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# SECOND LANGUAGE PROCESSING OF WH-MOVEMENT IN ENGLISH: THE EFFECTS OF FIRST LANGUAGE AND LEARNING ENVIRONMENT

By

Se Hoon Jung

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Submitted to
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ABSTRACT

SECOND LANGUAGE PROCESSING OF WH-MOVEMENT IN ENGLISH:
THE EFFECTS OF FIRST LANGUAGE AND LEARNING ENVIRONMENT

By

Se Hoon Jung

The present study, through the replication and extension of Juffs's (2005) research, sought to investigate the effects of different L1 syntactic features (including two factors: lack of wh-movement, and the head-final VP feature) and different learning environment on proficient adult learners' processing of wh-filler/gap constructions in English. The three groups of English learners (Chinese ESL, Korean ESL, and Korean EFL) and a group of native English speakers as control participated in a word-by-word self-paced online reading and the consequent grammaticality judgment tasks that included three types of wh-constructions that violate Subjacency and four types of grammatical long distance (LD) wh-extraction. While all learner groups showed sensitivity to Subjacency violation, the analysis of their accuracy scores and word-level reading profiles on grammatical wh-structures showed a strong effect of L1, in which, while lack of overt wh-movement in L1 syntax was found to be disadvantageous for all learners' processing and comprehension of those structures, the head-final characteristic of L1 Korean put additional burden on L1 Korean learners' wh-filler/gap processing in English. The analysis also found a significant effect of learning environment, in which the Korean EFL learners demonstrated greater processing difficulty as compared to the Korean ESL learners especially in the extraction of wh-phrase from the finite clausal condition.

Table of Contents

List of Tables

List of Figures

## Introduction

Accessibility to Universal Grammar (UG) in second language acquisition has long been a primary research area specifically within the generative framework, in which especially the question of whether or not (or more moderately, 'to what extent') adult learners are able to acquire native-like second language (L2) grammatical knowledge has been controversial among researchers (see, White, 2003). This question, however, has not clearly been resolved, mainly due to inconsistent research results observed in a number of UG-based L2 studies (Juffs, 1998b).

In light of this ongoing controversy, there also have been considerable efforts to seek an alternative approach as a better model for explaining late learners' variant and relatively inferior L2 performance. One such effort is a syntax-based L2 research model that takes psycholinguistic consideration of first language (L1) sentence processing, such as Active Filler Hypothesis (Frazier, 1987; Frazier & Clifton, 1989) or Principle-based Parsing (Pritchett, 1992a), into account. The underlying assumption of this approach is that adult learners may encounter processing problems in parsing certain target language structures online (e.g., wh-constructions) regardless of their possession of relevant UG-driven L2 knowledge (Juffs & Harrington, 1995; White & Juffs, 1998; Williams et. al., 2001; Juffs, 2005). Given this assumption, some studies explored learners' online reading patterns to examine how they process the target structures differently from native speakers, by implementing experimental psycholinguistic methods, such as a moving window technique (e.g., Juffs & Harrington, 1995, 1996, Juffs, 2005) or an eye-tracking method (e.g., Frenck-Mestre, C., & Pynte, J., 1997).

If processability, in addition to competence deficit, can be another problem of adult learners, then the next question to consider is, "What factors make it more difficult for late L2 learners to process certain L2 structures?" One aspect that has been steadily investigated as such a factor is the assumption that syntactic variation between and among languages may be closely associated with different processing strategies, (e.g., Juffs & Harrington, 1995; White & Juffs, 1998). If this is the case, it will become evident that learners must learn not only the required L2 grammatical system, but also relevant L2 processing strategies to be fully proficient in their L2 use (Marinis, 2003). In formulating wh-questions, for example, the way a wh-element is placed in a sentence varies from language to language. Some languages require a wh-word to be overtly moved to the sentence-initial (or phrase-initial when it occurs in a relative clause) from its original position (i.e., wh-movement; English or Spanish, for example). On the other hand, some other languages require no such movement, at least on the surface level (i.e., wh-in-situ; Chinese, Korean or Japanese, for example). Based on such differences in syntax, L2 learners whose native languages do not require wh-movement may have difficulties in processing English wh-structures because the procedure of filling the wh-gap (i.e., finding the pre-movement position of wh-words) may not be familiar to those learners.

