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Rule-Based or Efficiency-Driven Processing of Expletive *There* in English as a Foreign Language

Research Article

Abstract: Although Native speakers (NSs) of English make plural agreement in preverbal-subject sentences (e.g., *A pen and eraser *is/are…*), previous studies have demonstrated that they prefer singular – not plural – agreement between verbs and conjoined noun phrases (NPs) in expletive *there* constructions (e.g., *there is/are a pen and an eraser…*), showing efficiency-driven processing prioritization of agreement between nearest constituents. This paper assesses whether Japanese L2 learners of English (JLE) show this tendency. The results of two self-paced reading experiments together indicated that even though efficiency-driven processing was available to L2 learners, their use was unstable due to the repeated exposure to *there are* NP_{pl}- and NP_{pl}-type sentences during the task. It seems possible that repeated exposure triggered learners' knowledge that that conjoined NPs are always plural. Hence, it could conceivably be hypothesized that a learner's specific knowledge intervenes the efficiency-driven processing strategy.

Keywords. Number agreement, conjoined NPs, expletive *there*, English, Japanese learners of English

1 Background

1.1 Linguistic descriptions for number agreement, conjoined NP and expletive there-*constructions*

How successfully second language (L2) learners can process number agreement between noun phrases and verbs is a popular research topic (e.g., Foote and Bock, 2012; Jiang 2004, 2007; Jackson et al., 2018; Lim and Christianson, 2015; Sato and Felser, 2010). The complexity of rules behind number agreement and the variability of agreement patterns, even among first language (L1) speakers, make learning it complex (e.g., Bock and Miller, 1991; Bock and Eberhard, 1993; Corbett, 2000). For example, the basic principle of subject-verb agreement is that the grammatical number of the subject(s) controls that of the verb (e.g., rejecting, **They is students* and accepting *They are students*). Number agreement, however, does not always follow this simple rule. An English example of this is in conjoined subjects, where two nouns are coordinated by the conjunction *and*. Generally, in prescriptive linguistics, when the conjoined NP functions as the subject of the sentence (hereafter called SVX sentences), singular agreement is grammatically unacceptable. Plural agreement is grammatical (1ab).

(1a) *A pen and a book is on the desk.

(1b) A pen and a book are on the desk.

However, as Morgan (1984, p.72) pointed out, conjoined NPs sometimes require singular agreement as shown below.

(2a) His aged servant and the subsequent editor of his papers was/were with him at his death bed.

(2b) Pickles and ice cream is/are delicious.

In (2a), if *servant* and *editor* refer to the same person, singular agreement is possible; however, if they refer to two people, the verb should be plural. The same applies to (2b): if *pickles and ice cream* are one combined dish, then the phrase warrants a singular verb, but if it refers to two foods, it warrants a plural verb. The examples shown in (2ab) imply that number agreement in conjoined NPs involves the interpretation of intended meaning. In addition, the problem becomes more complex if the conjoined NPs are used in expletive *there*-constructions (ETCs). In simple ETCs, the verb agrees in number with the following NP, as shown below.

(3a) There is a book on the desk.

(3b) There are two books on the desk.

However, the agreement pattern differs when the following NP is conjoined by *and*. The plural agreement in (4b) does not sound natural to native speakers of English (Milsark, 1979; Morgan, 1984). Rather, the singular agreement in (4a) seems natural, regardless of the plural NP, *a book and a pen*:

(4a) There is a book and a pen on the desk.

(4b) There are a book and a pen on the desk.

Johannessen (1996) takes the stance that singular agreement is driven by syntactic agreement with the first conjunct, while the plural agreement is the cause of semantic agreement. Some other linguists, including Munn (1999), attempted to explain the variability of number agreement in conjoined NPs by presupposing that when subjects follow verbs, such as in the case of English ETCs, then only the first conjunct is 'visible', while when verbs follow subjects (SVX patterns), both the first conjunct and the full conjoined NPs are visible. This way, singular agreement is preferred in the former case while plural agreement and singular agreement are both possible in the latter case (see Lorimor, 2007 for the review of more syntactic approaches to the agreement of conjoined NPs).

In contrast to this theoretical linguistic approach, other researchers attempted to provide an explanation for the number agreement problems from a language processing viewpoint, which will be reviewed in the next section.

1.2 Processing Explanation for number agreement in coordinated constructions

To account for the variability of number agreement in coordinated constructions, two factors have been proposed: linear proximity and processing costs (e.g., Deevy 1999; Schütze 1999; Sobin 1997). The proximity effect is the tendency for number agreement to occur between proximal elements. Sobin (1997) asked native speakers (NSs) of English to rate the acceptability of various sentence structures and found that verbs agreed with the number of the closest NP in ETCs, providing evidence for a proximity effect. Interestingly, this proximity effect was only observed in ETCs, not in SVX sentences. That is, in SVX sentences, NSs of English did not prefer to make singular agreement with the second NP, which was adjacent to the verb (e.g., **A pen and an eraser is*…). Sobin (1997) argues that agreement in ETC is governed by a *grammatical virus*, which is external to the grammar of a language, and it cannot see the number feature of a hierarchically higher position (coordinated NP) and rather checks the number feature of the nearest NP.

However, Schütze（1999) pointed out that looking at the results of Sobin (1997)'s survey, when the second NP is plural, the singular agreement is rated lower than two singular NPs conjoined by *and* (e.g., *There is* NP *and* NP: 3.58 vs. *There is* NP and NPs: 2.86). This pattern was also found in the contracted form (e.g., *There's* NP *and* NP: 4.36 vs. *There's* NP *and* NPs: 3.67). The influence of the number feature of the second NP implies that something in addition to linear proximity influences the number agreement process.

This problem can be solved by Deevy's (1999) explanation, which postulates that after initial agreement-checking between the verb and the first conjunct, the second check of agreement occurs between the full coordinated NP and the verb. According to Deevy, the

second check occurs when parsing the second NP after the coordinating conjunction. This explanation is based on the observation in interrogative sentences such as *were a boy and two girls…?* , which were rated more acceptable than *was two boys and a girl…?*, indicating that the plurality of conjoined NPs plays a role in number agreement. If only the number feature of the nearest NP matters, both sentences would have shown a similar acceptance rate. In other words, although linear proximity has priority in general, the processors can check agreement after the initial agreement process. It should be noted, however, that given the lesser influence of the plurality in conjoined NP in ETCs, Deevy concluded that ETCs do not undergo the second agreement check in the case of NSs.

In terms of processing costs and agreement, L1 psycholinguistic research has accumulated evidence that the human mental sentence processor tries to reduce the processing demand in online sentence processing (e.g., Gibson 1998; Grodner et al., 2002; Haskell and MacDonald 2005). Similarly, O'Grady (2005) maintained that in English ETCs, the sentence processor tends to resolve number agreement as soon as possible rather than holding number information until it processes the whole conjoined NP. That is, as in (4a), NSs of English tend to take an efficiency-driven processing strategy to resolve number agreement rather than computing canonical number agreement.

Corpus studies also provide some support to the agreement mismatches in ETCs (Crawford, 2005; Insua and Martinez, 2003). For example, Insua and Martinez (2003) investigated British National Corpus and found that when the post-verbal NPs are longer because of coordination and post-modification, singular agreement is more likely to be observed. Crawford (2005) also found that non-agreement *there is* patterns can be found not only in informal conversation, but also in formal lectures.[1]

[1] Using the Corpus of Contemporary American English, we compared the frequency of singular and plural agreement in ETC constructions that include conjoined NPs (*there is a* NP *and a* NP vs. *there are a* NP *and a* NP). As a result, we found only two examples of plural agreement (https://www.english-

1.3 Research on L2 sentence processing

In the previous section, we reviewed the previous studies on the number agreement in ETCs and several important factors that play a role in the processing of the language. In previous studies on L2 sentence processing, researchers have investigated how L2 learners process languages differently to L1 speakers, and if there are any differences, what causes of them. One of the most influential hypotheses regarding L2 processing is the Shallow-Structure Hypothesis (SSH), originally proposed by Clahsen and Felser (2006a, 2006b, 2006c) and recently updated by Clahsen and Felser (2018). According to SSH, during online processing in L2, learners underuse syntactic information and instead rely on "semantic, pragmatic, probabilistic, or surface-level information" compared to L1 speakers (Clahsen and Felser, 2018: 694). After the initial proposal in 2006, the SSH extended its scope to morphological processing as well, and argued that L2 learners rely on whole-word lexical processing in cases where L1 speakers use morphological decomposition (e.g., Silvia and Clahsen, 2008). This less robust morphological processing is considered to cause difficulty in processing morphosyntactic information such, as lexical gender and number information. This view is compatible with the morphological insensitivity view proposed by Jiang (2004, 2007). Although Clahsen and Felser (2018) take an agnostic view on L1 influence, Jiang put forward a hypothesis emphasizing the L1's influence on the acquisition of L2 grammar, namely, the Morphological Congruency Hypothesis (MCH): if the learner's L1 does not have grammatical features corresponding to those of the target language, it is more difficult for them to acquire that aspect of the target grammar (Jiang et al., 2011；Jiang et al., 2017). For example, Japanese

corpora.org/coca/?c=coca&q=104077051), while there are more than one hundred examples of singular agreement (https://www.english-corpora.org/coca/?c=coca&q=104077046).

does not have an obligatory number marking system and, therefore, Japanese learners of English (JLEs) have difficulty in acquiring number agreement.

However, there are some cases where JLEs are sensitive to number agreement mismatches, even if their L1 does not have number agreement. For example, Shibuya and Wakabayashi (2008) examined L1-Japanese learners' sensitivity to overuse and omission errors of English 3rd person singular *-s* in a self-paced reading task and revealed that learners were sensitive to the overuse of third person singular morpheme in the case of syntactically marked plural subjects (e.g., **Tim and Paul bakes*…). This implies that JLEs can process conjoined NPs as plural. Moreover, other studies have challenged Jiang's MCH and demonstrated that L2 learners can readily acquire number agreement even if their L1 does not have a corresponding system (Schlueter, Momma, and Lau 2017; Song 2015; Wen et al. 2010).

