

## **L2 learners' processing of English articles: An eye-tracking study\***

**Ji-Hyun Park**

**(Gyeongin National University of Education)**

**Park, Ji-Hyun. 2021. L2 learners' processing of English articles: An eye-tracking study.** *Linguistic Research* 38(3): 567-592. Adult language learners' difficulties with second language (L2) articles are well attested in the literature. Ionin et al. (2004, 2009) argued that L2 learners whose native language lacks articles have access to both possible semantic universals of the article system, namely, definiteness and specificity. The fluctuation between the two options may result in learners' misuse of the articles. This study investigates their claim using both online and offline measures of learners' linguistic knowledge. Twenty-two Korean learners and 22 native speakers of English read pairs of sentences that included (un)grammatical articles twice, first with a focus on meaning while their eye movements were recorded, and then to make grammaticality judgments. The learners' performances are discussed in terms of the grammaticality of the article use and the semantic contexts in which the target articles were used in comparison to native English speakers' performance on the same tasks. The online task produced mixed results for the L2 learners, while the offline task relied on the right option for English. **(Gyeongin National University of Education)**

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### **1. Introduction**

Many studies on second language acquisition have reported on learners' difficulties with and misuse of second language (L2) articles (Liu and Gleason 2002; Master 1994; Trenkic 2007). Although a few researchers have elicited learners' spontaneous use of the article during oral production (Robertson 2000; Trenkic 2007; Zdorenko and Paradis 2008), paper-based fill-in-the-blank tasks have been the most used measure of L2 article knowledge (e.g., Butler 2002; Hawkins et al. 2006; Ionin et al. 2004; Liu and Gleason 2002; Snape 2008). However, gap-fill activities may be less suitable for measuring learners' competence in using the articles because of the time they allow

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participants to engage in conscious reflection. Thus, there is a need for more studies that connect real-time processing and L2 article acquisition. Furthermore, as Trenkic et al. (2013) indicated, not much research has been conducted on how L2 speakers process the articles in comprehension. The present study attempts to fill these gaps in the literature by investigating how L2 learners of English comprehend articles during real-time reading.

Recently, the field has seen an increase in various online psycholinguistic methods to study the processing of sentences and morphologically complex words (Jegerski and VanPatten 2013; Kim et al. 2020). For example, researchers have recorded event-related brain potentials (ERPs) or eye movements and have measured comprehension latencies in self-paced reading or listening paradigms. These time-sensitive measures make it possible to tap into real-time processing, during which individuals can rely less on their explicit or metalinguistic knowledge (Ellis 2005). Time-sensitive measures may further reveal whether and how L2 learners perform differently from native speakers (e.g., Clahsen et al. 2010).

A couple of studies have applied online methodologies to investigate L2 learners' article processing. Kim and Lakshmanan (2009) were the first to connect real-time, online sentence processing and L2 article acquisition. They used a self-paced reading task and an offline semantic acceptability task to investigate the acquisition of article semantics. Comparing reading times and acceptability judgments in different semantic settings, the authors claimed that their intermediate L2 learners associated the use of the definite article with specificity, which is an inappropriate semantic distinction for English articles. The advanced L2 learner participants appropriately adhered to the definiteness setting in the offline task, although they did not find evidence through their performance in the online task. Cho (2020) also compared L2 learners' online and offline processing of English articles using a self-paced task and an untimed acceptability judgment task. The researcher found contrasting results with Kim and Lakshmana (2009). Cho reported that while L2 learners' judgment showed different patterns from native speakers in the offline task, they exhibited native-like sensitivity to (mis)uses of article during online processing. Trenkic et al. (2013) investigated how L2 learners from article-lacking backgrounds process English articles while listening using a visual-world eye-tracking technique.<sup>1</sup> The authors found evidence of target-like online processing behavior in that

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1 Participants look at a visual scene containing various objects and listen to an utterance simultaneously while their eye movements are being recorded.

Mandarin-speaking learners were sensitive to morphosyntactic cues in a manner similar to native English-speaking controls rather than over-relying on pragmatic cues.

The present study also employed an eye-tracking technique to study English article processing but in written, rather than auditory, modality. By doing so, the study attempts to investigate whether L2 speakers whose native language lacks articles show online sensitivity to the grammaticality of English articles and related semantic features.

## 2. Theoretical background

### 2.1 Article semantics and L2 article acquisition

Bickerton (1981) proposed one of the first systematic analyses of English articles and their acquisition, that is, how language learners determine the meaning of articles and how this determination governs their selection and/or use of articles in speech or writing. Bickerton analyzed the semantic function of a noun phrase using two features: (1) whether the determiner and following NP refer to a specific referent [ $\pm$  Specific Referent] ([ $\pm$ SR]) and (2) whether the referent is known to the reader or listener [ $\pm$  Assumed Hearer's Knowledge] ([ $\pm$ HK]). These two binary features created four possible combinations. Huebner (1983) adopted and elaborated on Bickerton's analysis by providing definitions and examples. According to his analysis, the use of the English definite article *the* is related to the [+HK] feature.

Several studies on English article acquisition employed Bickerton's binary semantic system [ $\pm$ SR,  $\pm$ HK] (Huebner 1983, 1985; Master 1987; Thomas 1989). Huebner (1983, 1985) and Master (1987) claimed that L2 learners initially associate *the* with the feature [+HK]. By contrast, Thomas (1989) argued that both L1 and L2 learners initially relate the definite article to the feature [+SR]. More recently, Ionin et al. (2004) investigated L2 learners' acquisition of the English articles in terms of two semantic features, but with a more restrictive notion of specificity. Ionin et al. (2004: 5) posited that a determiner phrase (DP) is [+specific], if "the speaker intends to refer to a unique individual in the set denoted by the NP and considers the individual to possess some noteworthy property". A noun is [+definite] when "the speaker and the hearer presuppose the existence of a unique individual in the set denoted by the NP". In accordance with previous studies (e.g., Thomas 1989), Ionin and colleagues also observed an overuse of *the* in indefinite

contexts. They accounted for this in terms of what they called the “Article Choice Parameter”.

