Symmetric and Asymmetric Properties in Korean Verbal Coordination: A Computational Implementation

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Jong-Bok Kim & Jaehyung Yang. 2011. Symmetric and Asymmetric Properties in Korean Verbal Coordination: A Computational Implementation. *Language and Information 15.2*, 1–21. Of the coordination structures in Korean, the symmetric and asymmetric properties of verbal coordination have challenged both theoretical and computational approaches. This paper shows how a typed feature structure grammar, HPSG, together with the notions of 'type hierarchy' and 'constructions', can provide a robust basis for parsing (un)tensed verbal coordination as well as pseudo-coordination found in the language. We show that the analysis sketched here and computationally implemented in the existing resource grammar for Korean, Korean Resource Grammar (KRG), can yield proper syntactic structures as well as enriched semantic representations for real-time applications such as machine translation. (**Kyung Hee University and Kangnam University**)

Key words: Korean verbal coordination, tensed coordination, untensed coordination, asymmetry, HPSG, Korean Resource Grammar

1. Nominal and Verbal Coordination

Korean employs two kinds of coordination marking: morphological and lexical marking (cf. Kim and Yang (2006) and references therein). In the morphological marking system, the language distinguishes nominal and verbal coordination. As seen in the corpus example (1a), nominal coordination uses suffixal markers (usually called particles in the traditional literature) like *-(k)wa, -hako, -(i)lang*

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'and' for conjunctive and *-(i)na* 'or' for disjunctive coordination. Meanwhile, as in (1b), verbal coordination uses the suffixal marker *-ko* 'and' for conjunctive and *-kena* 'or' for disjunctive coordination:[1]

(1) a. [khempwuthe-wa/hako/ilang intheneys-ul] paywu-ess-ta
computer-and/with/with internet learn-PAST-DECL
'(He) learned computer and internet.'

b. pelley-ey [mwulli-ko/kena sso-yess-ta]
insect-DAT bite-and/or sting-PAST-DECL
'(He) was bitten and/or stung by an insect.'

In addition to these morphological markers, the language employs independent words like *kuliko* 'and', *ttonun* 'or' as lexical coordinators. These coordinators, unlike the morphological coordinators, can be optionally used for both nominal and verbal coordination:

(2) a. hay-wa tal (kuliko) sem-i hamkkey ha-nun kos
sun-and moon and island-NOM together do-PNE place
'the place where sun, moon, and island exist together'

b. [Mimi-nun tali-ess-ko] (kuliko) [Nana-nun kel-ess-ta]
Mimi-TOP run-PAST-CONJ and Nana-TOP walk-PAST-DECL
'Mimi ran and Nana walked'.

There has been much debate regarding the syntactic structures of verbal coordination. Among the central questions are its asymmetry properties. An asymmetry arises in examples like the following where the tense marking in the NFC's (nonfinal conjunct) main verb is optional, while the one in the FC is obligatory:

(3) [[[[Mimi-un pap-ul mek-ko], [Nana-nun ppang-ul mek]]-**ess**]-ta]
Mimi-TOP rice-ACC eat-CONJ Nana-TOP bread-ACC eat-PAST-DECL
'Mimi ate (*eats) a rice bowl, and Nana ate bread.'

In such a case, even though the tense suffix appears only in the FC (final conjunct), it takes distributive scope over the NFC unmarked with tense information (cf. Kim (1995), Yoon (1997), Cho (2005), among others). This kind of asymmetric coordination has challenged both theoretical and computational approaches. In this paper, after reviewing main grammatical properties of both symmetric and asymmetric coordination, we provide a computationally feasible analysis in which verbal coordination has only binary syntactic structures and is tightly constrained by the interaction between lexical information and constructional constraints.

[1] The abbreviations used in this paper are ACC (accusative), ARG (argument), CARG (constant argument), C-ARG (conjunct argument), C-CONT (constructional content), DAT (dative), DECL (declarative), HON (honorific), LBL (label), L-INDEX (left index), LTOP (local top), NOM (nominative), PNE (prenominal ending), PL (plural), PST (past), R-INDEX (right index), RELS (relations), TOP (topic), etc.

2. Morpho-syntactic Properties

In terms of the patterns of coordination marking, natural languages employ four main types of coordination constructions from asyndeton (with no marking in each conjunct) to omnisyndeton (with one marking for each conjunct) (cf. Drellishak and Bender (2005)). In Korean, we can find most of these coordination types in nominal coordination:

(4) a. Asyndeton: A B C

haksayng, hakpwumo, kyosa-tul-i chamsek hayessta
student parent teacher-PL-NOM attendance did

'Students, parents, and teachers attended.'

b. Monosyndeton: A B conj C

haksayng, hakpwumo, kuliko kyosa-tul-i chamsek hayessta.
student parent and teacher-PL-NOM attendance did

c. Polysyndeton: A conj B conj C

haksayng-kwa hakpwumo kuliko kyosa-tul-i chamsek
student-CONJ parent and teacher-PL-NOM attendance
hayessta.
did

d. Omnisyndeton: A conj B conj C conj

haksayng-ilang hakpwumo-lang kyosa-lang motwu chamsek
student-CONJ parent-CONJ teacher-CONJ all attendance
hayessta
did

As seen here, Korean nominal coordination allows all the four coordination types, but verbal coordination in the language licenses only monosyndeton and polysyndeton (cf. Kim and Yang (2006)).[2] In monosyndeton strategies, we can use either a morphological marking (*ko* 'and', *kena* 'or') or lexical coordinator (*kuliko* 'and' *kena* 'or'):

(5) a. A-ko/kena (kuliko) B 'A-and/or and B'

b. A-ko/kena, (kuliko) B-ko (kuliko) C

This means that the attachment of the morphological marker *-ko* to the verbal element of the NFC is obligatory and the verbal projection ensures the NFC to function as a conjunct. As a way of representing this in grammar, following Kim and Yang (2006), we assume that the lexicon thus adds the head feature COORD (coordination) to a nominal or verbal expression when it hosts a morphological coordination marker while the coordinating lexical word *kuliko* 'and' is carrying the MOD feature:

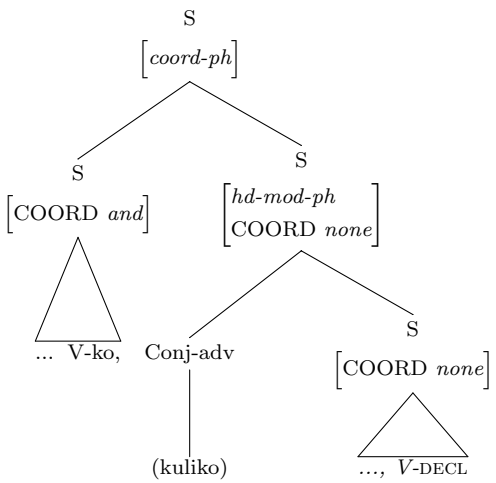
[2] Our search of the Sejong Corpus reveals that the language uses monosyndeton strategies most often.