1.4 L2 processing of coordinated NPs

In section 1.1 we reviewed the two explanations for the number agreement process of conjoined NPs in ETCs. First, as explained by Deevy (1999), the sentence processor does the initial agreement check between the verb and the first conjunct and does the second check between the verb and the whole conjoined NP. The other possibility is based on efficiency-driven processing, according to which, only the initial agreement check occurs, and the plurality of the conjoined NP does not have an impact on the number agreement process (O'Grady 2005).

One important study that investigated whether L2 learners use an efficiency-driven strategy to compute number agreement in ETCs was O'Grady and Yamashita (2002). They looked at number agreement in English disjunctive coordination, conducting a questionnaire survey on singular/plural agreement in both SVX sentences and ETCs. Sentences such as those below were used to see whether singular/plural agreement was influenced by the number of the closest NP.

(4a) An apple or two oranges is/are needed for the salad.

(4b) Two oranges or an apple is/are needed for the salad.

(5a) There is/are a car or two motorcycles in the garage.

(5b) There is/are two motorcycles in the garage.

The study participants were asked to choose which copula, singular or plural, was preferable in each construction. The results indicated that both L2 learners and NSs of English preferred singular agreement if the closest NPs were singular and plural agreement if the closest NPs were plural. Interestingly, this tendency was greater with ETCs, although the overall trend showed that L2 learners of English, like NSs, tended to be influenced by the number features of the conjunct that was closer to the verb. O'Grady and Yamashita concluded that the observed proximity effects in partial agreement were evidence that L2 learners can employ an efficiency-driven processing strategy in the same way NSs do. O'Grady and Yamashita (2002) further insisted that computation of number agreement in conjoined NPs in ETCs occurred at the interface of canonical grammar rules and a processing-driven strategy.

The other study that investigated the availability of efficiency-driven strategy in processing cojoined NPs is Tamura et al. (2021). The results of the offline error correction task demonstrated that in both ETCs and SVXs, L2 learners of English accepted plural agreement sentences and "corrected" singular agreement to plural agreement. However, since it is considered that L2 learners' performance differs in offline and online tasks and that offline task measures metalinguistic knowledge (e.g., Ellis, 2004; Jiang, 2004), Tamura et al. (2021) also carried out a self-paced reading task on ETCs with another group of the participants and compared the results with those of NSs of English. The results showed that L2 learners read faster when they processed the coordinating conjunction *and*, which implied a tendency to employ the second agreement check. Interestingly, NS group did not show the same second agreement check.

The results for L2 learners were incompatible with O'Grady's (2005) efficiency-driven processing account. Moreover, it was found that L2 learners read plural agreement sentences faster than singular agreement ones before processing the second NP, which is evidence of a second agreement check, although, according to Deevy (1999), the second check happened when processing the second NP. In other words, the second agreement check observed in Tamura et al's (2021) self-paced reading experiment seemed to happen earlier than theoretically expected.

One explanation is that, as proposed by SSH, L2 learners did not actually employ syntactic parsing of the coordinated NP, but rather processed the coordinating conjunction lexically and attached plurality to the word itself. Since the coordinating conjunction *and* can be used to connect clauses in addition to NPs, it is possible that the sentence continues as *there is an apple and it is rotten.* In this case, *and* does not bear plurality. The other explanation is that the faster plural reading observed is due to predictive processing, or adaptive processing. According to previous studies, with repeated exposure to a certain syntactic structure, speakers can adopt their syntactic expectations in sentence processing to compute given information efficiently (e.g., Fine et al. 2013). If that is the case, repeated exposure to *there are* NP *and* NP… patterns might make the learners predict that the first conjunct is coordinated even before processing the coordinating conjunction.

1.5 Motivation for the study

Investigating the extent to which L2 learners successfully compute simple agreement between subject NP (either singular or plural) and verb (either singular or plural) in declarative sentences, which is considered to be governed by the canonical grammar rule. Yet this does not fully reveal how they actually process language, given that native English-speakers use not only grammatical knowledge to process language but also a processing strategy that emerges in their observable behavior (O'Grady, 2005). In order to fully understand L2 learners'

sentence processing, we must first understand whether processing is guided by a certain competence that is outside of the learner's grammatical knowledge, as is the case with L1 speakers. Number agreement in ETCs is a good candidate to investigate this interaction of L2 learners' knowledge and processing strategy, for a deeper understanding of L2 processing. Investigating this specific case of number agreement in ETCs can demonstrate that one of the causes of L2 learners' processing behavior that seems different from that of L1 speakers could be their unique, and actually incorrect, application of interlanguage grammar, as suggested by Tamura et al. (2021). Most of the L2 studies that investigate grammatical knowledge, or sentence processing, argue that the differences between L1 and L2 are "failure" or "deficiency" of L2 learners. Nonetheless, what the L2 learners show can be derived from neither failure nor deficiency; rather, the cause may be the processing strategy they employ.

Although Tamura et al (2021) demonstrated that an efficiency-driven processing strategy may not be available to L2 learners, their investigation was still preliminary, given that the sample size was small, and therefore the study has yet to statistically reveal how learners use processing strategies, including predictive processing as Fine et al (2013) pointed out, while engaging in the online task. In addition, given that Tamura et al (2021) did not compare ETCs and SVXs in the self-paced reading task and that their self-paced reading experiment was of a word-by-word version of how the L2 learners process conjoined NPs, there is still uncertainty about how L2 learners process conjoined NPs in different linguistic environments. It is possible that the processing of conjoined NPs differs depending on learners' prior syntactic exposure to other languages and that the second agreement check found in Tamura et al (2021) is a task-effect of word-by-word presentation.

Moreover, even though their results of the offline error correction task suggested that L2 learners process conjoined NPs as plural, regardless of their syntactic position, it is still unclear whether L2 learners process the conjoined NPs syntactically in online processing. Thus, the

present paper attempted to overcome these weakness of Tamura et al (2021) by collecting data from a larger sample size, and used a larger number of test items and compared the processing behavior in ETCs and SVXs in different ways of presentation.

This paper, therefore, attempts to show which of the two, Deevy's (1999) second agreement check or O'Grady's (2005) efficiency-driven processing, can better explain the case of L2 learners' number agreement in ETCs. We report two self-paced reading experiments investigating number agreement in conjoined NPs. The participants were Japanese L2 learners of English. Since their L1 does not have number agreement system, the study offers some important insights into the learning of the processing strategy that is not available in their L1.

2 Experiment 1

The main focus of Experiment 1 is on how L2 learners process the whole conjoined NP. As reported below, a segment-by-segment version of a self-paced reading task (SPRT) was administered, to see whether L2 learners could syntactically process the conjoined NPs in ETCs. Presenting the conjoined NP as a whole (e.g., *a cat and a dog*) rather than presenting it word-by-word (e.g., | a | cat | and | a | dog |) enables us to see the syntactic representation of the whole conjoined NP. Recall that NSs prefer singular agreement even if the conjoined NP is presented as a whole (Sobin 1997; Deevy 1999). Thus, if efficiency-driven processing is available to L2 learners, they will read singular agreement sentences more quickly, even if the conjoined NP is presented as a whole, not word by word.

A related purpose of Experiment 1 is to confirm the influence of repeated exposure to *there are* NP *and* NP… patterns on the processing of number agreement in ETCs. By looking at the interaction between the trial order and the agreement condition, we can see whether the preference toward plural agreement found in Tamura et al (2021) is due to the fact that the participants received input of the plural agreement in ETCs during the experiment. If the exposure is relevant, the reading time differences between singular and plural conditions would

change during the experiment. If not, the reading time tendency would not differ across the experiment.

2.1 Participants

The participants in Experiment 1 were university students.[2] Based on the average TOEIC score, the proficiency level of the participants was approximately B2 on the Common European Framework of Reference. However, to control for the possible effect of learners' English language proficiency on reading time, the TOEIC score was included in the analysis. Table 1 summarizes the information about the participants, including study abroad experience. All participants gave written informed consent before voluntarily participating in the experiment.

[Insert Table 1 here]

2.2 Materials

The test items used in Tamura et al (2021, Experiment 1, offline error-correction task), were also used in Experiment 1 of the current study (see Appendix). The participants were assigned to one of the two counterbalanced lists to which they had not been assigned in Tamura et al (2021, Experiment 1), in order to ensure that they would not see the same items twice. In addition, eight new ETC items and 14 new SVX items, each presented in either a singular or a plural agreement condition, were added. Care was taken to control the vocabulary level of the test items using JACET 8000 (JACET Basic Words Revision Committee 2003) to avoid any interference from difficulty in reading comprehension. The examples of ETC and SVX sentences are presented as (6ab) and (7ab).

[2] The participants were the same as those in Tamura et al (2021, Experiment 1), except only 22 participants who reported their Test of English for International Communication (TOEIC) scores were included in the analysis here. The reason why a subset of the participants was analyzed here was to ensure that the proficiency level of the participants was properly controlled. It should also be noted that since the participants were engaged in the self-paced reading experiment reported here before the error correction task reported in Tamura et al (2021), there is no influence of the previous exposure to the test items in the self-paced reading task.

(6a) There **is** | a cat and a dog | behind the big sofa.

(6b) There **are** | a cat and a dog | behind the big sofa.

(7a) His | wife | and | son | **is** | in | the | cottage | now.

(7b) His | wife | and | son | **are** | in | the | cottage | now.

Distractor items were also added to prevent the learners from noticing the test items – 16 distractors in segment-by-segment reading and 24 in word-by-word reading.[3] In the experiment, all the test items and distractor items were presented randomly. Each participant read 34 ETC items in the segment-by-segment version of the SPRT and 48 SVX items in the word-by-word version of the SPRT. The reason why ETC and SVX items were presented separately was to avoid possible RT increases due to the change of the presented patterns. If segment-by-segment reading repeats several times and suddenly changes to word-by-word reading, the participants would likely change their reading, which could lead to unnecessary variance in the reading times (RTs). All the test items were followed by simple "true or false" comprehension questions. The two types of SPRT were developed using Hot Soup Processor ver. 3.2, a programming language. RT for each region was automatically measured using the computer program.

