an argument, and which can be combined with $\mathfrak{S}$ either as an argument of a hypothesis/function in $\mathfrak{S}$, or as a function taking the outermost hypothesis/function in $\mathfrak{S}$ as its argument. If no such hypothesis h can be found, then FAIL. Otherwise, integrate C and h into $\mathfrak{S}$ and return the updated structure. The hypotheses abduced in this step are ordered by the simplicity criterion.

Processing starts with **Init**. Subsequently, we cycle through **Scan**-**Lookup**-**Process**, either until we FAIL or until we arrive to the end of the sentence. If the structure $\mathfrak{S}$ contains no unmatched hypotheses, then the sentence is grammatical and can be assigned $\mathfrak{S}$; otherwise, the sentence is considered ungrammatical on $\mathcal{G}$.

To repeat an earlier example from Japanese: two nominative case marked NPs starting a sentence could be followed either by a stative predicate (2.3a), or a nested dependency construction with a single level of embedding (2.3b).

(3) a. $f_2(NP1[nom], NP2[nom])$
b. $f_3(NP1[nom], f_4(NP2[nom]))$

These are two hypotheses selected from $\mathcal{H}$. No other hypotheses are selected because these are the only two that are minimally consistent, given the information so far. These hypotheses are based on the grammatical possibilities in Japanese, and since a single clause sentence has a simpler structure than a sentence with an embedded clause, the hypotheses are ordered as shown above. Next, the appearance of an accusative case marked NP will result in these hypotheses being discarded and the new hypothesis being selected:

(4) $f_5(NP1[nom], f_6(NP2[nom], NP3[acc]))$

Since the number of hypotheses has fallen from two to one, the model predicts faster processing at the accusative NP. This prediction is borne out, as discussed further on. We turn next to the complexity metric.

2.3.1 The complexity metric

The complexity metric has two components: ABDUCTION COST, the cost associated with the abductive process, and MISMATCH COST, the cost associated with a mismatch between an encountered verb and abduced functions.

Abduction cost: This reflects the increasing processing load as sentence fragments appear incrementally. The abduction cost is the sum of the number of NPs seen so far, the number of functions f_i that are posited, and the total number of distinct hypotheses abduced at a given point. These three sub-components are intended to reflect the load in working memory of: (a) storing an increasing number of NPs; (b) positing functions; and (c) storing hypotheses.

Mismatch cost: We assume that the (queued) hypotheses are unanalyzable units at first. By the term "unanalyzable units" we simply mean that when a hypothesis like $f_i(NP1, f_j(NP2))$ is present in working memory and a verb is encountered, any attempt to match the verb with any of the functions f present in the hypothesis must be a left to right depth first search; the verb cannot directly match the right function. During this search process, every time a verb fails to match with a hypothesized function, there is a mismatch cost of one.

The numerical value associated with each sub-component in the metric is assumed to be 1 and the components are assumed to be additive. This is merely a convenience, and nothing crucial hinges on this assumption. In a fully implemented version of this model, the unit costs associated with each component will be associated with precise reading time predictions.

The complexity metric applies in conjunction with the application of the algorithm: at each stage when the algorithm incrementally builds/revises the list of possible hypotheses, the complexity metric is used to compute the processing cost at that point.

In the next section, we provide some illustrations of the empirical coverage of this processing model.

3 The empirical coverage

3.1 Japanese

Note that in the following discussion, the verbs in nested sentences are numbered in reverse order of occurrence, i.e., the matrix verb, which appears last, is V1. The numbers do not reflect the verbs' valencies; this reverse numbering convention is merely in order to highlight the difference from Dutch (discussed later).

3.1.1 Gibson's (1998) data

Gibson (Gibson 1998) has shown that (5a) is less acceptable than (5b).

(5) a. obasan-ga bebiisitaa-ga ani-ga imooto-o izimeta-to itta-to
aunt-nom babysitter-nom brother-nom sister-acc teased-comp. said-comp.
omotteiru
thinks
'The aunt thinks that the babysitter said that the elder brother teased the younger sister.'

b. bebiisitaa-ga ani-ga imooto-o izimeta-to itta-to obasan-ga
babysttr.-nom brother-nom sister-acc teased-comp. said-comp. aunt-nom
omotteiru
thinks
'The aunt thinks that the babysitter said that the elder brother teased the younger

sister.'

