英語の数(不)一致に対する日本人英語学習者のオンライン敏感度における単数/複数の非対称性

Singular/Plural Asymmetry in Japanese EFL Learners' On-line Sensitivity to English Number Dis/agreement

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Abstract

This study examined Japanese EFL learners' on-line sensitivity to an L2 English property that is not found in their L1 Japanese: subject-verb number agreement. A self-paced reading experiment demonstrated that they were more sensitive to number dis/agreement when the singular subject was followed by the plural *be*-verb (*were*) than when the plural subject was followed by the singular *be*-verb (*was*). Furthermore, a follow-up experiment suggested a possibility of proficiency effects on L2 sensitivity. We discuss two possible points of view for the reason why an asymmetrical L2 sensitivity was observed: the number featural specifications of the subject and the *be*-verb and markedness of number (i.e., unmarked singularity versus marked plurality).

Keywords — subject-verb number agreement, singular/plural asymmetry, Japanese EFL learners, on-line parsing, self-paced reading

1. Introduction

The goal of this study[1] is to investigate whether second language (L2) learners are sensitive to an L2 property that is not found in their first language (L1). Our focus is on Japanese EFL (English as a foreign language) learners' sensitivity to English number agreement as in (1a-b).

(1) a. One apple was/*were in the box.
b. Two apples were/*was in the box.

In English, the subject and the following verb have to agree in terms of number (e.g., singular in (1a) and plural in (1b))[2]. As we can see in (2a-b) corresponding to the English counterparts in (1a-b), subject-verb number agreement is not observed (at least, on the surface forms) in Japanese (Kuno 1973; Kuroda 1988; among others).

(2)[3] a. Ikko-no ringo-ga hako-no naka-ni *aru*.
one.CL apple-Nom box in-Loc is
b. Niko-no ringo-ga hako-no naka-ni *aru*.
two.CL apple-Nom box in-Loc is

Then, how do Japanese EFL learners deal with such grammatical information in L2 English, especially in their real-time processing?

2. Earlier Studies on L2 Sensitivity

There are a number of studies investigating whether L2 learners whose L1s lack number agreement are sensitive to such information in L2 English by comparing their responses to such a pair of grammatical and ungrammatical sentences as in (3a-b) (the star indicates the ungrammaticality).

(3) a. The bridges to the island were about ten miles away.
b. *The bridge to the island were about ten miles away.
(Jiang 2004: 615)

It has been demonstrated that native speakers of English show on-line sensitivity to number-agreement

[1] Portions of this study were presented at J-SLA2012 at Hosei University on June 2, 2012, and at TL&MAPLL2012 at Yamagata University on July 22, 2012. We thank invaluable comments from the audiences at both of them.

[2] As for ordinary main verbs, number agreement exists only in the third person singular subject in the present tense (e.g., *John likes/*like apples*.).

[3] CL stands for a classifier, Nom for a Nominative Case marker, and Loc for a Locative Case marker.

violations as in (3b) but most of the L2 learners do not, although both groups are able to make off-line grammaticality judgments with respect to number agreement (e.g., Jiang 2004; Ojima *et al*. 2005; Chen *et al*. 2007; Sato & Felser 2010).

Wen *et al*. (2010) argued that the linear or structural distance between an agreement-triggering element (e.g., the subject) and an element to be agreed with it (e.g., the following verb) affected the experimental results. They pointed out that the L2 speakers showed sensitivity to number dis/agreement only when those two elements were adjacent to each other (for the exceptional results, cf. Sato & Felser 2010). To focus on the linear distance effect, Wen *et al*. (2010) examined L2 sensitivity to number dis/agreement within such a single NP (Noun Phrase) as in (4a-d).

(4) a. Jill sold this$_{[sg]}$ beautiful house$_{[sg]}$ to her niece every evening.
b. *Jill sold this$_{[sg]}$ beautiful houses$_{[pl]}$ to her niece every evening.
c. Jill sold these$_{[pl]}$ beautiful houses$_{[pl]}$ to her niece every evening.
d. *Jill sold these$_{[pl]}$ beautiful house$_{[sg]}$ to her niece every evening.
(Wen *et al*. 2010: 450, $_{[sg/pl]}$ added)

A word-by-word self-paced reading experiment showed that both the native English speakers and the Chinese-speaking and Japanese-speaking advanced learners were sensitive to number disagreement, whereas the intermediate learners were not. Interestingly, in both groups of the native speakers and the advanced learners, an asymmetry in the degrees of sensitivity was found depending on the number marking of the demonstrative and the following noun. In particular, they exhibited a stronger sensitivity when the singular demonstrative was followed by the plural noun as in (4b) compared to the reversed relation as in (4d).

