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# The Modularity of Morphosyntax: Mentally Retarded Children's Production of Conjugated Predicates in Korean*

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**Jun, Jong Sup. 2012. The Modularity of Morphosyntax: Mentally Retarded Children's Production of Conjugated Predicates in Korean.** *Linguistic Research* 29(2), 381-402. In this paper, we investigate whether mentally retarded (=MR) Korean children's production of conjugated predicates follows the same generalization that has been reported for normal children's language performance. For this, we elicited narratives from 15 MR children, and analyzed their production of conjugated predicates. We cross-classified the conjugation patterns in terms of four categorical variables: morphological class, (morpho-)syntactic conjugation, semantic class, and age. Results from the log-linear regression analysis show that MR children's use of predicate conjugation is constrained by the *same* generalization that determines the distribution of normal children's conjugation patterns. That is, both MR and normal children's production of conjugated predicates is nicely predicted by the interaction between the morphological and semantic classes of each predicate, and by the main effect of conjugation type. The overall finding supports the *modularity* view of language in terms of morphosyntax; i.e. the language capacity is dissociated from the general cognition. **(Hankuk University of Foreign Studies)**

**Keywords** modularity, Korean morphology, conjugation, narrative, frog story, log-linear regression

## 1. Introduction

The *modularity* of language has been a foundational assumption of generative linguistics (Chomsky 1957, 1959, 1965). Some representative evidence comes from

* We built the corpus of MR children as part of a bigger project that explores both normal and MR children's language development. Representative publications under this project include Jun and Lee (2011), Jun and Yi (2011), and Jun (in press). Our foremost gratitude goes to our subject children and their parents. We also thank Brian MacWhinney and anonymous reviewers for helpful comments. This work was supported by Hankuk University of Foreign Studies Research Fund of 2011.

mentally retarded children's *intact* language performance. That is, the dissociation between language and cognition has been observed for Williams syndrome (Bellugi et al. 1988, Mervis et al. 2003), Down syndrome (Graham and Gulliford 1968, Rondal 1994), and autism (Waterhouse and Fein 1982, Tager-Flusberg 1994).

On the other hand, previous studies of mental retardation (MR) in the tradition of behavioral psychology strongly suggest that language interacts with general cognitive capacities.[1] In other words, linguists' belief in the dissociation between language and cognition can be misguided or exaggerated from behavioral psychologists' perspective.

The goal of this paper is to provide evidence for the dissociation between language and cognition from linguists' perspective with special reference to mentally retarded Korean-speaking children's production data. MR children's finite verb morphology (e.g. regular 3rd person *-s*, regular past *-ed*, irregular past, copula and auxiliary) has been studied mainly with English-speaking children. Note, however, that English is a morphologically impoverished language, and that finite verbs alone do not provide much information on the functional properties of predicate phrases.

For this reason, Korean verbs and adjectives offer a unique opportunity for exploring how speakers with MR handle the functional properties of predicates. A number of grammatical properties that are realized as a sequence of independent words in English (e.g. *must have been eaten*) are expressed as a series of agglutinative morphemes attached to a single root (e.g. *mek-hi-ess-keyss-ta* [*eat*-PASS-PAST-ASP-DEC]) in Korean.

In Jun (in press), we have shown that Korean-speaking *normal* children learn the predicate conjugation before age 4, and that their production of conjugated forms are strongly constrained by the interaction between morphological and semantic types of the predicate. Here, the present research question arises: *Do MR children show the same or different pattern of Korean predicate conjugation compared with normal children?* If MR children's production of conjugated predicates shows the same pattern as normal children, we can conclude that we have found important evidence for the dissociation between language and cognition.

For this, we elicited narratives from 15 MR Korean children (*mean age*, 9;2) by using Mercer Mayer's (1969) wordless picture book <Frog, where are you?>. From

1 See McDuffie and Abbeduto (2009) and the references therein.

the MR children's narratives, we extracted all the predicate tokens, and cross-classified the usage types with four categorical variables: morphological class, (morpho-)syntactic conjugation, semantic class, and age. Each cell in the cross-tabulation represents the number of a specific usage pattern produced by the MR children.

To analyze the data, we used a model-building method called log-linear regression, which is a specialized technique for a frequency table defined by more than two categorical variables. By using log-linear regression, we tested numerous hypotheses about the distribution of conjugated predicates, and obtained the same pattern for MR children as our previous finding about normal children (Jun in press). The overall result strongly supports the classical view of *modularity* of language in terms of morphosyntax.