(6)

a. $\begin{bmatrix} \textit{ko-conj-v} \\ \text{SYN}\begin{bmatrix}\text{HEAD}\begin{bmatrix}\text{POS } \textit{verb} \\ \text{COORD } \textit{and}\end{bmatrix}\end{bmatrix}\end{bmatrix}$ b. $\begin{bmatrix} \textit{conj-adv} \\ \text{ORTH } \langle \text{kuliko} \rangle \quad \text{`and'} \\ \text{SYN}\begin{bmatrix}\text{HEAD} \mid \text{POS } \textit{adv} \\ \text{MOD } \langle [\text{POS } \textit{verbal}] \rangle\end{bmatrix}\end{bmatrix}$

This lexical specification means that the obligatory element in the verbal conjunct is not the conjunctive word *kuliko* but the morphological suffix *ko*. The conjunctive *kuliko* will just combine with the following verbal element, forming a kind of head-adjunct phrase.[3] Within the binary structure that we assume (see section 3), we will then have a structure like the following:[4]

(7)



3. Symmetric Verbal Coordination

3.1 Tensed Symmetric Coordination

When the main verb of the NFC is tensed, the structure concerned behaves symmetrically in many respects (cf. Kim (1995), Yoon (1997), Kwon (2004), Cho (2005)). For example, the two tensed conjuncts can be permuted with no change in meaning:

[3] This analysis will then license cases where *kuliko* is used as a conjunctive adverb as in the following:

(i) kuliko Mimi-nun cip-ulo ka-ass-ta
and Mimi-TOP home-to go-PAST-DECL
'And Mimi went home.'

[4] As given in Kim (2004), we assume the Korean syntax allows binary structures only. One clear advantage of this binary structure is capturing the S internal scrambling possibilities in the language. See Kim and Yang (2004) also for further advantages.

(8) a. Mimi-ka thipi-lul po-ass-ko, Nana-ka chayk-ul
Mimi-NOM TV-ACC watch-PAST-CONJ Nana-NOM book-ACC
ilk-ess-ta.
read-PAST-DECL
'Mimi watched TV and Nana read a book.'

b. Nana-ka chayk-ul ilk-ess-ko, Mimi-ka thipi-lul
Nana-NOM book-ACC read-PAST-CONJ Mimi-NOM TV-ACC
po-ass-ta.
watch-PAST-DECL
'Nana read a book and watched TV.'

Similarly, true tensed conjuncts can be iterated or permuted with no meaning change:

(9) a. Mimi-nun kohayng-ey nam-ass-ko, Nana-nun chicik-ul
Mimi-TOP home.town-at remain-PAST-CONJ Nana-TOP job-ACC
ha-yess-ko, Yoyo-nun tayhak-ul ka-ass-ta
do-PAST-CONJ Yoyo-TOP college-ACC go-PAST-DECL
glt 'Mimi remained at hometown, Nana got a job, and Yoyo went to college.'

b. Nana-nun chicik-ul ha-yess-ko, Mimi-nun kohayng-ey nam-ass-ko, Yoyo-nun tayhak-ul ka-ass-ta

When the NFC is tense-marked, we can observe that as in true coordination structures, the coordination is subject to the CSC (Coordination Structure Constraint).

(10) a. *thipi-lul [[Mimi-ka chayk-ul ilk-ess-ko], [Nana-ka __
TV-ACC Mimi-NOM book-ACC read-PAST-CONJ Nana-NOM TV-ACC
po-ass-ta]].
see-PAST-DECL

b. *[[Mimi-ka __ ilk-ess-ko], [Nana-ka thipi-lul
Mimi-NOM read-PAST-CONJ Nana-NOM TV-ACC see-PAST-PNE
po-ass-ten]] chayk
book

c. *[mwuess-ul Mimi-ka ilk-ess-ko], [Nana-ka thipi-lul
what-ACC Mimi-NOM read-PAST-CONJ Nana-NOM TV-ACC
po-ass-ni]?
see-PAST-QUE

As shown in (10a), we cannot scramble an element in the FC out or topicalize it. We neither can relativize the expression in one conjunct as in (10b) nor can wh-question only the expression in the NFC as shown in (10c). Note that as the ATB (Across-the-Board) says, it is possible to extract from a coordination construction if one extracts or wh-questions the same constituent from both conjuncts simultaneously:

(11) a. [[Mimi-ka __ ilk-ess-ko] [Nana-ka __ kamcwhu-ess-ten]
Mimi-NOM read-PAST-CONJ Nana-NOM hide-PAST-PNE
chayk]
book
'the book that Mimi read and Nana hid'

b. mwues-ul [[Mimi-ka __ ilk-ess-ko], [Nana-ka po-ass-ni]]?
What Mimi-NOM read-PAST-CONJ Nana-NOM see-PAST-QUE
'What did Mimi read and what did Nana see?'

These examples thus further tell us that the two tensed conjuncts need to be like categories even with respect to the missing information or a wh-question. This condition holds even with topicalization. For example, the two sentential conjuncts need to carry the same topichood. That is, we cannot have topic only in one clause[5]

(12) a. ??Mia-ka chayk-ul ilk-ess-ko, Mimi-nun thipi-lul
Mia-NOM book-ACC read-PAST-CONJ Mimi-TOP TV-ACC
po-ass-ta.
see-PAST-DECL

b. ??Mia-nun chayk-ul ilk-ess-ko, Mimi-ka thipi-lul po-ass-ta.

c. Mia-nun chayk-ul ilk-ess-ko, Mimi-nun TV-lul po-ass-ta.

