Children's Strategic Processing of Korean Relative Clauses*

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Processing strategies for relative clauses have received much attention in the literature. Previous studies have approached the question by studying relative clauses (=RCs) in terms of both the main clause function and the embedded clause function of the head noun. This way, researchers could identify multiple processing strategies for RCs (cf. Clancy, Lee, & Zoh, 1996), but there has been little attempt to explicitly tease apart RC-internal factors like the embedded clause function from RC-external factors like the main clause function. In this paper, we focus on such RC-internal factors as word order and animacy by placing RCs within the copula construction *What is X?*, where *X* is the NP that contains the RC in question. Our test design follows the picture-cued comprehension paradigm. The test sentences are in two dimensions: first, the subject relative vs. the object relative distinction; and secondly, RCs with lexical heads vs. RCs with the bound nominal head *kes* 'thing'. We have tested 59 monolingual Korean children, and found out that monolingual Korean children strategically process RCs, assigning the subject/actor role to the linearly first NP (i.e. the word order strategy), and to an animate NP (i.e. the animacy strategy). Comparison with earlier works also suggests that there is a quantitative, but not a qualitative, difference in language development, between bilingual and monolingual Korean children.

Key words: language acquisition, processing strategy, relative clause, word order, animacy

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1. Introduction

Relative clauses (=RCs) have received special attention in the psycholinguistics literature thanks to their implication to both language development and language processing. For one thing, the complex nature of subordination of a sentence with RCs sheds light on the overall course of language development providing useful criteria to decide what stage a language learner lies in (cf. Brown, 1973; Radford, 1990). For another, language learners are forced to figure out the meaning of a complex sentence with RCs. In case they have not reached the target grammar of RCs, they tend to make conjectures about the meaning a sentence with RCs; controlled experiments can reveal some principled nature of the children's guesses. We can also run experiments with competent language users with the target grammar of RCs to see how they process a sentence with RCs in their mind.

Earlier studies of RCs have found a number of factors that play important roles in language processing. They include factors due to syntactic configuration (Clancy, Lee, & Zoh, 1986; Hakuta, 1981; Keenan & Comrie, 1977; MacWhinney, 1977, 1982; Sheldon, 1974; Slobin & Bever, 1982), factors due to semantic/pragmatic processing (MacWhinney & Pleh, 1988), and factors due to language learners' sloppy grammar (Sheldon, 1977; Tavakolian 1981). Researchers have focused on various processing strategies for the main clause subject NP whose head noun also functions as the subject of an embedded clause (i.e. the SS-type RC); the main clause subject NP whose head noun functions as the object of an embedded clause (i.e. the SO-type RC); the main clause object NP whose head noun functions as the subject of an embedded clause (i.e. the OS-type RC); and the main clause object NP whose head noun also functions as the object of an embedded clause (i.e. the OO-type RC). Representative data of the four types are summarized in (1).

(1) a. SS: The rabbit that *t* pushed the dog chased the cat
  b. SO: The rabbit that the dog pushed *t* chased the cat
  c. OS: The rabbit chased the cat that *t* pushed the dog
  d. OO: The rabbit chased the cat that the dog pushed *t*

The four-type classification of RCs is useful in understanding how a language user processes an RC using as many clues as are available from a sentence. For instance, when a language user processes (1a), (s)he takes into consideration not only the fact that *rabbit* is the subject of the embedded clause, but also an additional piece of information that *rabbit* is the subject of the main clause. Moreover, one can highlight the fact that the main clause function of *rabbit* is parallel with (i.e. the same as) the embedded clause function of *rabbit* (Sheldon, 1977). A major contribution of previous studies is to show that multiple strategies take part in the processing of a sentence with an RC (Clancy, Lee, & Zoh, 1986).

One problem with previous approaches is that they do not tease apart RC-internal clues from RC-external ones, so that it is not clear how a language user processes RCs when the main clause function does not matter. In other words, how do language users process *the rabbit that t pushed the dog* instead of (1a)? Sheldon (1974), for instance, emphasizes the parallel function of the NP in main and embedded clauses. SS and OO sentences are easier to process than SO and OS sentences, because the head noun of the NP in question has parallel functions in the main and embedded clauses of SS and OO sentences. Sheldon's theory does not make any prediction about a simple subject relative like *the rabbit that t pushed the dog* and a simple object relative like *the rabbit that the dog pushed t*. Subsequent studies have worked on RC-internal clues like the word order and the animacy, but the experimental paradigm did not explicitly take RCs apart from possible influences of RC-external clues like the main clause function.

In an experiment with children, it is not easy to entirely exclude RC-external clues. In the classical act-out task, where a child is asked to act out what (s)he just heard with toy dolls, it certainly does not provide a natural setting for an experimenter to say only *the rabbit that t pushed the dog* instead of *The rabbit that t pushed the dog did such and such things*. One possible solution is to place the RC in a main clause with an intransitive verb, or, what is better, a copula verb. To this end, we adopted a picture-cued comprehension paradigm (cf. Brown, 1971), where a child is asked to pick out one of the two pictures after hearing a wh-question with a copula verb like *What's the rabbit that t pushed the dog?*[1] We tested 59 Korean children of ages from 2;08 to 6;07 with Korean RCs.

