English determiner-noun agreement processing and effects of dependency length for Korean EFL learners

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Cho, Jeonghwa. 2017. English determiner-noun agreement processing and effects of dependency length for Korean EFL learners *SNU Working Papers in English Linguistics and Language 15, 1-26.* As has been claimed by the Shallow Structure Hypothesis (SSH) (Clahsen & Felser, 2006), L2 learners are reported to exhibit a limited ability to process grammatical forms when they are reading sentences for comprehension (Chen, Shu, Liu, Zheo, & Li, 2007; Jiang, 2004, 2007). Relatively less addressed is another claim by the SSH, that L2 learners' native-like agreement processing is restricted to local mismatches (Keating, 2009, 2010). This study investigates English determiner-noun number agreement processing by Korean EFL learners and whether their sensitivity to ungrammaticality decreases when there is an interference within the determiner phrase (DP). 13 native English speakers and 16 Korean early learners with high English proficiency participated in a self-paced reading task. In order to test the effect of dependency length, stimuli sentences were created that belong to either the short condition or the long condition. The results showed that the nonnative group's performance was highly modulated by dependency length while that of the native group was not.

Keywords: determiner-noun agreement, number agreement, SLA, dependency length

1. Background

L2 learners are reported to exhibit a limited ability to process grammatical forms when they are reading sentences for comprehension (Chen, Shu, Liu, Zheo, & Li, 2007; Felser & Cunnings, 2012; Felser, Sato & Bertenshaw, 2009; Felser & Roberts, 2007; Jiang, 2004, 2007). Clahsen and Felser (2006) explains this phenomenon by the Shallow Structure Hypothesis (SSH), which claims that grammatical processing of L1 speakers and L2 learners are fundamentally different. Assuming

two different routes in interpreting sentences, semantically based processing and syntactic analysis, L1 speakers allegedly make use of both routes when they read sentences. On the other hand, L2 learners fail at full parsing and rely on lexical-semantic cues more often than L1 speakers even at their advanced level.

Relatively less investigated is their second claim that learners process sentences in a native-like manner only in local domains. While the definition of 'local domain' is not clarified, examples they provide include word segmentation or agreement between adjacent constituents. Keating (2009) attempted to provide an empirical evidence for this hypothesis by comparing gender agreement processing by English learners of Spanish when the constituents are within the same phrase (1a; termed 'local') and are separated in different phrases (1b, 1c; termed 'nonlocal'). In Spanish, all nouns are specified as either masculine or feminine and should agree with their modifying determiners and adjectives in gender. For instance, the determiners *una* and *pequeňa* in (1) should have the same gender with the feminine noun they modify, *casa.*

(1) a. [$_{IP}$ Una <u>casa</u> <u>pequeňa</u> [$_{VP}$ cuesta mucho en San Francisco.]]
   "A small house costs a lot in San Francisco."
   b. [$_{IP}$ La <u>casa</u> es [$_{VP}$ bastante <u>pequeña</u> y necesita muchas reparaciones.]]
   "The house is quite small and needs a lot of repairs.
   c. [$_{IP}$ Una <u>casa</u> es [$_{VP}$ cuesta menos [$_{CP}$ si [$_{VP}$ es <u>pequeña</u> y necesita muchas reparaciones.]]]]
   "A house costs less if it is small and needs repairs.

In sentences such as (1a), the advanced learners showed sensitivity to agreement violations while intermediate and beginning learners did not. Conversely, the advanced learners did not perform as the native speakers in nonlocal conditions such as (1b) and (1c). These results suggest that

nonnative speakers are more easily affected by the distance between the agreeing constituents than native speakers as predicted in the SSH. It should be noted, however, that materials used in this study have linear effects and structural effects confounded together. That is, the three sentences in (1) differ not only in the linear distance between the noun and the adjective but also in the structural complexity; (1c) is the most complex followed by (1b) and (1a).