2.3 Procedures

The experiment was conducted individually with each participant. The participants sat in front of the computer and were given instructions on how to complete the task. They were instructed to read a sentence as quickly, but also as carefully, as possible, because they were not allowed to go back and read the sentence again. They were also informed that they would be asked to

[3] All the distractor items did not include ETCs or SVX patterns of conjoined NPs anywhere in the sentence.

answer a comprehension question after reading the sentence. After they fully understood how to do so, they were required to press a key to read the first sentence, either segment by segment (*there*-constructions) or word by word (SVX sentences). The word-by-word version and the segment-by-segment version were developed and administered separately. The order of the two types of the SPRT were counterbalanced. Taking a short break after the SPRT, the participants engaged in an offline error correction task, the results of which are reported in Tamura et al (2021, Experiment 1).

2.4 Analysis

The RT data were analyzed using generalized linear mixed-effects models (GLMMs), comparing RT differences in the target regions. Since the test items for *there*-constructions were presented segment by segment, the target region was the second region, where the participants encountered the conjoined NP:

There is/are | a cat and a dog | behind the big sofa.

Since the sentence was not presented word by word, we did not take account of the last region, the prepositional phrase, in the analysis, in order to see the spill-over effect, or delayed effect. On the other hand, because of the difficulty of deciding on segments in the case of SVX sentences, those items were instead presented word by word.

His | wife | and | son | $\underline{\text{is/are}}_{t1}$ | in_{t2} | the_{t3} | cottage | now.

The underlined words, forms of the copula *be*, were the target region, and the two following words were set to be the spill-over regions. In order to counterbalance the effect of the reading condition, half of the participants started with the segment-by-segment reading task and the other half with the word-by-word task.

Before the analysis, responses below 200 ms and above M +/- 2.5 SD for each participant in each condition were removed as outliers; in total, 2.5% and 6.8% of the data in the phrase-

by-phrase and word-by-word reading conditions respectively were excluded from further analysis.

After removing the outliers, a series of GLMMs was fitted using R 3.5.1 (R Core Team 2018) and the *lme4* package (Bates et al. 2019). The targeted explanatory variable was agreement condition (singular or plural). Additionally, length of the region (counted as a number of letters), trial order, and the participants' English language proficiency (measured by TOEIC score) were added as covariates. The proficiency score was added to control possible effect derived from differences in proficiency across participants. All covariates were *z*-transformed before being entered into the model to avoid convergence issues. A series of GLMMs with by-item and by-subject random effects was fitted with raw RT data as a response variable; the combination of gamma distribution and identity link function was chosen given that raw RT is a continuous variable greater than zero (Lo and Andrews 2015). Following Linck and Cunnings' (2015) recommendation, the categorical explanatory variable (agreement condition) was contrast coded (sg = -0.5, pl = 0.5).

If adding the interaction term between each of the covariates and the agreement condition improved the model, we added the interaction term (see the R output). Then, we compared models with different random effect structures and adopted the converged model that demonstrated the lowest Akaike Information Criterion (AIC).

2.5 Results

Tables 2 and 3 show the descriptive statistics of the RTs. The mean score on the comprehension questions was 84.67% (*SD* = 6.8%), which confirmed that the participants were engaged in meaning-focused processing during the task. First, we report the results of ETC sentences. The best converged model included all the covariates and the main effect of agreement condition as well as by-subject random intercept and the slope of the agreement condition and by-item random intercept. The main effects of the covariates were all significant

(proficiency: Estimate = -214.35, *SE* = 32.37, *t* = -6.62, *p* < .001; trial order: Estimate = -80.88, *SE* = 27.33, *t* = -2.96, *p* = .003; region length: Estimate = 212.34, *SE* = 51.27, *t* = 4.14, *p* < .001). These main effects indicated that (a) the more proficient participants took less time to respond; (b) the participants took more time to respond to longer phrases, and (c) the responses became faster as the task went on. More important, the main effect of the agreement condition was also significant (Estimate = 115.79, *SE* = 36.47, *t* = 3.18, *p* = .002), which implies that the participants took more time to read singular agreement sentences (e.g., *There is a pen and an eraser…*) than plural agreement sentences (e.g., *There are a pen and an eraser*…).

[Insert Table 2 here]

[Insert Table 3 here]

For SVX sentences, the analytical model for the first target region (the copula) included all four explanatory variables, an interaction term between trial order and agreement condition, and by-subject and by-item intercepts as well as the by-item random slope of the agreement condition. Neither the main effect of region length nor the proficiency score was significant (region length: Estimate = 17.28, *SE* = 13.44, *t* = 1.29, *p* = .20; proficiency: Estimate = -0.56, *SE* = 18.23, *t* = -0.03, *p* = .98). In contrast, a significant main effect of trial order was found (Estimate = -31.96, *SE* = 6.37, *t* = -5.02, *p* < .001), indicating that reading time became faster during task engagement. The main effect of the agreement condition did not reach significance (Estimate = -12.66, *SE* = 23.34, *t* = -0.54, *p* = .59); in other words, the participants did not respond more slowly to the ungrammatical singular agreement between the coordinated NP subject and the singular copula (e.g., **The bride and groom is in front of the church*). The interaction term was also not significant (Estimate = -4.50, *SE* = 12.45, *t* = -0.36, *p* = .72).

The model for the second target region (one word after the copula) included all the explanatory variables as fixed effects and two interaction terms – between trial order and agreement condition and between region length and agreement condition – as well as by-item and by-subject intercepts as random effects. Both the main effect of the trial order and that of region length reached significance (trial order: Estimate = -37.99, *SE* = 5.53, *t* = -6.88, *p* < .001; region length: Estimate = 33.24, *SE* = 8.47, *t* = 3.93, *p* < .001). However, the main effect of proficiency score was not significant (Estimate = -14.11, *SE* = 16.49, *t* = -0.86, *p* = .45), nor was the main effect of agreement condition (Estimate = -16.65, *SE* = 10.85, *t* = -1.53, *p* = .13). The interaction between trial order and agreement condition was also not significant (Estimate = -0.89, *SE* = 10.51, *t* = -0.08, *p* = .93), whereas the interaction between region length and agreement condition was significant (Estimate = 27.45, *SE* = 12.66, *t* = -2.17, *p* = .03). A closer look at this interaction reveals that when word length was longer, the participants took more time to read the grammatical plural agreement condition.

For analysis of the last targeted region, two words after the copula, the model was the same as the one in the second targeted region, except the by-item random slope of agreement condition was included here. Similar to the results for the second target region, both the main effect of trial order and that of word length were significant (trial order: Estimate = -36.13, *SE* = 6.32, *t* = -5.72, *p* < .001; region length: Estimate = 62.96, *SE* = 10.44, *t* = 6.03, *p* < .001); on the other hand, the main effect of proficiency score was not significant (Estimate = -18.15, *SE* = 20.90, *t* = -0.87, *p* = .39), nor was that of agreement condition (Estimate = 21.67, *SE* = 18.89, *t* = 1.15, *p* = .25). The two interaction terms also did not reach significance (agreement by trial order： Estimate = 17.27, *SE* = 11.97, *t* = 1.44, *p* = .20. agreement by region length: Estimate = 26.48, SE = 20.70, *t* = 1.28, *p* = .20).

2.6 Discussion

Overall, the results of Experiment 1 found an asymmetrical processing tendency. For ETCs, the results of Experiment 1 and those of Tamura et al (2021) are compatible, given that in both experiments the participants preferred plural agreement to singular agreement. Surprisingly, no interaction between trial order and agreement condition was found, suggesting that the participants preferred plural agreement not because of repeated exposure to those sentences but because their processor's preference derived from the syntactic representation of the conjoined NP. Taken together, L2 learners processed the conjoined NP as a whole and preferred to make plural agreement with it.

In contrast, although Tamura et al (2021, Experiment 1) found that the participants succeeded in making error corrections in SVXs in the offline task, the participants did not read grammatical plural agreement faster than ungrammatical singular agreement in the self-paced reading task. If their metalinguistic knowledge of the rule and their processing tendency had been compatible, the participants would have preferred plural agreement SVX sentences as they did in ETCs.

However, the lack of sensitivity to the agreement errors in SVXs could be due to the structure of the conjoined NPs. In Experiment 1, the conjoined NPs in the test items of SVX sentences only contained one determiner, such as *his mother and daughter*, which might have led the participants to process the NPs as singular, although this type of NP with one determiner can be found in many natural utterances (cf. Heycock & Zamparelli, 2005). Furthermore, although the purpose of implementing the segment-by-segment presentation was to investigate the phrase-level processing of the conjoined NP, the discrepancy between ETCs and SVXs in Experiment 1 might be due to a task effect (i.e., segment-by-segment presentation vs. word-by-word presentation). Presenting a conjoined NP as a whole (e.g., *a pen and an eraser*) led the participants to represent it as plural more easily than when it was presented separately (e.g.,

a | *pen* | *and* | *an* | *eraser*). Thus, in Experiment 2 the presentation and the structure of the conjoined NPs were controlled across SVXs and ETCs to compare the processing of conjoined NPs in both structures more rigorously.

3 Experiment 2

As discussed in the previous section, one of the objectives of Experiment 2 was to modify the test items so that all the conjoined NPs had D+NP *and* D+NP constructions (e.g., *the driver and the passenger*). The other objective was to compare the processing tendency of conjoined NPs in the same word-by-word SPRT. The results of Tamura et al (2021) and Experiments 1 in this study together seemed to imply that the processing of conjoined NPs by JLEs was unique, in that conjoined NPs were processed as if they were plural in ETCs, but not in SVXs. However, presenting the conjoined NPs as a whole inevitably prevented us from differentiating the first agreement check, where the copula and the first singular NP emerged, from the second agreement check, where the readers encountered the second singular NP. In Experiment 2, the conjoined NPs were presented word-by-word in both SVXs and ETCs, which enabled us to investigate the first agreement check and the second agreement check.