## **2.2 Cross-linguistic article grouping: Two-article languages**

Ionin et al. (2004) proposed two possible Universal Grammar (UG) options for article systems. Some two-article languages may distinguish articles based on definiteness (e.g., English), while others distinguish them based on specificity (e.g., Samoan). This optionality is termed the Article Choice Parameter (ACP). The authors hypothesized that L2 learners have full access to UG, including both settings of the ACP, and that L2 learners may fluctuate between the two settings in the process of parameter setting. The results of Ionin et al.’s study support this claim. Although the English article system is set based on definiteness, Russian and Korean learners of English still had access to a specificity feature. As a result, they overused *the* with specific indefinites and *a* with non-specific, definite DPs. Ionin et al. (2009) revised Ionin et al.’s (2004) original proposal on the ACP based on additional data from Samoan. The authors (2009) found that languages that distinguish two articles based on specificity (e.g., Samoan) mark definites and specific indefinites with the same article and unspecified indefinites with the other.

## **2.3 The context of the present study**

The present study aimed to test Ionin et al.’s (2004, 2009) proposals about fluctuations in L2 article use through online and offline measures of linguistic competence. Ionin et al. (2004: 25) stated that the main purpose of their study was “to elicit their learners’ intuitions about article choice rather than to test their knowledge of explicit rules”. However, as one of their reviewers pointed out, the use of a forced-choice elicitation task may not be conducive to testing learners’ intuitions as the task may lead learners to exploit their explicit knowledge. Ellis (2005) similarly pointed out that fill-in-the-blank exercises may invite the use of explicit knowledge. Therefore, it is important to address the generalizability of Ionin et al.’s findings using an online methodology. Addressing this issue, Kim and Lakshmanan tested Ionin et al.’s (2004) fluctuation hypothesis, using a combination of self-paced reading and an offline semantic

acceptability task. Their goal was to demonstrate that learners at a certain stage of L2 development fluctuated between the two article-choice parameter settings. They found that intermediate-level learners relied on the specificity setting in online self-paced reading tasks, but showed evidence of fluctuation in offline tasks. Their advanced learners showed fluctuations between the two semantic settings in the online task. They relied on the correct definiteness setting in the offline task as native speakers of English. These results support the hypothesis of Ionin et al.. However, the study was limited in scope, as their experimental items instantiated only two of the four possible semantic conditions: [-definite, -specific] and [-definite, +specific].

The present study builds on Kim and Lakshmanan (2009), including experimental items for all four semantic conditions. The study employed a grammatical acceptability rating task as an offline measure, and a reading experiment with eye-tracking as an online task. Eye-movement data may afford a somewhat richer picture of L2 learners' processing patterns than self-paced reading, given that participants in an eye-tracking experiment, but not a self-paced reading study, can go back and reread a previous part of the sentence. Eye-movement data allow one to differentiate between successive visits to a critical area, which may prove important when distinguishing between early and late effects in processing (Dussias 2010; Frenck-Mestre 2005).

As in Kim and Lakshmanan's (2009) self-paced reading study, the study investigated L2 learners' sensitivity toward ungrammatical articles in different semantic contexts, as defined by combinations of the specificity and definiteness features. The specific research questions addressed in this study are as follows:

1. Do Korean L2 learners of English show sensitivity to the ungrammaticality of a given article in terms of definiteness, which is the correct setting for English?
2. If they do, does the sensitivity vary according to the specificity condition of the determiner phrase in which the article is used?

### **3. Methodology**

#### **3.1 Participants**

Twenty-two advanced Korean learners participated in the study. Only those who arrived in the United States as late adolescents or adults (over 17 years old) were

recruited. Their length of residence in an English-speaking country ranged from six months to six years. All participants were graduate or undergraduate students studying at a large Midwestern university in the United States. The Korean participants had taken the TOEFL test as part of their university entry requirements (iBT TOEFL: mean = 99.09, SD = 9.69, range: 82–112). To gather more updated proficiency data, the structures section of the DIALANG language proficiency diagnostic system (<https://dialangweb.lancaster.ac.uk/>) was administered. DIALANG is a self-assessment tool of language proficiency developed by a consortium of European higher education institutions. It diagnoses language skills in terms of the Common European Framework (CEF) for language learning. The levels of participants in the present study ranged from B2 (upper intermediate) to C1 (advanced). Three participants were classified as B1 (lower intermediate) and one as C2 (proficiency). Based on their TOEFL scores and the results of DIALANG, the participants were regarded as upper intermediate to advanced learners.

To counterbalance the materials of the study, the participants were divided into two groups, Group A and Group B (explained in more detail in the Materials section). Care was taken to have a similar distribution of Korean participants in terms of proficiency between the two groups. The number of participants at each level was roughly the same in both groups. The mean TOEFL score of Group A was 100 (SD = 8.91) and that of Group B was 98.18 (SD = 10.77). The results of an independent samples *t*-test showed that participants in the two groups did not differ significantly in proficiency level ( $t(20) = 0.43, p > .05$ ). Finally, 22 native English speakers, who were undergraduate students at the same university, participated as the control group in the study. Participants were randomly divided into two groups.

### 3.2 Materials

The online reading experiment comprised a total of 64 items. Of the 64 items, 32 were actual test items and 32 were fillers. The ratio between the test items and fillers was set according to Harvik et al. (2009). Additionally, three practice items were included at the beginning of the online task. The test items consisted of eight items for each semantic context type. Each item consisted of a pair of sentences. The target DP always appeared at the end of the first sentence but never in sentence-final position; that is, to avoid sentence wrap-up effects (Just and Carpenter 1980), an adverbial phrase was placed

after the DP.

For the [+definite, +specific] and [+definite, -specific] contexts, the stimuli were adapted from Ionin et al. (2004). The original stimulus items in Ionin et al. (2004) were conversations between two interlocutors. The author took the turn of the speaker that included the critical use of the article and edited it so that it became two sentences. The original wording of the areas of interest were retained. The first sentence consisted of two clauses (see Example (1) below). The first clause provided information that made the semantic context [+definite]. The second sentence further specified the target semantic condition as; either [+definite, +specific] or [+definite, -specific]. Thus regardless of the semantic condition created by the second sentence, the definite article *the* was appropriate.