To supplement Keating (2009), Keating (2010) investigated the same phenomenon with different materials, this time manipulating the linear distance only. The examples are presented in (2).

(2) a. La <u>tienda</u> está <u>abierta/*abierto</u> los sábados y domingos por la tarde.
   "The store is open Saturdays and Sundays in the afternoon."
 b. La <u>mochila</u> de la estudiante está <u>llena/*lleno</u> de libros de texto.
   "The backpack of the girl is filled with textbooks."
 c. La <u>falda</u> en la tienda de ropa femenina es <u>roja/*rojo</u> y viene de Italia.
   "The skirt in the store of women's clothing is red and comes from Italy."

The sentences contained linear distances of one word (2a), four words (2b) and seven words (2c). Although the native group performed generally better in detecting agreement violations, their sensitivity did not reach significance when the distance was seven words. The advanced learners showed sensitivity only in the one-word condition, reflecting their more vulnerability to the effects of dependency length.

The current study was motivated by Keating (2009, 2010) and attempted to explore whether the same results are obtained in other language domains and by different groups of language learners. To be specific, number agreement processing in the English DP (determiner phrase) by Korean learners of English is examined in this study. Studies on number

agreement processing within the DP have been mostly conducted in Spanish (White, Valenzuela, Kozlowska–Macgregor & Leung, 2004; Tokowicz & MacWhinney, 2005; Sagarra & Herschensohn, 2010) along with gender agreement processing. L2 processing studies of number agreement in English, on the other hand, have focused on the context of subject-predicate agreement (Jiang, 2004, 2007; Lim & Christianson, 2015). Conducted with Chinese and Korean L2 learners, whose L1 do not compute subject-verb number agreement as in English, all three studies revealed less sensitivity of L2 processing to agreement violations with an interference (e.g. *The bridge/*bridges to the island was*). However, they did not compare these conditions to violations without an interference. Neither has there been a study, as far as I am concerned, that examined number agreement processing in the DP. This is probably because agreement computation is limited to certain determiners in English (*this*/*that* for singular nouns and *these/those* for plural nouns). Nevertheless, it is worth investigating whether L2 learners are capable of detecting number disagreement between the determiner and the noun if not between the subject and the verb.

In addition, the DP structure was deemed to be appropriate for the purpose of the study since the dependency length can easily be manipulated by inserting adjectives between the determiner and the noun as illustrated in (3).

    (3) a. This detective
        b. This bright Irish detective

In (3a) the demonstrative pronoun is directly followed by the noun so that the linear distance between them is zero. In (3b), linear distance is increased to two words with the additional two adjectives between the demonstrative pronoun and the noun. The distance of two words was considered sufficient to test its modulating effect, because the advanced L2 learners in Keating (2009) failed in detecting ungrammaticality in (1b)

whose linear distance was two words. For the sake of convenience, sentences as (3a) are termed 'short condition' and sentences as (3b) are termed 'long condition' in this paper.

Another difference between the current study and Keating (2009, 2010) is that only early learners were included in the study. Although Keating controlled proficiency level of his participants, he did not take their age of onset (AO) into consideration. Considering that L2 learners' AO is a factor as important as their proficiency in acquiring native-like level of morphosyntax (Blom, Polisšenská, & Weerman, 2006; Clahsen & Felser, 2006; Granena & Long, 2012; Johnson & Newport, 1991; Long, 1990), the insensitivity of the L2 participants can be attributed to possible existence of those learners who began learning the L2 at a relatively late age. According to Long (1990), acquisition of native-like morphology and syntax is possible until age 6 followed by a decrease between 6 and the mid-teens (about 15 years old) and impossible after that. This was confirmed in Granena and Long (2012), where the decline in L2 learners' morphosyntax took place in the group whose AO ranged from 7 to 15 and then became weak after AO of 15. Therefore, it is only reasonable to compare L2 learners with an early AO with native speakers for one to investigate the difference and similarity in L1 and L2 processing. The AO range of the participants in the current study were from five to ten, which group them as early learners.