Taking this syntactic variation of wh-movement into consideration, Juffs and Harrington (1995) investigated how adult L1 Chinese (i.e., wh-in-situ) ESL (English as a Second Language) learners process English wh-constructions differently from native English speakers. They measured individual participant' word-level self-paced reading times (RTs) and accuracy rates on ungrammatical and grammatical wh-constructions

using a moving window technique (Just et al., 1982). While their grammatical sensitivity in rejecting ungrammatical wh-movement was comparable to the control (i.e., accuracy rates on the ungrammatical wh-constructions), the study found that the Chinese group showed significantly slower reading patterns to those of the control group specifically at the possible wh-gaps (i.e., subject or object candidate positions). Juffs and Harrington claimed that late learners' relatively poorer processing abilities (as they are compared to those of the native speakers), caused by syntactic differences between L1 and L2, may be the locus of adult learners' inferior performance.

Juffs (2005), based on previous research (e.g., Fender, 2003, Juffs, 1998a), also considered different headedness of the VP (i.e., head initial and head final) as another variable that may potentially influence adult L2 processing. With the test items developed from Juffs and Harrington (1995), Juffs (2005) compared L1 Spanish ESL and L1 Chinese ESL learners' (both head-initial: SVO) reading profiles and accuracy rates on grammatical wh-extraction to those of Japanese ESL learners (head final: SOV). In this comparison, Japanese learners showed significantly lower accuracy rates and slower RTs than other experimental groups especially when they were to integrate wh-phrases to the possible argument gaps, implying that the head-final feature in their L1 made the target structures more difficult to process for Japanese speakers; however, as noted by Juffs, it was not clear whether the Japanese speakers' less accurate and slower processing patterns was because of L1 effects or their initially lower L2 proficiency. Therefore, by matching the proficiency level between groups, this study seeks to explore this aspect further (i.e., the effect of different headedness in L1) through the replication of Juffs (2005).

In addition to investigating the effect of first language, the present study also explores the effect of learning environment on late learners' second language sentence processing, namely ESL and EFL (English as a foreign language) contexts. There have been ongoing debates in the generative SLA literature about the role of learning environment with relation to the issue of UG availability, which remains controversial. For example, those who argue against UG operation in L2A have argued that adult L2 learners in a foreign language learning context may not be able to acquire UG-driven L2 grammar because the types and amount of their L2 input is restricted to formal instruction in a classroom setting, (e.g., Felix & Weigle, 1991, Johnson & Newport, 1991). On the other hand, UG proponents argued that UG access by late learners can take place both in the foreign and second language learning contexts (e.g., White & Juffs, 1998). With this in mind, there has been little effort to explore how different learning environment and its consequences (e.g., different types of input or different amount of input) may play a role in late learners' L2 processing of target language structures in real time. Therefore, by comparing proficiency matched Korean ESL and Korean EFL learners' reading profiles and accuracy rates on the given structures, the present study seeks to reveal how different learning environment and its consequences (e.g., different amount of exposure to L2 in daily life) have an effect on late learners' L2 processing.

## Review of Literature

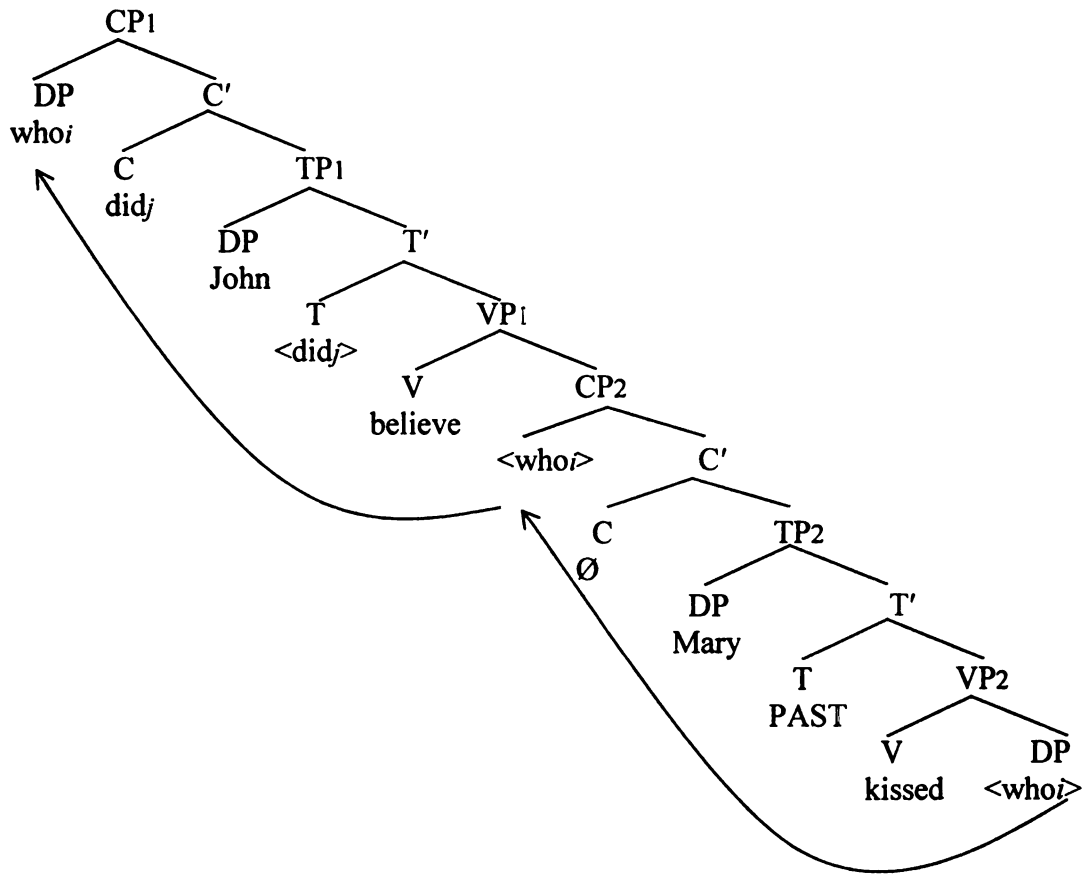
### *Parametric variation in wh-movement*

