Processing Empty Subject Sentences among Japanese Children

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There is a kind of lexical information called "control information", which determines how a particular verb influences the interpretation of the subject of infinitival (and gerundive) complements. Consider the following examples adapted from Chomsky (1981).

(1) a. $John_i$ promised Bill [PRO_i to feed himself].

b. *$Mary_i$ promised Bill [PRO_i to feed himself].

(2) a. John persuaded $Bill_i$ [PRO_i to feed himself].

b. *John persuaded $Mary_i$ [PRO_i to feed himself].

In (1a), the subject of the verb *promise* is assumed to be the understood subject of the infinitival clause, while in (2a) the object of the verb *persuade* is considered the understood subject of the infinitival clause. At the subject position of the infinitival clause, Chomsky (1981) posited the empty category PRO, which is an abstract syntactic element with no phonetic content. PRO must establish a relationship with an antecedent in order to acquire its meaning. This coreference is determined by a relationship called "control". When PRO appears in an infinitival complement clause, one of the arguments in the matrix clause must be understood as its antecedent (controller). Whether the controller is the subject or the object of the matrix clause depends on the intrinsic lexical properties of that verb. The ungrammatical versions (1b) and (2b) show clearly that *promise* is a subject control verb and *persuade* is an object control verb.

Two views have been proposed in previous studies on the processing of empty subject (PRO) sentences. "Recency strategy", which is a kind of "perceptual strategy", suggests that a parser fills the gap with the nearest filler (cf. Frazier et al., 1983). On the other hand, "transparency hypothesis" suggests that a parser fills the gap by referring to some linguistic clue (cf. Sakamoto, 1996, 2002).

Zhai (2012) clarified the empty subject sentence processing of elementary school students in China. The first-grader participants in the elementary school, who had not acquired the matrix verbs and had relatively low cognitive ability, preferred using "recency strategy" (the nearest filler, Zhai, 2012, pp. 99-100) to fill the empty subject. That is, perceptual strategy (i.e., non-linguistic strategy) was utilized at the earlier stage of language development. Both linguistic strategy and perceptual strategy were utilized in a mixed way in second, third, and fourth grader participants whose linguistic and cognitive ability were more advanced than first-grader participants. The fifth-grader participants used the control information on the verb to process the sentence. Thus, this shows that verb control information (linguistic strategy) becomes available at a later stage of language development. Zhai (2012) claimed that parsing strategies shift from perceptual strategy to linguistic strategy along with the development of linguistic knowledge, and referred to this proposal as the "Developmental Shift of Parsing Strategies (DSPS)" hypothesis (Zhai, 2012, p. 104).

If the DSPS hypothesis is a universal hypothesis, it should be applicable to other languages. Chinese noun phrases have no case-marking system that signifies their grammatical relations with the verb. Due to the lack of case information, one could argue that the parser is allowed to use "perceptual strategies" solely based on distance information at the stage when the matrix verb has not been acquired. Since the matrix verb is indispensable in identifying the empty subject, if the verb is not known to (not acquired by) the participants, there is a possibility that the perceptual information may become the most important information.

In contrast, Japanese is a language that uses case-marking particles. Case particles are added to the end of noun phrases. Even at a stage where the lexical properties of the matrix verb have not yet been acquired, it is possible that the parser uses the information provided by the case-marking particles. "Perceptual strategy" that separates parsing (sentence processing) from the representation of the grammar and linguistic knowledge explains the process of parsing by using more general cognitive concepts, such as position or number. However, the "transparency hypothesis" suggests that the parser and the properties of the grammar can *refer to* each other. If a Japanese child uses information of case-marking particles, one can suggest that the parser and the grammar can *refer to* each other. In this case, observing the DSPS hypothesis becomes impossible. Since the use of case-marking particles is not considered a non-linguistic strategy, the shift from a non-linguistic strategy to a linguistic strategy cannot be verified.

On the other hand, consider the case in which children disregard information of case particles, and use distance as high priority information. It is possible that the "perceptual strategy" is too strong for the parser to *see* the grammar. That is, the parser will need more effort to process the sentence at a lower level of cognitive ability. This causes the bypassing of available grammatical information and the high priority of cognitive strategy. In this case, the DSPS hypothesis can be observed.