(1) [+definite, +specific]

Sarah's mother was attacked last month and police are still searching for the attacker in the city. His name is Roger Williams.

(2) [+definite, -specific]

Tom's sister was attacked last week and police are still searching for the attacker in the city. I really want to know who it is.

For the other two indefinite semantic contexts, the stimuli from Kim and Lakshmanan's (2009) study were adapted. In these items, the second sentence manipulated the target semantic condition. As they were all in the [-definite] context, the indefinite article *an* is appropriate in the target DP.<sup>2</sup> One example of each context is given below. For the purposes of presentation, the target area is underlined, however, in the study these were presented in regular font.

(3) [-definite, +specific]

I'm going to interview an athlete this weekend. You won't believe which athlete I'm interviewing.

(4) [-definite, -specific]

I'd like to interview an actor for the school newspaper. Any actor will be fine.

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2 To reduce the influence of different lengths of the definite article *the* and indefinite article *a* on reading times, all the target determiner phrases were manipulated to involve *an* rather than *a*.

Two versions of test items were prepared. First, an ungrammatical counterpart of each test item was created by replacing *the* with *an* and vice versa. The test items were distributed across two counterbalanced presentation lists for Groups A and B to ensure that each participant would read either the grammatical or the ungrammatical version of a given stimulus pair, but not both. The same filler items were included in both versions. The filler items were in the same format as the test items. Half of them were designed to contain two sentences that were not logically connected to each other. In some cases, this logical flaw was due to grammatical errors such as gener or number disagreement.

After the initial version of the stimulus sentences was created, five native speakers read it and checked whether the sentences sounded natural and the target articles were used correctly. They read both the grammatical and ungrammatical versions. Items were revised where necessary based on their opinions. Then native speakers checked the finalized items once more.

The same material used in the online reading experiment was used in the offline acceptability rating task. The filler and practice items were excluded. Therefore, the material for the offline reading experiment consisted of only 32 test items. Each participant received the same version of the material as before. For example, a participant who read version A in the online experiment was asked to rate the acceptability of the same list of items.

### 3.3 Procedure

The experiment consisted of four parts in the following order: (1) a questionnaire on their demographic information, (2) an eye-tracking reading experiment, (3) an offline grammaticality acceptability rating experiment, and (4) DIALANG.

For the online reading experiment, the participants read four grammatical and four ungrammatical pairs of sentences in each of the four context types, supplemented by filler and practice items. The order of presentation of sentences was randomized. While the participants read the sentences on the computer screen, their eye movements were recorded with an EyeLink 1000 from SR Research, a desk-mounted eye-tracker with head and chin support. The computer screen was placed at a distance of about 80cm. After reading each pair of sentences which appeared in the middle of the screen, participants pushed a button to bring up a yes/no question. The question asked whether the sentences



made sense together. The aim of the questions was to prompt participants to read carefully to grasp the meaning. The participants were instructed to read the sentences as naturally as possible and to answer the questions as quickly as possible. No specific emphasis on grammar was placed in the instruction or during the experiment.

For the offline grammaticality acceptability rating task, the participants read each pair of sentences that they read during the eye-tracking experiment anew and judged the acceptability of the underlined determiner on a scale from 1 (least acceptable) to 4 (most acceptable). Then, the structure section of DIALANG was administered. It was conducted at the end of the experiment to avoid learners' focus on grammatical accuracy, which might have affected their performance in the online reading experiment.

### 3.4 Data analyses

#### *Online reading experiment with eye-tracking*

The regions of interest were the critical article and the whole DP including the critical article.<sup>3</sup> Each measure of fixation time (see below) for the region of interest was averaged over all participants and trials, and mean reading times were compared between native and non-native speakers in terms of grammaticality and semantic context. Following Godfroid and Uggen (2013), Keating (2009), and Roberts et al. (2008), three standard reading time measures were reported: first fixation duration, gaze duration, and total time. The first fixation duration refers to the duration of the first fixation in the critical region. Gaze duration is the sum of all fixations in the region from when the eyes enter the critical region for the first time until the eyes leave the region either to the left or right. For the total reading time, all fixations on the critical region were summed. In addition to these three measures, the re-reading time was calculated by subtracting the gaze duration from the total reading time. This indicates the amount of time spent when participants return to the critical region to reread.

In addition to these reading time measures, skipping rates were also computed. Since articles are short function words, it is highly probable that readers would skip them, at least initially during first-pass reading (Brysaert et al. 2005; Drieghe 2008; Frenck-Mestre 2005; Rayner et al. 1996). However, if the participants were sensitive to

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3 Interest areas were automatically defined at the single word level by Experiment Bilder software. Reading times on an article and the following noun phrase were calculated using the Get Reading Measures application from SR Research.

the ungrammatical article choice, they might have revisited the ungrammatical article later to reassess its meaning and fit within the discourse context. Therefore, in this study, the total skipping rate and first-pass skipping rate on the target articles were analyzed. It was hypothesized that lower skipping rates, especially lower total skipping rates, for ungrammatical than grammatical articles would signal grammatical sensitivity. It should be noted that less skipping increases average fixation durations, other things being equal. Therefore, these two behavioral indices of grammatical sensitivity (longer fixations and fewer skips) are conceptually related.

#### *Offline grammatical acceptability rating*

The mean and standard deviations of the rating scores were compared in terms of grammaticality and semantic context.