The research questions for the study are as below:

1. Are advanced early learners of English sensitive to number agreement violations between the determiner and the noun in the short condition while reading for comprehension?
2. If the learners can detect ungrammaticality in the short condition, do they continue to show sensitivity to agreement violations in the long condition?

If the L2 learners show a significant delay in ungrammatical sentences in the short condition, this indicates they have acquired number agreement in the DP and can implicitly process the morphosyntactic feature in the local domain. If they fail to perform in the same way in the long condition, this would mean their agreement processing was influenced by dependency length.

2. Method
2.1 Participants

Fifteen English native speakers and sixteen Korean learners of English participated in the study. The nonnative participants were undergraduate and graduate students in Seoul. There were twelve females and four males with a mean age of 24.75 (range: 21-27). The mean year of residence in English speaking countries was less than a year (0.44), indicating that most of the participants' English education took place in an EFL environment. Their AO ranged from five to ten, which classifies them as early learners. The proficiency level of the participants was confirmed by the standardized test, TEPS (Test of English Proficiency developed by Seoul National University). They had a TEPS score between 808 and 960, which falls into near-native and native level of communicative competence, as stated by the committee of TEPS. The statistical analysis revealed that there was no significant interaction effect between AO and grammaticality or between proficiency and grammaticality within participants. In other words, participants' AO or proficiency did not affect their performance in detecting grammatical errors. The participants' background information is summarized in Table 1. They were paid 4,000 won each for their participation.

Table1. Summary of nonnative participants' background information

	N	Minimum	Maximum	M	SD
Chronological age	18	23	27	25	1.09
Age of Onset	18	5	10	7.87	1.58
TEPS score	18	808	960	876	48.43
Residence in English speaking countries (yrs.)	18	0	1.75	0.44	0.55

The native participants were recruited via Amazon's Mechanical Turk and were self-reported native speakers of English. Ten of them were females and five were males. Their mean age was 26.6 (range: 20-33), which is similar to that of the nonnative participants. They were paid $0.50 for their participation.

2.2 Materials

40 target sentences were created and adapted from Lowder and Gorden (2014). They were modified to fit the purpose of the study so that each sentence started with either of two demonstrative pronouns (*this/these*). The nouns that matched with the demonstrative pronouns were all human subjects.
Twenty of the sentences were short condition sentences where the determiner pronoun was directly followed by the noun. They were further divided into two types: ten sentences starting with a singular demonstrative pronoun *this* and ten sentences starting with a plural demonstrative pronoun *these*.   Each sentence had a grammatical form and an ungrammatical form as illustrated below.

(4) a. This student/*students took the exam that turned out to be too easy.

   b. These doctors/*doctor treated the patient that used to smoke a lot.

Another twenty of the sentences were long condition sentences. Two adjectives were inserted between the demonstrative pronoun and the noun. The first adjective was chosen from most commonly used adjectives in Corpus of Contemporary America English (Davies, 2008-) and another adjective was chosen from nationality adjectives. Such combination was chosen as to make the sentences sound as natural as possible. As in the short condition, half of them started with a singular demonstrative pronoun and the other half started with a plural demonstrative pronoun. Each sentence had a pair of grammatical and ungrammatical forms. Examples for long condition sentences are provided below.

   (5) a. This bright Irish detective/*detectives located the killer that
          appeared on the television program.

       b. These young German beauties/*beauty admired the athlete
          that seemed very charming to all of us.

Two counterbalanced presentation lists were constructed, each of which consisted of a total of 80 sentences: ten grammatical short condition sentences, ten ungrammatical short condition sentences, ten grammatical long condition sentences, ten ungrammatical long condition sentences, and 40 filler sentences.   Each participant read either the grammatical form or the ungrammatical form of each sentence. No sentence appeared twice in the same list. Every sentence was followed by a simple comprehension question asking participants to decide if the given proposition was true or false. The propositions were designed to be irrelevant to the number information of the subject noun. The materials and questions used in the study are presented in Appendix A.