The intervention of case particles makes the processing of Japanese empty subject sentences more complicated. Whether the parser uses the case particle may yield different results from Chinese. It is therefore interesting to see whether the DSPS hypothesis applies to the processing of Japanese empty subject sentences among elementary school children.

PREVIOUS STUDIES

Empty subject processing of Japanese adults (Oda et al. 1997, Ninose et al. 1998)

Oda et al. (1997) used the experimental sentences in (3) to examine the real-time processing of empty subject sentences in Japanese. A sentence was presented to one ear of a participant, and after the onset of the sentence, a possible antecedent for the empty subject was presented to the other ear. There were 6 test points, each with a 300msec interval. The participants were asked whether or not the given antecedent would really go to Tokyo, by pressing the "YES" key or "NO" key as quickly as possible. Here, Zhai introduced the comparison between the reaction times of the subject control sentences and object control sentences in the case of "YES" responses at 0msec (i.e., right after the end of presentation of the sentence).

(3) a. Subject control

$Tosio_1$-ga	kinoo	$Junko_2$-ni	[PRO_1	Tokyo	iki]-o
Tosio-NOM	yesterday	Junko-DAT		Tokyo	going-ACC
tegami-de	hakuzyoosita.				
letter-by	confessed				

'Yesterday, Tosio confessed to Junko by a letter that he would go to Tokyo.'

b. Object control

$Tosio_1$-ga	kinoo	$Junko_2$-ni	[PRO_2	Tokyo	iki]-o
Tosio-NOM	yesterday	Junko-DAT		Tokyo	going-ACC
tegami-de	meireisita.				
letter-by	ordered				

'Yesterday, Tosio ordered Junko by a letter that she would go to Tokyo.'

The mean reaction time of subject control sentences such as (3a) was significantly faster than object control sentences like (3b). Oda et al. (1997) conclude that the results show a "subject preference" effect: the grammatical subject is preferred as the candidate for the empty subject.

These results suggest that the parser prefers the subject as a possible antecedent. The subject might be the preferred antecedent because it has the grammatical function as a "subject". However, this may not be the only possible way to explain the results because the subject is the first noun phrase at the beginning of a sentence. It is plausible that what the parser prefers as a possible antecedent for the empty subject is indeed the first noun phrase, since it is at the beginning of the sentence. In general, the one that exists in the sentence beginning is said that prominence is high. This effect is called "primacy effect". The following section introduces an experiment that resolves this issue. In order to examine the word order effect, Ninose et al. (1998) conducted an experiment employing the same procedure as that of Oda et al. (1997), except that the order of the subject and object in the sentence was reversed. The experimental sentences are shown in (4). The results showed that the reaction times for subject control sentences such as (4a) were significantly faster than object control sentences like (4b). Subject control sentences had a significantly higher consistency score than object control sentences.

(4) a. <u>Subject control</u>

Junko$_2$-ni	kinoo	Tosio$_1$-ga	*trace*$_2$	[PRO$_1$	Tokyo	iki]-o
Junko-DAT	yesterday	Tosio-NOM			Tokyo	going-ACC
tegami-de	hakuzyoosita.					
letter-by	confessed					

b. <u>Object control</u>

Junko$_2$-ni	kinoo	Tosio$_1$-ga	*trace*$_2$	[PRO$_2$	Tokyo	iki]-o
Junko-DAT	yesterday	Tosio-NOM			Tokyo	going-ACC
tegami-de	meireisita.					
letter-by	ordered					

The findings show that "subject preference" exists even when the order of the subject and object in the matrix clause is scrambled. Thus, as the results of the two recognition experiments indicate, regardless of the scrambling of word order, the participants tend to prefer the matrix clause subject as a possible antecedent for the empty subject.