3. The Present Study

The purpose of the present study is to examine whether Japanese EFL learners show such an asymmetrical pattern of sensitivity in subject-verb number agreement that is never found in their L1 Japanese. Notice that number agreement within a single NP, which was examined by Wen *et al*. (2010), is partially observed in Japanese[4], while number agreement in the subject-verb relation as in (1a-b) is never observed in Japanese (see (2a-b)). Given that in Japanese there is no equivalent (at least, overtly) property to subject-verb number agreement in English, then how do Japanese EFL learners process it? To investigate this research question, the present study conducted an on-line experiment.

3.1. Method

Participants

Thirty-two undergraduates at the University of Tokyo were paid to participate in the experiment. They were 24 males and eight females, and their mean age was 19.43 years old (SD = 0.87). Their proficiency level was estimated by a single TOEFL grammar test (extracted from Sharpe 2001), and their mean score was 14.40 out of 20 points (one point for one question) (SD = 3.32) (72.0% in percentage terms).

Materials

Twenty-four sets of the target sentences as in (5a-d), counterbalanced into four lists, were used with 48 filler sentences.

(5) R1 / R2 / R3 / R4 / <u>R5</u> / R6 / R7
a. The principal / saw / the students' teacher$_{[sg]}$ / who / was$_{[sg]}$ / relaxing / on the bench. (SG-SG)
b. *The principal / saw / the students' teacher$_{[sg]}$ / who / were$_{[pl]}$ / relaxing / on the bench. (*SG-PL)
c. The principal / saw / the student's teachers$_{[pl]}$ / who / were$_{[pl]}$ / relaxing / on the bench. (PL-PL)
d. *The principal / saw / the student's teachers$_{[pl]}$ / who / was$_{[sg]}$ / relaxing / on the bench. (*PL-SG)

[4] In Japanese, number agreement exists between the demonstrative and the following noun as in *kono inu* 'this dog' for one dog and *korera-no inu(-tati)* 'these dog(s)' for more than one dog (cf. Kuno's (1973) discussion that *-tati* in Japanese and *-s* in English are functionally different). Thus, it is conceivable that the L2 sensitivity to number agreement found in Wen *et al*. (2010) might have been affected by the learners' L1 characteristics.

As in (5a-d) above, the un/grammaticality was manipulated by number dis/agreement between the head noun and the following *be*-verb of relative clauses[5]. The experiment adopted 2x2 condition design (Singular/Plural (Number of the head noun and the following *be*-verb) x Match/Mismatch (Matching in number between the head noun and the following *be*-verb)). The resulting four conditions will be referred to as Singular-Singular Match (SG-SG) as in (5a), Singular-Plural Mismatch (*SG-PL) (an asterisk means number mismatch) as in (5b), Plural-Plural Match (PL-PL) as in (5c), and Plural-Singular Mismatch (*PL-SG) as in (5d), in order to clarify the number marking of the head noun and the following *be*-verb in each condition.

Procedure

A phrase-by-phrase, non-cumulative, moving-window, self-paced reading task[6] (controlled by Linger) was conducted individually in a soundproof chamber (the slashes in (5a-d) indicate segmentation). First, the participant received the oral/written experimental instructions. He/She was told about the inclusion of some ungrammatical sentences in the experiment (the ratio of ungrammatical sentences was 25% (18 out of 72 sentences), which was not informed to him/her). After the eight practice trials for the participant's familiarization with the PC procedure for self-paced reading, the main 72 trials were administered (the stimulus presentation was randomized by Linger for each participant). Each sentence for self-paced reading was followed by a corresponding comprehension question, e.g., for (5b), as in (6)[7].

(6) The principal saw the teacher.
1) correct 2) incorrect
3) ungrammatical

In (6), the expected answer was *ungrammatical* because of the ungrammaticality of (5b)[8]. There were no time limits for the participant's self-paced reading and answering the questions, nor feedback for his/her responses to the questions. Immediately after the self-paced reading task, a background questionnaire and then a TOEFL grammar test were conducted. Each participant took approximately 45 minutes to finish the experiment.

Data treatment

The participants were screened by their accuracy for the twelve comprehension questions accompanied with the corresponding distracter sentences[9]. If the participant's accuracy was below 65%, he/she was not included in further analyses. There were no such participants, and their mean accuracy was 85.67% (SD = 9.28). The raw reading time (RT) data were trimmed as follows. First, absolute cutoffs were applied for each region to exclude erroneous data points (R in (5a-d) stands for a Region of interest for RT, and for R3, for example, absolute cutoffs were shorter than 200ms or longer than 6500ms). Then, the data points shorter/longer than each participant's mean RT plus/minus 3SD were replaced with these cutoff values. (Less than 6% of the data were affected by this

