Processing the Mixed Properties of Light Verb Constructions

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Abstract. One of the most widely used constructions in Korean is the so-called light verb construction (LVC) involving an active-denoting verbal noun (VN) together with the light verb *ha-ta* ‘do’. This paper first discusses the argument composition of the LVC, mixed properties of VNs which have provided a challenge to syntactic analyses with a strict version of X-bar theory. The paper shows the mechanism of multiple classification of category types with systematic inheritance can provide an effective way of capturing these mixed properties. An implementation of the analysis within the LKB (Linguistics Knowledge Building) system proves its feasibility and efficiency.

1 Issues

The first main theoretical and computational issue we encounter in the analysis of the LVC is the status of the light verb and argument composition. One of the main properties the light verb *ha* ‘do’ carries is that it does not affect the argument structure of the VN (verbal noun) it combines with.¹

- (1) a. John-i Mary-eykey cenhwa(-lul hayessta)
John-NOM Mary-DAT phone-ACC did
‘John phoned Mary.’
- b. John-i Mary-lul myengtan-ey chwuka(-lul hayessta)
John-NOM Mary-ACC list-LOC addition-ACC did
‘John added Mary to the list.’

As observed here, it is the type of VN that decides the types of arguments in the given sentence. This has led the literature to view that the light verb has no argument structure on its own and inherits the argument structure of the theta-transparent VN.

The second main issue concerns the grammatical status of VNs. It is well-observed that in terms of the internal properties, VNs behave like verbs, whereas

¹ The abbreviations for the glosses and attributes used in this paper are ACC (ACCUSATIVE), ARG (ARGUMENT), C-CONT (CONSTRUCTIONAL CONTENT), DAT (DATIVE), DECL (DECLARATIVE), LBL (LABEL), LOC (LOCATIVE), LTOP (LOCAL TOP), NOM (NOMINATIVE), PL (PLURAL), PRE (PREDICATE), PST (PAST), IND (INDEX), RELS (RELATIONS), TOP (TOPIC), etc.

in terms of external syntax, they act like nouns. For example, as observed in (1), VNs select their own arguments and assign verbal cases such as ACC, regardless of the light verb's presence. Adverbial modification also supports the verbal properties of VNs: the VN can be modified by an adverb but not by an adjectival element.

- (2) catongcha-ul mikwuk-ey **elyepkey**/*elyewun swuchwul(-ul hayessta)
 car-ACC America-LOC hard/difficult export-ACC did
 '(They) exported cars to America with difficulty.'

Another main issue in the LVC comes from syntactic variations. It is well-observed that the VN in the true LVC has frozen effects: it does not undergo relativization, scrambling, clefting, and topicalization. The VN further cannot be wh-questioned or pronominalized:

- (3) a. John-i Bill-eykey tocaki-lul **senmwul-ul** hayssta
 John-NOM Bill-DAT china-ACC present-ACC did
 'John gave a china to Bill as a present.'
 b. *John-i Bill-eykey tocaki-lul han **senmwul** (relativization)
 c. *John-i **senmwul-ul** Bill-eykey tocaki-lul hayssta. (scrambling)
 d. *John-i Bill-eykey han kes-un **senmwul-i-ta** (clefting)
 e. *John-i Bill-eykey **ku kes-ul** hayssni? (pronominalization)
 f. *John-i Bill-eykey **mwues-ul** hayssni? (wh-question)

Intriguing facts emerge when the VN does not appear with the accusative object. In such cases, the frozen effects disappear: all these syntactic processes are possible.

- (4) a. John-i Bill-eykey **senmwul-ul** hayssta
 John-NOM Bill-DAT present-ACC did
 'John gave a present to Bill.'
 b. John-i Bill-eykey han **senmwul** (relativization)
 c. John-i **senmwul-ul** Bill-eykey hayssta. (scrambling)
 d. John-i Bill-eykey han kes-un **senmwul-i-ta** (clefting)
 e. John-i Bill-eykey **ku kes-ul** hayssni? (pronominalization)
 f. John-i Bill-eykey **mwues-ul** hayssni? (question)

There have been various attempts to account for these aforementioned properties of LVC constructions. In what follows, we lay out a constraint-based analysis adopting the mechanism of multiple inheritance hierarchies that enables us to capture the mixed properties as well as other related ones in a much more streamlined manner.