EXPERIMENT ON JAPANESE CHILDREN

Experimental Design

The experimental sentences are shown below[1]. Japanese script with Kana and Kanji were used in the actual experiment. The matrix verb *ibatta* "boasted" in (5a, c) is a subject control verb, while the matrix verb *susumeta* "persuaded" in (5b, d) is an object control verb. The verbs used for the

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[1] I am deeply thankful to Kumagami, M., appreciate her cooperation of the experimental sentences making.

experimental sentences (ten subject control verbs and ten object control verbs[2]) were chosen from a textbook used in the elementary school of Fukuoka, Japan, where the participants were recruited. (5a, b) take the "subject – object" word order, and (5c, d) take the "object – subject" word order. Thus, the experiment design is 2 (verb types) × 2 (word orders).

(5) a. SOV order, Subject control sentence

P1 P2 P3 P4 P5

けんじくん$_1$が/きのう/まりさん$_2$に/[PRO$_1$ パソコンを かう]ことを/いばった。

Kenji-kun$_1$-ga kinoo Mari-san$_2$-ni [PRO$_1$ pasokon-o kau] koto-o ibatta.

Kenji-NOM yesterday Mari-DAT computer-ACC buy fact-ACC boasted

'Yesterday, Kenji boasted to Mari that he would buy a personal computer.'

[Question sentence] けんじくんが パソコンを かいます。

Kenji-kun-ga pasokon-o kaimasu

Kenji-NOM computer-ACC buy

'Kenji will buy a personal computer.'

b. SOV order, Object control sentence

けんじくん$_1$が/きのう/まりさん$_2$に/[PRO$_2$ パソコンを かう]ことを/すすめた。

Kenji-kun$_1$-ga kinoo Mari-san$_2$-ni [PRO$_2$ pasokon-o kau] koto-o susumeta.

Kenji-NOM yesterday Mari-DAT computer-ACC buy fact-ACC persuaded

'Yesterday, Kenji persuaded Mari to buy a personal computer.'

[Question sentence] まりさんが パソコンを かいます。

Mari-san-ga pasokon-o kaimasu

Mari-NOM computer-ACC buy

'Mari will buy a personal computer.'

c. OSV order, Subject control sentence

まりさん$_2$に/きのう/けんじくん$_1$が/[PRO$_1$ パソコンを かう]ことを/いばった。

Mari-san$_2$-ni kinoo Kenji-kun$_1$-ga [PRO$_1$ pasokon-o kau] koto-o ibatta.

Mari-DAT yesterday Kenji-NOM computer-ACC buy fact-ACC boasted

'Yesterday, Kenji boasted to Mari that he would buy a personal computer.'

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[2] Ten subject control verbs: ibaru (boast); chikau (swear); damaru (silent); happyousuru (announce); jimansuru (proud); ayamaru (apologize); yakusokusuru (promise); kokuhakusuru (confess); houkokusuru (report); soudansuru (consult)

Ten object control verbs: yurusu (pardon); motomeru (request); youkyusuru (postulate); iraisuru (beg); shijisuru (instruct); susumeru (persuad); nozomu (desire); meireisuru (order); kyouseisuru (importune); tanomu (appeal)

[Question sentence] けんじくんが　パソコンを　かいます。

Kenji-kun-ga　pasokon-o　kaimasu

Kenji-NOM　computer-ACC　buy

'Kenji will buy a personal computer.'

d. OSV order, Object control sentence

まりさん$_2$に/きのう/けんじくん$_1$が/[PRO$_2$ パソコンを かう]ことを/すすめた。

Mari-san$_2$-ni　kinoo　Kenji-kun$_1$-ga　[PRO$_2$　pasokon-o kau]　koto-o susumeta.

Mari-DAT　yesterday　Kenji-NOM　computer-ACC buy　fact-ACC persuaded

'Yesterday, Kenji persuaded Mari to buy a personal computer.'

[Question sentence] まりさんが　パソコンを　かいます。

Mari-san-ga　pasokon-o　kaimasu

Mari-NOM　computer-ACC　buy

'Mari will buy a personal computer.'