Korean is particularly useful for our goal, since the language has an RC

1) To minimize possible influences of the main clause function, experimenters put a slight pause between the NP with an RC and the wh- word.

with a bound nominal head *kes* 'thing' as well as an ordinary RC with a lexical head. In an RC with a lexical head, there are two animate nouns inside the NP in question; e.g. *cat* and *dog* in *the cat that pushed the dog*. What matters here is the linear order of the two animate NPs, thereby showing the word order effect. On the contrary, in an RC with the bound nominal head *kes* 'thing', there is only one animate noun inside the NP in question; e.g. *dog* in *the thing that pushed the dog*. The difference in the number of animate nouns between an RC with a lexical head and an RC with the bound nominal head may provide a useful index for the animacy strategy.[2] With the two kinds of RCs, we have found out that monolingual Korean children assign the subject/actor role to the linearly first NP following the word order strategy up to age 4, and to an animate NP following the animacy strategy at age 3. Comparison of our data with earlier works suggests that strategic understanding of RCs is common to both bilingual and monolingual language development.

This paper is organized as follows. Section 2 is a brief summary of earlier works on the processing of RCs. Section 3 discusses relevant RC-internal factors that affect sentence processing; i.e. the word order and the animacy. Sections 4 and 5 describe our experiments and the main results: section 4 for RCs with lexical heads, and section 5 for RCs with the bound nominal head *kes* 'thing'. Section 6 is the general discussion and conclusion.

2. Earlier Works on the Processing of Relative Clauses

Earlier studies on the processing of relative clauses have found a number of factors in language processing. 2.1 discusses factors due to syntactic configuration; 2.2 discusses factors due to semantic/pragmatic processing; and 2.3 discusses factors due to language learners' sloppy grammar.

2.1. Factors Due to Syntactic Configuration

Sheldon's (1974) parallel function hypothesis is a classical proposal that emphasizes the relationship between the processing load and the grammatical function. In her theory, the processing load is greater when the main clause function of the head noun of an NP is different from the head noun's

2) See Section 3 for detail.

embedded clause function than when the two functions are parallel, i.e. the same. SS and OO type RCs are predicted to be easier than SO and OS sentences, since the main and embedded clause functions are parallel in SS and OO sentences. Her prediction is confirmed in many studies with respect to the relative difficulty of SS and SO, but experimental data vary from study to study with respect to the relative difficulty of SS, OO, and OS.3)

Keenan and Comrie (1977) draw our attention in that they focus on an RC-internal factor, namely the grammatical function inside an RC. According to their noun phrase accessibility hierarchy, subject relatives are easier than object relatives due to the implication hierarchy of grammatical roles; i.e. *subject > direct object > indirect object > prepositional object > possessive NP > object of a comparative particle*. Subject is higher in the implicational hierarchy than object; in other words, subject is much easier to access than object for language processing. Subsequent studies have confirmed the prediction that subject relatives are easier than object relatives (de Villiers et al., 1979; Harada et al., 1976; Y.-J. Kim, 1987; K.-O. Lee, 1990; S. Cho, 1999), and O'Grady's (1987, 1997) structural distance hypothesis provides principled account for why subject gaps are more accessible than object gaps. Interestingly, contradicting data are prevalent in the literature; O'Grady, S. Cho, M. Song, and M. Lee (1996) and J. S. Jun (2001) report that their Korean-American children find object relatives easier than subject relatives.

Smith (1974) makes use of Bever's (1970) Noun-Verb-Noun strategy plus C. Chomsky's (1969) minimal distance principle (MDP). In this theory, children expect a Noun-Verb-Noun basic sentence structure; when they confront a gap as in RCs, they tend to fill up the gap the with most recent (i.e. minimally distant) NP. OS sentences are the easiest since the head noun of the main clause object is automatically filled in the subject gap of the RC.4)

Another proposal that uses the linear order of NPs is Slobin and Bever's (1982) canonical schema, according to which children resort to the basic word order of a language for sentence interpretation. In SOV and SVO languages, the first NP is canonically interpreted as the subject of a sentence. O'Grady et al. (1996) and J. S. Jun (2001) adopt the canonical sen-

3) Hakuta (1981) provides a good review of the inconsistent data in the literature.

4) See Hakuta (1981) for problems of the theory when it is applied to SS, SO, and OO.

tence strategy, or the agent-first strategy to account for the problematic data in which Korean-American bilingual children do better for object relatives than for subject relatives contra Keenan and Comrie's (1977) accessibility hierarchy.

In Korean, RCs precede the head noun as shown in (2).

(2) a. [t holangi-lul ccocha-ka-nun] wenswungi
tiger-ACC chase-COMP monkey
'the monkey that is chasing a tiger'
b. [holangi-ka t ccocha-ka-nun] wenswungi
tiger-NOM chase-COMP monkey
'the monkey that a tiger is chasing'

In the subject relative in (2a), the first NP that precedes the verb is actually the object of the RC; in the object relative in (2b), the first NP is the subject of the RC. Children who do not make use of morpho-syntactic cues, i.e. the case endings, resort to the canonical sentence strategy assuming that the linearly first NP would be the subject or the actor of the sentence. The strategic understanding works out well for the object relatives, but not for the subject relatives (J. S. Jun, 2001). The canonical sentence strategy uses a configurational property inside an RC, namely an RC-internal factor.