The phenomena we have observed so far tell us that when the NFC is tensed, the sentence involved is both syntactically and semantically symmetric. That is, verbal coordination with the tensed NFC is true coordination, which leads us to assume the following canonical coordination rule (cf. Kim and Yang (2006)):

(13) Coordination Rule:

$$\mathrm{XP}\left[\textit{coord-ph}\right] \rightarrow \mathrm{XP}\begin{bmatrix}\mathrm{POS}\ \boxed{4}\\ \mathrm{VAL}\ \boxed{5}\\ \mathrm{GAP}\ \boxed{6}\\ \mathrm{COORD}\ \textit{coord}\end{bmatrix}, \textbf{(H)}\mathrm{XP}\begin{bmatrix}\mathrm{POS}\ \boxed{4}\\ \mathrm{VAL}\ \boxed{5}\\ \mathrm{GAP}\ \boxed{6}\\ \mathrm{COORD}\ \textit{none}\end{bmatrix}$$

The rule specifies that two identical phrases can be coordinated when the NFC includes a non-empty COORD value. The two conjuncts need to have the identical POS value and VAL feature, let alone nonlocal features such as the GAP attribute. This symmetric condition will license coordination of Vs, VPs, and Ss:

(14) a. Mimi-nun [[$_V$ tali-ess-ko] [$_V$ iki-ess-ta]]
Mimi-TOP run-PAST-CONJ win-PAST-DECL
'Mimi ran and won.'

b. Ai-nun [[$_{VP}$ cal mek-ess-ko] [$_{VP}$ cal calla-ss-ta]]
Child-TOP well eat-PAST-CONJ well grow-PAST-DECL
'The child ate well and grew well.'

[5] There is a possibility for the topic phrase here to be interpreted as contrastive. If this happens in one conjunct, the same interpretation is prefered in the other conjunct(s).

However, note that this coordination rule is not completely symmetric: it has some asymmetric constraints. The COORD values in the two conjuncts are different and further the final conjunct is marked as the syntactic **H** (head). This direction ensures the value of the head feature COORD of the whole phrase to be determined not by the NFC but by the FC (final conjunct). This means that the final conjunct sentence does not carry a COORD value, reducing ambiguities in coordination. For example, the grammar will license only the structure in (15b), not the one in (15a):

(15) a. ∗[[$_S$ [S-ko] [S-ko]] S]
b. [[S-ko] [$_S$ [S-ko] S]]

In (15a), the second final conjunct has a non-empty COORD value, thus the rule in (14) cannot be applied.

Another motivation to treat the final conjunct to function as the 'syntactic head' even though this is symmetric coordination is to ensure the MOOD value of the final conjunct to determine that of the whole sentence. Note that the mood marking must be absent in the NFC while obligatory in the FC:[6]

(16) a. yelum-i tep-ess-ko, kyewul-i chwup-ess-ni?
summer-NOM hot-PAST-CONJ winter-NOM cold-PAST-QUE
'Was the summer hot and the winter cold?'
b. *yelum-i tep-ess-ta-ko, keywul-i chwup-ess-ta
summer-NOM hot-PAST-DECL-CONJ winter-NOM cold-PAST-QUE

In sum, verbal coordination with two tense conjuncts is taken to be basically symmetric but with respect to the feature values MOOD and COORD, it is taken to be asymmetric. This partial symmetric analysis can in a straightforward manner reflect the head properties of the FC with respect to certain syntactic features.

3.2 Nontensed Symmetric Coordination

As noted, the NFC need not be tense-marked, but we still can get symmetric coordination with respect to many syntactic and semantic properties (cf. Cho (2005)). This happens regardless of the main verb's stativity (contra to Yoon (1997)). Consider the following stative and nonstative examples:

(17) a. Mimi-nun ttokttokha-ko, Nana-un hyenmyongha-ta
Mimi-TOP smart-CONJ Nana-TOP wise-DECL
'Mimi is smart and Nana is wise.'

[6] The grammar that this analysis is couched upon is the KRG (Korean Resource Grammar) and the Grammar Matrix (see Section 5). The matrix system is an open source tool designed for the rapid development of precision-based grammars, within the HPSG and MRS formalism (Bender, Flickinger, and Oepen (2002), Bender et al. (2010)). Most of the KRG is customized for the matrix system, but unlike the Grammar Matrix where the MOOD value is part of the index value, the MOOD realized as an inflectional suffix in the language is taken to be a syntactic head feature. See Kim (2004) for details.

b. Mimi-nun swuyong-ul paywu-ko, Nana-nun kolphu-lul
Mimi-TOP swim-ACC learn-CONJ Nana-TOP golf-ACC
chi-n-ta
play-PRES-DECL
'Mimi learns swimming and Nana plays golf.'

Stative verbs are canonically non-tense marked. In particular, stative verbs cannot combine with the present tense suffix *nun*, which may cause the absence of tense marking in the NFC in (17a). However, the nonstative verb of the NFC in (17b) can also be untensed, still inducing symmetric coordination in many respects.

The symmetric properties of such untensed cases are supported from the fact that the properties of true coordination can also be found from such cases: permutation possibility with no meaning change, observation of the CSC and ATB constraints, and so forth.

(18) Permutation with no meaning change (cf. (17))

a. Nana-un hyenmyongha-ko, Mimi-nun ttokttokha-ta
Nana-TOP wise-CONJ Mimi-TOP smart-DECL
'Nana is wise and Mimi is smart.'

b. Nana-nun kolphu-lul chi-ko, Mimi-nun swuyong-ul
Nana-TOP golf-ACC play-CONJ Mimi-TOP swim-ACC
paywu-n-ta
learn-PRES-DECL
'Nana plays golf and Mimi learns swimming.'

(19) CSC Constraint:

a. *[Mimi-nun __ paywu-ko], [Nana-nun kolphu-lul chi-nun] swuyong
Mimi-TOP learn-CONJ Nana-TOP golf-ACC play-PNE swimming
'*the swimming that Mimi learn and Nana played golf'

b. *Mimi-nun mwues-ul paywu-ko, Nana-nun kolphu-lul chi-ni?
Mimi-TOP what-ACC learn-CONJ Nana-TOP golf-ACC play-QUE
'*What did Mimi learn and Nana played golf?'

(20) ATB Constraint:

a. [Mimi-nun __ paywu-ko], [Nana-nun __ kwukyongha-n] swuyong
Mimi-TOP learn-CONJ Nana-TOP see-PNE swimming
'the swimming that Mimi learn and Nana see'

b. Mwues-ul [Mimi-nun __ paywu-ko, Nana-nun __ chi-ni]?
what-ACC Mimi-TOP learn-CONJ Nana-TOP play-QUE
'What does Mimi learn and Nana play?

As seen from the comparison between (17) and (18), the two conjuncts can be permuted with no meaning change. We cannot relativize or question only the object from the NFC as illustrated in (19a) and (19b). However, nothing is wrong to relativize or question the object in both conjuncts simultaneously as shown in (20).