2.3 Procedure

The experiment was conducted web-based using the Ibex web interface. Participants were assigned to one of the two presentation lists randomly and tested individually. They first filled in personal information and had a practice session of four sentences. This was to help them get used to self-paced reading before the experiment began. Their task was to read each sentence word by word for comprehension at their own pace. They first saw a series of dashes on a white monitor. The dash was replaced by a word every time they pressed a space bar. The previous word was hidden by a dash once the next word appeared. A comprehension question appeared on the monitor after the last word of each sentence. The participants were instructed to press '1' on the keyboard if they thought the sentence was true and press '2' if they thought the sentence was false. Their reading times and the answers were recorded. When they answered the question, the next sentence appeared. The experiment lasted approximately twenty minutes.

2.4 Data Analysis

Prior to analysis, accuracy rates for the comprehension questions of each participant were examined. Two native speakers were excluded from data analysis whose accuracy rates were below 80%. The remaining thirteen native speakers' mean accuracy rate was 95%. The mean accuracy rate for the nonnative speakers was 92.7%. This indicates that both groups were reading the sentences for comprehension.

Reading times (RTs) above or below three standard deviation from the region mean were considered outliers and were removed, which accounted for 1.86% of total data. For the purpose of data analysis, three regions from each sentence were selected as test regions (Table 2). They were i) critical word where the agreement violation takes place and the next two words from the critical word, ii) spillover1 and iii) spillover2. Then residual RTs for each region were calculated to remove word length effect.

Data for short condition sentences and long condition sentences were analyzed separately. Also, a separate analysis was conducted for the native group and the nonnative group. A generalized linear mixed effects model was used at each region with Grammaticality as a fixed factor and subjects and items as random factors. The whole process was done using the lme4 library in the R program (version 3.4.0).

Table 2. Test regions of target sentences

	Pre-critical	Critical word	Spillover1	Spillover2
Short condition	This	student(s)	took	the
Long condition	This (…) Irish	detective(s)	located	the

3. Results
3.1 Raw RTs

Table 3 presents raw RTs of native participants and nonnative participants at the three test regions. A liner mixed effects model found a main effect of Group (native vs. nonnative) in the short condition (*estimate* =132.77, *SE* = 27.63, *df* = 1737.40, *t* = 4.806, *p* < .001***) and in the long condition (*estimate*= 213.63, *SE* = 28.64, *df* = 1652.00, *t* = 7.460, *p* < .001***) indicating that the RTs for nonnative speakers were longer than native speakers.

There was also a main effect of Grammaticality among native speakers at the spillover1 region in the short condition (*estimate* = 50.32, *SE* = 23.81, *df* = 229.65, *t* = 2.113, *p*   < .05*) and at all test regions in the long condition (*estimate* = 51.51, *SE* = 21.15, *df* = 240.86, *t* = 2.436, *p* < .05* at the critical word; *estimate* = 62.77, *SE* = 25.35, *df* = 234.95, *t* = 2.476, *p* < .05* at the spillover1; *estimate* = 54.93, *SE* = 15.57, *df* =

231.17, $t = 3.597$, $p < .001***$ at the spillover2) . The main effect of Grammaticality for the nonnative speakers was significant only at the spillover1 region in the short condition (*estimate* = 139.10, *SE* = 55.41, *df* = 284.41, $t = 2.510$, $p < .05*$)