First, consider the application of the algorithm for (5a):

Step 1:

Input	Abduction/deduction	Abduction Cost	mismatch cost
NP1-ga	f_1(NP1)	1+1+1=3	0

Here, given only the first NP (*obasan-ga*), a sentence with an intransitive verb (IV), denoted by f_1, is abduced. This contributes 3 to our cost so far (abduction cost, composed of the number of NPs seen so far (1), plus the number of functions abduced (1), plus the number of hypotheses abduced (1); mismatch cost is currently 0).

Step 2:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2) f_3(NP1,f_4(NP2))	2+3+2=7	0

Given the second NP (*bebisitaa-ga*), and given that both the NPs seen so far are nominative case marked, the abducible structures are: a stative predicate taking two nominative arguments (f_2(NP1,N2)), and a center embedded construction (f_3(N1,f_4(N2))). The abduction cost here is 7: 2 NPs, 3 functions, and 2 hypotheses.

Step 3:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2) f_3(NP1,f_4(NP2))	2+3+2=7	0
NP3-ga	f_5(NP1,f_6(NP2,NP3)) f_7(NP1,f_8(NP2,f_9(NP3))	3+5+2=10	0

We now have three nominative NPs, and so we either have an embedded stative predicate, as in f_5(NP1,f_6(NP2,NP3)), or a center embedding, as in f_7(NP1,f_8(NP2,f_9(NP3))). The abduction cost is now 10.

Step 4:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2)	2+3+2=7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2=10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1=8	0

f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4))) is abduced because the fourth NP is marked with accusative case, and so there must be at least one embedding with a transitive embedded verb. The abduction cost is now 8; i.e., the model predicts that processing will take less time at this fourth NP, compared to the third NP.

Step 5:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2)	2+3+2=7	0
	f_3(NP1,f_4(NP2))		
NP3-ga	f_5(NP1,f_6(NP2,NP3))	3+5+2=10	0
	f_7(NP1,f_8(NP2,f_9(NP3))		
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1=8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(N3,NP4)))	4+2+1=7	2

Here, the next word is *izimeta-to*, 'teased-complementizer', and a deduction is performed in the following manner:

(i). V3 tries to match f_{10} in

f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4))) ⇒ failure.

This matching attempt fails because the outermost function f_{10} has a valency frame that doesn't match the actual verb's.

(ii). V3 tries to match f_{11} in

f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4))) ⇒ failure.

Here, again, the failure occurs due to the valency frame of the verb not matching that of the next function.

(iii). V3 tries to match f_{12} in

f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4))) ⇒ f_{10}(NP1,f_{11}(NP2,V3(N3,NP4)))

This succeeds because the valency frame of the verb matches that of the next function. The cost now is the sum of the abduction cost (7) plus the number of failed matches (2): 9. Notice that the number of abduced functions is now 2, not 3; this is because one of the abduced functions has already been resolved by its matching with V3.

Step 6:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2) f_3(NP1,f_4(NP2))	2+3+2=7	0
NP3-ga	f_5(NP1,f_6(NP2,NP3)) f_7(NP1,f_8(NP2,f_9(NP3))	3+5+2=10	0
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1=8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(N3,NP4)))	4+2+1=7	2
V2	f_{10}(NP1,V2(NP2,V3(NP3,NP4)))	4+1+1=6	1

The deductive process goes as follows:

(i). V2 tries to match f_{10} in

f_{10}(NP1,f_{11}(NP2,V3(N3,NP4))) ⇒ failure.

(ii). V2 tries to match f_{11} in

f_{10}(NP1,f_{11}(NP2,V3(N3,NP4))) ⇒ f_{10}(NP1,V2(NP2,V3(NP3,NP4)))

V2 fails to match f_{10}, but successfully matches f_{11}. The cost is now 7 (the abduction cost, 6, plus the mismatch cost, 1).