#### *Statistical analyses*

The present study aimed to investigate whether upper-intermediate-to-advanced Korean ESL learners are sensitive to the grammaticality of a given article (research question 1) and whether they are more sensitive to grammaticality in some semantic contexts than others (research question 2). To answer the research questions, statistical tests in SPSS (version 19) were run with grammaticality and semantic condition as fixed variables and each of reading time measure and skipping rate as a dependent variable. Reading times were measured at two different levels: at the level of the article and at the level of the whole DP. The reading time data at the DP level met the assumptions after being transformed with a log function, and a factorial ANOVA on the log-transformed data was conducted. The reading times of the articles did not meet parametric assumptions. For these measures, a series of Mann-Whitney U tests on the reading times for the ungrammatical and grammatical articles were conducted for each semantic condition. Skipping rates were also measured at the level of article. For the statistical analysis of skipping rates, the author examined whether the given article was skipped in each trial. As it was a categorical variable, a binary logistic regression was performed with participants and test items as a subject and within-subject variable, respectively, and grammaticality as a categorical predictor.

To answer the second research question, participants' sensitivity to ungrammaticality in different semantic contexts was investigated. Following previous studies (Jiang 2004;

Keating 2009), differences in reading times between grammatical and ungrammatical items were used for the sensitivity scores. As these data did not satisfy parametric assumptions, a series of Mann-Whitney U tests were conducted. Offline task scores were also statistically investigated using Mann-Whitney U tests.

### 3.5 Predictions

#### *Online reading experiment with eye-tracking*

The basic question of the experiment was whether the participants would react differently when they encountered the expected and unexpected uses of the articles. In the online task employed in the study, different reactions were expected to show in different reading times for the region of interest.

Table 1 shows which article participants expect to appear in each semantic context if they rely on the definiteness or the specificity option. In either setting, the definite article *the* is expected in the [+definite, +specific] condition (condition 1) and the indefinite article *an* is expected in the [-definite, -specific] context. According to Ionin, Zubizarreta and Philippor (2009), the same article use is expected in the [+definite, -specific] as well. Therefore, the [-definite, +specific] and [+definite, -specific] contexts will be the critical conditions for analysis to distinguish between reliance on definiteness and specificity following Ionin et al. (2004), and only the [-definite, +specific] condition following Ionin et al. (2009).

Table 1. Expected use of the article on the basis of two semantic universal options

	Semantic Condition	Definiteness	Specificity
1	[+definite, +specific]	the	the
2	[+definite, -specific]	the	*an/**the
3	[-definite, +specific]	an	the
4	[-definite, -specific]	an	an

Note: \*An is expected following Ionin et al. (2004); \*\*the is expected following Ionin et al. (2009).

The prediction for the native English-speaking control group was that they would distinguish the two articles based on definiteness, which is the right semantic setting in English. It was not expected that the sensitivity effect would differ in different semantic contexts. Furthermore, because definiteness is established early in the discourse, that is,

before the occurrence of the target DP (cf. examples (1)–(4) in the materials section) the effect could manifest itself in early measures of processing, such as first fixation and gaze duration.

There are three possible patterns that L2 participants may show. First, they may adhere to the definiteness option and show processing patterns similar to the native speaker group. This indicates that they successfully acquired the semantic dimension of the English article system.

Second, the L2 participants may have distinguished the articles based on specificity. In that case, their processing patterns would still resemble native speakers, except for condition 3 [-definite, +specific], in which they would be expected to skip *an* less and/or look at *an* for longer than *the*. This is the opposite of what one would predict under a definiteness account. As the specificity of a referent is not clear until after the target DP (compare examples (1) and (3) with (2) and (4)), grammatical sensitivity in condition 3 [-definite, +specific] may only manifest itself in late reading measures such as re-reading and total time. To elaborate, participants may go back to the region of interest after reading the second sentence in the trial because this is the sentence that determines whether the target DP is specific.

Finally, it is also possible that the participants fluctuated between the definiteness and specificity options, as predicted by Ionin et al. (2004, 2009). As the two parameter settings converge on article choice in three out of four contexts, it is predicted that participants will process *the* items faster in condition 1 [+definite, +specific] and condition 2 [+definite, -specific] and *an* items faster in condition 4 [-definite, -specific], compared to their ungrammatical counterparts. However, the fluctuation hypothesis predicts that L2 participants will not show sensitivity, but rather comparable reading times and skipping rates, for violations in condition 3 [-definite, +specific].

Regardless of the option in article grouping (definiteness, specificity or fluctuation), L2 learners are expected to show sensitivity to grammaticality in conditions 1 [+definite, +specific], 2 [+definite, -specific] and 4 [-definite, -specific]. However, it is also possible that L2 participants' reading behavior does not match any of the predictions described above. Specifically, if L2 learners are unable to access article semantics during real-time reading, they may not detect the ungrammaticality of a given article in any context.

#### *Offline grammaticality acceptability rating*

If the participants respond according to definiteness, they are expected to rate *the* items

higher in conditions 1 and 2 [+definite, ±specific] contexts and *an* items higher in conditions 3 and 4 [-definite, ±specific]. If participants rely on specificity, they will rate *the* higher for conditions 1 and 3 [±definite, +specific], but they will prefer *an* in condition 4 [-definite, -specific]. If the participants fluctuate between the two options, their ratings will follow the same pattern, except that they will show no difference between *the* and *an* items in condition 3 [-definite, +specific].

## 4. Results

### 4.1 Online reading experiment with eye-tracking

#### *Reading times and skipping rates at the level of article*

While online reading, native speakers showed some sensitivity toward the ungrammaticality of the articles. They consistently fixated on ungrammatical articles for longer than grammatical ones, regardless of whether the semantic condition required a definite or indefinite article (Table 2). This difference in reading times was considered to reflect their sensitivity toward the ungrammaticality, and a series of Mann-Whitney U tests showed that the differences were significant in condition 3 [-definite, +specific] during first-pass reading (measured by first fixation duration and gaze duration). Differences in re-reading and total reading were significant in all the semantic conditions (Table 3). By contrast, Korean learners tended to read *the* for longer than *an* regardless of grammaticality. In semantic conditions 1 and 2, they fixated on grammatical *the* for longer than ungrammatical *an*, both during first-pass and re-reading. In conditions 3 and 4, they read ungrammatical *the* for longer than grammatical *an*. Differences in re-reading time and total reading time were significant in condition 4 [-definite, -specific] (Table 3).