Table3. Raw RTs of native speakers and nonnative speakers

Native speakers				
		Critical word	Spillover1	Spillover2
Short	Grammatical	398	411	388
		(187)	(374)	(144)
	Ungrammatical	407	456	404
		(200)	(359)	(170)
	Difference	9	45*	16
Long	Grammatical	407	415	328
		(176)	(219)	(127)
	Ungrammatical	410	481	388
		(286)	(400)	(182)
	Difference	3*	66*	60**
Nonnative speakers				
		Critical word	Spillover1	Spillover2
Short	Grammatical	402	420	513
		(351)	(425)	(316)
	Ungrammatical	442	523	493
		(717)	(661)	(268)
	Difference	40	103*	-20
Long	Grammatical	677	632	468
		(568)	(552)	(289)
	Ungrammatical	727	678	473
		(572)	(537)	(326)
	Difference	50	46	5

note: SD in parenthesis, * a significant effect of Grammaticality ($p < .05$), ** $p < .01$

3.2 Residual RTs

Table 4 and Table 5 summarize the statistical analyses conducted on residual RTs examining the main effects of Grammaticality at each region by the native and nonnative speakers. The results for the short condition and the long condition will be reported separately.

Table 4. The main effect of Grammaticality at each region for residual RTs (short condition)

		Est.	SE	df	t	p
Native speakers	Critical word	20.00	12.33	248.23	1.62	0.10
	Spillover1	46.14	22.76	275.54	2.03	0.04*
	Spillover2	15.04	15.26	258.28	0.98	0.32
Nonnative speakers	Critical word	37.59	34.90	308.99	1.07	0.28
	Spillover1	136.33	54.06	300.91	2.52	0.01*
	Spillover2	18.23	20.09	302.73	0.91	0.36

note: * $p <$ .05, ** $p <$ .01, *** $p <$ .001

Table 5. The main effect of Grammaticality at each region for residual RTs (long condition)

		Est.	SE	df	t	p
Native speakers	Critical word	50.04	20.06	258.01	2.49	0.01*
	Spillover1	61.56	24.21	254.24	2.54	0.01*
	Spillover2	54.39	14.85	258.21	3.66	0.00***
Nonnative speakers	Critical word	22.31	52.44	299.47	0.42	0.67
	Spillover1	36.01	55.40	305.54	0.65	0.52
	Spillover2	5.37	32.23	299.65	0.77	0.87

note: * $p <$ .05, ** $p <$ .01, *** $p <$ .001

3.2.1 Short Condition

For the native speakers, there was a significant main effect of grammaticality at the spillover 1 region. No such effect of grammaticality was found at the critical word or spillover 2 regions. In other words, the delay due to ungrammaticality occurred right after the critical word.

The same trend was observed in the nonnative speakers group. The main effect of grammaticality was significant at the spillover 1 region but not in other two regions. This indicates that the nonnative participants also slowed down at the spillover 1 region when there was an agreement violation between the demonstrative pronoun and the noun.

3.2.2 Long Condition

In the long condition, the native speakers showed a significant main effect of Grammaticality at all three test regions (i.e., critical word, spillover1, and spillover2). That is, they were hindered by the number disagreement at the critical word and this effect lingered until the next two words. On the other hand, main effects of Grammaticality were not found for the nonnative speakers at any of the three regions.

4. Discussion

The purpose of this study was to determine 1) whether L2 learners of English with an early AO and a high proficiency are capable of agreement processing in the DP in the local domain and 2) whether there is any effect of dependency length in their performance. As for the first research question, the L2 learners in the study were sensitive to agreement violations in the short condition as were the native speakers. This indicates the learners have acquired and are capable of online

processing of the number feature (*singular/plural*) of *this* and *these* at least when there is no interference. According to Corrêa and Name (2003), agreement processing within the DP is a "post-lexical checking process". In this model, syntactic agreement is described as feature sharing, that the agreeing constituents share the same feature (number, gender, case, etc.). The parser checks for the congruence of the feature of the determiner and the noun after he or she has parsed the whole DP instead of pre-activating elements from the lexicon by encountering the determiner. Monolingual child Portuguese speakers in her study could make use of morpho-phonological information of the determiners that determine the gender feature in Portuguese to correctly process the gender feature of the novel nouns that were matched with the determiners, the result of which supports this model. Adapting this model, the performance of the participants in this study can be interpreted as follows: both the native and the nonnative speakers computed the number feature of the determiner pronouns and the nouns and could successfully judge whether the feature of the two components are congruent.