Step 7:

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-ga	f_1(NP1)	1+1+1=3	0
NP2-ga	f_2(NP1,NP2) f_3(NP1,f_4(NP2))	2+3+2=7	0
NP3-ga	f_5(NP1,f_6(NP2,NP3)) f_7(NP1,f_8(NP2,f_9(NP3))	3+5+2=10	0
NP4-o	f_{10}(NP1,f_{11}(NP2,f_{12}(NP3,NP4)))	4+3+1=8	0
V3	f_{10}(NP1,f_{11}(NP2,V3(N3,NP4)))	4+2+1=7	2
V2	f_{10}(NP1,V2(NP2,V3(NP3,NP4)))	4+1+1=6	1
V1	V1(NP1,V2(NP2,V3(NP3,NP4)))	4+0+0=4	0

The deduction in this case is immediate:

V1 tries to match f_{10} in

$$f_{10}(\text{NP1},\text{V2}(\text{NP2},\text{V3}(\text{N3},\text{NP4}))) \Rightarrow \text{V1}(\text{NP1},\text{V2}(\text{NP2},\text{V3}(\text{NP3},\text{NP4})))$$

Here, V1 matches the outermost abduced function f_{10} immediately, and the parse is completed. The cost at this stage is 4.

The total cost (the sum of the costs at each step) gives us the overall complexity of the sentence relative to other sentences. So, in this case, the total cost is 48.

By contrast, (5b)'s processing yields a lower total cost of 38:

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ga	f_1(NP1)	1+1+1=3	0
2	NP2-ga	f_2(NP1,NP2)	2+3+2=7	0
		f_3(NP1,f_4(NP2))		0
3	NP3-o	f_5(NP1,f_6(NP2,NP3))	3+2+1=6	0
4	V3	f_5(NP1,V3(NP2,NP3))	3+1+1=5	1
5	V2	f_7(x,V2(NP1,V3(NP2,NP3)))	4+1+1=6	0
6	NP4-ga	f_7(NP4,V2(NP1,V3(NP2,NP3))	4+1+1=6	0
7	V1	V1(NP4,V2(NP1,V3(NP2,NP3))	4+0+1=5	0

Table 1: (5b)

Note that in Step 5 above, the appearance of an embedded verb results in an abduced hypothesis involving a matrix verb and a nominal argument. This is because V2 has the complementizer *-to*, which requires it to be an embedded verb; i.e., the second clause in the definition of minimal consistency applies.

3.1.2 Nakatani et al. (2000)

(Nakatani *et al*. 2000) conducted several off-line acceptability rating questionnaire experiments with Japanese; their results may be summarized as follows:[13]

Nakatani et al. found that double embeddings are less acceptable than left branching structures. The examples below illustrate the relevant structures.

(6) a. [obasan-wa [bebiisitaa-ga [imooto-ga naita-to] itta-to] omotteiru]
aunt-top babysitter-nom sister-nom cried-comp. said-comp. thinks
'The aunt thinks that the babysitter said that the younger sister cried.'

---

[13] Note: the English glosses are sometimes different from (Nakatani *et al*. 2000).

b. [imooto-ga naita-to] bebiisitaa-ga itta-to] obasan-wa omotteiru]
sister-nom cried-comp. babysitter-nom said-comp. aunt-top thinks
'The aunt thinks that the babysitter said that the elder brother teased the younger sister.'

Our model makes the correct prediction about this set of examples, as the following two derivations show.

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-wa	f_1(NP1)	1+1+1=3	0
2	NP2-ga	f_2(NP1,NP2) f_3(NP1,f_4(NP2))	2+3+2=7	0
3	NP3-ga	f_5(NP1,f_6(NP2,NP3)) f_7(NP1,f_8(NP2,f_9(NP3)))	3+5+2=10	0
4	V3-to	f_7(NP1,f_8(NP2,V3(NP3)))	3+2+1=6	2
5	V2-to	f_7(NP1,V2(NP2,V3(NP3)))	3+1+1=5	1
6	V1	V1(NP1,V2(NP2,V3(NP3)))	3+0+1=4	0

Table 2: Double nesting, total cost is 40 for (6a)[14]