[5] In this paper, we treat the head noun of relative clauses as subject in the sense of subject-verb number agreement.
[6] See Just *et al*. (1982) for a self-paced reading technique.
[7] The intension for why the comprehension question was not interrogative but rather affirmative was to measure the time of the participant's self-paced reading as naturally as possible, for example, without his/her paying too much attention to answering such a question as "Is the sentence that you read ungrammatical?" by using his/her metalinguistic knowledge. As for the three possible choices as in (6), however, notice that the metalinguistic term, *ungrammatical*, was used. The participants were instructed to choose *in/correct* if the sentence for self-paced reading was in/consistent with the content of the question sentence for comprehension or *ungrammatical* if the sentence for self-paced reading was ungrammatical.
[8] Although the sentence in (5b) is consistent with the content of the question sentence in (6), the instruction required the participants to choose *ungrammatical* when the sentence for self-paced reading was ungrammatical.
[9] This means that in the following the reading time data of the target items were analyzed irrespective of the participants' responses to the accompanied questions. The reason for why only the 12 questions were used for participant screening was that those questions were easy to answer without any confusion, compared to the other 60 questions accompanied with the target and other filler sentences (comprehension accuracy of the 60 questions was relatively low (around 60%) probably because of the comprehension question with three possible choices (in particular, *ungrammatical*) leading to the participants' confusion for answering it).

trimming). After the data trimming, a series of 2x2 (Singular/Plural (Number) x Match/Mismatch (Matching)) repeated-measures ANOVAs were performed for the mean RT in each region. The rationale was that the participant's longer RT in the underlined, critical R5 in mismatch sentences as in *SG-PL (5b) and *PL-SG (5d) compared to their match controls as in SG-SG (5a) and PL-PL (5c) would indicate his/her sensitivity to number dis/agreement.

3.2. Results

Figure 1[10] summarizes the mean RTs by condition (the solid lines stand for grammatical SG-SG as in (5a) and PL-PL as in (5c) with black triangle and white square plots, respectively, and the broken lines for ungrammatical *SG-PL as in (5b) and *PL-SG as in (5d) with black triangle and white square plots).

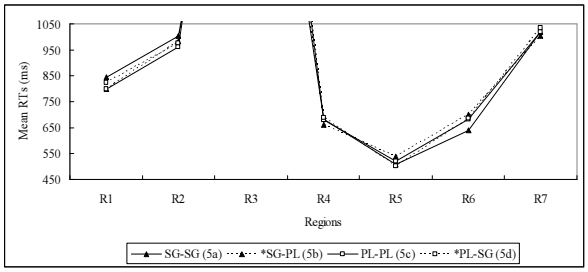

Figure 1: Mean RTs by Condition

Because of the length, the mean RTs in R3 are separately presented in Figure 2 (the black bars stand for grammatical SG-SG and ungrammatical *SG-PL, and the white bars for grammatical PL-PL and ungrammatical *PL-SG).

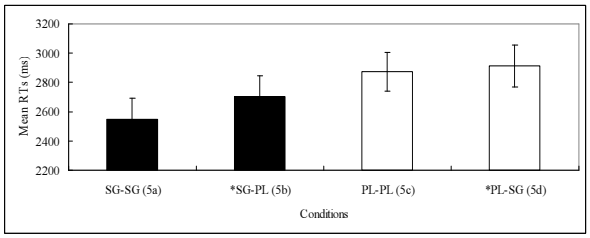

Figure 2: Mean RTs in R3

In the first four regions except for R3, there were no reliable RT differences among the four conditions (all *Ps* > .05) (there was a main effect of Number (*F1*(1,31) = 10.52, *P* < .01; *F2*(1,23) = 10.88, *P* < .01) in R3 but its interaction with Matching was not significant (*Ps* > .05)[11]). The results of RT in the critical R5 and the following R6 are summarized in Figures 3 and 4 (the black bars for SG-SG and *SG-PL and the white bars for PL-PL and *PL-SG).

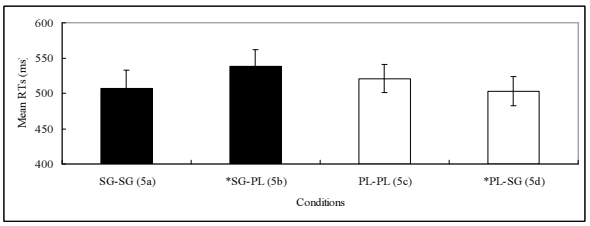

Figure 3: Mean RTs in the Critical R5

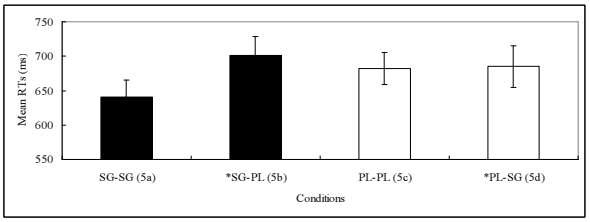

Figure 4: Mean RTs in R6

In the critical R5, there were no main effects of Matching and Number (all *Ps* > .05), but the interaction between them was almost significant (*F1*(1,31) = 3.77, *P* = .061; *F2*(1,23) = 4.24, *P* = .051). In the following R6, there was a main effect of Matching in the item analysis (*F1* (1,31) = 2.23, *P* > .05; *F2*(1,23) = 4.29, *P* < .05), and its interaction with Number was marginal (*F1*(1,31) = 3.22, *P* = .082, *F2*(1,23) = 3.43, *P* = .076) (no main effect of Number was observed (*Ps* > .05)). In the last R7, there was no significant RT difference among the conditions (all *Ps* > .05).