## 2. Cognitive Deficits and Language

### 2.1 Language Impairment in Pathological Studies

Despite the textbook claim that the intact language of children with Williams syndrome provides evidence for the dissociation between language and cognition (Jackendoff 1994, Pinker 1994), a number of studies have shown that children with impaired cognition do have problems with language, especially with finite verb morphology. Many studies have reported that even children with Williams syndrome have difficulty with language. Clahsen and Temple (2003) show that children with Williams syndrome make significantly more errors in irregular morphology than normal controls. Volterra et al. (2003) also show that Williams syndrome children's morphosyntactic errors can distort the intended meaning.

According to Chapman et al. (1998), children with Down syndrome are likely to omit such functional elements as modals, prepositions, progressive *−ing*, and possessive *−'s*. Fowler (1988) reports that Down children do not perform as well as normal children matched for chronological age in grammatical morphemes. Overall, children with Down syndrome show similar language performances with SLI children (Oetting and Hadley 2009). Autistic children do not use as many grammatical morphemes as normal children (Bartolucci et al. 1980), and their syntax on standard language tests is not as mature as IQ-matched normal controls (Kjelgaard and Tager-Flusberg 2001). Indeed, we cannot make an easy claim that language is independent of the general cognitive capacity based on a few textbook examples.

Note that many earlier studies by pathologists and behavioral psychologists have certain limitations in common. First, most, if not all, studies have focused on English-speaking children. Second, they have focused more on obtaining test results than drawing linguistic generalizations through linguistic analyses of children's spontaneous speech. Third, they have not emphasized the possible hidden factors.

The second and third points require further clarification. Suppose that an MR child made four morphological errors out of ten verb types. One may wish to describe the child's peculiar performance in comparison with a normative model. But, without careful analyses of the verb's morphological class, semantic class, syntactic configuration, and so on, we cannot determine whether the peculiarity results from the mental condition or from other linguistic factors.

The problem of possible hidden factors calls for the most appropriate statistical analyses. Basic statistics like the t-test, ANOVA, and the Chi-square test have many limitations in controlling for hidden factors. On the other hand, model-building procedures like log-linear regression provide more opportunities for identifying the underlying generalizations behind apparent observations. Based on these considerations, we aim to examine how MR children handle the complex agglutination rules of Korean predicate morphology, and to draw linguistic generalizations by analyzing the data with model-building procedures.

### 2.2 Previous Research on MR Korean Children's Language Development

Mentally retarded children show difficulty with such functional categories as tense and agreement (Eyer and Leonard 1995, Hegarty 2005). But their language problems frequently go beyond tense and agreement. For instance, Chapman et al. (1998) report that children with Down syndrome have severe expressive grammatical impairments in terms of modals, conjunctions, and progressive *-ing* among others. Hence, we want to know how MR children handle languages like Korean with rich agglutinative morphology.

Pathologists, who are interested in MR children's use of Korean, have focused on developmental issues that will confirm the general expectation that mental retardation hinders language development. Hwang and Cho (2008) show that MR children produce much smaller number of predicate types than normal controls. Y-T. Kim (2002) reports that MR children's language development is delayed not only in the level of vocabulary, but also in the syntactic complexity.

It is S-J Kim (2004) who attempted to analyze normal and MR Korean children's predicates at the morphological level. She classified children's production of verbs in terms of morphological classes, i.e. simple, derivative, and compound verbs. However, Kim's linguistic motivation was blurred by incomplete analyses. By using basic statistics, she claimed that children's use of derivative verbs revealed the presence or absence of MR. By contrast, Jun and Yi (2011) conducted a log-linear regression analysis on her data, and showed that the effect of the mental condition reported in her paper came from the combined main effects of age and verb types.

Jun (in press) points out a non-trivial problem in earlier studies: the role of morphosyntactic conjugation.[2] Korean speakers utter all the conjugated verbs in (1).