Twenty pairs of experimental sentences like (5), which consisted of four conditions (SOV word order vs. OSV word order; subject control vs. object control), were used, making a total of eighty sentences. Latin square method was adopted in this experiment. The eighty experimental sentences were divided into four lists. This was to ensure that only one condition from each pair was presented to each participant. Each list was composed of fifty-two sentences including twenty experimental sentences, twenty filler sentences, six practice sentences and six warm-up sentences. Experimental and filler sentences were presented with a random order in the list.

Apparatus and Procedure

Eighty participants from the first to fifth grade (sixteen participants in each grade) participated in this experiment. All participants were native Japanese speakers studying in elementary school. All participants had normal or corrected eyesight.

The experiment was conducted with LinguaLab running on a CX/835LS Dynabook notebook computer. Each trial consisted of two parts, namely the self-paced reading task and the comprehension task. In the self-paced reading task, participants were asked to read sentences in a moving window. The sentence was chunked into phrases. One phrase was displayed at a time. Participants were instructed to press the "Space" key on a standard keyboard at the beginning of each trial. A "★" sign appeared to signal the beginning of a sentence. Participants were told to press the same space key immediately after they had finished reading the text on the screen. Once the key was pressed, the moving window would move rightward, so that the previous chunk would disappear from the screen and the next chunk would show up. All sentences ended with a full stop mark (。). The comprehension task was to start once the full stop mark had been read. A YES/NO question about the subject control sentence, like "*Kenji will buy a personal computer*", and a question about the object control sentence, like "*Mari will buy a personal computer*" were displayed in the middle of the screen. A subject control sentence was always followed by a "correct" sentence in which the subject of the control sentence was also the subject of the question sentence. In the same way, an object control sentence was always followed by a "correct" sentence in which the object of the control sentence was the object of the question sentence. Participants were instructed to respond to the questions using either the YES or NO key.

Following the on-line tasks, the participants were asked whether they knew the subject/object control verbs used in the experiments. This off-line experiment was carried out after the on-line experiment. Table 1 shows the results of the off-line experiment. There are five subject control verbs and five object control verbs in one list. Since there are sixteen participants in this experiment, the total number of subject control verbs is eighty (5 verbs × 16 participants), and that of object control verbs is also eighty (5 verbs × 16 participants).

Table 1: Number of acquired verbs (AV) and unacquired verbs (UV)

	First Grade		*Second Grade*		*Third Grade*		*Fourth Grade*		*Fifth Grade*	
	AV	UV	AV	UV	AV	UV	AV	UV	AV	UV
Subject control verb	33	47	44	36	68	12	75	5	80	0
Object control verb	17	63	20	60	37	43	57	23	73	7
Total	50	110	64	96	105	55	132	28	153	7

PREDICTIONS

From the result of the off-line experiment (Table 1), it is known that the acquisition level of the experimental verbs (such as *ibatta* and *susumeta*) is low in the lower classes (first graders 50/160=31.3% and second graders 64/160=40%). In the third and fourth grades, the ratio of matrix verb acquisition is more than 50% (third graders 105/160=65.6% and fourth graders 132/160=82.5%). Fifth graders had almost acquired all control information of the experimental verbs (153/160=95.6%). When lexical information on the verb had not been acquired, nothing could be done on the judgment of PRO. Participants have to employ some strategies to "guess" the sentence. Three strategies can be raised.

・perceptual strategy: recency strategy →an empty subject is filled with the nearest filler

・perceptual strategy: primacy strategy →an empty subject is filled with the filler at the beginning of the sentence

・linguistic strategy: case-maker *ga* preference →the case-marker *ga* is preferred by the participants because of its prominence

When the participants read the experimental sentences with an acquired matrix verb, the correct rate should be high. It is predicted that empty subject sentences with an acquired matrix verb are processed in a manner similar to adults, who can classify the sentence type correctly.

In the empty subject sentence processing studies (Oda *et al.* 1997, Ninose *et al.* 1998) that used the same "recognition task" on adult participants, a "subject preference" effect (the grammatical subject is preferred as the candidate for the empty subject) was shown. Thus, if the participants use the control information from the matrix verb as good as adults, the empty subject would be filled by the subject initially. When the matrix verb is shown, re-analysis would be needed if the matrix verb is an object control, but not for a subject control verb. Due to this reanalysis, the reading times (RTs) of the object control verbs should be longer than that of subject control verbs.