Regarding the second question, the lack of evidence of delay to disagreements by L2 participants in the long condition implies that they were hindered by an interference between the agreeing constituents when processing number agreement. This is in line with what was found in Keating (2009, 2010) and seems to support the SSH that nonnative speakers are able to process agreement in a native-like pattern only in local domains. Moreover, the distinction of the terms 'local' and 'nonlocal' are not necessarily confined to whether the constituents are "within a phrase" or "outside a phrase". Even when the constituents are within the same phrase (DP in the current study), the physical distance was enough to affect the performance of the L2 learners.

Yet, the results of this study do not directly lead to the qualitative difference of L1 and L2 processing. Reasons for L2 learners' shallow parsing according to linear distance are so far not clear. Clahsen and Felser (2006) argue for an incomplete, divergent representation of L2

grammar which is not explained by processing-related variables such as working memory capacity, reading speed and transfer of L1 processing mechanisms. On the contrary, Cunnings (2016) and Sorace (2006) take the position of processing deficit, arguing that shallow parsing results from not the less detailed L2 grammar but the higher cognitive demands in processing in the L2. According to Cunnings (2016), L2 learners' slow reading speed may lead to difficulties in retrieval of target items, resulting in less sensitivity to grammatical errors in the long dependency length. Since the Group effect (native vs. nonnative) in this study was significant in the analysis of raw RTs, further analyses were conducted if this was also the case in the residual RTs. A linear mixed effects model with Group as a fixed factor and subject and item as random factors revealed a strong main effect of Group in both conditions (*estimate* = 82.37, *SE* = 15.47, *df* = 1680.60, *t* = 5.325, *p* < .001*** in the short condition; *estimate* = 126.84, *SE* = 17.73, *df* = 1696.10, *t* = 7.155, *p* < .001*** in the long condition), such that the native speakers read sentences significantly faster than the nonnative speakers. This indicates that the nonnative participants were experiencing more cognitive burden than the native participants, which might have prevented them from holding the number information of the determiner until they reached the noun while processing additional two adjectives. Hence, the results of this study are better explained by the difference in the L1 and L2 processing than the incomplete L2 representation, although more empirical data are necessary before any firm claim can be made.

Finally, no effect of individual variables (i.e. AO and proficiency) was found in this study. However, individual data from the L2 learners suggest the possibility of proficiency effect in processing long distance agreement. In order to examine the existence of any L2 learner who was sensitive to grammatical errors in the long condition, each participant's mean RRTs in grammatical sentences and ungrammatical sentences at the spillover1 region were compared. The results for all L2 participants are presented in Table 5. Those participants whose RRTs were longer in

ungrammatical sentences are marked by shaded cells. Among the six participants whose mean difference was larger than 100ms, five but one had a TEPS score above average (876). From the perspective of the proficiency level, 71.4% (5 out of 7) of the participants with a TEPS score higher than the average read the word right after the critical region for a longer time when there was a disagreement. Only 11.1% (1 out of 9) of the group with a TEPS score lower than the average performed in this pattern. The effect of AO was not observed in the data. This may be in part due to the already small range of AO owing to the fact that only early learners were included as participants in this study. In addition, it is noteworthy that the participants are EFL learners whose English education mostly took place in Korea. Studies on the role of starting age for EFL learners (Burstall, 1975; Miralpeix, 2006; Muñoz 2008; Singleton, 1995, 1999) suggest that early learners in classroom settings do not take the benefit of an early exposure to the language, unlike those in naturalistic settings. According to Muñoz (2008), the asymmetry between the two settings is due to the different intensity of language exposure. The language input in foreign language settings is usually limited and inconsistent, whereas learners in immersion or naturalistic settings receive unlimited amount of target language input. In other words, the learners' exposure to the target language should be intensive enough for the AO effect to come into play. Hence, additional information is necessary on how long the L2 participants are exposed to English in everyday life, especially in EFL settings, in order to examine the AO effect. Since the amount of language exposure of the participants was not controlled in this study, their possibly varied or little English input may have obscured the AO effect. Finally, it should be emphasized that the interpretation above is not based on any statistical analysis due to a small number of items and should be interpreted with caution.