3.3 Semantics of the Coordination

Let us first consider how we can generate proper semantics for these two types of coordination in which the NFC is tensed or untensed. Intuitively, what we need for the semantics of coordination is a coordination relation at the top that links the two conjuncts involved. As a way of representing semantics, we follow the framework of MRS (Minimal Recursion Semantics, Copestake et al. (2005)). MRS offers an interface between syntax and semantics using feature structures. In MRS, the meaning of expressions is represented as a flat bag of elementary predications (EPs), combines naturally with typed feature structures. Together with the MRS system, we follow Kim and Yang (2006) in that the constructional constraint of Korean coordination ensures the semantic linkage between the two daughter conjuncts in coordination: [7]

(21) Coordination Rule (for semantics)

$$\mathrm{XP}\left[\begin{array}{l}\textit{coord-ph}\\ \mathrm{SEM}\,|\,\mathrm{HOOK}\,|\,\mathrm{INDEX}\ \boxed{3}\\ \mathrm{C\text{-}CONT}\,|\,\mathrm{RELS}\left\langle\left[\begin{array}{l}\mathrm{PRED}\ \textit{coord-rel}\\ \mathrm{C\text{-}ARG}\ \boxed{3}\\ \mathrm{L\text{-}IND}\ \boxed{1}\\ \mathrm{R\text{-}IND}\ \boxed{2}\end{array}\right]\right\rangle\end{array}\right] \rightarrow \mathrm{XP}\left[\mathrm{INDEX}\ \boxed{1}\right],\ \mathbf{(H)}\mathrm{XP}\left[\mathrm{INDEX}\ \boxed{2}\right]$$

We can observe here that the *coord-ph* introduces a constructional relation *coord-rel* in the C-CONT (constructional content) which is basically triggered from the COORD feature.

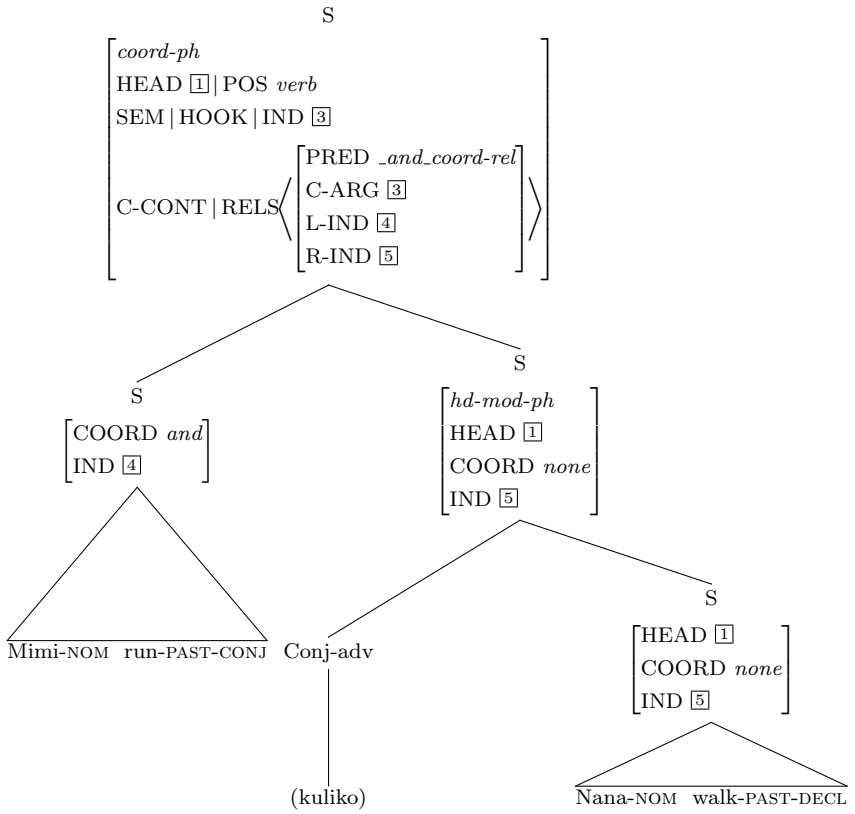
This relation has three arguments: C-ARG (conjunct argument), L-INDEX (left conjunct's index) and R-INDEX (right conjunct's index value). The value of C-ARG is the conjoined index *conj-index* which serves as a pointer to the separate conjoined entity and thus is identified with the INDEX value of the whole phrase. As noted here, the semantic attribute, in additon to RELS and HCONS, can include the HOOK attribute.[8] The feature HOOK is a group of distinguished externally visible attributes of the atomic predications in RELS. The feature HOOK basically has LTOP and INDEX. Canonically, this HOOK value is thus identified with the semantic head's INDEX value.[9] As an illustration, let us see the structure of (2b):

[7] This coordination analysis is slightly different from Drellishak and Bender (2005) in several respects. For example, we introduce *coord-rel* as s constructional constraint. However, the semantic output is basically the same.

[8] The feature RELS is a bag of elementary predications (EP) whose value is a *relation*. Each *relation* has at least three features LBL (label), PRED, and ARG0. The feature HCONS represents set of handle constraints on scoping. This value can be resolved in such a way that the quantifiers 'float in' wherever there is a 'space' left by a *qeq* (equality modulo quantifiers) constraint through the attributes LARG and HARG. See Copestake et al. (2005) for details.

[9] There are basically two coordination relations: *and-coord-rel* and *or-coord-rel* relations. These two relations are linked to the conjunctive morphological markings.

(22)



As represented here, the present analysis can produce a proper semantic representation for the final outcome that an external expression can refer to. In particular, we can observe that the index value of the whole phrase is identified with the C-ARG value of the coordination phrase, yielding us the proper semantic output.

The remaining issue then arises with the untensed NFC: how the nontensed NFC can be anchored to the tense information derived from the the FC? We cannot simply assume that the tense marking on the final conjunct always scopes over the first one because of examples like the following (cf. Chung (2005)):[10]

[10] A reviewer points out that in examples like the following the first conjunct can have either a past or future reading:

(i) motwu yehayngka-ko na-man honca cip-ul cikhi-n-ta
all travel.go-CONJ I-only alone house-ACC keep-PRES-DECL
'With all going out for travel, I alone stays at home.'

Such examples indicate that a context cue may assign a tense value to the untensed NFC. One thing to note here is that the NFC cannot have any tense value: it refers only to the present or a temporal point that precedes the one denoted by the FNC. This seems to imply that the conjunctive marker may contribute to such a sequential reading.