RESULTS AND DISCUSSION

First grade

Table 2: Questions and YES/NO responses by first graders on unacquired verbs in SOV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, distant filler)	31 (66%)	16 (34%)	47
NP2 (*Mari-san*, *ni*-object, recent filler)	30 (48%)	33 (52%)	63
total	61	49	110

(Fisher's exact test: $.05 < p < .10$)

Table 3: Questions and YES/NO responses by first graders on unacquired verbs in OSV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, recent filler)	35 (74%)	12 (26%)	47
NP2 (*Mari-san*, *ni*-object, distant filler)	36 (57%)	27 (43%)	63
total	71	39	110

(Fisher's exact test: $.05 < p < .10$)

Table 2 shows a significant tendency between responses given to subject control sentence questions and object control sentence questions (Fisher's exact test, n=110, p=0.0805). Although the preferential bias for NP1 (*Kenji-kun*) is found among first graders, the difference only shows a significant tendency, and do not reach a significant difference. At first glance, it may seem that first graders employed no strategies to process the sentences. However, the first graders in Japan are older than the first graders in China for seven months (the average age of first graders in China is 6.11, while the average age of first graders in Japan is 7.6). Moreover, first graders have better knowledge of matrix verbs and higher cognitive ability than the first graders in China. It is appropriate to think that first graders did employ some strategies to "guess" the sentences.

The above results confirm the prediction that first graders would use either the recency strategy, primacy strategy, or the nominative information of case-marker *ga*. Recency strategy enhances the NP2 (*Mari-san*) preference, while the case-maker *ga* and the primacy strategy makes NP1 (*Kenji-kun*) more salient. Competition between the two resulted in an insignificant difference between the YES/NO responses. The strategies employed in first grade for the SOV word order are shown below.

(6) Strategies used by first graders for unacquired verbs in SOV order:

a. perceptual strategy: recency strategy + perceptual strategy: primacy strategy

b. perceptual strategy: recency strategy + linguistic strategy: case-maker *ga* preference

Table 3 shows a significant tendency of difference between responses given to subject control sentence questions and object control sentence questions (Fisher's exact test, n=110, p=0.0716). As discussed above, the first graders in Japan are older than the first graders in China for seven months. Moreover, first graders have better knowledge of matrix verbs and higher cognitive ability than the first graders in China. It is appropriate to think that first graders did employ some strategies to "guess" the sentences.

From above results, first graders might have employed both "recency strategy + primacy strategy", where recency strategy strengthened NP1 preference and primacy strategy enhanced NP2 preference. Also, "primacy strategy + case-maker *ga* preference" could be another possibility, because case-maker *ga* preference could have promoted the NP1 preference while the primacy strategy enhanced NP2 preference. The strategies employed in first grade for the OSV word order are shown below.

(7) Strategies used by first graders for unacquired verbs in OSV order:

a. perceptual strategy: recency strategy + perceptual strategy: primacy strategy

b. perceptual strategy: primacy strategy + linguistic strategy: case-maker *ga* preference

The strategies used by first graders in the SOV and OSV word orders are shown below.

(8) perceptual strategy: recency strategy + perceptual strategy: primacy strategy

Second grade

Table 4: Questions and YES/NO responses by second graders on unacquired verbs in SOV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, distant filler)	25 (69%)	11 (31%)	36
NP2 (*Mari-san*, *ni*-object, recent filler)	26 (43%)	34 (57%)	60
Total	51	45	96

(Fisher's exact test: $p<.05$)

Table 5: Questions and YES/NO responses by second graders on unacquired verbs in OSV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, recent filler)	26 (72%)	10 (28%)	36
NP2 (*Mari-san*, *ni*-object, distant filler)	28 (47%)	32 (53%)	60
Total	54	42	96

(Fisher's exact test: $p<.05$)