(1) a. mek-e
eat-DEC
b. mek-ko
eat-CONJ
c. mek-ko-yo
eat-CONJ-DEC
d. mek-ess-e
eat-PAST-DEC
e. mek-ess-ko
eat-PAST-CONJ
f. mek-ess-keyss-ko
eat-PAST-ASP-CONJ

[2] In the literature of Korean verb morphology, there is a heated debate among scholars on the nature of the morphological operation. Are they *inflected* (or *conjugated*) or *agglutinated*? Are the verb endings added to the verb, to the VP, or to the entire sentence? Are the verb endings suffixes or clitics? Are the verb endings added to the stem by the movement of functional categories or by virtue of templates? Instead of attempting to answer any of these questions, we remain as neutral as possible in our theoretical position. Therefore, we employed terms like *ending* rather than *inflection* or *suffix*. Of course, the term *conjugation* is not neutral, but we could not but use it because we found no appropriate alternative. For a detailed discussion on the theoretical debates about the Korean verb morphology, see H. Im (1998).

Previous studies have considered the six verb forms in (1) as different tokens of the verb type *mek-ta* ‘to eat’. But what if MR children use specific forms in (1) more frequently than others? What if MR children never use certain forms that are frequently used by normal children? Important generalizations would be missed if we did not pay attention to various conjugation patterns. For this reason, this paper is a significant departure from previous studies. We collected data, cross-classified predicates in terms of their actual conjugation patterns, and found a deeper generalization behind the data.

## 3. Methods, Procedures and the Cross-tabulation

### 3.1 Participants and Data Collection

Previous studies of MR children’s language development have focused mainly on subjects around 3-5 years old, and reported their deviation from normative models. On the other hand, there is an alternative view that MR children’s language is delayed, but not impaired (Fowler 1984). That is, MR children go through same developmental stages as normal children at a slower rate (Fowler et al. 1994). Oetting and McDonald (2001) report that language-impaired children’s grammatical competence does not differ from that of normal controls after age 8.

Hence, we collected data from children over five years old ranged from 5;10 to 14;5 (*mean age*, 9;2). The MR participants were clients of social welfare centers in Seoul, Incheon, and Kyunggi areas in Korea; and they were diagnosed with third-level MR or above based on the Korean government’s *Welfare Law for the Disabled*. Their IQ scores (KEDI-WISC-Ⅲ) and standard language test scores (REVT or PRES) were located below -2 standard deviation ranges.

We interviewed each MR child individually, and videotaped their narration of Mercer Mayer’s wordless picture book <*Frog, where are you?*>. From the speech transcripts, we extracted 847 predicate tokens, which were coded into a cross-tabulation defined by four categorical variables: morphological class, (morpho-)syntactic conjugation, semantic class, and age.

### 3.2 Data Coding

In Jun (in press), we have studied normal Korean children's conjugation patterns using log-linear regression. It is a forerunner study for this work, and provides us with a methodological routine to study MR children's production of conjugated predicates. We cross-classified MR children's conjugated predicates into a frequency table defined by the four categorical variables in Table 1.

**Table 1.** Variable for Data Coding

| Variable Names with Abbreviations in Parentheses | Values |
|---|---|
| Age (=A) | [1] 4-7;11 (n=6) |
| | [2] 8-10;11 (n=5) |
| | [3] Above 11 (n=4) |
| Morphological Class (=M) | [1] Simple |
| | [2] Derived |
| | [3] Compound |
| Semantics/Aktionsart (=S) | [1] State |
| | [2] Activity |
| | [3] Accomplishment |
| | [4] Achievement |
| Conjugation/Morphosyntax (=C) | [1] Root+CONJ/Final(+Final) |
| | [2] Root+PreFinal+CONJ |
| | [3] Root+PreFinal+Final |
| | [4] Root+PreFinal+CONJ+Final |

To determine the category membership for M(orphological class), we used Nam and Go's (2003) formal criteria, according to which derived verbs contain such bound morphemes as -*i/hi/li/ki*- 'CAUSE/PASS', -*ttuli/chi/talah*- 'EMPHATIC', -*ha*- 'DO', -*toy/(e)ci*- 'PASS', and -*lop/sulep*- 'HAVING_PROPERTY_OF', whereas compound verbs are composed of free morphemes that are characterized by such syntactic and semantic relationships as Subject–Predicate (*kep-na*- 'to be intimidated' [fear–pop_up]), Object–Predicate (*him-ssu*- 'to help' [power–use]), and Adverbial–Predicate (*aph-se*- 'to precede' [before–stand]).

The category membership for S(emantic class) is based on Vendler's (1967) aspectual class or *aktionsart*. Following Jun (in press), we adopted Y-S Kim's formal criteria in Table 2.