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ga	f_1(NP1)	1+1+1=3	0
2	V3-to	f_2(V3(NP1),x)	2+1+1=4	0
3	NP2-ga	f_2(V3(NP1),NP2)	2+1+1=4	0
4	V2-to	f_3(V2(V3(NP1),NP2),y)	3+1+1=5	0
5	NP3-ga	f_3(V2(V3(NP1),NP2),NP3)	3+1+1=5	0
6	V1	V1(V2(V3(NP1),NP2),NP3)	3+0+1=4	0

Table 3: Left branching, total cost is 25 for (6b)

Moreover, Nakatani et al. found that in double embeddings intransitive V3's are more acceptable than transitive V3's. Examples of these structures are shown below.

(7) a. haha-ga titi-ga fukigen-na akatyan-ga naita-to itta-to
mother-nom father-nom fussy baby-nom cried-comp. said-comp.
omotteiru
thinks
'My mother thinks that my father said that the fussy baby cried.'

---

[14] In examples like (6a), we predict a fall in reading time at V3 due to a hypothesis being eliminated. We do not have any data yet to confirm or disconfirm this prediction.

b. obasan-ga syoojiki-na bebisitaa-ga ani-ga imooto-o izimeta-to
aunt-nom honest babysitter-nom brother-nom sister-acc teased-comp.
itta-to omotteiru
said-comp. thinks
'My aunt thinks that the honest babysitter said that my brother teased my sister.'

The model makes the correct prediction since (7)a has cost 40 and (7)b has cost 48. See earlier derivations (Table 2 and the full derivation for (5a)) respectively).

3.1.3 Yamashita (1997)

Yamashita (Yamashita 1997) investigated the effect of word order and case marking on the processing of Japanese. One of her experiments is a moving window task involving three conditions:

Condition A. Canonical order, with 4NPs and 2 verbs:

[NP1-nom NP2-dat [NP3-nom NP4-acc V2] V1]

Condition B. Same structure as in Condition A, but scrambled NP3 and NP4:

[NP1-nom NP2-dat [NP4-acc NP3-nom V2] V1]

Condition C. Same structure as in Condition A, but scrambled NP1, NP2, NP3 and NP4:

[NP2-dat NP1-nom [NP4-acc NP3-nom V2] V1]

The results for Condition A are interesting in the context of the present model;[15] consider the example below.

(8) [denwa-de hansamu-na gakusei-ga sensei-ni [tumetai koibito-ga nagai
phone-on handsome student-nom teacher-dat cold girlfriend-nom long
tegami-o yabutta-to] itta]
letter-acc tore-comp. said
'On the phone, a handsome student told the teacher that the cold-hearted girlfriend had torn up the letter.'

Yamashita found that reading times rose steadily in such examples till the accusative marked NP, and then fell at the accusative NP.

---

[15] In this paper, we do not discuss the effect of word order variation since this introduces issues of pragmatics that the model currently does not take into account. The model can, however, be extended to incorporate constraints from pragmatics; essentially, the idea would be to include information from the pragmatics of an utterance in the abductive process.

The present model predicts this pattern, as shown below.

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ga	f_1(NP1)	1+1+1=3	0
2	NP2-ni	f_2(NP1, NP2)	2+1+1=4	0
3	NP3-ga	f_3(NP1, NP2,f_4(NP3)) f_5(NP1, f_6(NP2, NP3))	3+4+2=9	0
4	NP4-o	f_7(NP1, NP2,f_8(NP3,NP4))	4+2+1=7	0
5	V2	f_7(NP1, NP2,V2(NP3,NP4))	4+1+1=6	1
6	V1	V1(NP1, NP2, V2(NP3,NP4))	4+0+0=4	0

Table 5: (3.1.3)

Before step 4, the reading time is predicted to rise steadily. At step 4, a fall in reading time is predicted since the number of hypotheses falls from two to one, and the number of functions is now one.

3.2 Dutch and German

3.2.1 Dutch: Kaan et al. (2000)

Turning next to Dutch, Kaan and Vasić (Kaan & Vasić 2000) conducted several moving window studies and found the following.