2 A Typed Feature Structure Grammar: KPSG

2.1 Mixed Properties Within a Multiple Inheritance System

Our grammar KPSG (Korean Phrase Structure Grammar), based on the framework of HPSG (head-driven phrase structure grammar), aims at building a

computationally feasible Korean grammar with a comprehensive coverage. In the grammar, all the linguistic expressions are types of *sign* which in turn has *lex-sign* (lexical sign) and *syn-sign* (syntactic sign) as its subtypes. Following traditional wisdom, the KPSG takes the basic lexical categories of the grammar (*lex-sign*) to include *verbal*, *nominal*, *adverbial*, and *adnominal* as its subtypes which again are subclassified according to their properties. The following is a simplified hierarchy, representing the relevant part:²

The key point of capturing the mixed properties of VNs lies in the cross-classification and multiple inheritance mechanism.³ As noticed in the hierarchy, the type *vn* is declared to be the subtype of both *verbal* and *n-lxm*, implying that it will inherit all the constraints of these supertypes. The type *verbal* is declared to have the value [V +] with a non-empty ARG-ST value, whereas *n-lxm* has the value [POS *noun*]. The inheritance mechanism will then ensure that the type *vn* has at least the information in (6)a. This lexical information will then be enriched as in (6)b when each lexical intance inherits all the relevant constraints from its supertypes.⁴

² The dot line here means the existence of other types between the two types. The type glosses mean *v-ind*(ependent), *v-dep*(endent), *v-ger*(undive).

³ The type *v-ger* is gerundive verbs like *ilk-ess-um* 'read-PST-NMLZ' which also display mixed properties. See [1].

⁴ The semantics we represent here is a simplified version of a flat semantic formalism MRS (minimal recursion semantics). See [2] and [3] for details.

As observed here, the system clearly represents why VNs are in part nominal ([N +]) and are in part verbal ([V +]) though in terms of POS, they are more like nouns. In addition, by referring to a proper feature value, the grammar can be flexible enough to capture other related properties. For example, the KPSG allows an adverb to modify a [V +] element. This would then predict the adverb modification in the LVC we discussed in (2). In addition, since the type *vn* as a subtype of *n-stem* bears [N +] and [POS *noun*], we naturally predict that the VNs will act like other nominal elements: the VNs can have case markings attached to them, have the GEN grammatical case, and can serve as the head of a relative clause construction like the other [POS *noun*] elements.

2.2 Argument Composition and the Syntax of the LVC

The argument composition properties between the VN and the following light verb lead us to take the light verb as a kind of auxiliary verb as given in (7):⁵

$$(7) \quad \left[\begin{array}{l} \text{PHON } \langle \text{ha-ta} \rangle \text{ 'do'} \\ \text{SYN} \mid \text{HEAD} \mid \text{POS } \textit{verb} \\ \text{ARG-ST} \left\langle [\text{INDEX } i], \left[\begin{array}{l} \text{LEX } + \\ \text{XARG } i \end{array} \right] \right\rangle \end{array} \right]$$

According to this lexical information, just like an auxiliary verb, the light verb is syntactically transitive, selecting a subject argument and a VN expression (lexical or phrasal). The VN forms a well-formed phrase with the light verb in accordance with the following grammar rule:⁶

$$(8) \quad \text{Head-Lex Rule:} \\ \left[\begin{array}{l} \textit{hd-lex-ex} \\ \text{COMPS } \boxed{A} \end{array} \right] \rightarrow \boxed{} \left[\begin{array}{l} \text{LEX } + \\ \text{COMPS } \boxed{A} \end{array} \right], \text{H} \left[\begin{array}{l} \text{AUX } + \\ \text{COMPS } \langle \boxed{} \rangle \end{array} \right]$$

The Head-Lex Rule specifies that the auxiliary head combines with a [LEX +] complement⁷, and that to the resulting combination the COMPS value of this lexical complement is passed up. This kind of argument composition is different from the previous analyses ([5], [6]). mainly in that the composition happens in syntax rather than in the lexicon. Since the external argument of the light verb is identical with the first argument, it in turn means the subject of the LVC is determined by the VN.