2.2. Factors Due to Semantic/Pragmatic Processing

MacWhinney (1982) proposes a perspective maintenance hypothesis as an alternative to Sheldon's (1974) parallel function. According to his analysis, we want to maintain the perspective of active agents rather than passive recipients just as we prefer figures against grounds to grounds containing figures. Because the main clause subject in general corresponds to active agents, i.e. figures, it is easier to maintain the perspective of the subject, i.e. agents, than to change the perspective. This not only explains why subject relatives are easier to process than object relatives in English, but also makes a prediction that SO sentences are the most difficult since they involve the shift of the perspective twice; i.e. from the subject to the object trace, and then to the subject again ([S [$_{RC}$ S V $_{Obj}$-t] V O]).[5]

5) MacWhinney's prediction is SS > {OO, OS} > SO. See also the focus maintenance determinant in MacWhinney and Pleh (1988).

2.3. Factors Due to Language Learners' Sloppy Grammar

The canonical sentence strategy or the word order strategy blames language learners' sloppy grammar, and introduces structure-based heuristics into language processing. Some studies make direct use of language learners' sloppy grammar to account for their poor performance with particular structures. Tavakolian's (1981) conjoined clause analysis draws our attention to children's tendency to analyze a subordinating clause as a conjoined clause. According to her proposal, children analyze *The rabbit that pushed the dog chased the cat* as *The rabbit pushed the dog and chased the cat.* This makes a prediction that SS sentences are the easiest, and that OO and OS sentences are the most difficult.[6]

In sum, a number of strategies have been proposed in the literature in order to account for the processing difficulty of particular types of RC. Some experimental findings are consistent; e.g. the relative difficulty of SO sentences. But there are more inconsistent experimental data from study to study. We have contradicting data even within one language: some studies report the relative ease of subject RCs in Korean, whereas others report the relative ease of object RCs in the same language. One thing that is not clear is the distinction between RC-internal factors and RC-external factors. The accessibility hierarchy and the canonical schema are RC-internal factors, whereas the parallel function, the perspective maintenance and the conjoined clause analysis put heavy emphasis on RC-external factors. Clancy, Lee, and Zoh's excellent study advocates multiple processing strategies, but they do not explicitly tease apart RC-internal factors. Our research question is this: *How would a language user process RCs if other things were equal?* Before we try to answer this question, we discuss relevant RC-internal factors in section 3.

3. RC-internal Factors as Working Hypotheses

The word order and the animacy are widely discussed in the psycholinguistics literature as two clause-internal factors that affect sentence processing (Kilborn, 1994; Lee, Jun, & Park, 2003; Lee, Jun, Park, & Ahn 2003; Liu, Bates, & Li, 1992; MacWhinney, 1992). O'Grady et al. (1996) and J. S.

6) See also Sheldon's (1977) adjacency strategy that seems to work well for French.

Jun (2001) make use of the canonical word order to account for Korean-American bilingual children's better performance for object relative than for subject relatives contra Keenan and Comrie's (1977) accessibility hierarchy. As was already discussed in (2), in Korean, RCs precede head nouns; the linearly first NP in subject relatives is actually the object of the RC (cf. (2a)); and the linearly first NP in object relatives is the subject of the RC (cf. (2b)). The canonical word order or the agent-first strategy assigns the subject function or the agent role to the linearly first NP. As a result, the strategic understanding does not work out well for the subject relatives, but for the object relatives.

Another relevant RC-internal factor is the animacy: speakers assign the agent role to animate nouns. Animacy plays a central role in mapping linguistic forms, i.e. the surface strings of sounds, to grammatical functions or thematic roles. Chinese and Italian children actively adopt the animacy strategy (along with the word order for Chinese and agreement for Italian) for sentence processing (Bates and MacWhinney, 1989; Miao et al. 1986). Lee, Jun, and Park (2003) show that monolingual Korean children use the animacy strategy up to age 5. Lee, Jun, Park, and Ahn's (2003) subsequent study show that Korean-Chinese bilingual children also use the animacy strategy along with the word order strategy.

The RCs with lexical heads in (2) cannot be used to directly test the animacy strategy. There are two animate nouns in each example of (2): *holangi* 'tiger' and *wenswungi* 'monkey'. If language users resorted to only the animacy strategy, it would be hard for them to assign the actor role to either of the two animate nouns. They would perform at chance level picking out any of the two nouns by chance. Nevertheless, children understand subject and object relatives differently. This means that there is something more than animacy for (2).[7]

To see the animacy effect, it is essential to test an RC with only one animate participant as well as an RC with two animate participants. Korean provides a good testing ground for this, since the language has an RC with the bound nominal head *kes* 'thing'.

7) This indirectly explains why we use RCs with lexical heads to test the word order strategy, instead.

(3) a. [t holangi-lul ccocha-ka-nun] kes
tiger-ACC chase-COMP thing
'the thing that is chasing a tiger'
b. [holangi-ka t ccocha-ka-nun] kes
tiger-NOM chase-COMP thing
'the thing that a tiger is chasing'

The two RCs in (3) has only one animate noun *holangi* 'tiger'. If language users resorted to only the animacy strategy, i.e. if they assigned the subject/actor role to the animate noun, they would perform below chance level for subject relatives in (3a), and above chance level for object relatives in (3b). These predictions are mostly confirmed in our experiments in subsequent sections.