(23) a. emenim-un cikum pyeng-ulo nwuwekyesi-ko apenim-un caknyen-ey
mom-TOP now illness.by lying-CONJ dad last.year
sakolo tolakasi-ess-ta
accident.by passed.away-PAST-DECL
'My mother is now lying in bed due to an illness and my father passed away by an accident last year.'

b. motwu ecey yehayngka-ko na-man honca cip-ul
all yesterday trip-CONJ I-only alone home-ACC
cikhi-n-ta
keep-PRES-DECL
'Everyone left on a trip yesterday and I am alone staying home.'

In these examples, the tense information of the FC cannot scope over the NFC even though the NFC's verb is not marked with tense. This is due to the fact that the NFC includes a temporal adverb contributing to the interpretation of the tense marking. That is, for example, the adverb *ecey* 'yesterday' in (23b) will mark the TENSE value of the NFC as 'past'. We cannot mark the two conjuncts have identical index values as argued for Turkish VP coordination by Fokkens, Poulson, and Bender (2009): we have two sentential conjuncts (untensed sentential NFC and tensed sentential FC) here, each of which obviously has different index values.[11]

The direction we thus take is a constructional perspective. That is, when the output of a coordination phrase is ended up with the NFC being untensed, the grammar identifies the tense information of the two conjuncts as identical:

(24) Tense Assignment Coordination Rule

[11] As questioned by a reviewer, examples like (ia) are not acceptable to some speakers:

(i) a. John-i [ecey sakwa-lul mek-ko] [nayil pay-lul mek-kess-ta]
John-NOM yesterday apple-ACC eat-CONJ tomorrow pear-ACC eat-FUT-DECL
'(int.) John ate an apple yesterday and will eat a pear tomorrow.

b. John-i [ecey sakwa-lul mek-ko] [onul pay-lul mek-nun-ta]
John-NOM yesterday apple-ACC eat-CONJ tomorrow pear-ACC eat-FUT-DECL
'(int.) John ate an apple yesterday and will eat a pear tomorrow.

However, note that (ib), whose structure is similar to those of (23), is much better. What this means is that the oddness of (ia) may be related to pragmatics. That is, the two conjuncts in (ia) describe nonconsecutive events: one in the past and the other in the future. Meanwhile, (ib) describes two consecutive events which may have a semantic relation.

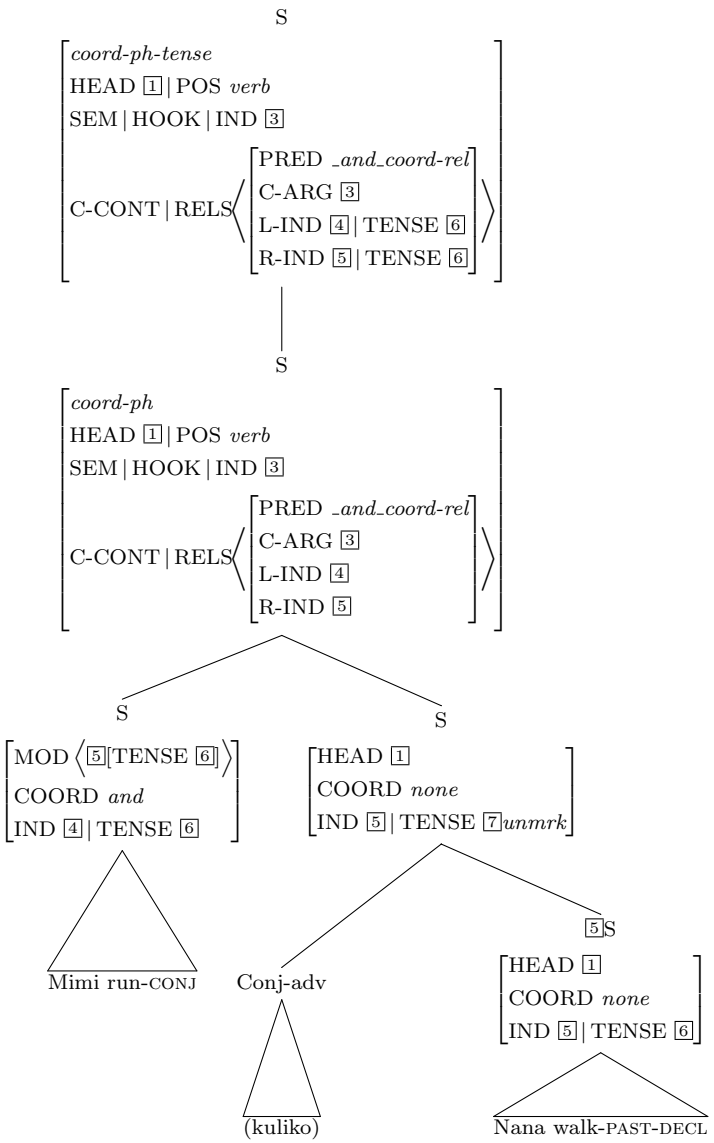
$$\text{XP}\left[\begin{array}{l}\textit{coord-ph-tense}\\ \text{SEM}\,|\,\text{HOOK}\,|\,\text{INDEX}\ \boxed{3}\\ \text{C-CONT}\,|\,\text{RELS}\left\langle\left[\begin{array}{l}\text{PRED}\ \textit{coord-rel}\\ \text{C-ARG}\ \boxed{3}\\ \text{L-IND}\ \boxed{1}\,|\,\text{TENSE}\ \boxed{4}\\ \text{R-IND}\ \boxed{2}\,|\,\text{TENSE}\ \boxed{4}\end{array}\right]\right\rangle\end{array}\right]$$

$$\rightarrow\quad\text{XP}\left[\begin{array}{l}\textit{coord-ph}\\ \text{SEM}\,|\,\text{HOOK}\,|\,\text{INDEX}\ \boxed{3}\\ \text{C-CONT}\,|\,\text{RELS}\left\langle\left[\begin{array}{l}\text{PRED}\ \textit{coord-rel}\\ \text{C-ARG}\ \boxed{3}\\ \text{L-IND}\ \boxed{1}\,|\,\text{TENSE}\ \textit{unmrk}\\ \text{R-IND}\ \boxed{2}\end{array}\right]\right\rangle\end{array}\right]$$

What this constructional constraint means is that when the NFC is projected as untensed, its tense will be identified with that of the FC at the final sentence level. This kind of unary pumping rule will generate a structure like the following:[12]

[12] As a reviewer questioned, this unary is necessary to assign a tense value to the clause with no tense value.