Given that the interaction between Matching and Number was almost significant in the critical R5 and marginal in the following R6, the subsequent pairwise

[10] In the following Figures, (5a-d) indicate examples of the four conditions (i.e., SG-SG, *SG-PL, PL-PL, and *PL-SG).

[11] Note that in R3 the lexical items were different in the four conditions due to the Genitive Case marker and the plural morpheme (i.e., *'s* and *-s*). Since no reliable RT difference was found among the conditions in the following R4, it is not unreasonable that we treat the RT data from R4 independently of the RT difference in R3.

comparisons were performed for the mean RTs in R5 and R6 in match and mismatch sentences. In the critical R5 (Figure 3 above), the RT difference was marginal in the subject analysis between SG-SG and *SG-PL (507ms vs. 538ms ($F1$(1,31) = 3.13, P = .086; $F2$(1,23) = 2.60, P > .05)) but not significant between PL-PL and *PL-SG (521ms vs. 503ms (Ps > .05)). In the following R6 (Figure 4 above), the RT difference was significant between SG-SG and *SG-PL (641ms vs. 701ms ($F1$(1,31) = 4.86, P < .05; $F2$(1,23) = 7.55, P < .05)) but not so between PL-PL and *PL-SG (692ms vs. 685ms (Ps > .05)).

3.3. Discussion

The mean RT difference between SG-SG (e.g., *teacher ... was* as in (5a)) and *SG-PL (e.g., **teacher ... were* as in (5b)) was marginal in the critical R5 but significant in the following R6. That can be considered as a spill-over effect from the previous R5 because the same lexical items were used in R6. This is not an unusual pattern of data, as spill-over effects are observed in native speakers of English in self-paced reading studies on on-line sensitivity to subject-verb number agreement (e.g., Jiang 2004). Recall that there were no reliable RT differences in both R5 and R6 between PL-PL (e.g., *teachers ... were* as in (5c)) and *PL-SG (e.g., **teachers ... was* as in (5d)). Thus, the experimental results suggest that the Japanese EFL learners were sensitive to English subject-verb number dis/agreement when the singular head noun was followed by the plural *be*-verb but not when the plural head noun was followed by the singular *be*-verb. In other words, we observed an asymmetry in their L2 sensitivity in English depending on the combination between the number marking of an agreement-triggering subject and that of a *be*-verb to be agreed with it.

4. A Follow-up Experiment

To find out a possibility of proficiency effects on L2 sensitivity, a follow-up experiment was conducted with a new group of Japanese-speaking learners who were more heterogeneous in terms of their proficiency levels in English than those in the main experiment.

4.1. Method

Thirty-nine undergraduates at Gunma University were recruited to take part in the follow-up experiment. The materials, procedure, and data treatment were the same as used in the main experiment. What was new in the follow-up experiment was the administration of an off-line, paper-and-pencil questionnaire to elicit the participants' responses to the comprehension questions accompanied with the target 24 and filler 24 sentences. Those responses were used for participant screening, which excluded three participants for further analyses. The remaining 36 participants were 17 males and 19 females, their mean age was 20.25 years old (SD = 0.84), and their mean score on the TOEFL grammar test was 13.44 out of 20 points (SD = 2.70) (67.2 % in percentage terms).

4.2. Results

In Figure 5, the mean RTs are summarized for each condition.

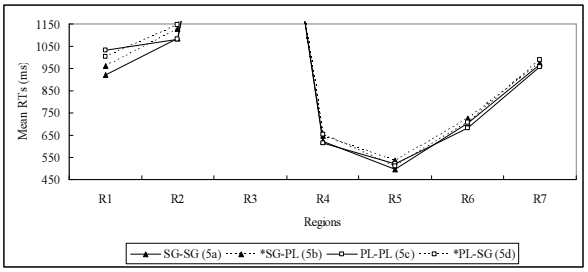

Figure 5: Mean RTs by Condition (Follow-up Exp.)

Figure 6 displays the mean RTs in R3 separately because of their length.

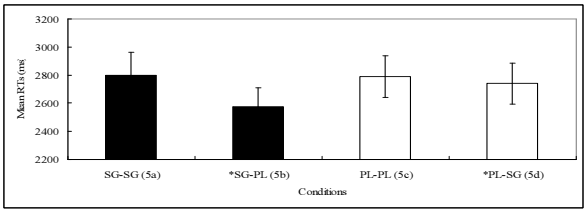

Figure 6: Mean RTs in R3 (Follow-up Exp.)