Finally, there is an important confounding factor in our experimental paradigm. We adopt a picture-cued comprehension paradigm (cf. Brown, 1971; J. S. Jun, 2001), in which a child hears a wh-question with a copula verb like *What's the rabbit that t pushed the dog?*, and picks out one of the two pictures that correctly answers the question. The two pictures describe reversed roles of the participants. For instance, in one picture, a rabbit is pushing a dog; in the other picture, a dog is pushing a rabbit. Susumu Kuno (p.c.) observed that all the pictures in Jun's experiments, which we use as our pilot study, accidentally placed an actor on the left and a patient on the right; then we could not be sure whether a child assigned the actor role to the linearly first NP or simply to the left most animal in a picture. To control for this possible left-to-right, or simply the left-as-agent effect, we made two sets of pictures for all the test sentences; i.e. in one set of pictures, actors are placed on the left; and in the other set of pictures, actors are placed on the right.[8]

8) Clancy, Lee, and Zoh (1986), in their influential paper advocating multiple universal processing strategies, use the term *left-to-right strategy* for operating principles that make use of canonical sentence structures; i.e. the leftmost NP is the subject of a sentence. It is a misnomer, however, since the term *left-to-right* makes a strange assumption that *linearly left in space* is *linearly first in time*. In a culture with a right-to-left orthography (i.e. *god eht* for 'the dog'), *linearly right in space* should be *linearly first in time*. Unlike Clancy, Lee, and Zoh, we use the term *left-to-right* for the relative positions of the actor and the patient in a picture.

4. Experiment 1: RCs with Lexical Heads

4.1. Subjects

We have recruited 59 Korean monolingual children of ages from 2;08 to 6;07 from a kindergarten in Bangbae-dong, Seoul, Korea. None of our subjects reportedly have language impairment or intellectual deficits. We neither made a preliminary age group distinction like age 3, age 4, etc., nor assigned the same number of students to each predefined group. Rather, we just tested as many children as possible regardless of their ages, and tried to find out the most statistically significant boundaries among age groups. Table 1 summarizes our post-determined age groups for the subjects after running numerous inferential statistical tests with various age groups. Surprisingly, what we get at after numerous statistical tests is a classical distinction like age 3, age 4, age 5, and age 6, which is indicated by the mean and the standard deviation columns in Table 1. Our initial test design included a personal variable *gender*, and we used two test formats with different mixture of test questions, which defined another variable *test type*. Both *gender* and *test type* proved to be of no statistical significance, so we eliminated the two variables from our report in this paper.

Table 1. Subjects' Age Groups

Age Group	Number of Subjects	Minimum (year;month)	Maximum (year;month)	Mean (year;month)	SD (year;month)
3	17	2;08	3;10	3;06	0;04
4	16	3;11	4;11	4;05	0;04
5	14	5;00	5;09	5;04	0;03
6	12	5;11	6;07	6;03	0;03
Total	59	--	--	--	--

4.2. Procedure and Material

The procedure is simple. An experimenter asks a child a wh-question in Korean. Each question is in the format of *What is X?*, where *X* is an NP with either a subject RC or an object RC. Two pictures are presented before each child. The child's job is to pick out a picture which correctly describes the *X* in *What is X?*. Before the test begins, each child goes through trial sessions up to three times to be familiarized with the test procedure.

Following Lee, Jun, and Park (2003) and Lee, Jun, Park, and Ahn (2003), all test sentences were made up of the animate nouns and verbs that were excerpted from S.-H. Lee's (1999) list of the verbs and nouns that more than 50% of two-year-old Korean children use in their voluntary speech according to their parental reports. Our first set of experiment includes 6 subject relatives and 6 object relatives, as shown in (4).

(4) a. Subject RC (=SRel):
[t komtoli-lul ttayli-n] kangaci-i mues-ilkka?
bear-ACC hit-COMP dog-NOM what-be
'What is the dog that hit the bear?'
b. Object RC (=ORel):
[komtoli-ka t ttayli-n] kangaci-i mues-ilkka?
bear-NOM hit-COMP dog-NOM what-be
'What is the dog that the bear hit?'

For (4a) and (4b), Figures 1 and 2 are presented at the same time. To minimize any possible bias to choose either the picture on the left or the picture on the right, one picture is placed on top of the other.

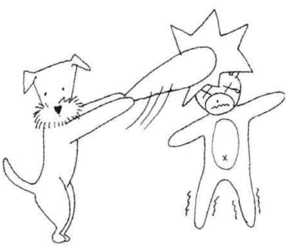

Figure 1. the dog that hit the bear

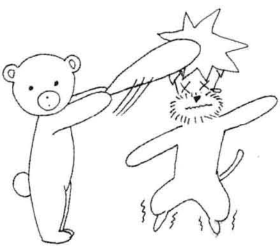

Figure 2. the dog that the bear hit

Finally, to control for the left-to-right, or the left-as-agent effect, (4a) and (4b) are asked again (after several other questions) with reversed pictures. In reversed pictures, actors are placed on the right, and patients are placed on the left. Figures 3 and 4 illustrate reversed pictures.