**Table 2.** Formal Criteria for the Aspectual Classification of Korean Predicates (Y-S. Kim 2001, p. 11)

| Formal Criteria | State | Activity | Accomplishment | Achievement |
|---|---|---|---|---|
| Progressive (*-ko iss*-'-ing') | × | ○ | ○ | ○/? |
| Duration adverbial (*tongan* 'for') | × | ○ | ○/? | × |
| Time frame adverbial (*-maney* 'within') | × | ○/? | ○ | ○ |
| Time point adverbial (*-ey* 'at') | × | ○ | ○* | ○** |
| Imperfective paradox (Progressive → Perfection) | | ○† | ×‡ | |

* initiation of an event

** completion of an event

† The man is driving a car. → The car is already driven by the man.

‡ The child is drawing a picture. → ~~The picture is already drawn by the child~~.

Finally, we classified C(onjugation pattern) into four values, as shown in (2) with relevant examples.

(2) Four values of the variable Conjugation/Morphosyntax (=C):

a. Root + CONJ/Final(+Final):

- 'Root + CONJ' : *ca-taka* [sleep-WHILE], *chac-a* [find-CONJ], etc.
- 'Root + Final' : *musep-e* [scared-DEC], *iss-ta* [be-DEC], *ssup-nita* [write-$DEC_{Hon}$], etc.
- 'Root + CONJ + Final' : *mantul-ko-yo* [make-CONJ-$DEC_{Hon}$], *iss-ese-yo* [be-CONJ-$DEC_{Hon}$], etc.

b. Root + Prefinal + CONJ: *nao-ass-ko* [come.out-PAST-CONJ], *tomangchi-ess-nuntey* [run. away-PAST-CONJ], etc.

c. Root + Prefinal + Final: *kelli-ess-supnita* [be.hung-PAST-$DEC_{Hon}$], *tteletttuli-ess-ta* [let.fall-PAST-DEC]

d. Root + Prefinal + CONJ + Final: *molu-keyss-nuntey-yo* [not.know-

PAST-CONJ-DEC$_{Hon}$], etc.

Note that we adopted the representative verb endings from Jun (in press) to categorize conjugation patterns, as in (3).

(3) a. Non-sentence-final endings: Conjunctives (CONJ) and functional converters such as -*key*-, -*ko*-, -*nuntey*-, -*ni(kka)*-, -*taka*-, -*la(ko)*-, -*(u)lye(ko)*-, -*myense*-, -*a/e*-, -*(a/e)to*-, -*(a/e)se*-, -*(a/e)kaciko*-, -*ci*-, -ciman-, and -*teni*-
b. Sentence-final endings: Declarative and honorific endings such as -*ta*, -*a/e*, -*(a/e/ci/ney/lkey)yo*, and -*supnita*
c. Prefinal endings: Tense and honorific morphemes such as -*ass/ess*-, -*keyss*-, and -*si*-

### 3.3 Usage Patterns and the Cross-tabulation

We initially extracted 847 predicate tokens from the transcribed narratives. These tokens were organized into *usage patterns* with reference to the four categorical variables, i.e. A, M, S, and C, in Table 1. For example, among the 847 predicate tokens, we have 13 occurrences of the verb type *nol*- 'to play'. The verb type *nol*- is classified as a simple activity verb, i.e. M=1, S=2. Table 3 summarizes these 13 occurrences of *nol*-.

**Table 3.** Classification of Predicate Tokens: The Case of *nol*- 'to play'

| # | Actual Token | M | S | C | A |
|---|---|---|---|---|---|
| 1 | nol-ko | 1 | 2 | 1 | 1 |
| 2 | nol-ko | 1 | 2 | 1 | 1 |
| 3 | nol-ko | 1 | 2 | 1 | 1 |
| 4 | nol-ko | 1 | 2 | 1 | 2 |
| 5 | nol-ko | 1 | 2 | 1 | 2 |
| 6 | nol-ko | 1 | 2 | 1 | 2 |
| 7 | nol-ko | 1 | 2 | 1 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | nol-taka | 1 | 2 | 1 | 1 |
| 9 | nol-ass-ko | 1 | 2 | 2 | 1 |
| 10 | nol-ass-ko | 1 | 2 | 2 | 1 |
| 11 | nol-ass-eyo | 1 | 2 | 3 | 1 |
| 12 | nol-ass-eyo | 1 | 2 | 3 | 1 |
| 13 | nol-ass-eyo | 1 | 2 | 3 | 1 |

In this table, *nol-ko* appears seven times: three times under age 8 (*rows* #1, #2, #3), and four times between age 8 and 10;11 (*rows* #4, #5, #6, #7). We can now define two distinct usage patterns depending upon the age group, as in Table 4.