In both the SOV and OSV word orders, the ratio of YES NP1 in subject control sentence questions (SOV word order: 69%; OSV word order 72%) is higher than the ratio of YES NP2 in object control sentence questions (SOV word order 43%; OSV word order 47%), and the ratio of NO NP2 in object control sentence questions (SOV word order 57%; OSV word order 53%) is higher than the ratio of NO NP1 in subject control sentence questions (SOV word order 31%; OSV word order 28%). The result of YES responses shows NP1 (*Kenji-kun*) preference, which is a direct indication that supports the case-maker *ga* preference or primacy strategy. On the other hand, the result of NO responses also shows NP1 (*Kenji-kun*) preference, which is an indirect and secondary indication that supports the case-maker *ga* preference or primacy strategy. Therefore, it seems that the case-maker *ga* or primacy strategy, but not the recency strategy, has become prominent at this stage. The strategies used by second graders in the SOV and OSV word orders are shown below.

(9) i) perceptual strategy: primacy strategy

ii) linguistic strategy: case-maker *ga* preference

Third grade

Table 6: Questions and YES/NO responses by third graders on unacquired verbs in SOV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, distant filler)	9 (75%)	3 (25%)	12
NP2 (*Mari-san*, *ni*-object, recent filler)	23 (53%)	20 (47%)	43
total	32	23	55

(Fisher's exact test: p=.2085, n.s.)

Table 7: RTs of acquired verbs (per mora and per character) in SOV order

	mora			*character*		
	S-control verb	O-control verb		S-control verb	O-control verb	
Third grade	185ms	304ms	$t_{(12)}$=3.7, p<.05	222ms	350ms	$t_{(12)}$=2.4, p<.05
Fourth grade	292ms	308ms	$t_{(15)}$=.62, p=.547 n.s.	359ms	386ms	$t_{(15)}$=.88, p=.393 n.s.
Fifth grade	220ms	250ms	$t_{(15)}$=1.41, p=.179 n.s.	275ms	319ms	$t_{(15)}$=1.3, p=.206 n.s.

Table 8: Questions and YES/NO responses by third graders on unacquired verbs in OSV order

response / *subject NP of question sentence*	*YES*	*NO*	*total*
NP1 (*Kenji-kun*, *ga*-subject, recent filler)	10 (83%)	2 (17%)	12
NP2 (*Mari-san*, *ni*-object, distant filler)	23 (53%)	20 (47%)	43
total	33	22	55

(Fisher's exact test: .05<p<.10)

Table 9: Percentage of correct answers for acquired verbs in OSV order

	Third Grade	*Fourth Grade*	*Fifth Grade*
Subject control sentence	52/68=76.5%	55/75=73.3%	64/80=80%
Object control sentence	20/37=54.1%	35/57=61.4%	46/73=63.0%
t test	$t_{(15)}$=3.0, p<.01	$t_{(15)}$=.78, p=.446 n.s.	$t_{(15)}$=2.7, p<.05

From the results of the SOV word order (Table 7), in which the RTs of subject control verbs are shorter than those of object control verbs (185ms : 304ms; 222ms : 350ms), third graders might have employed "case-maker *ga* preference", "primacy strategy" or "subject preference". These factors make third graders fill the empty subject with NP1 at first, but when the matrix verb is input, re-analysis resulted in longer RTs for object control verbs. When they "guessed" sentences with unacquired verbs, third graders might have employed "recency strategy + primacy strategy" or "recency strategy + case-maker *ga* preference".

From the results of the OSV word order (Table 9), the higher percentage of correct answers in subject control sentences show that third graders used "subject preference" when they processed sentences with acquired verbs. On the other hand, when they "guessed" sentences with unacquired verbs, third graders might have employed "recency strategy + primacy strategy" or "primacy strategy + case-maker *ga* preference".