Table 5.   The mean differences in RRTs of grammatical sentences and ungrammatical sentences in the long condition for each L2 participant

subject no.	proficiency	AO	RRTs in grammatical sentences (ms)	RRTs in ungrammatical sentences (ms)	Difference (ms)
4	808	10	-83.5677	-28.2901	55.27767
15	812	8	-81.273	-40.2506	41.02233
7	823	6	-65.2064	163.1019	228.3083
18	835	10	148.4345	-0.89914	-149.334
10	840	6	-0.30858	-9.63091	-9.32233
14	841	9	66.44343	-178.946	-245.39
16	858	8	160.8625	-47.022	-207.885
12	872	5	-0.14545	-57.0678	-56.9223
22	872	9	-17.9315	17.20773	35.13921
2	879	8	-114.865	75.15739	190.0223
6	902	6	-101.103	213.9302	315.0328
5	920	10	13.63041	-58.4473	-72.0777
11	926	7	-300.733	31.45477	332.1879
19	928	9	-216.709	205.7137	422.4223
20	941	7	-95.3435	117.5341	212.8777
21	960	8	-157.377	-69.861	87.5163

note: shaded cells indicate participants with longer RRTs in ungrammatical sentences

This study has its value in that it is the first study to examine determiner-noun agreement processing in English. Moreover, it extended the language domain for the effect of dependency length to number agreement in the L2 processing. Meanwhile, the limitation of this study lies in the use of materials. The presentation of the demonstrative pronouns without any prior context could have affected readers' performance because demonstratives are used as discourse markers. In fact, an L2 participant reported that he did not notice at first that *this* was used as a determiner of the noun when they were not matched in gender.

For example, in phrases such as *this teachers*, he considered *this* as an objective pronoun. Such confusion could have been mediated if larger context was given. Another limitation is that only AO and proficiency were considered as possible individual differences. Future studies that involve other variables such as working memory and aptitude could provide a different picture in L2 learners' agreement processing.

5. Conclusion

The advanced early learners of English in this study performed in a native-like way in processing number agreement in the DP when there was no interference. When the dependency length increased to two words, they failed to show such sensitivity to grammatical errors. This implies that L2 learners with an early AO and a high proficiency can acquire agreement that does not exist in their L1. Nonetheless, their processing abilities are not as consistent as native speakers so that they are more vulnerable to dependency length. Whether this restriction is due to deficits in processing or representation of L2 grammar, however, needs further investigation.

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Appendix A. Test materials

Short condition

[singular]

1. This student/*students took the exam that turned out to be too easy.
Question: The exam was difficult.

2. This author/*authors wrote the novel that discussed how harsh life was during the Civil War.
Question: Life was hard during the Civil War.

3. This artist/*artists created the portrait that gained instant popularity among the collectors.
Question: The portrait was a failure.

4. This reporter/*reporters wrote the article that discussed some controversial issues that had not been addressed before.
Question: The article contained controversial issues.

5. This soldier/*soldiers killed the cowboy that wore a red vest and tan hat.
Question: The dead cowboy was wearing a blue vest.

6. This teacher/*teachers taught the student that entered the top university in the town.
Question: The student entered the best university in the town.

7. This driver/*drivers bought the car that looked expensive but old-fashioned.
Question: The car looked cheap.

8. This farmer/*farmers bought the land that looked rather dry after five years of draught.
Question: The land looked dry.

9. This athlete/*athletes received the trophy that weighed more than five kilograms.
Question: The trophy weighed 1kg.

10. This florist/*florists arranged the flowers that survived longer than I expected.
Question: The flowers survived long.