The syntactic movement operation of wh-elements occurs if a language contains a strong wh-feature (e.g., English) in the head of CP (i.e., C), in which wh-phrases are to be

raised to the Spec of CP for feature checking (Chomsky, 1995). To take an example from English, in (2) *who* takes the movement operation and overtly moves from its original argument position (i.e., the object argument of *kiss*, as in (1)) into the Spec of CP1. During this procedure, movement is constrained by the Subjacency Principle in that a constituent (i.e., a wh-word) may not cross more than one bounding node[1] in a single movement (Chomsky, 1977; 1981).

(1) John believed (that) Mary kissed who (m).

(2)

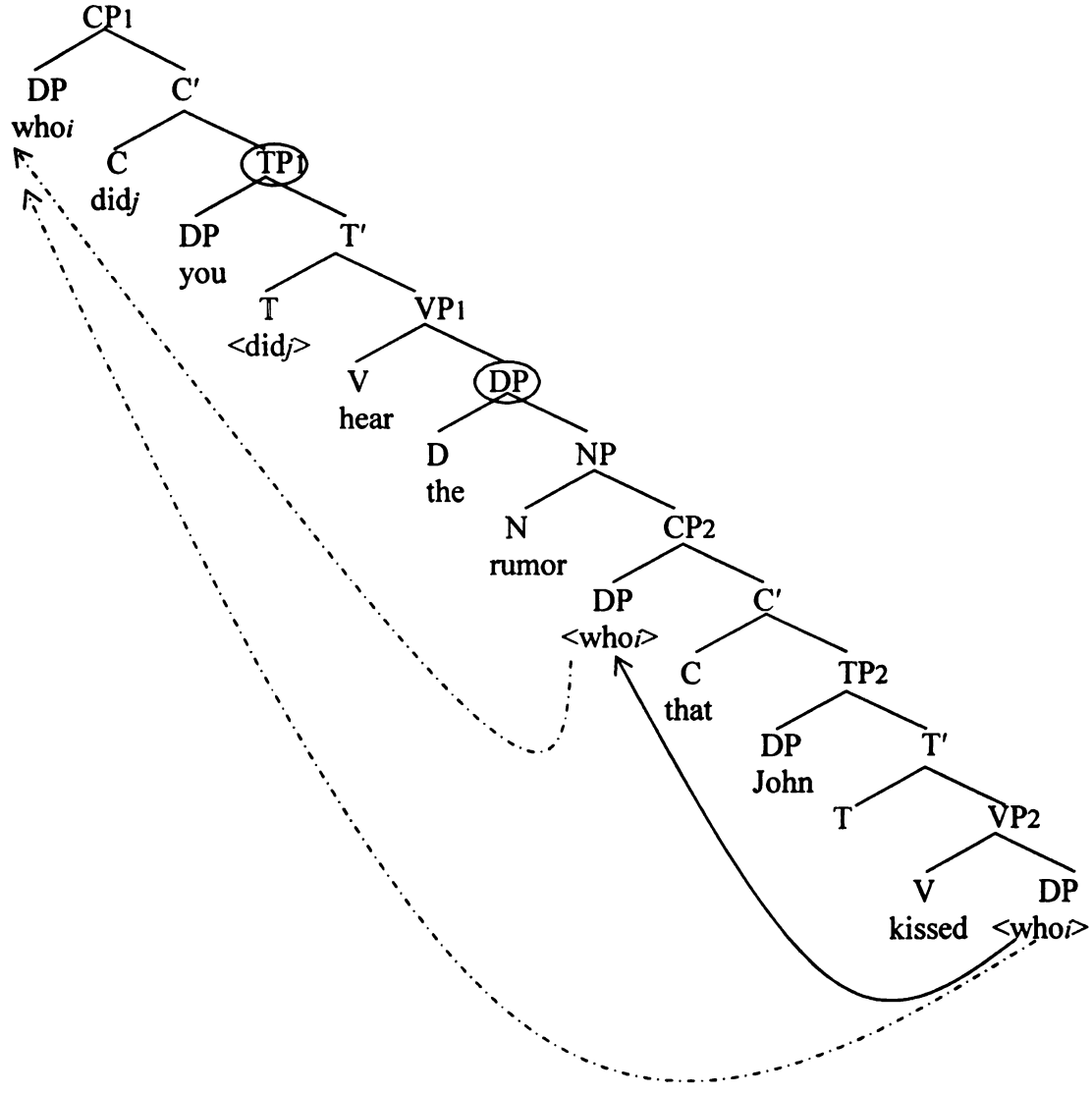



[1] In English, a bounding node generally refers to IP or TP, and DP (Hawkins, 2001; White, 2003).

Given this constraint on the movement operation, in (3) *what*$_i$ cannot move to the Spec of CP2 because that place is already occupied by another wh-element, *who*$_i$ (i.e., wh-island constraint). Another way of fronting *who*$_i$ is moving it directly to the Spec of CP1; however, this trial causes unacceptable movement (i.e., Subjacency violation) by crossing two bounding nodes (i.e., TP1 and TP2) in one single movement. A similar pattern of Subjancency violation can also be found in (4):

(3) *[CP1 What*i* did [TP1 Ryan think [CP2 who*j* [TP2 <who*j*> bought t*i*]]]]?

(4)



In (4), while the dashed line indicates the syntactically unacceptable movement, *who*$_i$ cannot move to the sentence-initial position because, from the Spec of CP2, it must cross two bounding nodes (i.e., DP and TP1) in a single movement (i.e., complex NP island).