To check the feasibility of our grammar equipped with the Head-Lex Rule and other X' grammar rules, we implemented this grammar in the LKB (Linguistic

⁵ The semantic attribute XARG identifies the semantic index of a phrase's external argument, usually the subject of a verb phrase.

⁶ This rule generates complex predicate constructions like auxiliary constructions in Korean. See [4].

⁷ The feature LEX is assigned to non-phrasal expressions such as words and complex predicates.

Knowledge Building System) (cf. [7]). The LKB system is a grammar and lexicon development environment for use with constraint-based linguistic formalisms such as HPSG.⁸ The following is the parsed tree and semantic representation of sentences like (3a).

Fig. 1. Parsed Tree and MRS for (3a)

The tree structure in the small box indicates that the light verb *hayssta* ‘did’ here combines with its VN complement *senmwul* ‘present’, forming a well-formed *hd-lex-ex*. This resulting combination also inherits the COMPS value of the VN in accordance with the Head-Lex Rule in (8). This will then combine with the argument *tocaki* ‘china’ whose resulting VP again combines with the dative argument *Bill-eykey*.

The bigger box represents the semantics of the sentence in the MRS (Minimal Recursion Semantics), developed by [3]. The MRS is a framework of computational semantics designed to enable semantic composition using only the unification of type feature structures. (See [3] and [2]) We can observe that the parsed MRS provides enriched information of the sentence. The value of LTOP is the local top handle, the handle of the relation with the widest scope within the sentence. The INDEX value here is identified with the ARG0 value of the *prpstn_m_rel* (propositional message). The attribute RELS is basically a bag of elementary predications (EP) each of whose value is a *relation*.⁹ Each of the types *relation* has at least three features LBL, PRED (represented here as a

⁸ The LKB is freely available with open source (<http://lingo.stanford.edu>).

⁹ The attribute HCONS is to represent quantificational information. See [2].

type), and ARG0. We can notice that the MRS correctly represents the propositional meaning such that John did the action of giving a china as a present to Bill.

2.3 Common Noun Usages

VNs can also be used as common nouns when they take no ACC arguments. For example, the VN-like nouns in (9) are different from the argument-taking VNs even though they combine with the light verb.¹⁰

- (9) a. John-i **kongpwu-ul** hayessta
 John-NOM study-ACC did
 ‘John studied.’
 b. John-i Bill-eykey **senmwul-ul** hayssta
 John-NOM Bill-DAT present-ACC did
 ‘John did an introduction to Bill.’

Unlike the true VNs with the feature $[N +, V +]$, these VNs are common nouns with the feature $[N +, V -]$. As noted in (4), they also can be modified by an adjectival element and they do not have frozen effects as VNs. In addition, even though they do not select an ACC argument, they still keep the dative argument *Bill-eykey*. To capture these relationships, our grammar posits the following lexical rule:

(10) VN-to-CN Lexical Rule:

$$\left[\begin{array}{c} vn-tr \\ ARG-ST \langle \boxed{1}, [] \rangle \oplus \boxed{A} \end{array} \right] \rightarrow \left[\begin{array}{c} cn-vn \\ HEAD | V - \\ ARG-ST \langle \boxed{1} \rangle \oplus \boxed{A} \end{array} \right]$$