In the first four regions except for R1, no reliable

differences in the mean RT were observed among the four conditions (all *Ps* > .05) (there was a main effect of Number in R1 (*F1*(1,35) = 5.92, *P* < .05; *F2*(1,23) = 8.306, *P* < .01), but its interaction with Matching was not significant (*Ps* > .05)[12]). Figure 7 summarizes the results of RT in the critical R5.

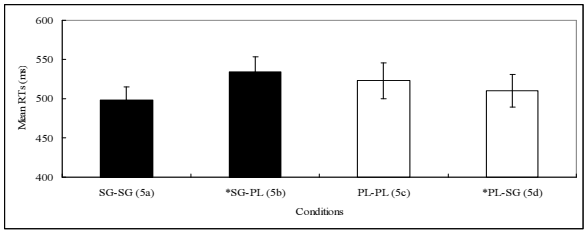

Figure 7: Mean RTs in the Critical R5 (Follow-up Exp.)

In the critical R5, there were no main effects of Matching and Number (all *Ps* > .05), but the interaction between them was marginal (*F1*(1,35) = 3.10, *P* = .086; *F2*(1,23) = 3.08, *P* = .092). The results of the subanalyses for R5 between match and mismatch conditions will be reported below. The RT difference was almost significant in the subject analysis between SG-SG and *SG-PL (498ms vs. 534ms (*F1*(1,35) = 3.90, *P* = .055; *F2*(1,23) = 2.24, *P* > .05)). On the other hand, no significant RT difference was found between PL-PL and *PL-SG (523ms vs. 510ms (*Ps* > .05)). In R6 and R7, there were no reliable RT differences among the conditions (all *Ps* > .05).

To examine proficiency effects on L2 sensitivity, the correlation between the RT difference (in the mean RT in the mismatch sentences minus that in their match controls for each participant) and each participant's score on the grammar test was examined for the critical R5 by using both data of the main and follow-up experiments. A weak correlation was found in SG-SG and *SG-PL (*r* = .217, *P* = .074), whereas there was no reliable correlation at all in PL-PL and *PL-SG (*r* = .012, *P* > .05).

[12] The reason for the RT difference in R1 was unclear. However, no reliable RT difference was found in the following R2 and thus we treat the RT data from R2 as unaffected by the RT difference in R1.

4.3. Discussion

In this follow-up experiment, no spill-over effect was observed. However, the RT difference in the critical R5 was marginal between SG-SG (e.g., *teacher ... was* as in (5a)) and *SG-PL (e.g., **teacher ... were* as in (5b)) but not significant between PL-PL (e.g., *teachers ... were* as in (5c)) and *PL-SG (**teachers ... was* as in (5d)). This indicates a (weaker but) similar tendency to that observed in the main experiment. That is, it appears that the Japanese EFL learners were sensitive to subject-verb number dis/agreement when the singular subject (in reality, the head noun of relative clauses) was followed by the plural *be*-verb but not when the plural subject was followed by the singular *be*-verb.

Furthermore, a marginally significant positive correlation was found between each participant's RT difference in the critical R5 in SG-SG and *SG-PL, not in PL-PL and *PL-SG, and his/her score on the grammar test. This leaves a possibility that Japanese EFL learners' on-line sensitivity to subject-verb number agreement in L2 English, which is never found in their L1 Japanese, is in fact modulated by their proficiency levels in English[13]. In other words, L2 sensitivity could be stronger as the learner's proficiency in the target language becomes higher.

5. General Discussion

Compare Wen *et al.*'s (2010) experimental results as in (7) with the present study's results as in (8).

(7) Wen *et al.*'s (2010) Results of Number Agreement within a Single NP
a. *this$_{[sg]}$ … houses$_{[pl]}$ (as in (4b))
b. *these$_{[pl]}$ … house$_{[sg]}$ (as in (4d))
L2/L1 Sensitivity Strength: a > b

(8) The Present Study's Results of Subject-verb Number Agreement
a. *teacher$_{[sg]}$ … were$_{[pl]}$ (as in (5b))
b. *teachers$_{[pl]}$ … was$_{[sg]}$ (as in (5d))
L2 Sensitivity Strength: a > b

[13] Note that in the present study the participants' proficiency was estimated by a single TOEFL grammar test.

The comparison may imply that the asymmetrical sensitivity is a phenomenon to be observed in number agreement in general in English (i.e., both in the demonstrative-noun relation as in (7a-b) above and in the subject-verb relation as in (8a-b)[14]). Since the present study dealt with only *be*-verbs for subject-verb number agreement, a question remains as to whether an asymmetrical sensitivity is observed for number agreement between the subject and the ordinary main verb (i.e., third person singular *-s*). Wakabayashi *et al*. (2007) examined in an ERP (Event-Related Potentials) study Japanese speakers' sensitivity to the un/grammaticality of the following sentences[15]:

(9) a. The teachers$_{[pl]}$ *answers$_{[sg]}$/answer$_{[pl]}$ our questions.
b. My mother$_{[sg]}$ *answer$_{[pl]}$/answers$_{[sg]}$ your question.
(Wakabayashi *et al*. 2007: 26, $_{[sg/pl]}$ added)

Their ERP study demonstrated that the native English speakers showed sensitivity (i.e., P600) to the un/grammaticality of (9a-b), whereas the Japanese speakers did not. However, whether the native speakers exhibit the same pattern of asymmetry in (9a-b) is not discussed. Ojima *et al*. (2005) (using ERPs) and Sato & Felser (2010) (using self-paced reading) also examined Japanese speakers' sensitivity to subject-verb number agreement using sentences such as (10) and (11) below.