From the results of the SOV and OSV word orders, third graders use a combination of "case-maker *ga* preference", "primacy strategy" and "subject preference" when the sentences included an acquired verb, and use the "recency strategy" and "primacy strategy" when the sentences included an unacquired verb. In Japanese, matrix verb appears at the end of the sentence, it works to checking the strategies used in the sentences. In other words, the strategies used at the stage before the matrix verb is input should be consistent, regardless of whether the matrix verb is acquired or not. Because the ratio of acquired matrix verbs by the third graders is high, it is necessary to focus mainly on the strategies of the acquired matrix verbs. Thus, the possibility that the third graders use the "case-maker *ga* preference", "primacy strategy" or "subject preference" is high. The strategies used by third graders in the SOV and OSV word orders are shown below.

(10) i) perceptual strategy: primacy strategy
ii) linguistic strategy: case-maker *ga* preference
iii) linguistic strategy: subject preference

Fourth grade

From the results of the SOV word order (Table 7), it is not clear what strategies are used. Based on the results of the RTs of matrix verbs in the OSV word order (Table 10), "subject preference" is seen in the fourth graders. However, this effect only showed up in the results for the characters, and had only a significant tendency in mora. The strategy used by fourth graders in the SOV and OSV word orders is shown below.

(9) linguistic strategy: subject preference-[3]

Table 10: RTs of acquired verbs (per mora and per character) in OSV order

	mora			*character*		
	S-control verb	O-control verb		S-control verb	O-control verb	
Third grade	228ms	240ms	$t_{(12)}$=.48, p=.638 n.s.	274ms	291ms	$t_{(12)}$=.24, p=.816 n.s.
Fourth grade	309 ms	383 ms	$t_{(15)}$=1.8, p=.088 .05<p<.10	376 ms	478 ms	$t_{(15)}$=2.3, p<.05
Fifth grade	215 ms	304 ms	$t_{(15)}$=2.3, p<.05	265 ms	387 ms	$t_{(15)}$=2.2, p<.05

Fifth grade

Table 11: Percentage of correct answers for acquired verbs in SOV order

	Third Grade	*Fourth Grade*	*Fifth Grade*
Subject control sentence	48/68=70.6%	61/75=81.3%	64/80=80%
Object control sentence	21/37=56.8%	41/57=71.9%	49/73=67.1%
t test	$t_{(15)}$=1.7, p=.107 n.s.	$t_{(15)}$=1.3, p=.201 n.s.	$t_{(15)}$=2.3, p<.05

In the SOV and OSV word orders (Table 11, Table 9), the higher percentage of correct answers shows that the fifth graders could answer the questions correctly. From the higher percentage of correct answers in subject control sentences, fifth graders are deemed to use "subject preference" to

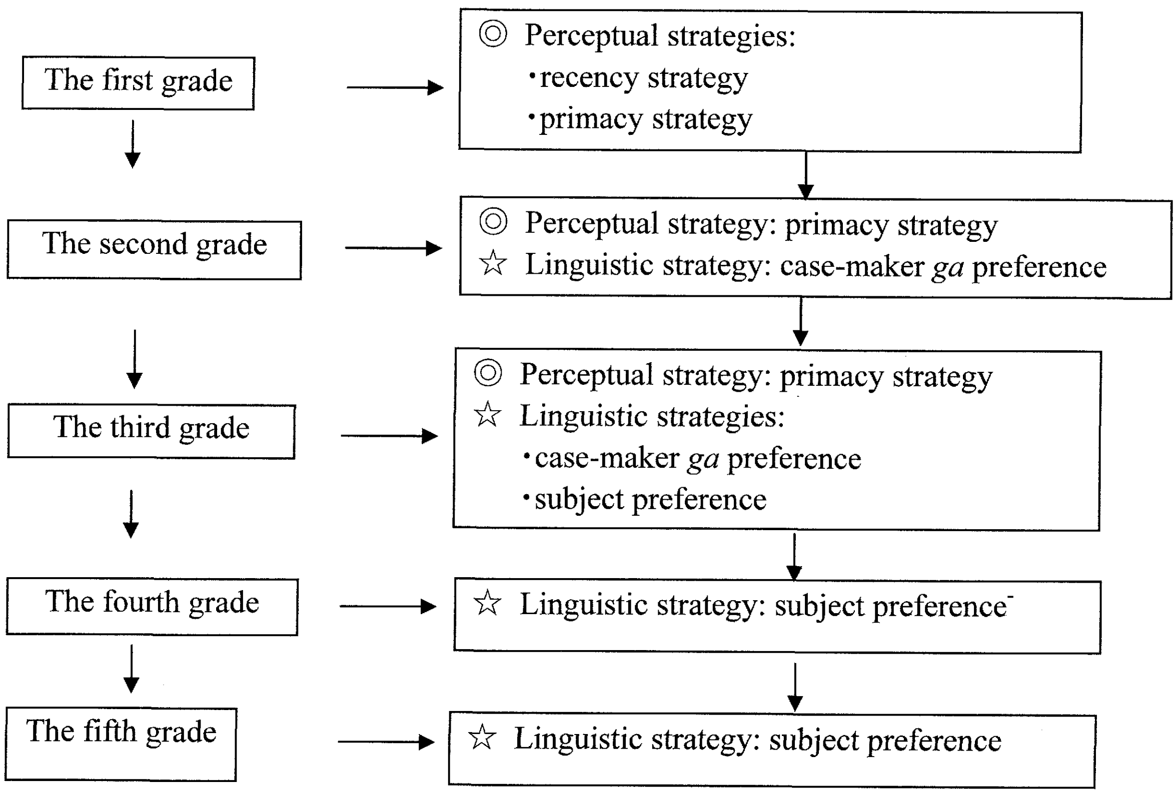
[3] These strategies are called linguistic strategies, but are not strategies used by adults.