While languages whose wh-feature is strong must follow the Subjacency constraint for making grammatically acceptable movements, languages such as Chinese, Korean or Japanese do not need to obey this principle, at least not overtly in syntax, because wh-feature of those languages is weak, hence having no reasons of operating movement for feature checking, at least in syntax boundary. For those that fall into this category, a wh-word stays in its original argument position overtly, which is shown in (5) through (8) with examples from Korean and Japanese. In (6) and (8), the subjects of the embedded clauses (i.e., *nu•ka* and *dare• ka,* respectively) are the requested information in the form of wh-phrases, and they are required to stay in the same position of *Amy* in (5) and (7).

- *Korean*

(5) Ryan•un Amy•ka Mercedes•reul sa•tta go seng•kak•he•tta.
Ryan-TOP Amy-NOM Mercedes-ACC buy-PAST-Comp think-past-Dec-Part
'Ryan thought Amy bought a Mercedes.'

(6) Ryan•un nu•ka Mercedes•reul satta go seng•kak•hen•ni?
Ryan-TOP who-NOM Mercedes-ACC buy-PAST-Comp think-PAST Q-Part
'Who did Ryan think bought a Mercedes?'

- *Japanese*

(7) Ryan•wa Amy•ga Mercedes•wo Ka•tta•to omoima•sita
Ryan-TOP Amy-NOM Mercedes-ACC Buy-Past-Comp think-PAST.
'Ryan thought Amy bought a Mercedes.'

(8) Ryan•wa dare•ga Mercedes•wo ka•tta to omoima•sita•ka?
Ryan-TOP who-NOM Mercedes-ACC buy-PAST-Comp think-PAST-Q-Part
'Who did Ryan think bought a Mercedes?'

*The effects of L1 and learning environment on adult L2 acquisition: UG debates*

While it is generally agreed that UG access is available in first language acquisition literature, it has been controversial in adult second language acquisition of morpho-syntax especially in relation to the effect of L1 and learning environment (e.g., Bialystok, 1997; Bley-Vroman et al, 1988; Johnson & Newport, 1989, 1991; Li, 1998; Patkowski, 1980; Schachter, 1989, 1990; Slabakova, 2003; White, 1992; White & Genesee, 1996; White & Juffs, 1998). This section briefly summarizes the previous UG-based studies that investigated late learners' acquisition of L2 Subjacency specifically in relation to these two factors.