**Table 4.** Usage Patterns of *nol-ko* with Frequency Information

| Actual Token | M | S | C | A | Frequency |
|---|---|---|---|---|---|
| nol-ko | 1 | 2 | 1 | 1 | 3 |
| nol-ko | 1 | 2 | 1 | 2 | 4 |

Likewise, *nol-taka*, *nol-ass-ko*, and *nol-ass-eyo* from the rows #8 through #13 yield the usage patterns in Table 5.

**Table 5.** Usage Patterns of *nol-taka*, *nol-ass-ko*, and *nol-ass-eyo* with Frequency Information

| Actual Token | M | S | C | A | Frequency |
|---|---|---|---|---|---|
| nol-taka | 1 | 2 | 1 | 1 | 1 |
| nol-ass-ko | 1 | 2 | 2 | 1 | 2 |
| nol-ass-eyo | 1 | 2 | 3 | 1 | 3 |

This way, all the 847 tokens were manually classified into 350 usage patterns across age groups. These usage patterns were cross-classified into a frequency table defined by the four categorical variables, i.e. A, M, S, and C, as follows:

**Table 6.** Cross-tabulation by A(ge), M(orphology), S(emantics), and C(onjugation)

※ **A: ①＝4～7;11, ②=8～10;11, ③=11<**
**M: ①=Simple, ②=Derived, ③=Compound**
**S: ①=State, ②=Activity, ③=Accomplishment, ④=Achievement**

| | | | | | | A | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ① | ② | ③ |
| **M** | ① | **S** | ① | **C** | Root+CONJ/Final(+Final) | 10 | 16 | 13 |
| | | | | | Root+PreFinal+CONJ | 3 | 0 | 3 |
| | | | | | Root+PreFinal+Final | 8 | 4 | 8 |
| | | | | | Root+PreFinal+CONJ+Final | 1 | 1 | 1 |
| | | | ② | **C** | Root+CONJ/Final(+Final) | 13 | 26 | 19 |
| | | | | | Root+PreFinal+CONJ | 3 | 0 | 2 |
| | | | | | Root+PreFinal+Final | 7 | 9 | 8 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ③ | **C** | Root+CONJ/Final(+Final) | 1 | 4 | 1 |
| | | | | | Root+PreFinal+CONJ | 1 | 1 | 1 |
| | | | | | Root+PreFinal+Final | 2 | 2 | 1 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ④ | **C** | Root+CONJ/Final(+Final) | 4 | 13 | 7 |
| | | | | | Root+PreFinal+CONJ | 0 | 2 | 1 |
| | | | | | Root+PreFinal+Final | 6 | 7 | 7 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | ② | **S** | ① | **C** | Root+CONJ/Final(+Final) | 1 | 3 | 1 |
| | | | | | Root+PreFinal+CONJ | 0 | 1 | 0 |
| | | | | | Root+PreFinal+Final | 0 | 0 | 2 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ② | **C** | Root+CONJ/Final(+Final) | 2 | 9 | 2 |
| | | | | | Root+PreFinal+CONJ | 0 | 0 | 1 |
| | | | | | Root+PreFinal+Final | 2 | 1 | 1 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ③ | **C** | Root+CONJ/Final(+Final) | 1 | 2 | 2 |
| | | | | | Root+PreFinal+CONJ | 0 | 1 | 0 |
| | | | | | Root+PreFinal+Final | 1 | 2 | 2 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ④ | **C** | Root+CONJ/Final(+Final) | 3 | 7 | 5 |
| | | | | | Root+PreFinal+CONJ | 3 | 1 | 2 |
| | | | | | Root+PreFinal+Final | 5 | 7 | 3 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ③ | S | ① | C | Root+CONJ/Final(+Final) | 1 | 1 | 0 |
| | | | | | Root+PreFinal+CONJ | 0 | 0 | 0 |
| | | | | | Root+PreFinal+Final | 0 | 0 | 0 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ② | C | Root+CONJ/Final(+Final) | 1 | 2 | 4 |
| | | | | | Root+PreFinal+CONJ | 0 | 1 | 1 |
| | | | | | Root+PreFinal+Final | 2 | 0 | 0 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |
| | | | ③ | C | Root+CONJ/Final(+Final) | 4 | 4 | 6 |
| | | | | | Root+PreFinal+CONJ | 2 | 2 | 1 |
| | | | | | Root+PreFinal+Final | 3 | 5 | 2 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 1 | 0 |
| | | | ④ | C | Root+CONJ/Final(+Final) | 2 | 1 | 6 |
| | | | | | Root+PreFinal+CONJ | 1 | 0 | 0 |
| | | | | | Root+PreFinal+Final | 2 | 0 | 6 |
| | | | | | Root+PreFinal+CONJ+Final | 0 | 0 | 0 |