Fact 1: Double embeddings harder than single embeddings

Examples of each type are shown below:

(9) a. De leider heeft Paul Sonya het kompas helpen leren gebruiken tijdens de
the leader has Paul Sonya the compass help teach use during the
bergtocht
hike
'The leader helped Paul teach Sonya to use the compass during the hike.'

b. Met aanwijzingen van de leider heeft Paul Sonya het kompas helpen
with directions of the leader has Paul Sonya the compass teach
gebruiken tijdens de bergtocht
use during the hike
'With the leader's directions Paul taught Sonya to use the compass during the hike.'

Double embeddings have a cost of 50:

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1	f_1(NP1)	1+1+1=3	0
2	NP2	f_2(NP1,NP2), f_3(NP1,f_4(NP2))	2+3+2=7	0
3	NP3	f_5(NP1,NP2,NP3)) f_6(NP1,f_7(NP2,NP3)) f_8(NP1,f_9(NP2,f_{10}(NP3)))	3+6+3=12	0
4	NP4	f_{11}(NP1,f_{12}(NP2,NP3,NP4)) f_{13}(NP1,f_{14}(NP2,f_{15}(NP3,NP4)))	4+5+2=11	0
5	V1	V1(NP1,f_{14}(NP2,f_{15}(NP3,NP4)))	4+2+1=7	0
6	V2	V1(NP1,V2(NP2,f_{15}(NP3,NP4)))	4+1+1=6	0
7	V3	V1(NP1,V2(NP2,V3(NP3,NP4)))	4+0+0=4	0

Table 6: total cost is 50 for (9a)

Single embeddings have a lower cost of 30.

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1	f_1(NP1)	1+1+1=3	0
2	NP2	f_2(NP1,NP2), f_3(NP1,f_4(NP2))	2+3+2=7	0
3	NP3	f_5(NP1,NP2,NP3)) f_6(NP1,f_7(NP2,NP3)) f_8(NP1,f_9(NP2,f_{10}(NP3)))	3+6+3=12	0
4	V1	V1(NP1,f_7(NP2,NP3))	3+1+1=5	0
5	V2	V1(NP1,V2(NP2,NP3))	3+0+0=3	0

Table 7: total cost is 30 for (9b)

Kaan and Vasić found that RTs increased with each incoming NP, and fell at the innermost verb, which is what our model predicts. In the present model, the NP reading times are predicted to rise due to the increase in the number of abduced functions, and a fall in reading time is predicted at the first verb due to the elimination of some hypotheses (see derivations above to see how exactly this happens).

3.2.2 Dutch and German: Bach et al. (1986)

Bach et al. (Bach *et al*. 1986) showed that Dutch crossed dependencies were easier to process for native Dutch speakers than German nested dependencies are for native German speakers. Examples of crossed Dutch and nested German dependencies are shown below:

(10) a. NP1 NP2 NP3 V1 V2 V3

Jan Piet Marie zag laten zwemmen
Jan Piet Marie saw make swim

'Jan saw Piet make Marie swim.'

b. NP1 NP2 NP3 V3 V2 V1

...dass Hans Peter Marie schwimmen lassen sah
...that Hans Peter Marie swim make saw

'...that Hans saw Peter make Marie swim.'

The Dutch CECs are called crossed because of the fact that the verbs and the subjects they link with form crossing chains (NP1 NP2 NP3 V1 V2 V3), and the German CECs are nested since the pattern is NP1 NP2 NP3 V3 V2 V1.

Our model predicts that Dutch center embeddings will be more acceptable since, as shown in Tables 6 and 7, in Dutch, there will be no mismatch cost; in the analogous German exampls, however, there will be a mismatch cost associated with each embedded verb.

3.3 Hindi

Vasishth (Vasishth 2001) conducted a self-paced reading time study and found that in center embeddings, accusative case marking on direct objects in Hindi (which marks specificity in the case of inanimate objects), makes processing harder. Examples of single center embeddings are shown below.