This lexical rule turns any transitive VNs selecting two or more arguments into CNs (*cn-vn*) with no change in the meaning. However, the output has no verbal properties any more as indicated from the $[V -]$ value. The following illustrates an example of this lexical process:

$$(11) \left[\begin{array}{c} vn-tr \\ PHON \langle senmwul \rangle \\ SYN \left[\begin{array}{c} HEAD \left[\begin{array}{c} POS \text{ noun} \\ V + \\ N + \end{array} \right] \end{array} \right] \\ ARG-ST \langle NP_i, NP_j, NP_k \rangle \end{array} \right] \rightarrow \left[\begin{array}{c} cn-vn \\ PHON \langle senmwul \rangle \\ SYN \left[\begin{array}{c} HEAD \left[\begin{array}{c} POS \text{ noun} \\ V - \\ N + \end{array} \right] \end{array} \right] \\ ARG-ST \langle NP_i, NP_k \rangle \end{array} \right]$$

As noted, the *cn-vn* is losing the $[V +]$ property and becomes a canonical common noun. One thing to note here is that even though the output is a common noun, it still has the identical LEX and semantic value. This output will then allow us to generate a structure like the following:

¹⁰ All the VNs are selecting a subject and an argument which are realized as NOM and ACC.

Fig. 2. Parsed Tree and MRS for (4a)

As given in the parsed tree, the light verb *hayessta* combines with *senmwul-ul* ‘present’, forming a *hd-lex-ex* since the former has the LEX feature. The resulting expression also inherits the COMPS value of *senmwul-ul*, the DAT argument *Bill-eykey*. This is a complement sentence with no argument missing in which *senmwul-ul* is a canonical NP that can undergo various syntactic processes as given in (4). We also can observe that the grammar correctly provides a correct MRS meaning representation.

3 An Implementation and Its Results

In testing the performance and feasibility of the grammar, we first built up our test sets from (1) the SERI Test Suites ’97, (2) the Sejong Project Basic Corpus, and (3) self-constructed examples adopted from the literature. The SERI Test Suites [8], designed to evaluate the performance of Korean syntactic parsers, consists of total 472 sentences (292 test sentences representing the core phenomena of the language and 180 sentences representing different types of predicate). Meanwhile, the Sejong Corpus have about 2,061,977 word instances with 179,082 sentences. Of these, we found total 95,570 instances of the combination of a noun (tagged as NNG) with the light verb *ha-ta*.¹¹ Some of the nouns with the higher frequency are given here:

5111 말/NNG+ㅏ/XSV ‘speak’	3021 생각/NNG+ㅏ/XSV ‘think’
1730 시작/NNG+ㅏ/XSV ‘begin’	897 필요/NNG+ㅏ/XS ‘need’

¹¹ The Sejong Corpus thus does not distinguish general nouns from verbal nouns.

834 종 요 /XR+ 하/XSA ‘important’ 619 사 용 /NNG+ 하/XSV ‘use’
 543 주 장 /NNG+ 하/XSV ‘claim’ 528 시 작 /NNG+ 되/XSV ‘begin’

Based on the frequency list, we first extracted the most frequently used 100 VNs, and from these VNs we selected 100 simple sentences (one from each VN type) that could show us at least the basic patterns of the LVC.

The following shows the results of parsing our test suits:

Corpus Types	# of S	# of Parsed S	# of LVC Ss	Parsed LVC Ss
SERI Test Suite	472	443 (93.7%)	12	12 (100 %)
Self-designed Test Suite	350	330 (94.2%)	100	94 (94 %)
Ss from the Sejong Corpus	179, 082		100	87 (87 %)
Total LVC Ss			212	190 (89%)

As the table shows, our system correctly parsed about 93 percent of the total 472 Seri Test Suite sentences which include those sentences that theoretical literature have often discussed. The system also parsed about 94% of the self-designed test sentences most of which are also collected from the major literature on the LVC. As for the Sejong corpus, the system parsed about 87% of the simple sentences from the Sejong corpus. Though there is need for extending this current grammar to the wider range of authentic corpus data that display more complex properties of the language, the parsing results indicate that the current grammatical system is feasible enough to capture the mixed properties and gives us the possibility of deep processing for such phenomena.

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