## 4. Log-linear Models for MR Children's Production of Conjugated Predicates in Korean

### 4.1 Basics of Log-linear Regression[3]

We used a model-building method called log-linear regression to analyze Table 6. When we analyze a frequency table with one or two categorical variables, we usually use the Pearson Chi-square test. When there are more than two categorical variables in a frequency table, however, we cannot calculate the expected frequency by using the Pearson Chi-square algorithm.

Log-linear regression is a specialized technique for a cross-tabulation defined by more than two categorical variables. It enables us to find hidden generalizations out of random occurrences of events. Such generalizations take the form of log-linear equations, and hence the procedure is called *log-linear regression*.[4][5]

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[3] This sub-section introduces the analytical framework adopted in this paper. Not surprisingly, more or less the same content appears in our other papers that use the same analytical tool (Jun and Lee 2011, Jun and Yi 2011, Jun in press).

[4] For more information on log-linear regression, see Agresti (2007), Jun (2010), Kennedy (1992), Knoke and Burke (1980), and Li (2002).

The goal of log-linear regression is to find the most parsimonious, i.e. simplest, mathematical model or equation that correctly predicts the entire distribution of the frequency counts in the table. To achieve this goal, we first set up a model that includes all the possible effect terms: the *saturated* model. The parameters of the saturated model are mathematically set up to yield exactly the same output as the actual frequency values in the cross-tabulation.

Suppose that we have a cross-tabulation defined by three categorical variables, namely X, Y, and Z. Then, we set up the saturated model, as in (4), such that the natural log of the frequency of a cell (=$\ln F_{XYZ}$) is the sum of the constant effect ($\lambda$), three main effects ($\lambda X + \lambda Y + \lambda Z$), three two-way association effects ($\lambda XY + \lambda XZ + \lambda YZ$), and the three-way interaction effect ($\lambda XYZ$).

(4) {XYZ}:
$$\ln F_{XYZ} = \lambda + \lambda X + \lambda Y + \lambda Z + \lambda XY + \lambda XZ + \lambda YZ + \lambda XYZ$$

Here, we use *lambda* as the notation for an effect parameter. We also abbreviate the entire log-linear equation into the capital letters in curly brackets that show the highest effect term of the equation; i.e. {XYZ}.

Next, we have to produce as many *reduced* models as possible by deleting one or more effect terms from the saturated model. For instance, we may wish to delete ' $\lambda YZ + \lambda XYZ$' from (4), and produce a conditional independence model in (5).

(5) {XY}, {XZ}:
$$\ln F_{XYZ} = \lambda + \lambda X + \lambda Y + \lambda Z + \lambda XY + \lambda XZ$$

Likewise, we can delete all the interaction terms from (4), and obtain a complete independence model in (6).

(6) {X}, {Y}, {Z}:
$$\ln F_{XYZ} = \lambda + \lambda X + \lambda Y + \lambda Z$$

[5] Log-linear regression is sometimes confused with binary logistic regression. In logistic regression, the probability of an event is logit-transformed, and is used as a dependent variable. On the other hand, log-linear regression directly predicts the natural log of frequency values in the cross-tabulation by assessing a number of restricted models.

The models in the log-linear regression analysis should be considered as possible *hypotheses* about the data. That is, the model in (5), i.e. '{XY}, {XZ}', is the formal statement of the hypothesis that the frequency distribution of our interest is explained by the interaction between X and Y plus the interaction between X and Z. Similarly, the model '{X}, {Y}, {Z}' in (6) is the formal statement of the hypothesis that the phenomena of interest are well explained by the main effects of X, Y, and Z.