(11) a. Siitaa-ne Hari-ko [kitaab khariid-ne-ko] kahaa
Sita-erg Hari-dat book buy-inf told

'Sita told Hari to buy a/the book.'

b. Siitaa-ne Hari-ko [kitaab-ko khariid-ne-ko] kahaa
Sita-erg Hari-dat book-acc buy-inf told

'Sita told Hari to buy the book.'

The model predicts that in the case of (11a), there will be only one hypothesis by the time the third NP is processed, whereas in (11b), there will be two hypotheses at the third NP. These two hypotheses arise because of the fact that both the dative and accusative case markings in Hindi are marked by the suffix/postposition *-ko*, and because Hindi has extremely free word order. The phonologically similar case marking combined with the possibility of reordering NP2 and NP3 results in two possible hypotheses.

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ne	f_1(NP1)	1+1+1=3	0
2	NP2-ko	f_2(NP1,NP2)	2+1+1=4	0
3	NP3	f_3(NP1,f_4(NP2,NP3))	3+2+1=6	0
4	V2	f_2(NP1,V2(NP2,NP3))	3+1+1=5	1
5	V1	V1(NP1,V2(NP2,NP3))	3+0+0=3	0

Table 8: total cost is 22 for (11a)

Step	Input	Abduction/deduction	Abduction Cost	Mismatch Cost
1	NP1-ne	f_1(NP1)	1+1+1=3	0
2	NP2-ko	f_2(NP1,NP2)	2+1+1=4	0
3	NP3-ko	f_3(NP1,f_4(NP2,NP3)) f_5(NP1,f_6(NP3,NP2))	3+4+2=9	0
4	V2	f_2(NP1,V2(NP2,NP3))	3+1+1=5	1
5	V1	V1(NP1,V2(NP2,NP3))	3+0+0=3	0

Table 9: total cost is 24 for (11b)

Similar predictions hold for double embeddings, but a discussion is omitted. For details, see (Vasishth 2001).

4 Concluding remarks

A hybrid abductive/deductive model of human language processing is proposed, based on existing psycholinguistic results. An important observation is that many of the mechanisms proposed have correlates in other theories. For example, the number of NPs seen up to a given point are counted as part of the abduction cost; this corresponds to the number of discourse referents, which is a critical component in Gibson's model. Our contribution is to propose a very general general perceptual mechanism– abduction– as the key process that allows an incremental parse, given a particular grammar $\mathcal{G}$ for the relevant language $\mathcal{L}$. The parsing mechanism in our model is very similar to the well-known shift-reduce parser and the Earley parser (Aho & Ullman 1993), (Sikkel 1997); due to space constraints, we do not present a detailed discussion of the similarity and differences. See (Vasishth in progress) for a discussion.

The model fares better than existing accounts for the data considered here. For example, none of the existing theories can currently account for the fall in reading times at the accusative verb in Japanese, and at the first verb in Dutch; and Gibson's model (Gibson 1998) appears to make incorrect predictions for the rising reading times for verbs (see (Kaan & Vasić 2000) for details). However, it remains to be seen whether the predictions it makes are all borne out. For example, the model predicts that there will be a fall in reading time when the number of abduced hypotheses is reduced in working memory to one as a result of new incoming information. This happens to be the correct prediction for Yamashita's Japanese data and Kaan and Vasić's Dutch data, but we do not have enough data yet to determine whether this prediction is borne out (for example) for (5b).

Further, we currently do not have a precise account for the scrambling facts (e.g., those presented in (Yamashita 1997)). One reason that we hesitate to extend our model for scrambling is that word order variation is almost always correlated with a particular discourse context, and yet studies on scrambling and processing like Yamashita's (Yamashita 1997) assume that processing of a scrambled sentence presented to subjects out of the blue (i.e., without any discourse context) can be compared with unscrambled correlates. Pilot sentence completion studies using Hindi, conducted by the first author, indicate that subjects find scrambled sentences less acceptable than unscambled ones (these were presented without any preceding discourse context). We must therefore await further empirical work before any valid conclusions can be drawn about the processing of scrambled sentences.

There are some facts that our model fails to capture. For example, Nakatani et al. found that a singly nested, 5 NP stack was more acceptable than doubly nested, 3-4 NP stacks ((Lewis 1993) was the first to discuss such 5-NP structures). The relevant examples are given below and the derivation for (12a) is shown in Table 4.