Bley-Vroman et al. (1988) sought to find evidence of maturational effects on L2 acquisition and examined 92 adult Korean speaking learners of English by testing their grammatical sensitivity to Subjacency and ECP (Empty Category Principle) violation via a grammaticality judgment task (GJT). The focus of the research was whether or not those adult learners acquired subtle knowledge of English subjacency that is not operative in their L1. In their experiment, participants showed approximately 75 percent accuracy rates in rejecting ungrammatical wh-movement and ECP, implying that those participants correctly understood the rules of wh-movement in English, at least, at above the chance level. However, the authors suggested two other possible interpretations for such high accuracy results; first, UG could be operative in adult L2 acquisition, but its strength may be weaker than in child L2 acquisition. Second, a fundamentally different learning

"cognitive system, a general problem solving system", rather than UG operation, may be applied in adult L2 learning (p. 27).

Similarly, Schachter (1989; 1990) also investigated L1 Korean late ESL learners' acquisition of Subjacency via a GJT. The result showed that the participants did not show the relevant knowledge of Subjacency by accepting the ungrammatical wh-movement as correct in many cases; the accuracy rates were even below the chance level (i.e., less than 50 percent in the Yes/No grammaticality judgments). Schachter concluded that late L2 learners cannot access UG, and therefore they cannot acquire UG-driven L2 knowledge (i.e., they cannot acquire knowledge of the Subjacency Principle in L2 as long as it is not operative in their L1s).

Johnson and Newport (1991) tested Chinese-speaking learners of English to examine the effects of age on L2 acquisition. They divided participants into four groups based on learners' age of arrival in the English speaking environment. The test results from the GJT on Subjacency revealed that participants who were exposed to ESL contexts after puberty performed significantly more poorly on the test as opposed to the other comparison groups, whereas the three other experimental groups, divided by age of arrival from the age of 4 to 16 (hence, roughly before puberty), showed results relatively comparable with the control group.

In addition, Johnson and Newport found that there was a continuous decline in participants' performance along with the age of arrival. They concluded that there is a maturational effect in the process of second language acquisition, and consequently L2 learners would not be able to acquire subtle syntactic features of L2 that are not operative in their L1s if their learning started after puberty (i.e., approximately 15-16 years old,

according to Long, 1990), or if their L2 input before puberty was limited to formal instruction (e.g., a foreign language environment).

In relation to those studies, Felix and Weigle (1991) investigated more specifically the effect of learning environment in SLA. They included English wh-extraction as a part of the test items in a GJT and tested 77 German high school EFL students whose exposure to English was limited to formal classroom instruction. For their English learning, participants usually received rather non-communicative English lessons (e.g., traditional audio-lingual and grammar-translation methods) and their L2 proficiency was represented roughly as "beginning, intermediate, and advanced learners" by the researchers (p. 166). In their conclusion, Felix and Weigle claimed that EFL learners whose L2 input is restricted to formal classroom settings cannot access UG.

On the other hand, White and Juffs (1998), based on their findings, argued that late learners can access to UG regardless of their learning environments. They examined ESL/EFL learners' grammaticality judgments on Subjacency violation in English and their sentence-level reading profiles on grammatical wh-constructions. The results showed that both ESL and EFL learners performed well, showing almost equivalent accuracy rates in rejecting ungrammatical wh-extraction as compared to the control. From this result, the authors claimed that those adult learners were able to correctly distinguish possible and impossible wh-movement in English although Subjacency is not attainable in their L1 (i.e., Chinese). The authors concluded that UG is available regardless of the place (i.e., types or amounts of L2 input) in which L2 learning occurs.

In addition to investigating the availability of UG, White and Juffs (1998) also attempted to explore the effect of learner processability in the same study by measuring

participants' sentence-level RTs and comparing them to those of the control. This comparison showed that although learners' average RTs were significantly slower than native speakers, their accuracy rates and reading patterns in terms of predictable difficulty were comparable to the control group; all groups performed better on object extraction than subject extraction. While this finding was correspondent to that of Jorden (1991), Schacter (1990) and Schacter and Yip (1991), White and Juffs suggested that processing difficulties could be a better explanation for learners' relatively poorer performance on grammatical subject wh-extraction (i.e., less accurate for their grammatical judgments and slower in their readings). Although their aim was in supporting UG availability in the L2 domain, this implication they suggested became a crucial starting point for later studies (Juffs, 2005; Juffs & Harrington, 1995[2]).

*The effects of L1 and learning environment: L2 processing of wh-filler/gap constructions*

While UG-based research has not provided reliable accounts for inconsistent L2 performance of late learners, research interest in how late learners actually process L2 structures online has steadily grown. Followed by White and Juffs (1998), Juffs and Harrington (1995) focused more on aspect of L2 sentence processing. They brought the Principle-based Parsing framework that has been widely accepted in the L1 processing literature (Fender, 2008; Gibson and Hickok, 1993; Stowe, 1986; Williams, 2006) in which Juffs and Harrington adopted two primary principles proposed by Pritchett (1992a), as shown in (9) and (10).