3.1 Participants

Thirty-two JLEs enrolled in Japanese universities participated in Experiment 2; none of them had participated in Experiment 1 and the experiments reported in Tamura et al (2021). Their mean age was 24.77 (SD = 5.35). Their mean TOEIC score (M = 824.22, SD = 113.22) showed that they were more proficient learners than those who had participated in Experiment 1 and Tamura et al (2021). Table 4 summarizes the demographic information of the participants in Experiment 2. All the students signed a consent form and agreed to participate in the

experiment, which took around 90 minutes, including other experiments not reported here; they were compensated 1000 Japanese yen for their participation.

[Insert Table 4 here]

3.2 Materials and procedures

The test items used in Experiment 2 were mostly identical to those in Experiment 1. As discussed above, however, all the conjoined NPs in the test items on SVX sentences in Experiment 2 were *DP* + *DP* structures such as the following:

(8) The mother and her son *is/are in the cottage now.

The target features were both ETCs and SVX sentences. There were 18 target items for ETC and 20 for SVX sentences, both of which were presented in either singular or plural agreement. In addition to the 38 test items, 52 distractors were also included, and all the items were divided into two counterbalanced lists; one-third of the items in each list were followed by comprehension questions.[4]

To avoid any fatigue effects, the two self-paced reading sessions were divided by a few minutes' break.

3.3 Analysis

The target regions for SVX sentences were the copula *be* (t1) and the latter two regions (t2 and t3) for the delayed effect.

The | *mother* | *and* | *her* | *son* | *is/are* t1 | *in* t2 | *the* t3 | *cottage* | *now*.

[4] All the distractor items did not include ETCs or SVX patterns of conjoined NPs anywhere in the sentence.

For ETCs, the target region was the first indefinite article (t1) and the following noun (t2) for the delayed effect. We also took into account the coordinating conjunction *and* (t3), the indefinite article (t4), and the following NP (t5).

There | *is/are* | *a* t1 | *gym* t2 | *and* t3 | *a* t4 | *library* t5 | *near* | *the* | *subway* | *station.*

Before the analysis, we removed responses below 200 ms and above each participant's M +/- 2.5 SD, accounting for 6.1% and 5.1% of the data for ETCs and SVXs, respectively. After removing the outliers, a series of GLMMs were performed to ascertain the RT differences between singular and plural agreement conditions. The analytic procedure for the GLMM was identical to the one used in Experiment 1.

3.4 Results and discussion

3.4.1 Expletive there constructions

The descriptive statistics of RTs in each target region and the graphical representation of their mean RT profile are presented in Table 5 and Figure 1. The best converged GLMM model for the first target region (t1: the first determiner) included all the main effects of covariates (trial order, proficiency score and word length), the main effect of the agreement condition, and the interaction term between the agreement condition and the trial order. The model also included by-subject and by-item random intercepts. Though included in the final model, neither the main effect of the proficiency score nor the main effect of word length reached significance (proficiency score: Estimate = 11.19, *SE* = 15.73, *t* = 0.71, *p* = .48; word length: Estimate = 7.13, *SE* = 5.26, *t* = 1.36, *p* = .17). On the other hand, the main effect of agreement condition and the main effect of trial order were both significant (agreement condition: Estimate = -24.35, *SE* = 6.88, *t* = -3.58, *p* = .001; trial order: Estimate = -11.78, *SE* = 3.58, *t* = -3.29, *p* < .001). The interaction between agreement condition and trial order was almost significant (Estimate

= 12.56, *SE* = 7.06, *t* = 1.78, *p* = .07). As can be seen in Figure 2, the RT difference at the beginning of the session was large, but it decreased through the session. The *testInteractions* function via the *phia* package (De Rosario-Martinez, 2015) found that the simple main effect of trial order was only significant in the plural agreement condition (plural agreement: Estimate = -18.08, χ^2 = 12.11, *p* = .001; singular agreement: Estimate = -5.49, χ^2 = 1.28, *p* = .259). Also, the pairwise comparison using the *emmeans* function via the *emmeans* package (Lenth, 2021) found that although the difference between singular and plural conditions existed in the middle point of the task (Estimate = 24.3, *SE* = 6.88, *z* = -3.54, *p* < .001), it disappeared by the end of the session (Estimate = -11.8, *SE* = 9.8638, *z* = -1.22, *p* = .220).

[Insert Table 5 here]

[Insert Figure 1 here]

[Insert Figure 2 here]

In the second target region (t2: the first singular noun), the best model included the main effects of all three covariates, the main effect of agreement condition, the interaction between agreement condition and trial order, and by-subject and by-item random intercepts. Both the main effects of trial order and word length were significant (trial order: Estimate = -21.94, *SE* = 6.37, *t* = -3.44, *p* < .001; word length: Estimate = 26.19, *SE* = 9.91, *t* = 2.64, *p* = .008). However, neither the main effect of proficiency score nor the main effect of agreement condition was significant (proficiency score: Estimate = -23.18, *SE* = 28.76, *t* = -0.81, *p* = .42; agreement condition: Estimate = -18.32, *SE* = 11.93, *t* = -1.54, *p* = .12). Though included in the model, the interaction term was also not significant (Estimate = 3.25, *SE* = 12.47, *t* = 0.26, *p* = .794).

The model for the third target region, where the participants encountered *and*, was identical to the model for the second target region, except that the main effect of word length was not included because all the words were *and*; in addition, the by-subject random intercept of agreement condition was included. The main effect of proficiency score did not reach significance (proficiency score: Estimate = 6.23, *SE* = 14.98, *t* = 0.42, *p* = .68), and neither the main effect of agreement condition nor the trial order were significant (agreement condition: Estimate = -28.07, *SE* = 16.20, *t* = -1.73, *p* = .08; trial order: Estimate = -9.94, *SE* = 5.67, *t* = -1.75, *p* = .08).

In the fourth target region (t4: indefinite article following the second noun), all the words that appeared were the indefinite article, *a*, so we excluded the main effect of word length. The best model included the main effects of agreement condition, trial order, and proficiency score as well as by-subject and by-item intercepts and by-item random slope of agreement condition; all the main effects of the explanatory variables were non-significant (proficiency score: Estimate = 9.01, *SE* = 14.96, *t* = 0.60, *p* = .55; agreement condition: Estimate = 3.90, *SE* = 14.52, *t* = 0.27, *p* = .79) except the trial order (Estimate = -8.29, *SE* = 3.80, *t* = -2.18, *p* = .03). The interaction term was also not significant (Estimate = 3.52, *SE* = 7.63, *t* = 0.46, *p* = .65).

In the last target region (t5: second singular noun), the interaction term between agreement condition and trial order was included in the model in addition to all four explanatory variables and by-subject random intercepts. Only the main effect of trial order and word length were significant (trial order: Estimate = -15.44, *SE* = 6.46, *t* = -2.39, *p* = .017; ; word length: Estimate = 19.46, *SE* = 6.31, *t* = 3.08, *p* = .002); the other two fixed effects were not significant (agreement condition: Estimate = 2.62, *SE* = 11.45, *t* = 0.23, *p* = .819; proficiency score: Estimate = -17.02, *SE* = 21.26, *t* = -0.80, *p* = .42). Although no significant interaction between agreement condition and trial order was found (Estimate = 18.67, *SE* = 11.64, *t* = 1.61, *p* =.109), as can be seen in the interaction plot in Figure 3, it seems that at the beginning the participants

took more time to read plural agreement sentences than singular sentences, but that by the end of the experiment the RT difference was reversed, and the participants read singular agreement sentences more slowly than they read plural agreement sentences. In fact, simple main effect tests using *testInteractions* function via the *phia* package (De Rosario-Martinez, 2015) revealed that the slope was significant for the plural agreement condition (Estimate = -24.78, $\chi^2 = 8.38$, $p = .008$) but not for the singular condition (Estimate = -6.11, $\chi^2 = 0.48$, $p = .49$).

[Insert Figure 3 here].

Taken together, these results suggest that the participants responded to agreement mismatch between the copula and the indefinite article, although the mismatch effect gradually declined as the session went on, possibly because the participants anticipated the upcoming conjoined NPs during repeated exposure to them in the ETCs. Still, the mismatch effect is a novel finding, since Experiment 1 did not find it, and this suggests the availability of efficiency-drive processing as proposed by O'Grady (2005). Moreover, the interaction effect was also new, given that neither Experiment 1 nor Tamura et al (2021, Experiment 2) found a change in RT tendency during the session. The other notable finding was in the RT tendency after participants processed the coordinating conjunction. Even though we found evidence suggesting efficiency-driven processing, the RT analyses of t3 to t5 indicate that toward the end of the session, the participants became engaged in the second agreement check when they noticed that the two nouns were conjoined. This corresponds to Experiment 1 and Tamura et al (2021), which suggest that L2 learners make plural agreement in processing conjoined NPs in ETCs. We will discuss the findings in more detail in the general discussion section below.

3.4.2 SVX sentences

Table 6 summarizes the descriptive statistics for RTs in the interested regions, and Figure 4 graphically represents the mean RT profile.

[Insert Table 6 here]

[Insert Figure 4 here]

The best model in the first target region (t1), where the participants read the copula, included all three covariates and the main effect of agreement condition as well as the interaction between agreement condition and trial order and the by-subject and by-item random intercepts. The main effects of proficiency score and word length did not reach significance (proficiency score: Estimate = 6.32, *SE* = 16.55, *t* = 0.38, *p* = .70; word length: Estimate = -3.19, *SE* = 11.57, *t* = -0.28, *p* = .78); in contrast, the main effect of trial order was significant (Estimate = -18.16, *SE* = 5.10, *t* = -3.56, *p* < .001). On the other hand, neither the main effect of agreement condition nor the interaction between agreement condition and trial order was significant (agreement condition: Estimate = -22.45, *SE* = 17.65, *t* = -1.27, *p* = .20; interaction: Estimate = 6.66, *SE* = 9.54, *t* = 0.70, *p* = .48).