[plural]

11. These lawyers/*lawyer provided the evidence that turned out to be powerful enough to convince everyone in the court.
Question: The evidence was too weak.

12. These doctors/*doctor treated the patient that used to smoke a lot.
Question: The patient smoked a lot.

13. These singers/*singer provided the music that became a symbol of the spirit of resistance.
Question: The music was a symbol of obedience.

14. These workers/*worker built the railroad that connected California with the east coast.
Question: The railroad connected California with the east coast.

15. These soldiers/*soldier attacked the town that consisted of more than 250 houses.
Question: The town consisted of less than 10 houses.

16. These victims/*victim accused the suspect that arrived at the courthouse early.
Question: The suspect arrived early.

17. These tourists/*tourist visited the restaurant that served a wide variety of cuisines.
Question: The restaurant served only one cuisine.

18. These experts/*expert reviewed the trial that focused on the multiple rapes committed by a serial rapist.
Question: The trial was about rapes.

19. These editors/*editor received the letter that contained the threat of a new terrorist attack.
Question: The letter was about pleasant news.

20. These scientists/*scientist conducted the study that proved that the chemical is harmful to human beings.
Question: The chemical was found to be harmful.

Long condition

[singular]

21. This famous French actress/*actresses loathed the movie that cost more money than we had anticipated.
Question: The movie did not cost a lot.

22. This heroic American officer/*officers grabbed the spy that wounded a woman during the struggle.
Question: A woman was wounded.

23. This handsome Jewish pilot/*pilots directed the helicopter that transferred the soldiers to the nearest hospital.
Question: The helicopter transferred animals.

24. This arrogant British queen/*queens despised the comedian that charmed all of the other dinner guests.
Question: Other guests liked the comedian.

25. This cautious Hispanic lifeguard/*lifeguards noticed the swimmer that disappeared into the vast ocean.
Question: The swimmer swam close to the lifeguard.

26. This brilliant Black surgeon/*surgeons remembered the operation that taught us several valuable lessons last night.
Question: The operation taught us lessons.

27. This lucky Hungarian driver/*drivers avoided the accident that caused a number of serious injuries.
Question: Nobody was injured in the accident.

28. This wounded Asian captain/*captains watched the ship that turned unexpectedly toward the rocks.
Question: The ship turned toward the rocks.

29. This bright Irish detective/*detectives located the killer that appeared on the television program.
Question: The killer appeared on a radio show.

30. This creative Spanish architect/*architects trusted the guy that assisted the carpenter in building the new house.
Question: The guy assisted the carpenter.

[plural]
31. These brave Italian soldiers/*soldier attacked the castle that held a great deal of important information.
Question: The castle held important information.

32. These veteran German musicians/*musician preferred the instrument that arrived right before the concert began.
Question: The instrument arrived after the concert ended.

33. These childish Turkish students/*student disliked the girl that became more appealing with each passing year.
Question: The girl became more and more appealing.

34. These fearless Scottish hikers/*hiker followed the dear that moved quickly down the side of the mountain.
Question: The deer moved slowly.

35. These wicked Russian scouts/*scout defeated the fort that protected the city from enemies for many more years.
Question: The fort had protected the city for a long time.

36. These injured Syrian rebels/*rebel attacked the camp that housed the fugitives somewhere in the middle of the forest.
Question: The camp housed the fugitives by the sea.

37. These generous Arabian neighbors/*neighbor loved the kids that fed the guests at the Christmas party.
Question: The kids fed the guests.

38. These young German beauties/*beauty admired the athlete that seemed very charming to all of us.
Question: The athlete was not at all charming.

39. These great Greek knights/*knight protected the kingdom that stood tall and proud against the golden horizon.
Question: The kingdom stood tall and proud.

40. These rural Indian peasants/*peasant detested the tractor that ruined the crops before we even had a chance to harvest anything.
Question: The tractor turned out to be helpful.