The raw data revealed that the first-pass reading time was often zero, but the total reading time exceeded zero. This indicates that the participants skipped the article while reading these trial sentences at first but returned and revisited the article later. To see whether they skipped the article more in certain semantic conditions than others, the skipping rates for grammatical and ungrammatical items were calculated. Native speakers skipped correct articles significantly more often than incorrect articles in semantic

Table 2. Reading times and skipping rates

Measure/ Semantic condition	AOI	Korean Learners					Native Speakers					
		Gram		Ungram		MD	Gram		Ungram		MD	
		M	SD	M	SD		M	SD	M	SD		
First Fixati on Durati on	1	Article	98.58	104.26	82.99	123.66	-18.62	73.86	101.51	82.72	116.04	6.98
		DP	173.23	101.53	210.00	121.79	30.06	176.23	83.40	209.08	86.24	28.10
	2	Article	81.77	107.13	57.00	92.36	-25.35	64.64	99.61	82.93	145.57	18.03
		DP	184.58	98.50	166.51	123.16	-19.17	179.43	82.71	221.98	119.42	42.52
	3	Article	104.53	119.35	112.99	118.05	5.92	74.18	106.00	120.50	113.55	46.32
		DP	184.41	109.93	189.88	101.37	0.65	195.08	103.87	206.44	94.61	11.36
	4	Article	95.47	124.43	113.23	124.67	18.46	90.24	116.18	93.66	116.95	3.42
		DP	178.00	118.17	179.44	104.34	2.29	191.73	85.12	187.59	92.48	-4.14
Gaze Durati on	1	Article	100.87	107.14	84.53	124.40	-19.37	78.44	112.52	86.81	125.87	6.40
		DP	369.55	264.79	360.33	235.03	-22.63	275.65	182.78	312.93	158.91	30.17
	2	Article	85.41	112.84	57.00	92.357	-29.02	65.87	101.47	87.44	152.15	21.20
		DP	359.37	230.66	298.77	251.61	-62.06	293.14	184.44	337.15	219.06	43.75
	3	Article	104.53	119.35	122.20	135.05	14.92	74.18	106.00	125.07	120.32	50.89
		DP	362.48	258.91	388.81	289.80	15.87	324.33	213.66	376.88	219.17	52.55
	4	Article	95.47	124.43	113.23	124.67	18.46	94.67	123.04	96.60	119.92	1.93
		DP	387.19	302.85	406.60	290.57	21.18	307.86	198.09	308.27	195.90	0.41
Re-re ading time	1	Article	228.67	300.49	165.93	229.29	-68.32	87.71	144.66	237.54	309.78	144.43
		DP	756.90	894.55	854.46	1097.92	68.90	220.93	256.06	521.16	571.23	288.39
	2	Article	194.84	318.08	189.94	275.65	-8.44	78.77	127.65	164.44	200.53	85.52
		DP	632.92	751.90	724.14	986.30	80.67	181.56	230.74	349.91	419.80	167.26

3	Article	213.21	275.02	254.72	315.14	37.18	145.03	223.60	237.59	289.30	92.56
	DP	704.13	699.72	807.99	833.68	87.54	301.11	313.47	435.91	460.34	134.80
4	Article	168.26	283.64	262.78	378.90	92.89	90.83	167.80	261.65	298.26	170.82
	DP	724.38	881.28	927.21	1058.33	199.39	279.21	264.52	572.44	484.83	293.24
1	Article	329.55	311.45	250.46	261.55	-87.69	166.15	170.18	324.35	333.49	150.83
	DP	1126.44	901.13	1214.79	1096.08	46.28	496.58	277.45	834.09	574.71	318.56
2	Article	280.25	318.89	246.94	275.00	-37.46	144.64	145.01	251.89	236.58	106.72
	DP	992.29	759.02	1022.91	952.59	18.60	474.70	246.16	687.06	457.15	211.01
3	Article	317.74	299.35	376.92	354.73	52.10	219.22	221.89	362.66	302.06	143.44
	DP	1066.61	744.11	1196.80	878.70	103.41	625.44	351.31	812.78	459.65	187.34
4	Article	263.72	283.79	376.01	395.36	111.36	185.50	228.39	358.25	317.36	172.75
	DP	1111.57	954.36	1333.81	1019.17	220.57	587.07	329.76	880.72	541.01	293.65
First skip	1 Article	.50	.50	.64	.48	.14	.63	.48	.62	.49	-.01
	2 Article	.61	.49	.71	.45	.10	.68	.47	.69	.46	.02
	3 Article	.51	.50	.47	.50	-.04	.64	.48	.41	.49	-.23
	4 Article	.57	.50	.48	.50	-.09	.57	.50	.56	.50	-.01
Total skip	1 Article	.19	.39	.32	.47	.13	.38	.48	.27	.44	-.11
	2 Article	.28	.45	.32	.47	.05	.43	.49	.32	.47	-.11
	3 Article	.23	.42	.19	.39	-.04	.33	.47	.14	.34	-.19
	4 Article	.24	.43	.20	.40	-.04	.41	.49	.15	.35	-.26

*Note:* AOI = Area of Interest, Gram = Grammatical, Ungram = Ungrammatical, M = Mean, SD = Standard deviation, MD = Mean difference, Condition 1 = [+ definite, +specific], 2 = [+definite, -specific], 3 = [-definite, +specific], 4 = [-definite, -specific]

Table 3. Mann-Whitney Results (Article reading times)