The best model in the second target region (t2), one word after the copula, was almost identical to the previous model, except that it included the interaction between agreement condition and region length. Although the main effect of proficiency score was not significant (Estimate = 10.74, *SE* = 14.38, *t* = 0.75, *p* = .46), the main effects of both trial order and word length were significant (trial order: Estimate = -18.20, *SE* = 4.58, *t* = -3.98, *p* < .001; word length: Estimate = 29.51, *SE* = 8.55, *t* = 3.45, *p* < .001). Similar to the tendency of RT in the previous region, the main effect of agreement condition in the second target region was not significant (Estimate = -1.24, *SE* = 8.81, *t* = -0.14, *p* = .89). Although the interaction between agreement condition and word length did not reach significance (Estimate = 5.73, *SE* = 10.41, *t* = 0.55, *p* = .58), the interaction between agreement condition and trial order was marginally significant (Estimate = -15.63, *SE* = 8.90, *t* = -1.76, *p* = .08). Since it is possible that the simple

main effect of trial order differs in singular and plural agreement sentences, we performed simple main effect test using the *testInteractions* function and found that the simple main effect of trial order was only significant in the singular agreement condition (plural agreement: Estimate = -10.21, χ^2 = 2.62, p = .11; singular agreement: Estimate = -27.10, χ^2 = 16.00, p < .001), suggesting that the participants tended to read the ungrammatical singular condition faster as the session went on (Figure 5).

[Insert Figure 5 here]

In the last target region (t3: first singular noun), the model was identical to the one in the previous region. The main effect of proficiency score was not significant (Estimate = 3.59, *SE* = 20.29, t = 0.18, p = .86), while the main effect of both trial order and word length were significant (trial order: Estimate = -18.51, *SE* = 5.44, t = -3.41, p < .001; word length: Estimate = 58.10, *SE* = 12.37, t = 4.70, p < .001), but not the main effect of agreement condition (Estimate = 14.36, *SE* = 11.01, t = 1.30, p = .19). Neither interaction term was significant, either (agreement*trial order: Estimate = -4.97, *SE* = 10.83, t = -0.46, p = .65; agreement*word length: Estimate = 9.11, *SE* = 13.62, t = 0.67, p = .50).

Overall, the results of SVX sentences failed to find a clear mismatch effect between grammatical plural agreement and ungrammatical singular agreement conditions. However, faster reading of the ungrammatical singular condition found in the second target region could indicate that in contrast to the results of ETCs, the participants might have failed at syntactically processing the coordinating conjunction. Instead, they might have preferred the ungrammatical first conjunct agreement, because otherwise they would have read the grammatical plural agreement sentences faster. We will discuss this asymmetry further below.

4 General Discussion

Recall that the purpose of the present study was to investigate JLEs' processing of conjoined NPs in SVXs and ETCs and whether it is guided by efficiency-driven constraints. Our findings for ETCs in Experiment 1 indicated that JLEs preferred plural agreement over singular agreement in online processing. Nevertheless, we did not obtain any confirmatory evidence that the JLEs were able to process conjoined NPs as plurals in SVXs in Experiment 1. However, some of the test items used in Experiment 1 had only one determiner (e.g., *his mom and dad*), which might have led the participants to assign singularity to the conjoined NP because they processed the nouns as a group. To rule out this possibility, the test items used in Experiment 2 were improved so that all the conjoined NPs followed a D+NP *and* D+NP structure (e.g., *the mother and the father*). The other purpose of Experiment 2 was to compare the processing tendency of the SVXs and ETCs in word-by-word SPRT. The results of Experiment 2 revealed two things: first, as found in Tamura et al (2021, Experiment 2), in the case of ETCs the JLEs assigned a plural feature to the conjoined NP after they had processed *and*. Second, the JLEs were found deficient in detecting agreement mismatch between conjoined NPs and copulas in SVX sentences, which suggested that they failed to recognize conjoined NPs as plural when the conjoined NP appeared in the sentence subject position.

Three especially interesting findings emerged from these two experiments considered in combination with previous studies. First, the fact that the JLEs showed significant RT increase in making number agreement between the copula and the first singular NP (e.g., *there is/*are a pen*…) corresponds to previous research (Deevy, 1999; Sobin, 1997). This correspondence suggests that in online sentence processing, where the pressure to parse the sentence efficiently is high, JLEs process ETCs as NSs do; that is, the efficiency-driven processing proposed by O'Grady (2005) would likely be available to JLEs when required.

Those findings are also in line with O'Grady and Yamashita (2002), who revealed proximity effects in disjunctive coordination construction by L2 learners, using an offline

forced-choice questionnaire. Our study expanded O'Grady and Yamashita (2002) by investigating conjoined NPs rather than disjunctives and by applying online reading experiments. The results provide further support for the hypothesis that there is a certain aspect of the native speaker's parsing strategy that is available to adult L2 learners.

Nonetheless, it should be noted that the JLEs demonstrated the second agreement check between the copula and the conjoined NP, one of the possibilities proposed by Deevy (1999). This tendency was accompanied by an interaction between trial order and agreement condition, suggesting that RTs became faster when reading plural agreement (*there are a pen and an eraser…*). These findings are contrary to the efficiency-driven processing account. Since in Tamura et al (2021, Experiment 2), the NSs of English did not show such evidence of second agreement check – although the number of participants was small in terms of achieving adequate validity – it seems possible that they did not correct their first singular agreement even if they later saw the coordinated marker and reanalyzed the target as a conjoined plural NP, as proposed by Deevy (1999). In fact, previous studies have demonstrated that NSs of English prefer singular agreement of conjoined NPs in ETCs to plural agreement (e.g., Deevy, 1999; Schütze, 1999; Sobin, 1997). Therefore, it can be concluded that second agreement check in processing ETCs is peculiar to L2 learners.

Another interesting finding is the relationship between repeated exposure and the learner's meta-linguistic knowledge. The interaction effect implies that the second agreement check was induced by repeated exposure to *there are NP and NP* type of sentences. We speculated that the repeated exposure might have triggered L2 learners' knowledge that two singular nouns conjoined by *and* received a plural feature, which thus might have resulted in the adaptation to *there are…* sentences followed by conjoined NPs.

This kind of adaptation induced by repeated exposure have also been found in other sentence processing research (e.g., Fine et al., 2013). However, the case observed in the present

study is unique, because the adaptation was not directly triggered by the exposure but by the L2 learners' knowledge that conjoined NPs receive plurality. As a result, the learner's knowledge could be inadequately applied in online sentence processing. As reviewed earlier, *there is* NP *and* NP patterns are more frequent than *there are* NP *and* NP patterns in natural input (Insua and Martinez, 2003). Therefore, even if L2 learners are repeatedly exposed to the less frequent *there are* NP *and* NP patterns, they would not find the plural agreement sentences acceptable. That is, the L2 learners develop peculiar interlanguage grammar that is not based on the input available to them, and moreover, this plays a role in online sentence processing. Given that this phenomenon is unique in L2 sentence processing, future sentence processing studies focusing on L2 learners should further investigate the impact of their knowledge on sentence processing.

The last important finding is the asymmetry between SVX sentences and ETCs. Although the JLEs successfully interpreted conjoined NPs as plural in ETCs, they exhibited inconsistency in the case of SVXs. The discrepancy could demonstrate the underutilization of syntactically processing conjoined NPs, as proposed by SSH (Clahsen & Felser, 2018). If so, the results of Experiment 1, which showed a preference for plural agreement in ETCs, and the results of Experiment 2, which showed an interaction between trial order and agreement condition, could be because *and* was processed lexically, not syntactically. Although Shibuya and Wakabayashi (2008) found that JLEs were sensitive to the overuse of 3PS when the subject is syntactically plural (e.g., *Tim and Paul bake<u>s</u>*…), there are several differences between Shibuya and Wakabayashi (2008) and the current study. First, regular verbs were used in their study, whereas the copula *be* was used in this study. Second, their conjoined NP consisted of two proper nouns, while the current study used two definite singular nouns (e.g., *the TV and the computer*). These differences could be potential sources of the discrepancies. Therefore, further studies are necessary to investigate the relationship between types of conjoined NPs

and types of verbs. Another possible explanation to the differences in sensitivity to number agreement in ETCs and SVXs is the difference in the agreement dependencies. In the case of ETCs, the agreement dependency arises when an inflected verb is processed, which triggers a certain type of NP that matches in number. In the case of SVXs, however, seeing a subject NP does not necessarily trigger number agreement given that auxiliaries and past tense verbs other than *be* do not show number agreement with the subject NP. Therefore, this agreement dependency difference could be the cause of inattention to number agreement mismatches in SVXs. Nevertheless, the question of why native speakers of English do not show this inattention to number in SVXs still remains, though the present study did not directly investigate this matter.

5 Limitations

Before moving on to the conclusion, we would like to point out some limitations of the present study. First, it should be noted that the offline error correction task was not administered to the participants of Experiment 2, where it would also have been meaningful. The participants in Experiment 2 might not have shown a strong tendency to prefer conjoined NPs as always plural, leading to plural agreement, in an offline error correction task.

Second, we did not compare the performance of NSs in offline and online tasks and, therefore, a strong claim cannot be made regarding the difference between NSs and JLEs. Nevertheless, Tamura et al (2021, Experiment 2) compared JLEs and NSs in SPRTs and found that only JLEs responded to the coordinating conjunction *and* in ETCs. For future studies, it will be worthwhile to investigate whether NSs process conjoined NPs as plural in online sentence processing. To do so, eye-tracking techniques may be useful because, unlike SPRTs, they can record backward processing as well, which allows us to examine whether the parser is reanalyzing the conjoined NPs.

Lastly, our experimental materials did not fully cover all the verbs that could be used in ETCs such as the following patterns:

(8) There *seem/seems* to be a pencil and a pen on the desk.

(9) There *has/have to* be a pencil and a pen on the desk.

It is possible that the responses to singular/plural mismatches between these verbs and conjoined NPs could be different from what is reported in the current paper. Therefore, further studies should include a wider variety of verb patterns to fully reveal the singular/plural preference to the agreement in ETCs.