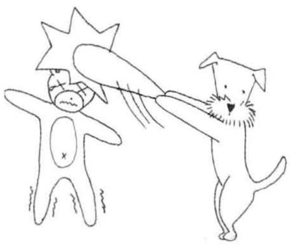

Figure 3. the dog that hit the bear

Figure 4. the dog that the bear hit

In short, 12 questions, i.e. 6 SRel's and 6 ORel's, are asked twice, i.e. once in the left-as-agent format, and then in the right-as-agent format for the second time. This way, each subject is asked exactly 24 questions.

4.3. Results and Discussion

For each question, the score of 1 is given to a correct answer, and 0 to an incorrect answer. Table 2 summarizes the mean scores by question types and ages.

Table 2. Mean Scores by Questions Types and Ages

	SRel	ORel	SRel_reversed	ORel_reversed
Age 3	.49	.72	.58	.68
Age 4	.61	.70	.74	.71
Age 5	.79	.75	.83	.81
Age 6	.82	.96	.82	.93

First, we can see the sharp contrast between SRel and ORel (Figure 5): children perform above chance level (i.e. $>.5$) for ORel even at age 3, whereas children make guesses at chance level (i.e. $=.5$) for SRel up to age 4. This is confirmed by one-sample t-tests with the test value of .5: for SRel, $t(16)=-.141$, $p=.890$ at age 3, and $t(15)=1.842$, $p=.085$ at age 4. Repeated measures ANOVA with the Within-subject factor of SRel and ORel reveals very significant Within-subject and Between-subject effects ($F(1, 55)=7.399$, $p=.009$ for Within; and $F(3, 55)=1122.355$, $p=.000$ for Between). Children's above-chance level performance for ORel is explained well by the canonical word order strategy, according to which children assign the subject/actor role to the linearly first NP.

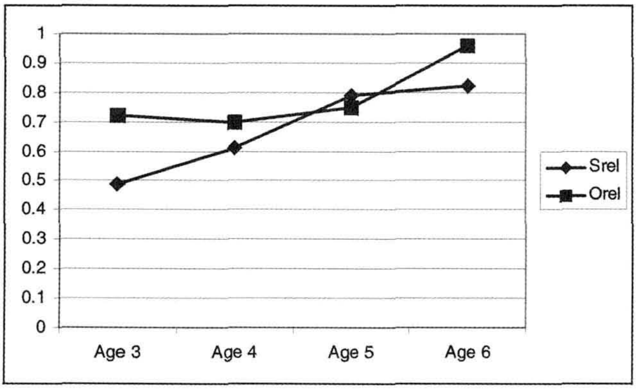

Figure 5. SRel vs. ORel

Children's chance level performance for SRel up to age 4 could be explained by the animacy strategy. For SRel, the word order strategy makes incorrect predictions, since the linearly first NP is not the subject of the clause. When confronted with two animate NPs, however, children cannot use the animacy strategy, either, therefore performing at chance level.

Both the word order and animacy are important for monolingual Korean children's sentence processing.[9] But here is a more crucial question: *How does a child know when to apply the word order strategy, and when to apply the animacy strategy?* We cannot provide a satisfactory answer to this question from our current experimental setting, but our plausible guess is that children should somehow combine a third factor, perhaps morphology, with the word order and animacy factors. This sounds reasonable, especially because Korean children acquire the nominative ending earlier than the accusative ending (cf. Y.-J. Kim, 1987, 1997). If this conjecture were right, children who recognize the nomnative ending in the linearly first NP of ORel sentences would know that they can use the word order strategy, whereas they would hesitate to use the word order strategy to SRel sentences. We leave this question to a more controlled study in the future.

We do not see a significant contrast between SRel and SRel_reversed, which suggests that the left-to-right, or the left-as-agent factor does not complicate our discussion ($F(1, 55)=3.723$, $p=.06$ for Within-subject effects).

9) This result is consistent with Lee, Jun, and Park (2003).

Likewise, there is no significant difference between ORel and ORel_reversed (F(1, 55)=.000, p=.99 for Within-subject effects). When we compare SRel_ reversed with ORel_reversed, however, we see a mysterious effect of the right-as-agent pictures: there is no significant difference between SRel_ reversed and ORel_reversed (F(1, 55)=1.746, p=.192 for Within-subejct effects). This is strange in that we had a sharp contrast between SRel and ORel (p=.009), and the contrast is suddenly eliminated. This right-as-agent picture effect is due to the improved performance of SRel_reversed sentences up to age 4, as is observed in Figures 6 and 7.