The third step of log-linear regression is to test the validity of each reduced model. In other words, we have to test each hypothesis. As mentioned earlier, the saturated model is mathematically set up, such that its predicted values exactly match the observed frequency counts. Our goal is to identify a *simpler model* that makes more or less the same predictions as the saturated model. If the reduced model in (6) makes the same predictions as the saturated model, the reduced model should be preferred, because it is simpler than the saturated model.

To test the goodness-of-fit, i.e. validity, of a reduced model or a hypothesis, we perform a likelihood ratio Chi-square test with the formula in (7), where $n_{ijk}$ is the observed frequency of the *ijk*-th cell, and $\mu_{ijk}$ is the expected frequency of the same cell.

(7) $G^2 = 2\sum n_{ijk} \ln\left(\frac{n_{ijk\mu}}{\mu_{ijk}}\right)$

Because we want the reduced model to predict more or less the same frequency counts as the saturated model, we want the Sig. value of the likelihood ratio Chi-square to be greater than the critical α=.05. In other words, we do not want the reduced model to be significantly different from the saturated model. Once we find several reduced models that explain the actual frequency counts well, we choose the model with the smallest number of effect terms as the most parsimonious and hence *best* model for the data.

### 4.2 MR Children's Production of Conjugated Predicates in Korean

We performed log-linear regression to analyze the frequency distribution in Table 6. First, we set up the saturated model that includes all possible effect terms of the four categorical variables, as follows:

(8) {AMSC}:

$$\ln F_{AMSC} = \lambda + \lambda A + \lambda M + \lambda S + \lambda C + \lambda AM + \lambda AS + \lambda AC + \lambda MS + \lambda MC + \lambda SC + \lambda AMS + \lambda AMC + \lambda ASC + \lambda MSC + \lambda AMSC$$

The model {AMSC} predicts exactly the same values as the actual frequency counts in Table 6.

The next step of log-linear regression is to posit simpler hypotheses or reduced models. For instance, we can delete age-related effects from (8), and get a reduced model in (9).

(9) {MSC}:

$$\ln F_{AMSC} = \lambda + \lambda M + \lambda S + \lambda C + \lambda MS + \lambda MC + \lambda SC + \lambda MSC$$

If the reduced model {MSC} makes the same predictions as the saturated model {AMSC}, we have reasons to believe that any apparent effect of A(ge) has actually come from other effect terms, and that A(ge) does not play a role in explaining the data.

This way, we tested hundreds of hypotheses, i.e. models, using log-linear regression. Table 7 summarizes the test results of just 10 hypotheses, but adequately shows the main point of our discussion.

**Table 7.** Model-building in Hierarchical Log-linear Regression

| # | Performed action | Model | $G^2$ | df | Sig. |
|---|---|---|---|---|---|
| 1 | All two-way interaction model | {AC}, {AM}, {AS}, {MC}, {SC}, {MS} | 61.575 | 96 | .998 |
| 2 | Deleting {AC} from Model #1 | {AM}, {AS}, {MC}, {SC}, {MS} | 72.622 | 102 | .988 |
| 3 | Deleting {AM} from Model #2 | {AS}, {MC}, {SC}, {MS} | 80.849 | 106 | .967 |
| 4 | Deleting {AS} from Model #3 | {MC}, {SC}, {MS} | 90.668 | 114 | .947 |
| 5 | Deleting {MC} from Model #4 | {SC}, {MS} | 93.094 | 120 | .967 |
| 6 | Deleting {SC} from Model #5 | {MS} | 408.498 | 132 | .000 |

| | | | | | |
|---|---|---|---|---|---|
| 7 | Adding {C} to Model #6 | {MS}, {C} | 114.846 | 129 | .809 |
| 8 | Deleting {MS} from Model #5 | {SC} | 305.054 | 128 | .000 |
| 9 | Adding {M} to Model #8 | {SC}, {M} | 186.525 | 126 | .000 |
| 10 | Deleting 'λMS' from Model #7 | {M}, {S}, {C} | 208.276 | 135 | .000 |

In Table 7, we can see that models #1, #2, #3, #4, #5, and #7 make accurate predictions of the frequency counts in Table 6, since their Sig. values are all greater than the critical $\alpha$=.05. In other words, these models are not significantly different from the saturated model. Among these models, #7, i.e. {MS}, {C}, is the simplest, and hence the best log-linear equation for the entire frequency distribution in Table 6. The log-linear equation in (10) shows the simplicity of model #7 compared with the saturated model in (8).