[2] It is necessary to note for clarification that the experiment in White and Juffs (1998) preceded the one reported in Juffs and Harrington (1995) (Juffs, 2005, p.123).

(9) Theta Reanalysis Constraint (TRC):

"Syntactic reanalysis which re-interprets a theta-marked constituent as outside of a current theta domain is costly." (Pritchett, 1992a, p.15)

(10) Generalized Theta Attachment (GTA):

"Every principle of the syntax attempts to be maximally satisfied at every point during processing." (Pritchett, 1992a, p.138)

The intrinsic basis for these two principles is that the parser processes the sentence in an incremental manner when it attempts to find the place for wh-fillers. In other words, native speakers try to fill the wh-gap as soon as possible as they read the sentence incrementally word-by-word (i.e., GTA). The incremental characteristic of sentence processing is also assumed as a native speaker's basic processing strategy in Frazier's (1987) Active Filler Strategy (AFS) (Dallas & Kaan, 2008). AFS assumes that the filler's syntactic category is hypothesized at each grammatically possible position and each gap is tested as a candidate for a filler position until the parser successfully find the right place (Frazier and Clifton, 1989).

The evidence of incremental processing manner can be found in processing Garden Path (GP) sentences, an example of which is shown in (11):

(11) After Steve ate the soup proved to be poisoned (Pritchett, 1992b, p. 326).

In processing this sentence, *the soup* would be initially analyzed as a direct object of *ate*, but then this analysis must be revised when the parser runs into the incoming word *proved*; *the soup* must be reanalyzed as a subject of *proved* in the main clause. During this procedure, additional processing burden may be required for readers under the

prediction by the TRC because the syntactic reanalysis has to be made from the adverbial to the main clause (i.e., reinterpretation of the argument, *the soup* across the different theta domain; *ate* → *proved* domain), possibly causing garden-path effects (Juffs and Harrington, 1996).

While assuming that Principle-based Parsing accounts might work in describing late learners' inferior L2 performance, Juffs and Harrington (1995) hypothesized that late English learners whose L1s lack Subjacency Principle (i.e., wh-in-situ) would encounter processing difficulty to some extent when they are involved in a wh-filler/gap procedure. This is because the incremental wh-filler/gap procedure—which has been generally accepted as a general parsing mechanism by native English speakers—is not required in their L1 processing of wh-constructions. The test items they analyzed include three types of ungrammatical wh-extraction and four types of grammatical wh-extraction. The grammatical wh-extraction types are shown in (12) through (15) with the sub-details of incremental filler-gap procedures in each structure; the examples and its procedural description of each were described based on Juffs and Harrington (1995) and Juffs (2005):

(12) Who does Andy expect to meet Laura? <u>(subject extraction, nonfinite clauses)</u>

a) Initial posit: wh-word as an object of the main clause

- *Who$_i$ does Andy expect $t_i$ ?*

b) Reanalysis: object → subject of the embedded nonfinite clause

- *Who$_i$ does Andy expect [$_{IP}$ $t_i$ to]?*

c) Reanalysis: subject → object of the embedded clause

- *Who$_i$ does Andy$_k$ expect [$_{CP}$ [$_{IP}$ PRO$_k$ to meet $t_i$ ?]]*

d) Reanalysis and parsing termination: object → subject of the embedded clause

- *Who$_i$ does Andy$_k$ expect [$_{CP}$ [$_{IP}$ $t_i$ to meet Laura?]]*

(13) Who did the manager expect to hire? (Object extraction, nonfinite clauses)

a) Initial Posit: wh-word as an object in the main clause

- *Who did the manager expect $t_i$ ?*

b) Reanalysis: object of the main clause → subject of the embedded clause

- *Who did the manager$_k$ expect [$_{IP}$ $t_i$ to]?*

c) Reanalysis and parsing termination: subject → object of the embedded clause

- *Who$_i$ did the manager$_k$ expect [$_{CP}$ [$_{IP}$ PRO$_k$ to hire $t_i$]] ?*

(14) Who$_i$ did Soojin think $t_i$ loves Jenny? (subject extraction, finite clauses)

a) Initial posit: wh-word as an object of the main clause

- *Who$_i$ did Soojin think $t_i$?*

b) Reanalysis: object → subject of the embedded finite clause

- *Who$_i$ did Soojin think [$_{IP}$ $t_i$ loves?]*

c) Parsing termination

- *Who$_i$ did Soojin think [$_{IP}$ $t_i$ loves Jenny]*

(15) Who does John think Ryan met yesterday? *(object extraction, finite clauses)*

a) Initial Posit: wh-word as an object of the main verb *believe*

- *Who$_i$ does John think $t_i$?*

b) Reanalysis and parsing termination: object (main clause → embedded clause)