6 Conclusion

Together, the results of the two experiments revealed that L2 learners utilize distinct processing strategies for conjoined NPs, influenced by the combination of repeated exposure and learner's peculiar meta-linguistic knowledge. In ETCs, the JLEs detected number agreement mismatch between the copula and the first singular NP in online sentence processing. This result may be explained by O'Grady's efficiency-driven account, which proposes that the human sentence processor prefers to resolve agreement dependency at the first opportunity. However, it seemed that once participants realized that the first singular NP was part of a conjoined NP, they assigned plurality to the whole conjoined NP, which Deevy (1999) argued NSs seemed not to do. Furthermore, efficiency-driven processing is vulnerable and overcome by the knowledge that *and* has a plural meaning, which is triggered by the repeated exposure to the *three are NP and NP* type of sentences. Interestingly, the JLEs failed to detect number mismatches in SVX sentences. Overall, we can conclude that although the underlying processing behavior is universal in L1 and L2, the JLEs underutilized the syntactic representation of conjoined NPs and instead engaged in "shallow" processing, as SSH proposes. Moreover, their L2 processing could possibly be influenced by their metalinguistic knowledge.

Appendix

All the stimuli are available at the following URL:

https://osf.io/gz6q8/

References

Bates, Douglas, Martin Maechler, Ben Bolker & Steven Walker. 2019. *lme4: Linear mixed-effects models using Eigen and S4* [R package version 1.1-21]. Retrieved from https://cran.rproject.org/package=lme4

Bock, Kathryn & Carol A. Miller. 1991. Broken agreement. Cognitive Psychology 23(1). 45–93.

Bock, Kathryn & Kathleen M. Eberhard. 1993. Meaning, sound and syntax in English number agreement. *Language and Cognitive Processes* 8. 57–99. https://doi.org/10.1080/01690969308406949

Brehm, Laurel & Kathryn Bock. 2017. Referential and lexical forces in number agreement. *Language, Cognition and Neuroscience* 32. 129–146. https://doi.org/10.1080/23273798.2016.1234060

Clahsen, Harald & Claudia Felser. 2006a. Continuity and shallow structures in language processing. *Applied Psycholinguistics* 27(1). 107–126. https://doi.org/10.1017/S0142716406060206

Clahsen, Harald & Claudia Felser. 2006b. Grammatical processing in language learners. *Applied Psycholinguistics* 27(1). 3–42. https://doi.org/10.1017/S0142716406060024

Clahsen, Harald & Claudia Felser. 2006c. How native-like is non-native language processing? *Trends in Cognitive Sciences* 10(12). 564–570. https://doi.org/10.1016/j.tics.2006.10.002

Clahsen, Harald & Claudia Felser. 2018. Some notes on the Shallow Structure Hypothesis. *Studies in Second Language Acquisition* 40(3). 693–706. https://doi.org/10.1017/S0272263117000250

Corbett, Greville G. 2000. Number. Cambridge University Press.

Crawford, William J. 2005. Verb agreement and disagreement: A corpus investigation of concord variation in existential there + be constructions. *Journal of English Linguistics* 33. 35–61. https://doi.org/10.1177/0075424204274001

Deevy, P. Lynn. 1999. *The comprehension of English subject-verb agreement.* Amherst, MA: University of Massachusetts Amherst PhD dissertation.

Ellis, Rod. 2004. The definition and measurement of L2 explicit knowledge. *Language Learning* 54. 227–275. https://doi.org/10.1111/j.1467-9922.2004.00255.x

Fine, Alex B., T. Florian Jaeger, Thomas A. Farmer & Ting Qian. 2013. Rapid expectation adaptation during syntactic comprehension. *PLOS ONE* 8(10). e77661. https://doi.org/10.1371/journal.pone.0077661

Foote, Rebecca. & Kathryn Bock. 2012. The role of morphology in subject–verb number agreement: A comparison of Mexican and Dominican Spanish. *Language and Cognitive Processes* 27. 429–461. https://doi.org/10.1080/01690965.2010.550166

Franck, Julie, Gabriela Soare, Ulrich H. Frauenfelder & Luigi Rizzi. 2010. Object interference in subject–verb agreement: The role of intermediate traces of movement. *Journal of Memory and Language* 62. 166–182. https://doi.org/10.1016/j.jml.2009.11.001

Gibson, Edward. 1998. Linguistic complexity: Locality of syntactic dependencies. *Cognition* 68. 1–76. https://doi.org/10.1016/S0010-0277(98)00034-1

Grodner, Daniel, Edward Gibson & Susanne Tunstall. 2002. Syntactic complexity in ambiguity resolution. *Journal of Memory and Language* 46. 267–295. https://doi.org/10.1006/jmla.2001.2808

Haskell, Todd R. & Maryellen C. MacDonald. 2005. Constituent structure and linear order in language production: Evidence from subject-verb agreement. *Journal of*

Experimental Psychology: Learning, Memory, and Cognition 31. 891–904. https://doi.org/10.1037/0278-7393.31.5.891

Heycock, Caroline & Roberto Zamparelli. 2005. Friends and colleagues: Plurality, coordination, and the structure of DP. *Natural Language Semantics 13*. 201–270. https://doi.org/10.1007/s11050-004-2442-z

Insua, Ana E. Martinez & Martinez, Ignacio M. Palacios 2003. A corpus-based approach to non-concord in present day English existential there-constructions. *English Studies* 84. 262–283. https://doi.org/10.1076/enst.84.3.262.16852

JACET Basic Words Revision Committee (eds.). 2003. *JACET list of 8000 basic words* (JACET8000). Tokyo: JACET.

Jackson, Carrie N., Elizabeth Mormer & Laurel Brehm. 2018. The production of subject-verb agreement among Swedish and Chinese second language speakers of English. *Studies in Second Language Acquisition* 40. 907–921. https://doi.org/10.1017/S0272263118000025

Jiang, Nan. 2004. Morphological insensitivity in second language processing. *Applied Psycholinguistics* 25. 603–634. https://doi.org/10.1017/S0142716404001298

Jiang, Nan. 2007. Selective integration of linguistic knowledge in adult second language learning. *Language Learning* 57. 1–33. https://doi.org/10.1111/j.1467-9922.2007.00397.x

Jiang, N., Eugenia Novokshanova, Kyoko Masuda & Xin Wang. 2011. Morphological congruency and the acquisition of L2 morphemes: Morphological congruency. *Language Learning* 61(3). 940–967. https://doi.org/10.1111/j.1467-9922.2010.00627.x

Jiang, Nan, Guiling Hu, Anna Chrabaszcz & Lijuan Ye. 2017. The activation of grammaticalized meaning in L2 processing: Toward an explanation of the

morphological congruency effect. *International Journal of Bilingualism* 21(1). 81–98. https://doi.org/10.1177/1367006915603823

Johannessen, Janne Bondi. 1996. Partial agreement and coordination. *Linguistic Inquiry* 27. 661–676. doi:10.2307/4178956

Lenth, Russell. 2021. *emmeans: Estimated Marginal Means, aka Least-Squares Means* [R package version 1.60]. Retrieved from https://cran.r- project.org/package=emmeans

Lim, Jung Hyun & Kiel Christianson. 2015. Second language sensitivity to agreement errors: Evidence from eye movements during comprehension and translation. *Applied Psycholinguistics* 36. 1283–1315. https://doi.org/10.1017/S0142716414000290

Linck, Jared A. & Ian Cunnings. 2015. The utility and application of mixed-effects models in second language research. *Language Learning* 65. 185–207. https://doi.org/10.1111/lang.12117

Lo, Steson & Sally Andrews. 2015. To transform or not to transform: Using generalized linear mixed models to analyse reaction time data. *Frontiers in Psychology* 6. 1171. https://doi.org/10.3389/fpsyg.2015.01171

Lorimor, Heidi. 2007. *Conjunctions and grammatical agreement when wholes differ from the sums of their parts*. Unpublished doctoral dissertation. University of Illinois at Urbana-Champaign.

Milsark, Gary L. 1979. *Existential sentences in English*. Garland.

Morgan, Jerry L. 1984. Some problems of determination in English number agreement. In Gloria. Alvarez, Belinda Brodie & Terry McCory (Eds.), *Proceedings of the Eastern States Conference on Linguistics* (pp. 69–78). Ohio State University.

Munn, Alan. 1999. First conjunct agreement: Against a clausal analysis. *Linguistic Inquiry* 30. 643–668. doi:10.1162/002438999554246

O'Grady, William. 2005. *Syntactic carpentry: An emergentist approach to syntax*. Mahwah, NJ: Erlbaum.

O'Grady, William & Yoshie Yamashita. 2002. Partial agreement in second-language acquisition. *Linguistics*, *40*, 1011–1019. https://doi.org/10.1515/ling.2002.034

De Rosario-Martinez, Helios. 2015. *phia: Post-hoc interaction analysis* [R package version 0.2-1]. Retrieved from https://cran.rproject.org/package=phia

Sato, Mikako & Claudia Felser. 2010. Sensitivity to morphosyntactic violations in English as a second language. *Second Language* 9. 101–118.

Schlueter, Zoe, Momma Shota, Lau Ellen. 2017. *No grammatical illusion with L2-specific memory retrieval cues in agreement processing*. Poster at the 30th annual CUNY Conference on Human Sentence Processing, Cambridge, MA. March 30-April 1.

Schütze, Carson T. 1999. English expletive constructions are not infected. *Linguistic Inquiry* 30. 467–484. https://doi.org/10.1162/002438999554156

Shibuya, Mayumi, & Shigenori Wakabayashi. 2008. Why are L2 learners not always sensitive to subject-verb agreement? *EUROSLA Yearbook* 8. 235–258. https://doi.org/10.1075/eurosla.8.13shi

Silva, Renita & Harald Clahsen. 2008. Morphologically complex words in L1 and L2 processing: Evidence from masked priming experiments in English. *Bilingualism: Language and Cognition* 11(2). 245–260. https://doi.org/10.1017/S1366728908003404

Sobin, Nicholas. 1997. Agreement, default rules, and grammatical viruses. *Linguistic Inquiry* 28. 318–343.