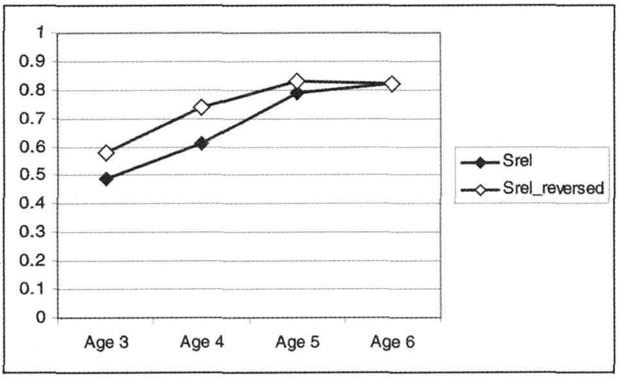

Figure 6. SRel vs. SRel_reversed

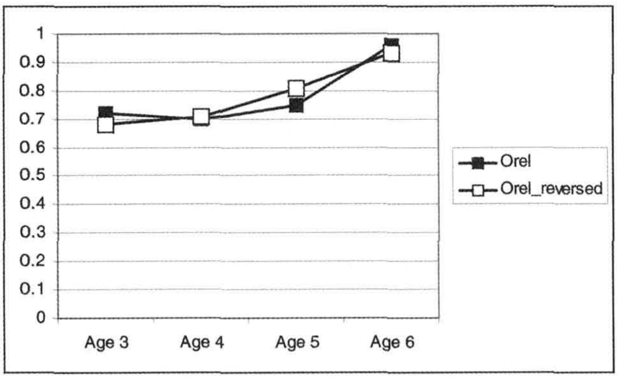

Figure 7. ORel vs. ORel_reversed

Nothing is clear at this moment: it might be a sampling problem related with the well-known type II error; or it might be a call for a more seriously controlled experiment than this. But we are pretty positive that it is not the left-as-agent effect. To verify our thought, we manipulated the data, and created an independent variable *reversed_or_not* that distinguishes the left-as-agent condition (i.e. Figures 1 and 2) from the right-as-agent condition (i.e. Figures 3 and 4). We also created two more variables *SRel_general* and *ORel_general*, which combine SRel and SRel_reversed, and ORel and ORel_reversed respectively.

Then, we did multiple regression (=MR) analyses with *SRel_general* and *ORel_general* as dependent variables, and *age* and *reversed_or_not* as independent variables. We checked the coefficients for each independent variable in the MR equation; this way, we could understand how much the overall variabilities of *SRel_general* and *ORel_general* are explained by the variabilities of *age* and *reversed_or_not*. The t-statistics in our MR analyses show that the coefficients for *age* in the regression equation are very significant (p=.000 for both *SRel_general* and *ORel_general*); on the contrary, the coefficients for *reversed_or_not* are not significant at all (p=.101 for *SRel_general* and p=.985 for *ORel_general*). This shows that *reversed_or_not* does not have significant effect on the variability of *SRel_general* and *ORel_general*. Therefore, we have reasons to believe that children's performance is not significantly affected by the relative position (i.e. left or right) of an agent in a picture. In sum, in our first set of experiment, we have found that monolingual Korean children use both the word order strategy and the animacy strategy, and that the suspicious left-as-agent effect does not play a role in children's language processing.

5. Experiment 2: RCs with the Bound Nominal Head

5.1. Subjects

All the 59 children in experiment 1 participated in experiment 2.

5.2. Procedure and Material

The procedure is similar to the procedure of experiment 1. An experimenter asks a child a wh-question in Korean. Each question is in the format of *What is X?*, where *X* is an NP with either a subject RC or an object RC. Unlike in the previous experiment, one picture instead of two is used. Each picture describes three animals' successive motion; e.g. in one picture, a dog is biting a bear, and the bear is biting a tiger (Figure 8).

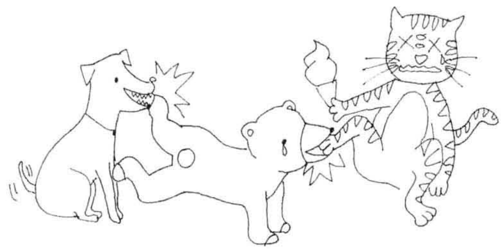

Figure 8. Three animals are biting each other

The child's job is to pick out an animal which correctly answers the *X* in *What is X?*[10] Before the test begins, each child goes through trial sessions up to three times to be familiarized with the test procedure.

As in experiment 1, we have the *reversed* condition, where the question is the same, but the picture is drawn in the right-as-agent format (Figure 9).

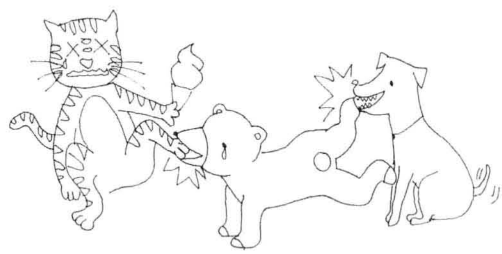

Figure 9. Three animals are biting each other

All test sentences were made up of one animate noun plus the bound

10) Experiment 2 differs from experiment 1 in three respects. First, in experiment 2, we provide the subjects with only one picture. Secondly, each picture in experiment 2 depicts a successive motion of three, instead of two, animals. Finally, children are asked to pick out a particular animal in experiment 2. The changes in the test design result from our compromise between the changes of experimental conditions from RCs with lexical heads to RCs with the bound nominal head and the need for minimizing workload for our subject children. In our pilot study (cf. J. S. Jun, 2001), Korean-speaking children showed curious tendency to pick out an animal instead of the whole picture when asked an RC with the bound nominal head. On the other hand, the same children tended to pick out the whole picture when asked an RC with lexical heads. So we decided to ask our subjects to pick out an animal instead of the picture in experiment 2; and we used one picture with three animals instead of two pictures to minimize children's confusion.

nominal head *kes* 'thing'. Example sentences are in (5).