- *Who$_i$ does John think Ryan met $t_i$ yesterday?*

As shown above, the examples in (12) ~ (15), through its procedural description, show that there can be different levels of parsing complexity depending on the place of the gap position and the finiteness of the embedded clause, in which extraction of subject are expected to be relatively more difficult to process than extraction of object (i.e., subject-object asymmetry) within the identical clausal condition, and subject wh-extraction from nonfinite clause requires the most complicated parsing process (i.e., more frequent experience of TRC). To take an example from (12), the extraction of wh-phrases from a subject gap in a nonfinite clause is considered to be the most complicated structure in terms of its processing complexity. In (12), the wh-word is initially tested in the object position of the matrix verb *expect* (12a), then the parser must change this hypothesis as it encounters the next word *to*; the initially posited object is to be analyzed as a subject in the nonfinite embedded clause (12b). The second reanalysis occurs in (12c) after the parser processes the next unit, *to* in which the previously posited subject must be reanalyzed as an object of the embedded clause, as in (12c). Lastly, the parser must go back to its second analysis (12b) when the object trace is filled with *Mary*. On the other hand, object extraction from finite clauses seems to require relatively less complicated action for parsing, in which the parser takes only one time of theta reanalysis, as in (15).

As noted earlier, White and Juffs (1998) speculated that there may be processability problems in late learners' L2 performance. However, because they simply measured sentence-level RTs, it was not clear at which points learners had more processing problems thereby spending more time. To clarify this issue, Juffs and Harrington (1995) conducted a test of Subjacency with late L1 Chinese ESL learners by implementing an on-line moving window procedure and the consequent GJT. In this

procedure, each sentence was given one word at a time, and each individual participant was allowed to control the pace of word presentation by pushing the designated button at his/her own pace. In this way, Juffs and Harrington measured each individual's word-level RTs. The results showed that Chinese participants' performance on the ungrammatical wh-extraction was comparable to that of the control group, but that they were less accurate and slower on grammatical subject wh-extraction, which, according to the Principle-based Parsing account, requires heavier parsing procedure (e.g., case reassignment, reanalysis of structure position). In the conclusion, the authors claimed that adult learners' processing deficit, rather than deficient L2 competence, may be the better explanation for adult L2 learners' inferior performance on the given stimuli.

In a follow-up study, Juffs (2005) replicated Juffs and Harrington (1995) with three highly proficient groups of ESL groups: L1 Spanish, L1 Chinese, and L1 Japanese speakers. The L1 Spanish group (wh-movement & SVO in L1) was added to confirm the L1 effects (absence/presence of wh-movement in L1) found in the previous research. By comparing accuracy scores and reading patterns of the L1 Spanish (wh-movement) ESL to those of the L1 Chinese Japanese (wh-in-situ) ESL groups, the author hypothesized that the Spanish group would outperform the Chinese and Japanese groups because, Spanish speakers might be more familiar with the incremental wh-filler/gap activities from their L1 processing experiences (i.e., positive transfer).

In addition, Juffs (2005) also considered different headedness of VP (i.e., word order) as another independent variable in this study; thus the Japanese group (SOV, head-final) was also included. The prediction of this factor was based on Fender (2003) and Juffs (1998a; 1998b). In those studies, L2 learners whose L1s are the head-final (i.e.,

SOV) showed more difficulties "when incrementally integrating English words into phrase and clause structures" (Fender, 2003, p.296). In SOV languages such as Japanese and Korean, arguments of a verb (e.g., subject or object) are processed before the verb. Given that a verb generally constrains its arguments, the parser in those head-final languages may delay its decision of case and theta assignment until it processes the verb (Pritchett, 1992b). Taking such differences of parsing strategies between L1 (i.e., Japanese, head-final: delay of argument integrations into VP) and L2 (i.e., English, head-initial: argument integrations in an incremental fashion), Juffs postulated that L1 Japanese ESL learners may have additional processing loads as compared to the other ESL groups when parsing the head initial English wh-constructions.

To briefly summarize the results of Juffs (2005), the effect of the L1 in terms of wh-movement was confirmed to some extent; while all participants showed subject-object asymmetry, the Spanish group showed better accuracy rates and faster RTs than the Chinese and Japanese groups in processing grammatical wh-extraction. In terms of different headedness of VP, the Japanese group showed more difficulties not only in filling subject gaps, but also in "integrating objects into the parse" (p.143). However, Juffs could not elicit a strong claim that different headedness of VP in L1 may play a role in L2 sentence processing because, as previously mentioned, the L1 Japanese group's English proficiency level was initially lower than the other groups. Thus it was not clear whether their poor performance was influenced by their L1 or by their low L2 proficiency.