(12) a. tuma-wa kakarityoo-ni uranaisi-ga otto-ni seekoo-o
wife-nom chief-clerk-dat fortune-teller-nom husband-dat success-acc
yakusoku-sita-to ziman-sita
promised-comp. boasted

'The wife boasted to the chief clerk that the fortune-teller promised the husband that he'd succeed.'

b. haha-ga titi-ga fukigen-na akatyan-ga naita-to itta-to
mother-nom father-nom fussy baby-nom cried-comp. said-comp.
omotteiru
thinks

'My mother thinks that my father said that the fussy baby cried.'

c. obasan-ga syoojiki-na bebisitaa-ga ani-ga imooto-o izimeta-to
aunt-nom honest babysitter-nom brother-nom sister-acc teased-comp.
itta-to omotteiru
said-comp. thinks

'My aunt thinks that the honest babysitter said that my brother teased my sister.'

Input	Abduction/deduction	Abduction Cost	Mismatch Cost
NP1-wa	f_1(NP1)	1+1+1=3	0
NP2-ni	f_2(NP1, NP2)	2+1+1=4	0
NP3-ga	f_3(NP1, NP2,f_4(NP3))	3+2+1=6	0
NP4-ni	f_5(NP1, NP2,f_6(NP3,NP4))	4+2+1	0
NP5-o	f_7(NP1, NP2,f_8(NP3,NP4,NP5))	5+2+1=8	0
V2-to	f_7(NP1, NP2,V2(NP3,NP4,NP5))	5+1+1=7	1
V1	V1(NP1, NP2,V2(NP3,NP4,NP5))	5+0+0	0

Table 10: total cost is 41 for (12a)

Our model incorrectly predicts that (12a) will be less acceptable than (12b) (which has cost 40) (see Table 2), but correctly predicts that it will be more acceptable than (12c), which has cost 48 (see the first derivation presented in this paper). However, we consider our model to be primarily a theory of the encoding processes that occur during NP processing, and we propose to integrate this theory of encoding-via-abductive-inference with Lewis' Interference and Confusability Theory (ICT) which is a theory of the integration of encoded NPs with verbs. Integrating the present theory with Lewis' ICT gives us a complete account of encoding and retrieval processes during sentence processing; this integrated account, we argue, makes more correct predictions than other current sentence processing models. See (Vasishth 2001) (this volume) for details.

Finally, in relation to other, similar accounts, we contend that our account is a useful generalization over accounts like the ones based on pushdown automata (Joshi 1990), or incremental processing by prediction of minimum valency as proposed in work by Scheepers et al. (Scheepers *et al*. 1999). Implicit in all these treatments is the idea of abductive inference. Our proposal foregrounds abduction, and demonstrates the considerable predictive power such foregrounding makes available to us: for example, thinking about processing as abduction helped us identify the components of our complexity metric. In this sense, our model is less a challenge to existing accounts than a reformulation of these in more general (although very precise) terms. Future work will consist of building a computational implementation of the integrated ICT/abductive inference model.

Acknowledgments

Thanks to Richard Lewis and John Josephson for their detailed feedback, and to Chris Brew, Takao Gunji, Martin Jansche, Keith Johnson, Neal Johnson, Brian Joseph, Mineharu Nakayama, Shari Speer, and Mark Steedman, for many useful comments. At the time of writing, the second author was a visitor at the Institute of Communicating and Collaborative Systems (ICCS), Division of Informatics, University of Edinburgh, and would therefore like to acknowledge here Mark Steedman's and Bonnie Webber's hospitality. An earlier version of this paper was presented in Japan at the Japanese Cognitive Science Meeting, 2000, at the Kobe Shoin Graduate School, and at the ESSLLI 2000 Linguistic Theory and Grammar Implementation Workshop, Birmingham, UK; we thank the audiences there for their comments. The authors alone are responsible for any errors. Please note that this is

work in progress; a more articulated version of this paper can be obtained from the authors, who can be contacted at the addresses given below. An Edinburgh Prolog implementation of the model presented here is available from the first author.

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