(5) a. Subject RC with the bound nominal head (=SRelB):
[t komtoli-lul kkaymul-en] kes-i mues-ilkka?
bear-ACC bite-COMP thing-NOM what-be
'(Lit.) What is the thing that bit the bear?'
b. Object RC with the bound nominal head (=ORelB):
[komtoli-ka t kkaymul-en] kes-i mues-ilkka?
bear-NOM bite-COMP thing-NOM what-be
'(Lit.) What is the thing that the bear bit?'

Each test question targets the animal in the middle of the picture. Therefore, with the picture in Figures 8 and 9, only the animal in the middle of the picture, i.e. *bear*, appears as an animate noun in relevant test questions. Each subject is asked 12 questions -- four SRelB, four ORelB, two SRelB_reversed, and two ORelB_reversed -- in this experiment.

5.3. Results and Discussion

For each question, the score of 1 is given to a correct answer, and 0 to an incorrect answer. Table 3 summarizes the mean scores by question types and ages.

Table 3. Mean Scores by Questions Types and Ages

	SRelB	ORelB	SRelB_reversed	ORelB_reversed
Age 3	.34	.81	.56	.74
Age 4	.53	.81	.50	.69
Age 5	.64	.87	.86	.82
Age 6	.90	.81	.88	.83

The word order strategy predicts that children will do better with ORelB than with SRelB. This prediction is nicely confirmed by a highly significant Within-subject effect ($F(1, 55)=22.859$, $p=.000$). RCs with the bound nominal head are crucial in testing the animacy strategy in that there is only one animate NP in an RC with *kes* 'thing'. When a child followed the animacy strategy, (s)he would assign the subject/actor role to the single animate NP. There is no room for hesitation, or guesswork. The prediction is, therefore, that children would perform at below chance level (i.e. <.5) for SRelB, and above chance level (i.e. >.5) for ORelB. The prediction is confirmed by the data. One sample t-tests with the test value of .5 show a significant difference at age 3 for SRelB (t(16)=-2.393, p=.029). At ages 4 and above, children's performance improve above the chance level.[11] Although we are not sure what causes this improved performance in those age groups, the improved performance *per se* does not discredit our analysis.[12]

We do not have a significant contrast between ORelB and ORelB_reversed, which again suggests that the left-to-right, or the left-as-agent factor has no room in our analysis (F(1, 55)=2.631, p=.111 for Within-subject effects). On the contrary, there is a significant difference between SRelB and SRelB_reversed (F(1, 55)=5.181, p=.027), which reminds us of the improved performance between SRel and SRel_reversed. As a consequence of the improved performance of SRelB_reversed, the significant effect between SRelB and ORelB is eliminated (F(1, 55)=1.031, p=.314 for SRelB_reversed and ORelB_reversed).

This is troublesome as discussed in 4.3, but again our reasonable guess is that it is not the left-as-agent effect. Our supporting evidence comes from multiple regression analyses: as in 4.3, we created an independent variable *reversed_or_not*, and two combined variables *SRelB_general* and *ORelB_general*, which combine SRelB and SRelB_reversed, and ORelB and ORelB_reversed respectively. We ran multiple regression analyses with *SRelB_general* and *ORelB_general* as dependent variables, and *age* and *reversed or not* as independent variables. As expected, the t-statistics for the coefficients for *age* are significant (p=.000), whereas the t-statistics for the coefficients for *reversed_or_not* are not significant (p=.091 for *SRelB_*

11) One anonymous reviewer correctly points out that it is not clear whether children's improved performance for ORelB results from the animacy strategy or from the word order strategy, since the word order strategy also predicts that children will do better for ORelB sentences than for SRelB sentences. We have no definitive answer for this question, yet. But we have reasons to believe that children's better performance for ORelB than for SRelB is affected by the animacy strategy. The animacy strategy together with the word order strategy predicts that children will have more difficulty for ORel sentences than for ORelB sentences at early ages, since when there are two animate NPs as in ORel sentences, children are confused which animate NP to assign the actor role to. This prediction is confirmed by the repeated measures ANOVA for ORel and ORelB as a Within-subject factor and age as a Between-subject factor: there is a significant interaction between the Within-subject factor and age (F(3, 55)=2.859, p=.045).

12) On the other hand, if children at age 3 performed *above* chance level, and at age 4 *below chance level* etc., we would face a serious problem with our analysis.

general and p=.186 for *ORelB_general*).

6. General Discussion and Conclusion

In the beginning, we raised a question of how children would process RCs with RC-internal resources like the word order and animacy. Earlier studies did not explicitly tease apart RC-internal factors from RC-external factors despite their excellent contribution to our understanding of sentence processing. The four-way distinction of RC types like SS, SO, OS, and OO is useful in identifying all the factors that influence the processing of RCs, but does not tell much about RCs *per se*. We now know whether or not an RC is easier to process in case the NP containing the RC is the subject (or the object) of the sentence; but we are not sure whether or not an RC is easier to process when RC-external factors are equal.

To focus on RC-internal factors, we have given up the classical distinction of SS, SO, OS, and OO that uses a transitive main verb, and placed an RC in the copula construction of the format *What is X?*, where X has the RC in question. This way, we have reduced, if not completely, possible impacts of RC-external factors that come from the use of transitive main verbs. Instead of the act-out task, we have adopted the picture-cued comprehension paradigm, where a child is asked to pick out one of the two pictures that correctly describes what (s)he has just heard. We have used two sets of test sentences, i.e. RCs with lexical heads and RCs with the bound nominal head *kes* 'thing'. RCs with lexical heads are primarily used to test the word order effect, and RCs with the bound nominal head are primarily used to test the animacy effect. At the same time, we test the left-as-agent effect by setting up a *reversed* condition for all the test pictures we use.