(10) {MS}, {C}: (the best log-linear model in Table 7)
$\ln F_{AMSC} = \lambda + \lambda M + \lambda S + \lambda C + \lambda MS$

## 5. Discussion and Conclusion

In the beginning of this paper, we set up the research question, as follows: *Do MR children show the same or different pattern of Korean predicate conjugation compared with normal children?* Our goal was to provide evidence for the dissociation between language and cognition by answering this question. That is, if MR children's production of conjugated predicates shows the same pattern as normal children, we can support the *modularity* view of language that assumes the dissociation between language and cognition.

In 4.2, we tested a number of hypotheses about the data, and found that the simple log-linear equation in (10) accurately predicted the actual frequency counts in Table 6. That is, the usage patterns in Table 6 are explained well by the interaction between morphology and semantics ({MS}) plus the main effect of conjugation ({C}).

This result is consistent with our recent work on Korean children's morphosyntactic development. In Jun (in press), we have found from a series of log-linear regression analyses that normal Korean children learn the grammar of predicate conjugation before age 4, and that the overall frequency distribution of conjugated predicates is explained by the simple log-linear model '{MS}, {C}'. This is an impressive finding, in that we have obtained the same generalization, i.e. '{MS}, {C}', from the data of both normal and MR children.

Clearly, the present study poses a serious challenge to behavioral psychologists' works that have reported MR children's problems with finite verb morphology. Note that this paper can be distinguished from their works in several ways. First, we analyzed Korean, a language well-known for its rich predicate morphology. Second, we classified Korean children's actual use of predicates according to well-defined linguistic properties including aspectual classes and complex conjugation patterns. Third, we employed log-linear regression to control for effects hidden behind apparent differences.

Because the design of the present study is different from that of most behavioral studies, a simple comparison between this paper and the behavioral studies is not easy. For instance, there is a consistent claim in the literature that cognitively impaired children's semantic capability is not as mature as normal children. But their claim about child language semantics actually remains at the vocabulary level, since their evidence comes from the onset of first words (Trauner et al. 1995), receptive and expressive vocabulary levels (Haynes 1992, Hick et al. 2005, Leonard et al. 1999, Smith et al. 2007, Thal et al. 2004), word finding problems (Lahey and Edwards 1999), and vocabulary scores on standard IQ tests (Facon et al. 2002), among others.

What would have happened if they had narrowed down their focus on the aspectual class of verbs? Of course, vocabulary development is closely related to competent speakers' semantic systems. However, a number of other factors influence vocabulary development including poor working memory (Bishop et al. 1995, Dollaghan and Campbell 1998). It is not right to claim that MR children's semantic capability is weak simply because they have vocabulary problems.

However, it is not easy to explain why MR Korean-speaking children are good at complex predicate morphology, whereas MR English-speaking children are not. In fact, some cross-linguistic variations are already reported in the literature. In verb-second languages like German and Dutch, language-impaired children make frequent word order errors, but English-speaking children with language impairment rarely make word order errors (Leonard 2009). Leonard and Deevy (2006) also found that German- and Dutch-speaking SLI children were better at tense and agreement inflections than English-speaking controls. In this regard, the present study can be an important contribution to developing a plausible hypothesis about cross-linguistic differences among language-impaired children.

This study has some limitations. We collected narrative data from MR children by using a wordless picture book. The most important advantage of using the same wordless picture book is that we can control the content of narratives; i.e. we can see what verbs and sentences children use when they are forced to describe the same content. On the other hand, the shortcoming of the method is that we cannot collect a large number of verb types.

Although we initially included several three year old children among the subjects, we failed to collect meaningful data from them. Because of this limitation, we could not determine an overall developmental profile of conjugation patterns in Korean. Nevertheless, the finding that the same morphosyntactic principle constrains both normal and MR children is particularly important, since many earlier studies in the behaviorist tradition have reported that children with language impairment or cognitive deficits have non-trivial problems with morphosyntax.

In conclusion, we have found that MR children's use of Korean predicates is not different from normal children's predicates uses, and that the actual conjugation patterns are correctly predicted by a linguistic principle that makes reference to the morphological and semantic classes of the predicate. This shows that there exist purely linguistic components such as predicate morphology, semantic class, and morphosyntactic conjugation that are dissociated from the general cognition.

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