process the sentence. This is further verified in the RTs of the matrix verbs (Table 7, Table 10). Unfortunately, "subject preference" is only observed in the OSV word order, but not in the SOV word order. Since the parsing cost is higher for the OSV word order than the SOV word order, there is no room to process both at the same time when the matrix verb is input in the OSV order. This explains why the "subject preference" effect easily became prominent. The strategy used by fifth graders in the SOV and OSV word orders is shown below.

(10) linguistic strategy: subject preference

CONCLUDIND REMARKS

Graph 1: The results of L1 Japanese



From the results of SOV word order and OSV word order, it is clear that first grade elementary school children, who had not acquired the meaning of matrix verbs and had relatively lower cognitive ability, preferred the use of the "recency strategy" and "primacy strategy" to fill the empty subject. That is, non-linguistic, general-purpose strategies are utilized at the earlier stage of language development. For second graders, whose cognitive ability is a little more advanced than the first graders, the primacy strategy, but not the recency strategy, and a "linguistic strategy" (i.e., "case-maker *ga* preference") became prominent. Also, we point out the possibility that with the increase in memory capacity, the effect of primacy may become more pronounced. Third graders, whose linguistic ability and cognitive ability are more advanced than the lower graders, are able to use the primacy strategy instead of the recency strategy to process the sentence. Both non-linguistic strategy (i.e., "primacy strategy") and linguistic strategies (i.e., "case-maker *ga* preference", "subject preference") are utilized in a combined way. The fourth graders, who have acquired more matrix verbs than the third graders, are found to use "subject preference". The fifth graders, who have acquired the most matrix verbs, show the same parsing strategy, i.e., "subject preference," as the adults. The strategies used at different verb acquisition levels are shown in Graph1.

This results support that the DSPS hypothesis applies to the processing of Japanese empty subject sentences among elementary school children.

If the DSPS hypothesis is a universal hypothesis, it should be observed in second language acquisition as well. Second language learners, unlike grade-schoolers, are well developed in their cognitive ability. It would be interesting to know whether "perceptual strategies" would be used when the second language learners process sentences with unacquired matrix verbs. What causes the use of "perceptual strategies": the lower cognitive ability or insufficient linguistic knowledge? If results differ between first language learners and second language learners, what would be the cause of this difference? Is it due to influences by their first language?

If the DSPS hypothesis is a universal hypothesis, second language learners with high cognitive abilities but low proficiency may tend to use general strategies, such as the "recency strategy" or "primacy strategy", similar to a child who is acquiring first language, while those with higher proficiency will tend to employ more linguistic strategies in comprehension. Future research may continue to test the DSPS hypothesis in different settings.

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