Measure/ Semantic condition		Korean Learners			Native Speakers		
		Mann-Whitney U	Z	Asymp. Sig. (2-tailed)	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
First Fixation Duration	1	3277.00	-1.29	.20	3706.00	-0.27	.79
	2	3341.00	-1.58	.11	3778.00	-0.18	.86
	3	3630.00	-0.36	.72	2987.50	-2.83	.01**
	4	3428.00	-1.16	.25	3798.00	-0.24	.81
Gaze Duration	1	3278.00	-1.29	.20	3704.00	-0.28	.78
	2	3321.50	-1.65	.10	3763.00	-0.24	.81
	3	3566.00	-0.57	.57	2954.50	-2.93	.00**
	4	3428.00	-1.16	.25	3800.50	-0.23	.82
Re-reading	1	3210.00	-1.44	.15	2807.00	-3.27	.00**
	2	3676.00	-0.35	.73	2941.00	-2.95	.00**
	3	3476.50	-0.84	.40	3042.00	-2.62	.01**
	4	3149.00	-2.02	.04*	2234.00	-5.17	.00**
Total	1	3058.00	-1.86	.06	2733.00	-3.22	.00**
	2	3581.00	-0.62	.54	2934.00	-2.74	.01**
	3	3441.00	-0.92	.36	2675.50	-3.56	.00**
	4	3124.00	-2.00	.05*	2287.50	-4.74	.00**

Note: Condition 1 = [+ definite, +specific], 2 = [+definite, -specific], 3 = [-definite, +specific], 4 = [-definite, -specific]; \* $p < .05$ , \*\* $p < .01$

Table 4. Logistic regression results (Article skipping rates)

Measure/ Semantic condition		Korean Learners			Native Speakers		
		Wald Chi-square	df	Sig.	Wald Chi-square	df	Sig.
First skip	1	4.24	1	.04*	0.04	1	.83
	2	3.08	1	.08	0.09	1	.76
	3	0.42	1	.52	9.93	1	.00**
	4	1.06	1	.30	0.03	1	.86
Total trial	1	5.48	1	.02*	2.85	1	.09
	2	0.62	1	.43	3.66	1	.06
	3	0.57	1	.45	10.19	1	.00**
	4	0.30	1	.59	13.69	1	<.001

Note: \* $p < .05$ , \*\* $p < .01$

condition 3 during the first-pass reading. They did skip grammatical articles more often



in semantic conditions 1 and 4 as well, but the difference in skipping rates was not very large (Tables 2). The Korean participants patterned differently. They skipped more ungrammatical items in semantic conditions 1 and 2, but the other way around (i.e., skipped more grammatical items) in semantic conditions 3 and 4. To summarize, they skipped the indefinite article *an* more often than the definite article *the*, regardless of the grammaticality of the article.

Sometimes, the participants did not fixate on the article during the entire trial. The skipping rates during the entire trial were lower than those during the first-pass reading, which indicates that the participants returned to the article during further reading. Native speaker participants clearly skipped more correct articles than incorrect ones. The differences were significant in conditions 3 and 4. For Korean learners, the trend in skipping behavior was similar to that of first-pass reading (Table 4).

#### *Reading times at the level of determiner phrase (DP)*

At the DP level, native speakers' latencies varied in terms of grammaticality in the same way they did at the article level. In general, these participants read phrases more slowly when they were ungrammatical across semantic conditions (Table 2). However, the differences were significant only in condition 2 for the first fixation measure and gaze duration. For the total duration measure, the differences were significant in all semantic conditions (Table 5).

Table 5. ANOVA Results (DP reading times)

Measure/ Semancit condition	Korean Learners					Native Speakers					
	Sum Sq	df	Mean Sq	F	Sig.	Sum Sq	df	Mean Sq	F	Sig.	
First Fixation Duration	1	0.03	1	0.03	1.02	.31	.01	1	0.01	0.49	.49
	2	0.00	1	0.00	0.16	.69	.15	1	0.15	5.91	.02*
	3	0.00	1	0.00	0.15	.70	2.514E-5	1	2.514E-5	0.00	.98
	4	0.00	1	0.00	0.20	.66	.00	1	0.00	0.01	.91
Gaze Duration	1	0.03	1	0.03	1.25	.26	0.01	1	0.01	0.39	.53
	2	0.02	1	0.02	0.70	.40	0.19	1	0.19	7.03	.01*
	3	0.03	1	0.03	1.13	.29	0.03	1	0.00	0.09	.76
Re-readi ng	4	0.01	1	0.01	1.19	.66	4.419E-5	1	4.419E-5	0.00	.97
	1	0.10	1	0.10	1.22	.27	0.92	1	0.92	13.97	.00**
2	0.03	1	0.03	0.36	.55	0.11	1	0.11	1.70	.19	

	3	0.01	1	0.01	0.06	.82	0.00	1	0.00	0.02	.88
	4	0.02	1	0.02	0.29	.59	0.19	1	0.19	2.91	.09
Total	1	0.04	1	0.04	0.53	.47	0.95	1	0.95	15.31	.00**
	2	0.01	1	0.01	0.14	.71	0.48	1	0.48	7.74	.01**
	3	0.04	1	0.04	0.45	.50	0.29	1	0.29	4.70	.03*
	4	0.33	1	0.33	4.28	.04*	0.49	1	0.49	7.91	.01**

Note: Condition 1 = [+ definite, +specific], 2 = [+definite, -specific], 3 = [-definite, +specific], 4 = [-definite, -specific]; \* $p < .05$ , \*\* $p < .01$

The Korean participants read *the* + noun more slowly than *an* + noun during the first-pass reading (gaze duration). During re-reading, they fixated on ungrammatical DPs for slightly longer than grammatical DPs in all semantic conditions. However, the difference was significant only in semantic condition 4 (Table 5).

#### *Sensitivity across semantic conditions*

To answer the second research question, statistical differences in the magnitude of sensitivity across semantic conditions were investigated. Sensitivity was defined as the difference in reading times in the target regions between grammatical and ungrammatical conditions. The scores between semantic conditions 1 [+definite, +specific] and 2 [+definite, -specific] and between 3 [-definite, +specific] and 4 [-definite, -specific] were compared. If participants relied on the specificity or fluctuated between the two article semantic universals, then their processing patterns were expected to differ between the semantic conditions in each pair. Especially, the different reading patterns were expected during further pass reading (measured by re-reading and total reading time), because the information that set up the specificity condition appeared after the target DP. Korean learners did not show a significant difference in sensitivity to the article during further pass reading (Table 6). Interestingly, native English speakers' sensitivity scores were statistically different in re-reading duration at the level of the article and at the level of DP between semantic conditions 3 and 4. In other words, specificity condition played a role in native speakers' processing of articles in indefinite contexts. This was surprising as it has been claimed that English distinguishes the two articles solely based on the definiteness.