(25)



The difference between the tensed and nontensed NFC is thus the application of the unary rule by a constructional constraint. Once we have the output sentence structure with the NFC's tense value being unmarked, the only mechanism we need is to ensure that the L-IND's tense value is identified with R-IND's tense value.[13]

Though this kind of tense assignment rule may cause a further complexity in the grammar, it seems to be rather unavoidable to assign tense information to the nontensed NFC in symmetric coordination: we can take it just as an interpretation

[13] In the Grammar Matrix system, the INDEX attribute in turn has three subvalues: TENSE, ASPECT, and MOOD.

rule that accompanies no syntactic operation.

4. Pseudo-Coordination: Nontensed Asymmetry

The nontensed *ko* element has a dual life. It has both a coordination property as well as a modification one, implying that the untensed *-ko* expression can participate in both coordination and modification.

The dual life of the conjunctive coordination can be found in English too. English allows *and* to have a subordinating function which is often termed as pseudo-coordination. A typical property of pseudo-coordinative constructions is that, unlike ordinary coordination, they appear to violate the CSC-ATB Constraint, as observed from the following:

(26) a. What did she go and jump in __ ?
b. What did she try and jump in __
c. Which textbooks did the pupils sit and read try?

A similar phenomenon can be found in Korean verbal coordination, in particular, when the NFC's verb is nontensed and when the *ko* marked conjunctive verb induces a sequential reading or causal relation with the following conjunct:

(27) Sequential
a. Mimi-nun chayk-ul ilk-ko yenghwa-lul po-ass-ta
Mimi-TOP book-ACC read-CONJ movie-ACC see-PAST-DECL
'Mimi read a book and saw a movie.'
b. Mimi-nun pap-ul mek-ko khephi-lul masi-ess-ta
Mimi-TOP meal-ACC eat-CONJ coffee-ACC drink-PAST-DECL
'Mimi ate a meal and drank a coffee.'

(28) Causal & Concurrent
a. Mimi-ka phica-lul mek-ko pay-ka apha-ss-ta
Mimi-NOM pizza-ACC eat-CONJ stomach-NOM sick-PAST-DECL
'Mimi ate a pizza and had a stomachache.'
b. Mimi-ka hanpok-ul ip-ko cwum-ul
Mimi-NOM traditional.clothing wear-CONJ dance-ACC
cwu-ess-ta
dance-PAST-DECL
'Mimi wore traditional Korean clothes and danced.'

In such examples, similar to English absolute construction, the nontensed NFC is subordinate in form and modifies the sentence that follows. There is enough evidence telling us that this kind of coordination behaves like adjunction as also pointed out by Kim (1995), Yoon (1997), Kwon (2004), Cho (2005), and others. For example, it is natural to add the sequential marking *se* or *nun* to the nontensed *-ko* verb, which is not possible in true coordination:

(29) Mimi-ka chyak-ul ilk-ko-se/ko-nun yenghwa-lul poassta
Mimi-NOM book-ACC read-CONJ-then movie-ACC see-PAST-DECL
'Mimi read a book and then saw a movie.'

In addition, unlike the true coordination we have seen, the permutation of two conjuncts with the NFC being untensed lead to meaning change when there is a sequential or causal relation between the two:

(30) Sequential
a. Mimi-nun chayk-ul ilk-ko yenghwa-lul po-ass-ta
Mimi-TOP book-ACC read-CONJ movie-ACC see-PAST-DECL
'Mimi read a book and saw a movie
b. Mimi-nun yenghwa-lul po-ko chayk-ul ilk-ess-ta
Mimi-TOP movie-ACC see-CONJ book-ACC read-PAST-DECL
'Mimi saw a movie and then read a book.'

(31) Causal
a. Mimi-ka yak-ul mek-ko pay-ka apha-ssta
Mimi-NOM pill-ACC eat-CONJ stomach-NOM sick-PAST-DECL
'Mimi ate a pill and then had a stomach ache.'
b. Mimi-ka pay-ka ahu-ko, yak-ul mek-ess-ta
Mimi-NOM stomach-NOM sick-CONJ pill-ACC eat-PAST-DECL
'Mimi had a stomachache and had a pill.'

One obvious asymmetrical property that we can find comes from the CSC-ATB and Adjunct Constraint:

(32) a. Mimi-ka [chayk-ul ilk-ko] [__ po-n] yenghwa
Mimi-NOM book-ACC read-CONJ see-PNE movie
'the movie that Mimi watched after reading a book'
b. *Mimi-ka [__ ilk-ko] [yenghwa-lul po-n] chayk
Mimi-NOM read movie-ACC see-PNE book
'*the book that Mimi saw a movie after reading __ '

(33) a. Mimi-nun [mwues-ul ilk-ko] [yenghwa-lul po-ass-ni]?
Mimi-TOP what-ACC read-CONJ movie-ACC see-PAST-QUE
'What did Mimi read and then saw a movie?'
b. Mimi-nun [chayk-ul ilk-ko] [mwuess-ul poassni]?
Mimi-TOP book-ACC read-CONJ what-ACC see-PAST-QUE
'What did Mimi see after reading the book?

As shown in (33a), we can relativize the object of the final conjunct. However, as shown in (33b), we cannot do this with the object in the NFC since this is an adjunct, violating the Adjunct Constraint. In (33), we can wh-question the object in the NFC too since the language allows a wh-question in an adjunct clause.

Scrambling also indicates that the NFC with the untensed verb is an adjunct:

(34) a. yenghwa-lul Mimi-nun [chayk-ul ilk-ko] possta
movie-ACC Mimi-TOP book-ACC read-CONJ see-PAST-DECL
'As for movie, she saw it after reading a book.'

b. Mimi-nun yenghwa-lul [chayk-ul ilk-ko] poassta
Mimi-TOP movie-ACC book-ACC read-CONJ see-PAST-DECL
'Mimi saw a movie after reading the book.'

The object *yenghwa* 'movie' is scrambled out of the source sentence. This is possible since the bracketed untensed *ko* clause is just an adjunct.

Additional support can be found from NPI licensing:

(35) a. amwuto [chyak-ul ilk-ko] yenghwa-lul po-ci anh-ass-ta
anybody book-ACC read-CONJ movie-ACC see-COMP not-PAST-DECL
'Nobody saw the movie after reading the book.'

b. *amwuto [chaky-ul ilk-ess-ko] [yenghwa-lul po-ci anh-ass-ta]
anybody book-ACC read-CONJ movie-ACC see-COMP not-PAST-DECL

The NPI subject in (35a) can be licensed by the final auxiliary verb *anh-ass-ta* but this is not possible in (35b) where the NFC is tensed. The simplest way to account for this contrast is to take the untesed NFC is an adjunct.