Our experimental data with 59 children point to the fact that monolingual Korean children use both the word order strategy and the animacy strategy at early ages. That is, the linearly first NP is considered as the subject/actor of the sentence; at the same time, an animate NP is considered as the subject/actor of the sentence. The story gets complicated when the two strategies conflict with each other. For instance, we have two animate NPs in the experiment 1, and children seem to use the word order strategy for ORel and the animacy strategy for SRel. Our conjecture is that there is a third factor, possibly morphology, that children may use to combine with either the word order strategy and the animacy strategy; i.e. children would use the word order strategy when the linearly first NP were in nominative case. This is a reasonable guess in that the nominative case ending develops around 2;00 (Y.-J. Kim, 1997), so our subjects of age groups 3 to 6 should have some, if not perfect, command of case markers when they are tested in our experiments. We need a more controlled future study to test this conjecture.

We have also tried to test the left-as-agent effect, namely a possible tendency in which children picks out the animal on the left as the agent of the event that the picture describes. In most crucial cases (SRel vs. SRel_reversed; ORel vs. ORel_reversed; and ORelB vs. ORelB_reversed), we have found no left-as-agent effect. Some cases, however, are disturbing: the significant differences between SRel and ORel, and between SRelB and ORelB disappear in between SRel_reversed and ORel_reversed, and between SRelB_reversed and ORelB_reversed. This is due to the improved performance for SRel_reversed and SRelB_reversed. Although we could not tell what brings about the improved performance for these two variables, we have good reasons to believe that it is not the left-as-agent effect that is responsible for the improved performance. The multiple regression analysis with the *reversed or not* as an independent variable, and *SRel_general* and *SRelB_general* as dependent variables reveals that there is no significant contribution to the variability of the dependent variable from *reversed or not*.

A potential problem is that our data do not match the data in many earlier studies. In our study, Korean-speaking children consistently perform better with ORel than with SRel. Many earlier studies, however, confirm Keenan and Comrie's accessibility hierarchy; i.e. Korean-speaking children do better for SRel than for ORel (cf. Clancy, Lee, & Zoh, 1986). O'Grady et al. (1996) and J. S. Jun (2001), reporting the bilingual data consistent with our current study, assume that the difference is due to a qualitative difference between bilingual and monolingual Korean children. That is, bilingual, but not monolingual, Korean-speaking children would resort to the canonical sentence strategy.

Nobody was sure whether or not the canonical sentence strategy reflects qualitative differences between bilingual and monolingual children. In other words, we were not sure whether or not monolingual children, too, would show canonical sentence strategy in the course of language processing. In this paper, we explore the question of whether or not monolingual Korean children show any qualitative difference from bilingual children. Our experimental data provide consistent results showing that there is no qualitative difference between bilingual and monolingual Korean-speaking children. That is, both bilingual and monolingual Korean-speaking children use processing strategies for comprehending RCs. Hence, a more appropriate question is the quantitative difference between bilingual and monolingual children. J. S. Jun (2001) show that Korean-American children do better for ORel at age 5; O'Grady et al. (1996) show that bilingual children do better for ORel even at ages 6 to 7. Our present study suggests some quantitative difference; in our study, monolingual children resort to the canonical sentence strategy up to age 4. Although the difference between age 4 (in our study) and age 5 and above (in earlier works) looks like a dramatic quantitative, if not qualitative, difference, we need a more careful study to draw any significant conclusion.

We still do not understand why children do better for SRel in some studies, and do better for ORel in other works. One reason that immediately comes to our mind is the experimental format. Most classical studies that confirm the accessibility hierarchy (i.e. better SRel) have adopted the act-out task format, where children are asked to ack out with toy dolls what they just heard. On the other hand, O'Grady et al. (1996), J. S. Jun (2001), and our current work have all adopted the picture-cued comprehension paradigm.

A number of problems have been pointed out about the act-out task format (Correa, 1995). Here, we want to point out a problem that has something to do with perspective maintenance (cf. MacWhinney, 1982). When children are asked to act out for a sentence *The dog that t hit the cow did such and such things*, they first pick up a dog, hit a cow with the dog in hand, and then do some more action with the dog still in their hands. There is no perspective shift; i.e. they do not change the animal in their hands. On the other hand, when children are asked to act out for a sentence *The dog that the cow hit t did such and such things*, they first pick a cow, hit a dog with the cow in hand, lay down the cow, pick up the dog, and then do some more action with the dog in their hands. The perspective shift, or simply the change of animals, involved in ORel sentences in the classical act-out task would increase processing load for subject children. The sentence structure of Korean is different from that of English: in Korean, RCs precede the head noun, whereas in English RCs follow the head nouns. The act-out task in some sense hides this obvious difference in the sentence structure between Korean and English by imposing an unexpected perspective shift in the course of sentence processing. A more elaborate study is needed to control for the difference in experimental formats. This makes up a list of our future research questions with other important topics we have raised in this paper.

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