Table 6. Mann-Whitney U results (Sensitivity Scores)

Measure	Area of Interest	Korean						English					
		+definite			-definite			+definite			-definite		
		Mann-W hitney U	Z	Sig.	Mann-W hitney U	Z	Sig.	Mann-W hitney U	Z	Sig.	Mann-W hitney U	Z	Sig.
First Fixation Duration	Article	3607.00	-0.79	.43	3592.00	-0.83	.41	3794.50	-0.23	.82	2868.00	-2.97	.00**
	DP	3031.50	-2.49	.01*	3691.00	-0.54	.59	3635.50	-0.70	.48	3584.00	-0.85	.39
Gaze Duration	Article	3847.00	-0.07	.94	3687.00	-0.55	.58	3808.50	-0.19	.85	2807.00	-3.15	.00**
	DP	3496.50	-1.11	.27	3806.00	-0.20	.85	3835.50	-0.11	.91	3325.50	-1.62	.11
Re-reading	Article	3220.00	-1.93	.05	3459.00	-1.22	.22	3751.00	-0.36	.72	3019.00	-2.52	.01*
	DP	3772.00	-0.30	.77	3787.50	-0.25	.80	3563.00	-0.91	.36	3157.50	-2.11	.04*
Total	Article	3376.00	-1.47	.14	3465.50	-1.20	.23	3750.00	-0.36	.72	3607.50	-0.78	.43
	DP	3814.00	-0.17	.86	3685.00	-0.55	.58	3565.00	-0.91	.36	3476.00	-1.17	.24

Note: \* $p < .05$ , \*\* $p < .01$

#### 4.2 Offline grammaticality acceptability rating

In the offline task, the participants rated the extent to which the article used in the sentence was acceptable. The results show that the Korean participants in this study rated the acceptability of the article similarly to native speakers (Table 7). In the [+definite] contexts, both groups rated the definite article significantly higher than the indefinite article. Conversely, in the [-definite] contexts, acceptability ratings were higher for *an* items than *the* items. Independent samples Mann-Whitney U tests showed that the differences between grammatical and ungrammatical items were all significant ( $p < .001$ ) in every semantic condition for both participant groups.

Table 7. Mean grammatical acceptability ratings and standard deviations

Condition	Korean Learners				Native Speakers of English			
	Grammatical		Ungrammatical		Grammatical		Ungrammatical	
	M	SD	M	SD	M	SD	M	SD
1 [+def, +spec]	<b>3.84</b>	0.43	<b>1.38</b>	0.75	<b>3.90</b>	0.43	<b>1.30</b>	0.60
2 [+def, -spec]	<b>3.53</b>	0.76	<b>1.78</b>	1.08	<b>3.93</b>	0.26	<b>1.76</b>	1.03
3 [-def, +spec]	<b>3.38</b>	0.90	<b>1.72</b>	0.92	<b>3.85</b>	0.55	<b>2.04</b>	0.94
4 [-def, -spec]	<b>3.92</b>	0.27	<b>1.16</b>	0.45	<b>3.93</b>	0.26	<b>1.50</b>	0.72

Note: Significant contrasts are in boldface.

## 5. Discussion

The results of both online and offline tasks generally confirmed the previous findings that native speakers distinguish between the two articles based on definiteness. In the offline task, they rated *the* as more acceptable in [+definite] contexts and *an* as more acceptable in [-definite] contexts. They were also sensitive to the ungrammatical uses of the article in online sentence processing. In the online task, during first-pass reading, native speakers skipped grammatical and ungrammatical articles at similar rates. However, when they did not skip, they read ungrammatical items for longer than grammatical items. In other words, they fixated on the target region for longer when the indefinite article was used in [+definite] contexts and when the definite article was used in [-definite] contexts, regardless of whether the condition was [+specific] or [-specific]. During re-reading, native speakers read ungrammatical articles for significantly longer than grammatical ones in all semantic contexts. They skipped ungrammatical articles less than grammatical articles in all semantic conditions. This difference in skipping rates was significant in semantic conditions 3 (total skip) and 4 (first and total skip). Overall, native speakers' processing patterns were affected by the grammaticality of a given article.

As for the Korean learners, the offline task results confirmed the prediction that they would adhere to the definiteness distinction, which is the right option in English. They accepted the definite article and rejected the indefinite article in [+definite] conditions. Conversely, they accepted the indefinite article more than the definite article in [-definite] conditions. However, in the online reading experiment, they did not show native-like processing patterns, which indicates their lack of intuitive knowledge of the articles. During the first-pass reading, Korean learners of English skipped the indefinite article *an* more than the definite article *the* in all semantic contexts. When they fixated on the article, they read the definite article more slowly than the indefinite article although the differences in reading times were not statistically significant. Thus, the difference in reading time between the indefinite and definite article is explained by word length rather than grammaticality. The trend was similar during the re-reading. Overall, Korean learners of English were not sensitive to the ungrammatical uses of the article in an online reading experiment, at least in semantic conditions 1, 2 and 3. This result does not conform to any of the predictions made by the article grouping by two semantic universals, because even if they were still fluctuating, the participants would have been expected to show sensitivity to grammaticality in semantic conditions 1, (2) and 4 according to these

predictions.