Based on these observations, we differentiate the tensed *ko* verb from the non-tensed *ko* verb. In particular, when the nontensed *ko* combines with a non-sentential verbal expression, we basically take it as a modifier. We thus assume two different, but related *ko* suffixed words:

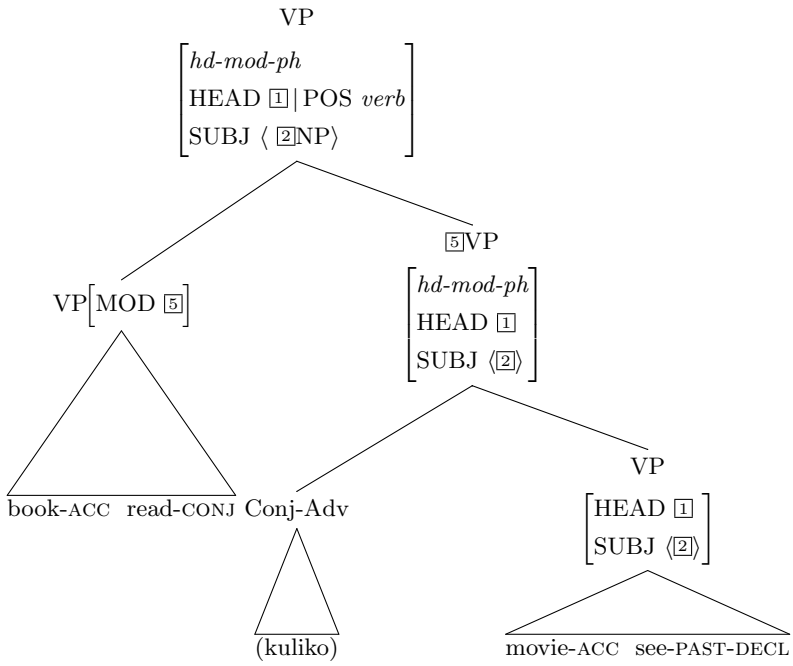
(36)

a.
$$\begin{bmatrix} \textit{ko-conj-v} \\ \text{SYN} \mid \text{HEAD} \begin{bmatrix} \text{POS} & \textit{verb} \\ \text{COORD} & \textit{and} \end{bmatrix} \end{bmatrix}$$

b.
$$\begin{bmatrix} \textit{ko-conj-mod} \\ \text{SYN} \mid \text{HEAD} \begin{bmatrix} \text{POS} & \textit{verb} \\ \text{MOD} & \left\langle \begin{bmatrix} \text{POS} & \textit{verbal} \\ \text{INDEX} \mid \text{TENSE} & \boxed{1} \end{bmatrix} \right\rangle \end{bmatrix} \\ \text{SEM} \mid \text{IND} \mid \text{TENSE} \ \boxed{1} \end{bmatrix}$$

That is, the untensed *-ko* verb can modify any verbal expression, as exemplified by the following structure:

(37)



Note that we have not introduced any new mechanism here. The structure is possible since the untensed *ko* expression can function as a modifier to a verbal expression, adding a sequential semantic relation (see the next section). The tense assignment in such examples is just the same as for examples like (23) where the NFC involves a temporal adjunct like *ecey* determining the clause's tense information.

When there is no tense marking on the non-final conjuncts, the tense value of the final conjunct scopes over these as we have seen. In fact, we find such uses are most common in real usages:

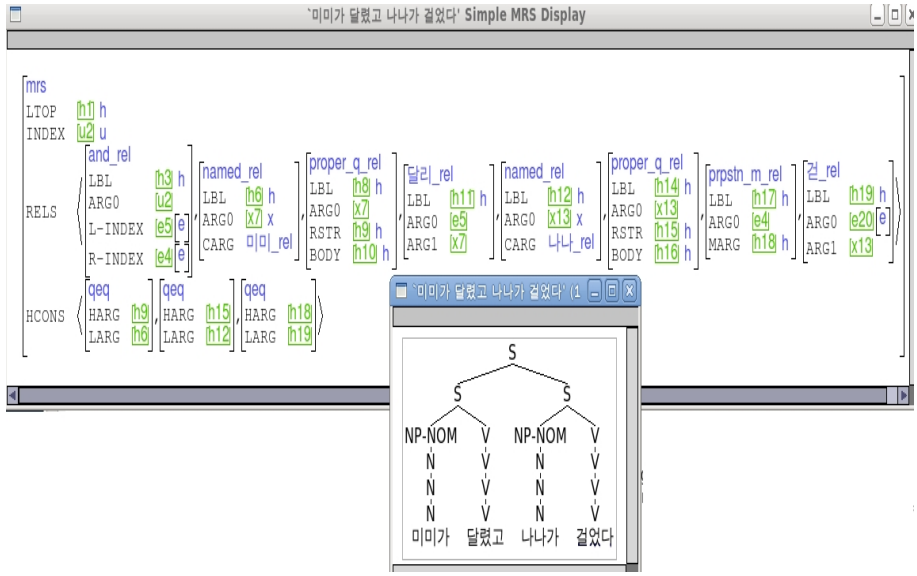
(38) a. thal-ul ssu-ko chwum-ul cwu-ess-ta
mask-ACC wear-CONJ dance-ACC dance-PAST-DECL
'(They) danced with a mask on.'

b. mal-ul tha-ko tali-ess-ta
horse-ACC ride-CONJ run-PAST-DECL
'(They) ran, riding a horse.'

5. A Computational Implementation

The analysis we have presented so far has been incorporated in the typed-feature structure grammar HPSG for KRG (Korean Resource Grammar) aiming at working with real-world data (cf. Kim and Yang (2004), Kim, Yang, and Song (2011)). To check the computational feasibility of the analysis, we have implemented the

analysis into the LKB (Linguistic Knowledge Building) system.[14] As the first step we selected 100 test suite sentences from our 486 sample sentences as well as literature. The test results give us the proper syntactic as well as semantic structures for the three different types of coordination: symmetric tensed coordination, nontensed coordination, and pseudo-coordination for the sentence *Mimi ran and (then) Nana walked*, as given in the following three figures.