Song, Yoonsang. 2015. L2 processing of plural inflection in English. *Language Learning* 65(2). 233–267. https://doi.org/10.1111/lang.12100

Tamura, Yu, Junya Fukuta, Yoshito Nishimura & Daiki Kato. 2021. L2 learners' number agreement in the expletive *there* constructions: Conjoined NP always plural? *Reports of*

2020 Studies in The Japan Association for Language Education and Technology, Chubu Chapter, Fundamentals of Foreign Language Educational Research Special Interest Group (SIG), 2–23.

Wen, Zhijun, Mari Miyao, Aya Takeda, Wei Chu & Bonnie D. Schwartz. 2010. Proficiency effects and distance effects in nonnative processing of English number agreement. In Katie Franich, Kate M. Iserman & Lauren L. Keil (eds.), *Proceedings of the 34th Annual Boston University Conference on Language Development*, 445–456. Somerville, MA: Cascadilla Press.

Figures

Figure1

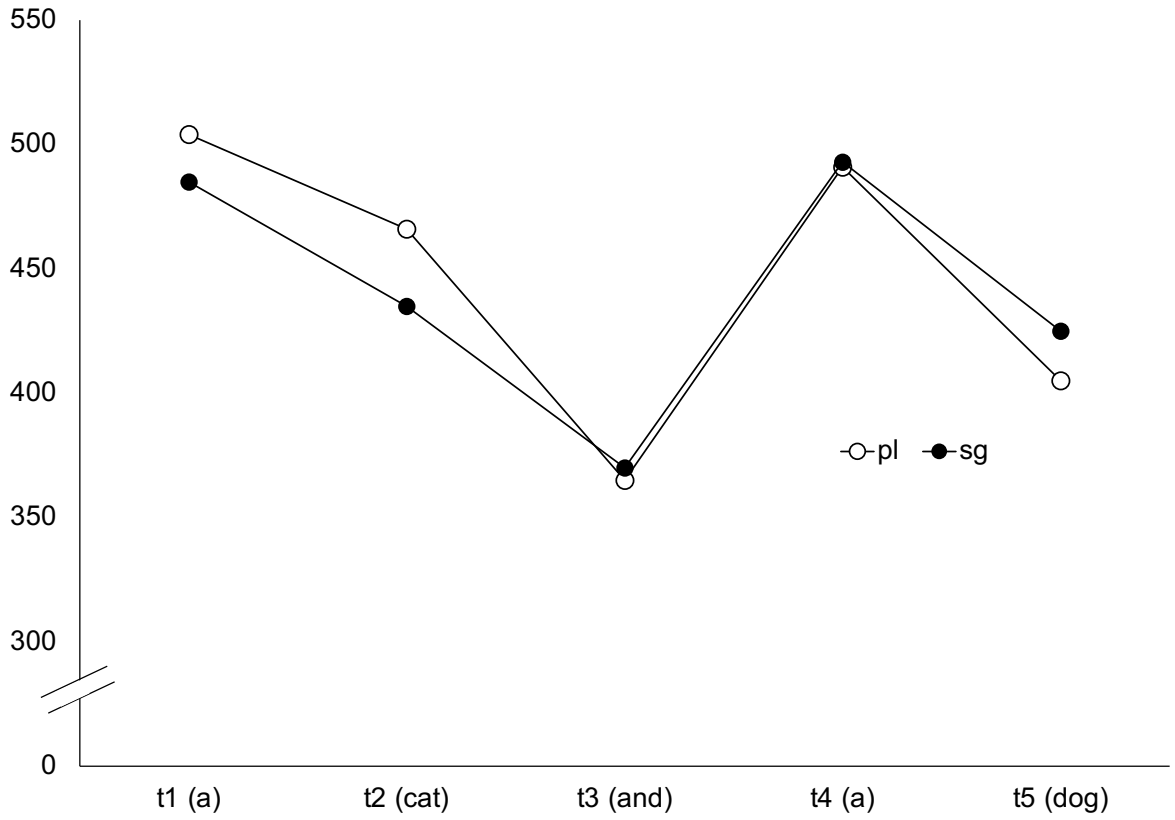

Figure 2

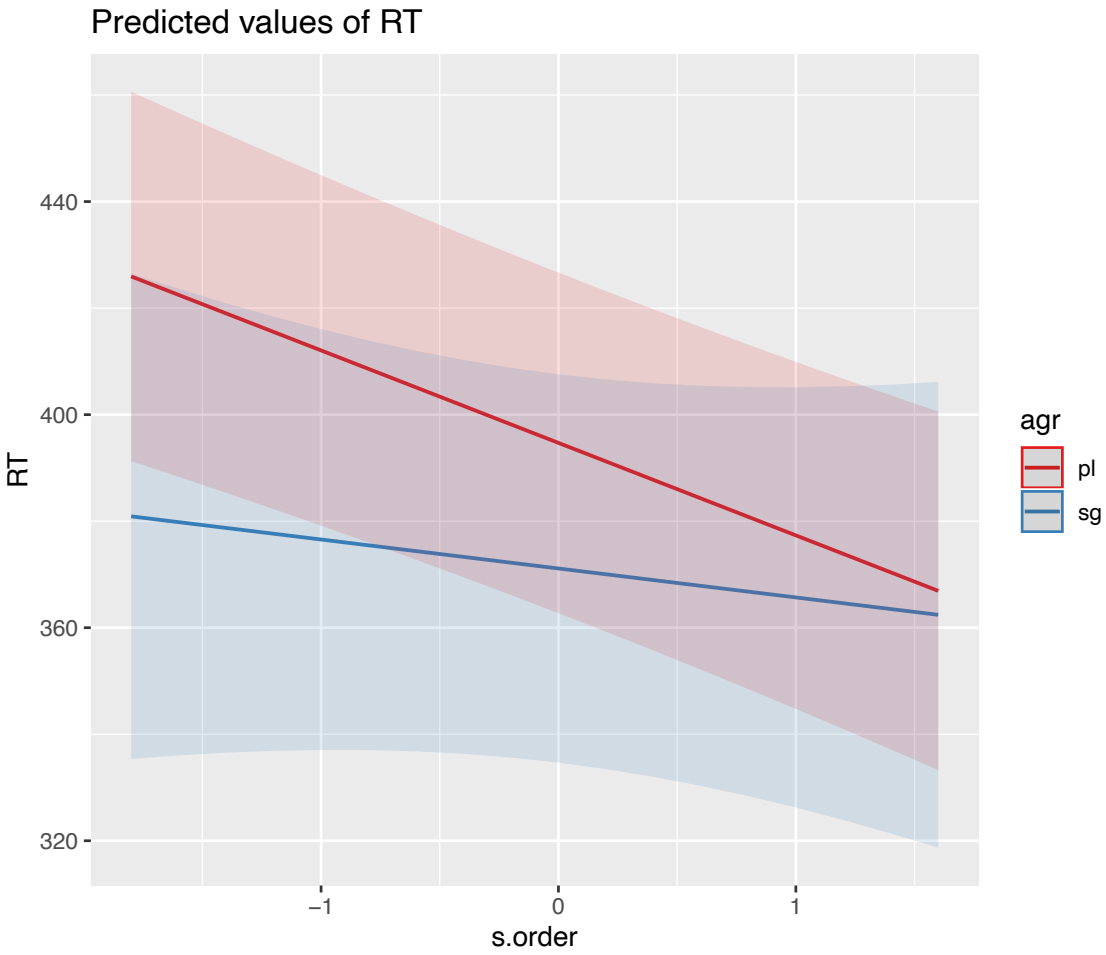

Figure 3

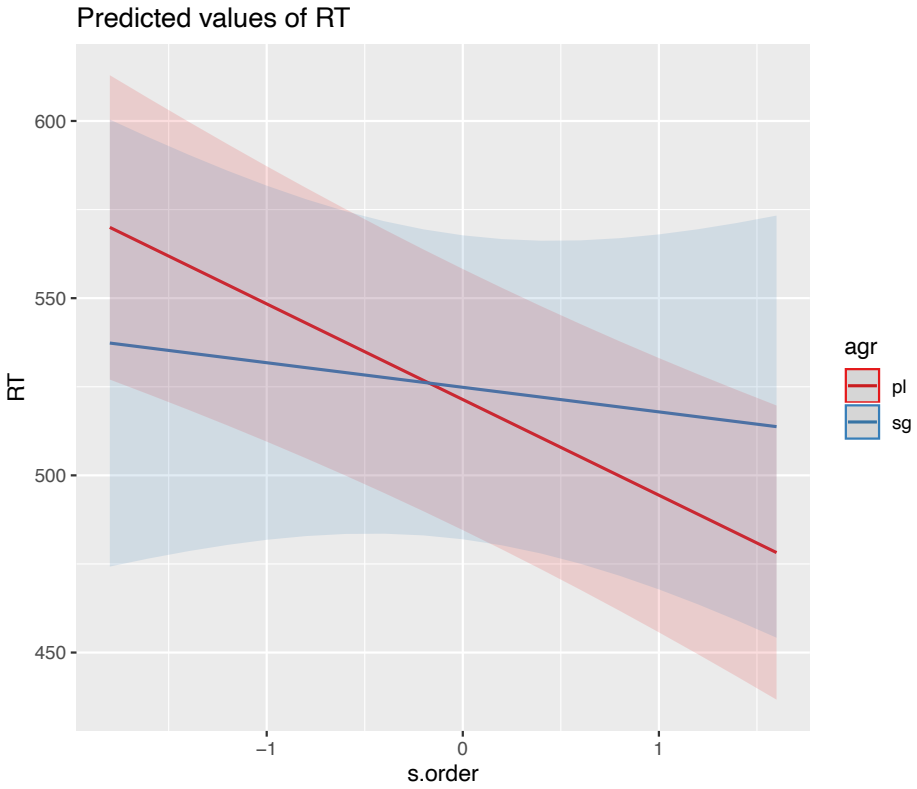

Figure 4

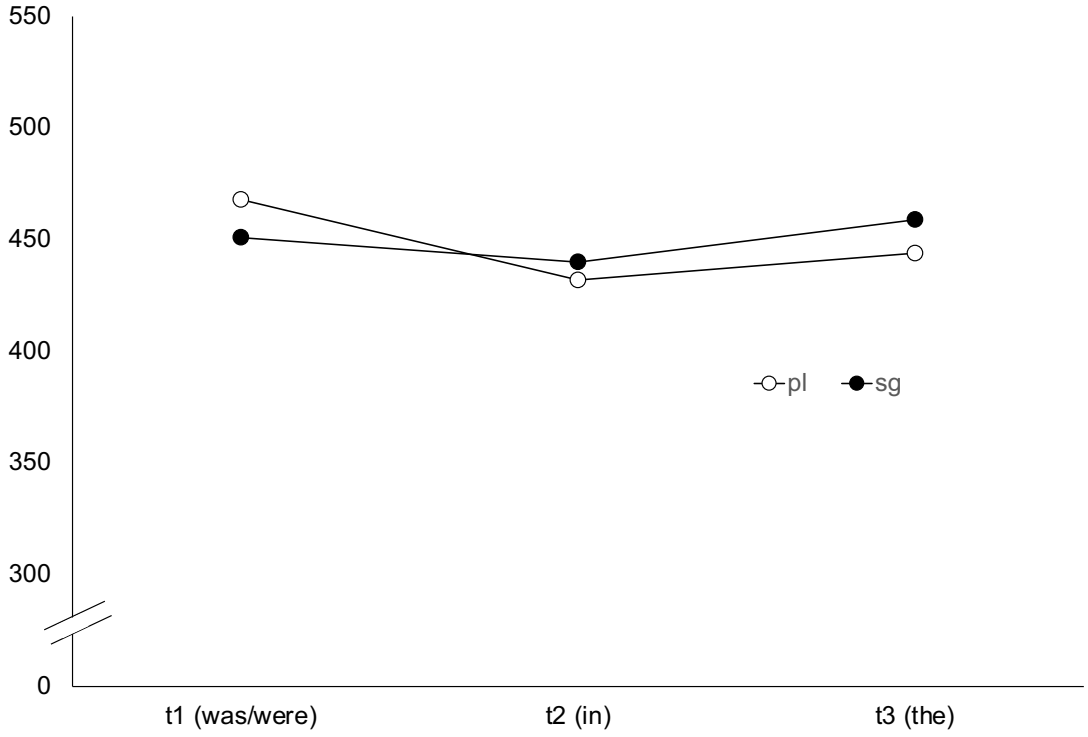

Figure 5

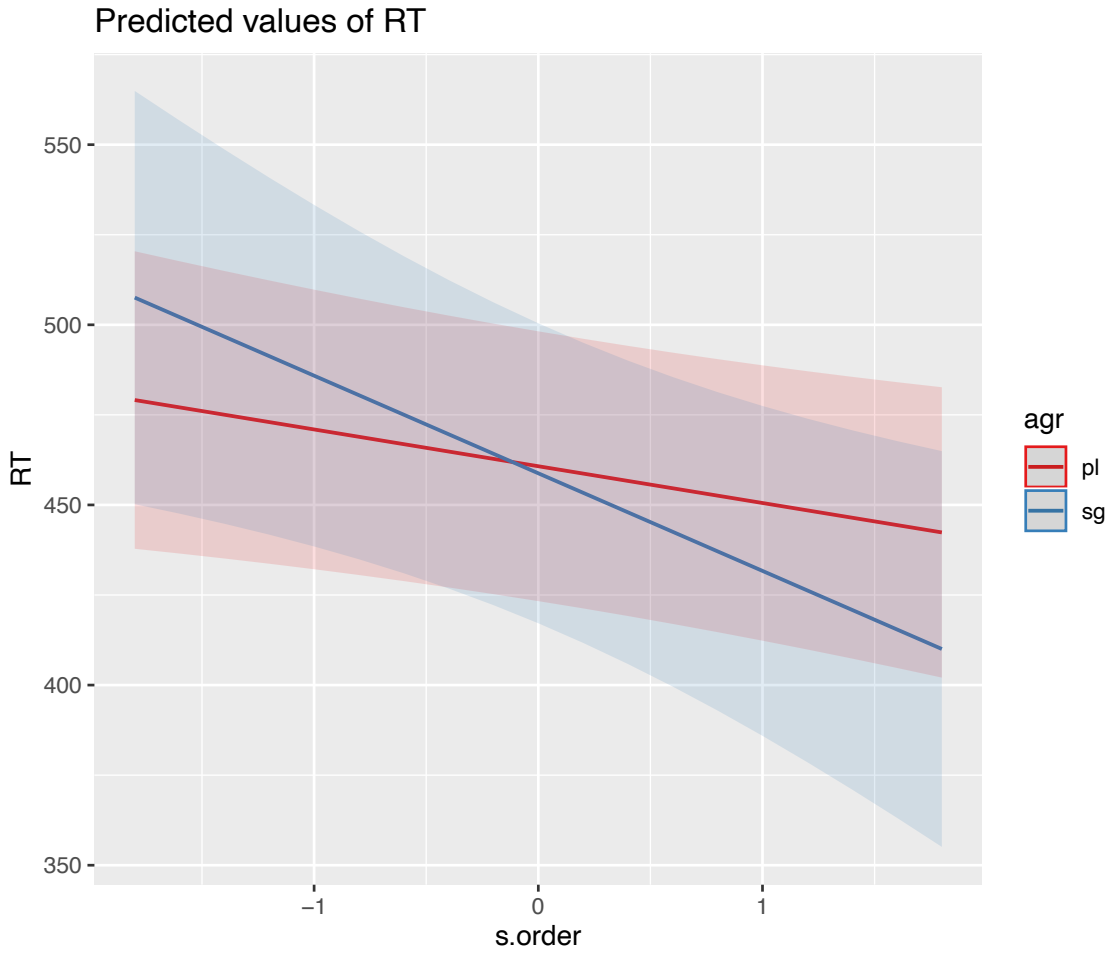
Predicted values of RT
RT
550
500
450
400
350
−1
0
1
s.order
agr
pl
sg

Figure Captions

Figure 1. Mean RT profile in ETCs in Experiment 2.

Figure 2. Interaction plot of t1 region in ETC in Experiment 2.

Figure 3. Interaction plot of t5 region in ETC in Experiment 2.

Figure 4. Mean RT profile in SVXs in Experiment 2.

Figure 5. Interaction plot of t2 region in SVX in Experiment 2.

Tables

Table 1.

Demographic Information of Participants in Experiment 1

	M	*SD*	Median	Min	Max	skew	kurtosis
Age[a]	24.05	4.26	23	19	37	1.33	1.52
Years of Learning English[a]	12.11	3.98	10.5	8	25	1.65	2.51
Study abroad (month) [b]	13.33	29.9	5	1	120	3	7.8
TOEIC[a]	780.91	115.78	787.5	565	960	0.06	-1.14

Note. $n^a = 22$, $n^b = 15$.

Table 2.

Descriptive Statistics of RTs in There *Sentences in Experiment 1*

condition	*M*	*SD*	Median	Min	Max	skew	kurtosis