Non-native-like online processing patterns by L2 learners, such as those found in the present study, were also observed in other studies (Jiang 2004, 2007; Tokowicz and MacWhinney 2005). For example, Jiang (2004) found that nonnative speaker participants were insensitive to the number morpheme in a comprehension-based self-paced reading task, although they showed nearly perfect performance on the written grammar test. He explained this discrepancy in learners' performance in terms of the competence deficit approach, which views second language learners' morphological difficulties as reflecting a deficit in their competence. He argued that although the learners had explicit knowledge about the number morpheme and subject-verb agreement in English, "this knowledge is not an integrated part of their L2 competence and thus is not activated in reading comprehension" (Jiang 2004: 624). What is interesting is that while some previous studies found that L2 learners have implicit sensitivity to ungrammaticality of the forms that are unique to the L2 (e.g., Tokowicz and MacWhinney 2005), the present study found that Korean learners whose native language lacks an article system did not process the articles online in a targetlike way. This may be related to the nature of the target structure. Articles are discourse-related grammatical structures, and as Robertson (2000) stated, the use of the definite article is often pragmatically redundant. For example, when a speaker says, "Please close the door," the use of the definite article is pragmatically redundant as reference is sufficient in the context to identify it. Pragmatically redundant arguments can be omitted in discourse-oriented languages, such as Chinese and Korean (Crosthwaite 2013). In other words, while the shared knowledge between the speaker and the hearer is signalled in the form of the definite article in English, it is not mentioned in the discourse in Korean and Chinese (refer to Lyons 1999 and Trenkic 2007, for more discussion on grammatical definiteness and semantic/pragmatic definiteness). Robertson (2000: 158) argued that "the article may not be used in the interlanguage grammar where the information encoded in the article of the native speakers' grammar can be recovered from the context". If this is the case, it is possible that L2 learners do not notice the information provided by the article in reading unless special attention is drawn to its form.

Although Korean participants were not sensitive to ungrammatical uses of the article during online reading and were sensitive in the offline task in general, the differences in acceptability rating and reading times between grammatical and ungrammatical articles varied according to the semantic conditions. In the offline task, the average acceptability

ratings differed across the semantic conditions. Between the two [+definite] contexts, the acceptance rate of *the* was a slightly higher in the [+specific] condition than in the [-specific] condition. They also rejected *an* more in the [+specific] condition. The same happened under the two [-definite] conditions: higher acceptance of *an* and rejection of *the* in the [-specific] context than in the [+specific] context. A possible explanation could be that the Korean participants in this study still fluctuated between the two settings, although they relied more on the definiteness option than the specificity. Some trends toward a specificity setting or fluctuation were also found in the online experiment. In the [+definite, +specific] condition, participants' average first fixation on the indefinite DP was longer than on the correct, definite DP. The re-reading time and total reading time were also longer although not statistically. By contrast, in the [+definite, -specific] condition, they tended to gaze at the definite DP for longer than at the indefinite DP during the first-pass reading. The result does not conform to the revised proposal on article grouping by Ionin et al. (2009), but it shows that the specificity feature affected the participants' article processing. As for the two [-definite] conditions, the participants looked at the definite article for longer than the indefinite article under both specificity conditions. Thus, overall, they seemed to rely on the definiteness setting to some extent. However, the sensitivity to ungrammaticality was significant only in the [-definite, -specific] condition, and the differences in reading times between grammatical and ungrammatical items were much larger in this condition than in the [-definite, +specific] condition as well. This finding demonstrates that specificity, not only definiteness, affected the participants' reading behavior in the two indefinite contexts. This may lend evidence to fluctuation prediction.

However, a more cautious interpretation may be needed because these differences across semantic conditions were also observed in the native speakers' data. In the offline task, the native speakers of English also rejected ungrammatical the less in [+specific] contexts, although they accepted the grammatical articles at consistently high rates in all contexts. Their online sensitivity toward ungrammaticality also varied significantly in semantic conditions 3 and 4. The results show that native speakers are less sensitive to the ungrammatical use of the articles when the value of two semantic features is mismatched. This may indicate that specificity may play a role in the article choice.

Thus, the definiteness setting does not seem to be as fixed as argued in previous studies. It is also possible that specificity is not clearly independent of definiteness, as Ionin et al. (2004) claimed. The more frequent use of [+definite, +specific] references

than the [+definite, -specific] references mentioned above supports this interpretation. According to the more traditional notion of specificity and definiteness of Bickerton (1981), all non-generic definite references are specific. In addition, it is possible to explain the results in terms of separate reception and production processes (see Spinner 2013, for an overview). Ionin et al. supported their claims for the ACP and the fluctuation hypothesis with written production data only. By contrast, the present study employed comprehension-based tasks. More research is needed to test the extent to which the claims made by the article grouping based on semantic universals generalize to online processing in comprehension as well.

## 6. Conclusion

Based on previous studies, this study predicted that Korean learners would adhere to either of the two grouping options for the articles (i.e., grouping by definiteness or specificity) or fluctuate between them. The Korean participants in this study did not show online sensitivity to the use of articles contrary to any of the predictions. However, they showed a rather clear reliance on the definiteness option in the offline task as native speakers did. The results of the present study indicate that although Korean learners have some knowledge of the use of English articles, they are unable to access it in real time, like native speakers.

Differences among different semantic conditions were found in the processing patterns of the Korean participants. They could be interpreted as evidence for the specificity setting or fluctuation, as native speakers did not perform differently across the semantic conditions, which is not compatible with the claims made by the previous studies on the two article-grouping options. Further research is required to investigate this phenomenon. Overall, the results present a challenge to the proposal of article grouping based on the two semantic universals.

There are several limitations to this study that might have affected the results. First, the number of participants was limited, and their proficiency levels varied. This may have caused the results to be mixed and less interpretable. Having different levels of participants in different groups and comparing their performance may provide a clearer picture of how Korean learners process the articles. Second, the value of the definiteness feature of a given pair of sentences may be subjective and open to the interpretation of

individual participants. Although designed carefully, creating a definite context with one or two clauses was challenging, and not every participant may have interpreted them as intended. This may have made the native speakers accept the ungrammatical article *the* at a rather high rate in the [-definite, +specific] contexts. Employing more extended contexts in test items is recommended for further studies.

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**Ji-Hyun Park**

Assistant Professor  
Department of English Education  
Gyeongin National University of Education  
Gyesan-ro 62, Gyeong-gu,  
Incheon, 20144 Korea  
E-mail: jhpark21@ginue.ac.kr

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