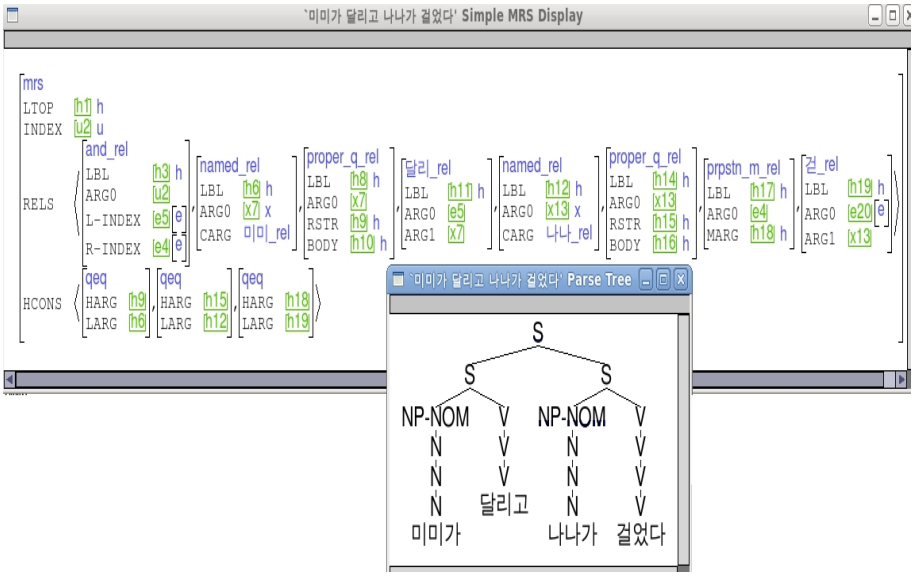
[Figure 1] Parsed Tree and MRS for the Tensed Symmetric Coordination S

The small box in each figure represents the tree structures whereas the bigger one shows us the relevant MRS representation. As seen here, the tree structures all give us binary structures.

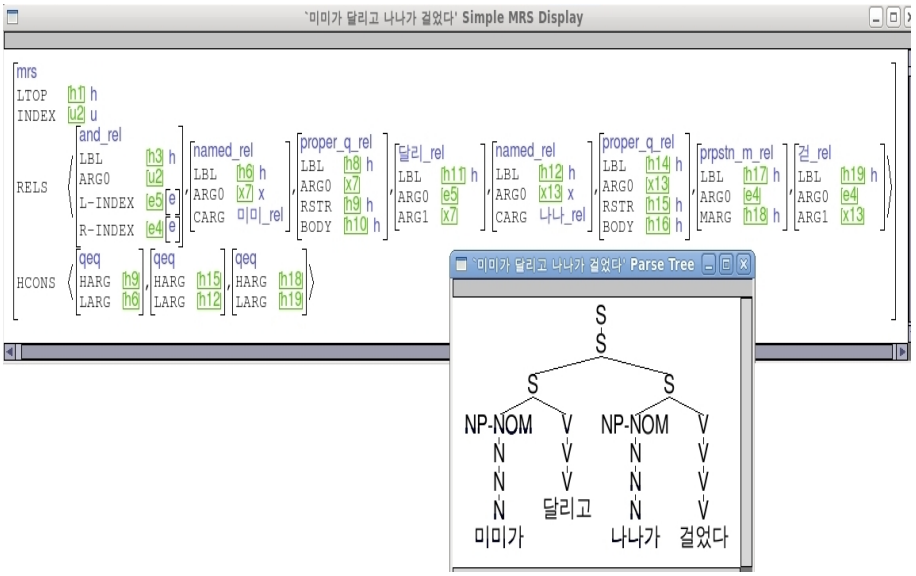
Figure 1 is true symmetric coordination where both conjuncts are tensed. We can notice here that the MRS generated by the grammar provides enriched semantic information of the parsed expression. The value of LTOP is the local top handle, the handle of the relation with the widest scope within the constituent and the INDEX value gives us the reference of the final output. In Figure 1, this value is identified with the ARG0 value in *_and_rel* which in turn includes L-IND and R-INDEX values. The former is identified with the index value of *run* while the latter with the propositional message value of the 'walk' relation, yielding the expected semantic outputs.

Figure 2 is also coordination, but the difference is that the NFC is non-tensed. What we can notice here is that this MRS is identical to the one in Figure 1, so

[14] As of August 2011, the KRG (Korean Resource Grammar), available online at http://krg.khu.ac.kr, has 659 lexical types and 114 phrasal types, 99 grammar rules, 304 inflectional rules, 39,688 lexical entries, and 1198 test-suite sentences, and 77% successful parsing rates for the current test suites of 1,000 sentences.



[Figure 2] Parsed Tree and MRS for the Nontensed Symmetric Coordination S



[Figure 3] Parsed Tree and MRS for the Pseudo-coordination S

that the only difference from the tensed one in Figure 2 is the tense value of the L-IND.

Figure 3 is not symmetric coordination but pseudo-coordination which we treat

to be an adjunct. Note that the main difference from Figure 1 and 2 is that this MRS includes *and_then-relation*, representing a sequential reading between the two conjunct-like clauses. This MRS does not include an *_and_rel* relation that we obtain for true coordination as in Figure 1 and 2. In addition, the INDEX value of this sentence is identical to that of *prpstn_m_rel* (propositional message relation), ensuring that the head is the final tensed clause while the first non-tensed clause is just a modifier.

As seen here, the MRS representations for each case we obtain from the implementation follow our expectations. It is true that this small-sized grammar implementation for Korean verbal coordination needs much more tests to prove its feasibility, but we can observe that the grammar can provide us with deep-processed output structures as well as enriched semantic representations.[15]

6. Conclusion

Korean verbal coordination has a high frequency in real-life texts. We identified three types of verbal coordination: symmetric, asymmetric, and pseudo coordination. We have developed an analysis that can reflect the grammatical properties of these three subconstructions. In doing so, we have placed emphasis on the interactions between lexical information, grammar rules with constructional constructions, and efficient semantic representations. In addition, the analysis presented here assigns dual structures to the untensed NFC constructions: coordination and modification. This seems to be inevitable. There is ample evidence that the untensed NFC is an adjunct. This does not mean that the untensed NFC is always an adjunct. As we have seen earlier, there are numerous examples where the NFC is untensed but the two conjuncts have no asymmetric relation in terms of syntax and semantics.

Any grammar, aiming for real-world applications, needs to provide a correct syntax from which we can build semantic representations in compositional ways. In addition, these semantic representations must be rich enough to capture compositional as well as constructional meanings. In this respect, the analysis we have sketched here seems to be promising as it provides enriched semantic representations for various types of verbal coordination that should be suitable for applications requiring deep natural language processing.

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[15] The space limit does not allow us to show the test for the computational feasibility of the analysis, using the program [incr tsdb()] (Oepen (2001)). In terms of computational implementation, there still are more issues for our analysis to be resolved. However, we can observe that the grammar implemented in the LKB system is feasible enough to extend to more complex data in a process of building a comprehensive KRG.

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