(10) The turtles$_{[pl]}$ *moves$_{[sg]}$/move$_{[pl]}$ slowly.
(Ojima *et al*. 2005: 1224, $_{[sg/pl]}$ added)

(11) He$_{[sg]}$ frequently *yawn$_{[pl]}$/yawns$_{[sg]}$.
(Sato & Felser 2010: 109, $_{[sg/pl]}$ added)

Although both studies showed the Japanese-speaking learners' on-line sensitivity, whether such sensitivity differs depending on the combination of the number features is unclear because both studies adopted only two conditions for number agreement ([pl] – *[sg]/[pl] in (10) and [sg] – *[pl]/[sg] in (11)).

Putting aside number agreement between the subject and the ordinary main verb (see Section 6 below), it appears that sensitivity becomes stronger if an agreement-triggering element is singular and an element to be agreed with it is plural as shown in (7) and (8). Why do we observe such an asymmetrical pattern of L2(/L1) sensitivity? There are two possible sources for the asymmetry in sensitivity: the number marking of (i) an agreement-triggering element (e.g., the demonstrative in (7a-b) and the subject in (8a-b)) and (ii) an element to be agreed with it (i.e., the noun in (7a-b) and the *be*-verb in (8a-b)). In the following, we consider the characteristics of the Japanese EFL learners' L1 Japanese and discuss featural specifications and markedness of number in relation with those two sources.

As exemplified in Japanese (2a-b) above with the English counterparts (1a-b), subject-verb number agreement in L2 English is not observed in Japanese-speaking learners' L1 Japanese. Thus, it is hard to consider our experimental results as a transfer effect of their L1 knowledge in L2 processing[16]. Then, what caused such an asymmetrical sensitivity to subject-verb number agreement observed in the present study as in (8a-b)? First, the featural specifications of number (i.e., singular or plural)

[14] Recall that, as in (i), the present study treated the head noun and *be*-verb of relative clauses as subject and verb in the sense of subject-verb number agreement and manipulated the number marking of agreement-triggering NP2 and *be* to be agreed with it.

(i) R1 / R2 / R3 / R4 / R5 / R6 / R7
Matrix Subject / Matrix V(erb) / NP1's NP2$_{[sg/pl]}$ / who / be$_{[sg/pl]}$ / V-ing / Prepositional Phrase

In the following, *subject-verb* number agreement refers mainly to subject-*be*-verb number agreement.

[15] Although Wakabayashi *et al*. (2007) used (9b) for person agreement rather than number agreement, both of (9a-b) can be discussed in terms of number agreement as specified in them (note that *answer*, not *answers*, can be used for the singular subject like *I* and *you*).

[16] See Wakabayashi *et al*. (2007). Based on an ERP study, they discuss that Japanese speakers are sensitive to the violations of subject-verb person agreement in L2 English because such agreement exists in Japanese (e.g., *Watasi/Anata/Kare-ga (watasi-ni) sore-o kureta. "*I/You/He gave it (to me)"), while they are insensitive to the violations of subject-verb number agreement in L2 English because such agreement is absent in Japanese (e.g., (2a-b) above).

marked on the subject and the *be*-verb seem to yield an asymmetrical sensitivity as in (8a-b). Depending on the combination of the featural specifications, sensitivity to subject-verb number agreement would become stronger or weaker. Second, markedness of number may account for the asymmetrical sensitivity. "It is generally accepted that the singular is the unmarked number as compared to the plural" (Corbett 2000: 17). In terms of markedness, the asymmetrical sensitivity can be described as follows: sensitivity is stronger when the unmarked singular element is followed by the marked plural element as in (8a) compared to the reversed relation as in (8b).