pl	2010	568	1885	1191	3327	0.56	-0.66
sg	2113	728	2061	1121	4597	1.53	3.65

Note. $N = 22$. pl = plural agreement; sg = singular agreement.

Table 3.

Descriptive Statistics of RTs in SVX Sentences in Experiment 1

Region	condition	*M*	*SD*	Median	Min	Max	skew	kurtosis
t1	pl	495	83	489	329	624	-0.13	-1.11
(is/are)	sg	464	97	455	278	681	0.26	-0.28
t2	pl	461	92	475	285	602	-0.37	-1.02
(in)	sg	448	87	450	302	581	-0.02	-1.28
t3	pl	471	98	478	295	691	0.05	-0.49
(the)	sg	492	116	472	267	681	-0.21	-1.03

Note. $N = 22$. pl = plural agreement; sg = singular agreement; t1 = the target region; t2 = one word after the target region; t3 = two words after the target region.

Table 4.

Demographic Information of Participants in Experiment 2

	M	*SD*	Median	Min	Max	skew	kurtosis
Age[b]	24.77	5.35	22	20	40	1.57	1.23
Years of learning English[a]	13.59	5.85	11.5	8	36	2.18	5.05
Studying abroad (month) [c]	11.36	13.28	9.5	0.5	54	1.89	3.28
TOEIC[a]	824.22	113.12	837.5	550	990	-0.61	-0.44

Note. $n^a = 32$, $n^b = 31$, $n^c = 18$.

Table 5.

Descriptive Statistics of RTs in ETCs in Experiment 2.

Region	condition	*M*	*SD*	Median	Min	Max	skew	kurtosis
t1	pl	504	145	496	228	751	0.13	-1.07
(a)	sg	485	145	464	224	952	1.03	1.67
t2	pl	466	97	468	262	616	-0.29	-0.83
(cat)	sg	435	77	441	272	577	-0.18	-0.78
t3	pl	365	70	356	276	592	1,27	1.60
(and)	sg	370	74	370	240	573	0.53	0.13
t4	pl	491	125	488	244	741	0.13	-0.59
(a)	sg	493	147	479	231	954	0.91	1.35
t5	pl	405	90	395	254	644	0.85	0.43
(dog)	sg	425	79	400	284	623	0.70	-0.26

Note. $N = 32$. pl = plural agreement; sg = singular agreement.

Table 6.

Descriptive Statistics of RTs in SVX Sentences in Experiment 2.

region	condition	*M*	*SD*	Median	Min	Max	skew	kurtosis
t1	pl	468	93	451	337	726	0.84	0.37
(was/were)	sg	451	100	418	324	737	1.28	1.43
t2	pl	432	78	434	258	562	-0.25	-0.88
(in)	sg	440	113	405	254	719	0.93	0.01
t3	pl	444	109	449	274	668	0.28	-0.94
(the)	sg	459	112	449	266	794	0.59	0.72

Note. $N = 32$. pl = plural agreement; sg = singular agreement.