From the markedness perspective, the studies of a phenomenon called agreement attraction may be insightful. As for production, Eberhard (1997, Experiments 1 and 2) showed that the error rate was higher in such a preamble as *The key$_{[sg]}$ to the cabinets$_{[pl]}$* (the rate was 65 out of 121 (i.e., 53.71%)) compared to such a preamble as *The keys$_{[pl]}$ to the cabinet$_{[sg]}$* (the rate was 11 out of 811 (i.e., 13.58%)). That is, it was demonstrated that the native English speakers were likely to produce correctly plural *be*-verb (*were*) for *The keys$_{[pl]}$ to the cabinet$_{[sg]}$* when the unmarked singular modifier (i.e., *the cabinet*) intervened between the subject and the verb, but to produce incorrectly plural *be*-verb (*were*) for *The key$_{[sg]}$ to the cabinets$_{[pl]}$* when the marked plural modifier (i.e., *the cabinets*) interfered. For comprehension of agreement attraction, Pearlmutter *et al*. (1999, Experiment 3) examined native English speakers' sensitivity to the following set of sentences (only the relevant parts are presented):

(12) a. The key$_{[sg]}$ to the cabinet$_{[sg]}$ was rusty
b. The key$_{[sg]}$ to the cabinets$_{[pl]}$ was rusty
c. The keys$_{[pl]}$ to the cabinets$_{[pl]}$ were rusty
d. The keys$_{[pl]}$ to the cabinet$_{[sg]}$ were rusty
(Pearlmutter *et al*. 1999: 455, $_{[sg/pl]}$ added))

In word-by-word self-paced reading, the processing difficulty was observed at the *be*-verb position between (12a-b) but not between (12c-d). (12b) ([sg] – [pl]) was more difficult to read than (12a) ([sg] – [sg]), whereas (12d) ([pl] – [sg]) was not different in processing difficulty from (12c) ([pl] – [pl])[17]. Thus, both in production and comprehension for agreement attraction, markedness of number seems to be involved in processing of number agreement[18].

A possible generalization to be verified in future research is that the processing difficulty in subject-verb number agreement would be higher when the unmarked singular is followed by the marked plural than when the marked plural is followed by the unmarked singular. The reason for why there is such a difference in processing difficulty may be related to some subset relation attributed to markedness of number[19]. Plurality includes the notion of singularity, but not vice verse. Thus, it is possible that the subset-superset (PL-SG) relation might be tolerate for processing (i.e., can be insensitive to or ignored) but the superset-subset (SG-PL) relation might not. Notice that markedness of number or the singular/plural distinction is available to Japanese speakers (cf. fn. 3), however, the singular/plural distinction is not overt in subject-verb number agreement in the Japanese language (see (2a-b) above). Hence, the experimental results presented in the current study may suggest that the Japanese EFL learners acquired the singular/plural distinction for subject-verb number agreement absent in their L1 Japanese and thus showed an asymmetrical sensitivity to the violations of subject-(*be*-)verb number agreement in L2 English by using their L1

[17] In (12c-d) the processing difficulty was found at *rusty*, but the pattern was opposite to (12a-b). That is, (12c) was more difficult than (12d), which is discussed in terms of some discourse effects (see Pearlmutter *et al*. 1999: 448-449).

[18] The experimental stimuli used in the present study may be considered as an interesting case of agreement attraction (see (5a-d)). Notice that the number marking of the two nouns (e.g., *the student's* and *the teacher*) that constitute the head of relative clauses does not match in number and thus causes agreement attraction as in (12b-c).

[19] See Eberhard's (1997: 162-163) account referring to the different featural specifications of singular and plural: The marked plural possesses an additional feature that is absent in the unmarked singular and thus processing the marked plural yields an extra processing load.

knowledge of markedness of number.

6. Concluding Remarks

This study found an asymmetry in the Japanese EFL learners' on-line sensitivity to subject-(*be*-)verb number agreement in L2 English. Based on Wen *et al*.'s (2010) findings, it seems that L2 learners' on-line sensitivity to English number agreement is modulated by the number marking of an agreement-triggering element (e.g., the subject for the following verb) and an element to be agreed with it (e.g., the noun for the preceding demonstrative).

Which of those two elements or what combination of them in terms of number causes an asymmetrical sensitivity is an intriguing question for future research. To narrow down the possible factors for the above-reported asymmetrical sensitivity, the following should be considered. In this study, we examined subject-verb number agreement in relative clauses. In the relative-clause environment, for example, there is a processing load related to movement for the formation of a relative clause, and the relative-clause boundary makes the subject (i.e., head noun) and verb structurally distant, although not so distant linearly. Thus, there remains a possibility that such peculiarities of a relative clause itself might have affected the participants' real-time performance. In future research, it is worth investigating whether such an on-line, asymmetrical sensitivity as observed in this study is found even in subject-verb number agreement in a variety of other environments such as the main clauses and questions. Moreover, the head noun treated as subject in this study was within a complex NP like *the students' teacher*, and consequently the processing of the Genitive Case marker might also have affected the participants' performance. In further research, a single NP rather than a complex NP should be used as subject for subject-verb number agreement. Possible examples of subject-verb number agreement to be examined are like (13) and (14) with *be*-verbs and like (15) and (16) with ordinary main verbs[20].

(13) a. The teacher$_{[sg]}$ was$_{[sg]}$ relaxing on the bench. (SG-SG)
b. *The teacher$_{[sg]}$ were$_{[pl]}$ relaxing on the bench. (*SG-PL)
c. The teachers$_{[pl]}$ were$_{[pl]}$ relaxing on the bench. (PL-PL)
d. *The teachers$_{[pl]}$ was$_{[sg]}$ relaxing on the bench. (*PL-SG)

(14) a. Was$_{[sg]}$ the teacher$_{[sg]}$ relaxing on the bench? (SG-SG)
b. *Were$_{[pl]}$ the teacher$_{[sg]}$ relaxing on the bench? (*SG-PL)

(15) a. The teacher$_{[sg]}$ relaxes$_{[sg]}$ on the bench. (SG-SG)
b. *The teacher$_{[sg]}$ relax$_{[pl]}$ on the bench. (*SG-PL)

(16) a. Does$_{[sg]}$ the teacher$_{[sg]}$ relax on the bench? (SG-SG)
b. *Do$_{[pl]}$ the teacher$_{[sg]}$ relax on the bench? (*SG-PL)

To examine whether an asymmetrical sensitivity is limited to the relative-clause environment or to the complex NP subject, the following examples would be also worth investigating (a single NP for the head noun in (17) and a complex NP for the subject in (18) and (19) with *be*-verbs and in (20) and (21) with ordinary main verbs).

(17) a. The principal saw the teacher$_{[sg]}$ who was$_{[sg]}$ relaxing on the bench. (SG-SG)
b. *The principal saw the teacher$_{[sg]}$ who were$_{[pl]}$ relaxing on the bench. (*SG-PL)

(18) a. The students' teacher$_{[sg]}$ was$_{[sg]}$ relaxing on the bench. (SG-SG)
b. *The students' teacher$_{[sg]}$ were$_{[pl]}$ relaxing on the bench. (*SG-PL)

[20] To exclude subject-verb person agreement as in personal pronouns like *I* and *you* (cf. Wakabayashi *et al*. 2007), the subjects in the examples are limited to the third-person nouns because for ordinary main verbs only the third person singular subject requires the agreement morpheme *-s* in the present tense context (cf. fn. 2). Out of the four conditions as in (13), only two conditions like (13a-b) are presented from (14). Notice that in questions as in (14) and (16) *SG-PL should be considered as *PL-SG as shown by $_{[sg/pl]}$. Note that, for ordinary main verbs as in (15) and (16), the verb without the third person singular morpheme *-s* (e.g., *relax*, not *relaxes*) can be used for the singular subject like *I* and *you* (cf. fn. 15). Although in the examples the subject and the verb are adjacent, it is interesting to observe sensitivity when an adverb intervenes between them to make them non-adjacent (cf. Bannai 2011).

(19) a. Was$_{[sg]}$ the students' teacher$_{[sg]}$ relaxing on the bench? (SG-SG)
b. *Were$_{[pl]}$ the students' teacher$_{[sg]}$ relaxing on the bench? (*SG-PL)

(20) a. The students' teacher$_{[sg]}$ relaxes$_{[sg]}$ on the bench. (SG-SG)
b. *The students' teacher$_{[sg]}$ relax$_{[pl]}$ on the bench. (*SG-PL)

(21) a. Does$_{[sg]}$ the students' teacher$_{[sg]}$ relax on the bench? (SG-SG)
b. *Do$_{[pl]}$ the students' teacher$_{[sg]}$ relax on the bench? (*SG-PL)

A possible predication is as follows: Sensitivity would be higher in unmarked-marked *SG-PL than in marked-unmarked *PL-SG (note that, in questions as in (14b), (16b), (19b), and (21b), the order of unmarked SG and marked PL is linearly reverse (i.e., *PL-SG rather than *SG-PL, as shown by $_{[sg/pl]}$) for parsing, and thus that some difference in sensitivity might be found in the minimal pair of the declarative and interrogative sentences such as (13b) and (14b)). For ordinary main verbs, SG can be morphologically more marked compared to PL because the verbal suffix *-s* is used only for the third person *singular* subject, not for the plural subject. If so, we would observe some difference between *be*-verbs and ordinary main verbs in on-line sensitivity to the violations of subject-verb number agreement.

Another interesting question is whether number-agreement in/sensitivity hinges on the L2 learners' proficiency levels in the target language (English). Recall Wen *et al*.'s (2010) findings that the advanced learners were sensitive to number dis/agreement, while the intermediate learners were not, and that only the advanced learners showed an asymmetry in the degrees of sensitivity as the native speakers did. The present study also suggested a possibility that L2 sensitivity could be stronger as the learner's proficiency becomes higher. To investigate proficiency effects on L2 sensitivity, more heterogeneous groups of learners should be examined.

One final question is whether an on-line asymmetrical sensitivity to subject-verb number agreement in English is specific to L2 learners or generally holds even for native speakers. Wen *et al*. (2010) demonstrated that both the advanced L2 learners and the native speakers showed an on-line asymmetrical sensitivity to number dis/agreement within a single NP (i.e., stronger sensitivity for *SG-PL (e.g., *this ... houses*) than for *PL-SG (e.g., *these ... house*)). Thus, in further research a native control group should be recruited.

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