Another interesting finding from Juffs's (2005) study was that the learner group showed the greatest difficulties in processing subject gaps in the finite clausal condition while the control group, consistent with the prediction of Principle-based Parsing, had

relatively more problems in filling subject gaps in the nonfinite clausal conditions. Such discrepancy between natives and nonnatives was also found in Juffs and Harrington (1995), in which L1 Chinese ESL learners also showed the lowest accuracy scores and the longest RTs on the subject wh-extraction from finite clause. Juffs claimed that this result might be due to "the severe garden path effects" that are caused by two adjacent finite verbs (Juffs, 2005, p.144), through which L2 learners might experience comparatively more parsing difficulty than native speakers. Jelliffe and Juffs (2004) also found similar patterns when they investigated the two types of English relative clauses with L1 Chinese and L1 Spanish ESL learners, in which English learners spent significantly longer RTs when they processed object relative clauses where two adjacent verbs were presented (e.g., '*the tiger that the lion chased climbed the tree' as compared to "the tiger that chased the lion climbed the tree'*, as cited in Juffs, 2005, p. 144).

Based on the review of literature, the main purpose for this replication study can be summarized as follows: Firstly, Juffs (2005) was not able to make a strong prediction about the effect of the different headedness of VP on late learners' performance on L2 English wh-filler/gap parsing mainly due to initially different English proficiency between the Japanese and the other experimental groups. Therefore, it is necessary to scrutinize this aspect again by matching group proficiency.

Secondly, as noted earlier, there has been little attempt to examine the role of L2 learning environment on late learners' L2 processing of wh-filler/gap constructions specifically when there is no such processing strategy in their L1. Although not directly related to the current research topic, Dussias and Sagarra (2007) investigated how differential amount of exposure to L2 (i.e., immersion experience in a ESL environment

vs. limited L2 English experience in Spain) might have an effect on proficient Spanish-English bilinguals' processing of L1 Spanish relative clauses, specifically in relation to their NP (i.e., an antecedent) attachment preferences, in which they revealed that those learners in the ESL context tend to employ L2 processing strategies in their L1 processing. They argued that daily exposure to L2 English influenced their NP attachment preferences in L1. Taking this into consideration, it seems to be reasonable to hypothesize that different amount of exposure to the target languages may play a role in the development or implementation of learners' target language processing strategies.

As mentioned previously, White and Juffs (1998) addressed the issue of processability in relation to the learning environment factor; however, they could not observe what types of processing strategy were actually implemented by learners because they simply measured sentence-level RTs. Furthermore, those two L2 groups (Chinese ESL and EFL) significantly differed in terms of their mean age at the time of the test and of their first exposure to communicative language use; the mean age difference between the two was almost 10 years[3], and the mean ages of first exposure to "nonformal L2 input" were significantly different from one another, according to the authors (p. 125).

Given that the age-related loss in language ability may be cumulative even after puberty (e.g., Long, 1990), this casts doubt whether those comparisons between ESL and EFL truly reflect the effect of learning environment. Therefore, age factors (both in terms of mean age at the test and the first exposure to the communicative L2 uses) need to be controlled for ESL and EFL groups to investigate the effects of environment

[3] Two groups' mean ages at the time of the test were 32.25 years old for the ESL and 22.8 for the EFL.

independently. With these matters in mind, the present study seeks to find the answers from the following research questions.

*Research Questions*

1. Do proficient late English learners (including both ESL and EFL) show grammatical sensitivity to structures that violate Subjacency? That is, are their accuracy rates on ungrammatical wh-extraction comparable to those of the control?
2. Do late English learners show subject-object asymmetry when processing types of grammatical wh-extraction? That is, do they have more difficulty in processing subject extraction than object extraction as predicted by Principle-based Parsing? If so, between subject extractions from finite and non-finite clauses, which construction is more difficult for learners to parse?
3. Are Chinese ESL and Korean ESL learners less accurate in their grammaticality judgments and slower at the critical regions than native speakers when they process types of grammatical long distance wh-extraction? If so, are Chinese ESL learners more accurate and faster than Korean ESL learners? That is, does the head-final characteristic in Korean make wh-filler/gap procedures more difficult for Korean English learners to perform as compared to L1 Chinese ESL learners whose L1 headedness is head-initial like English?
4. In their performance on grammatical LD wh-extraction, are Korean ESL learners more accurate (in their grammaticality judgments) and faster ((in filling wh-gaps) than Korean EFL learners? If so, does it indicate differences in learning environments can play a role in late learners' processing of English wh-constrictions?

## Methods

With these research questions in mind, this study implemented a moving window procedure, which includes both self-paced sentence reading and the consequent GJT on each stimulus. Participants' accuracy rates on each structure and word-level RTs on each stimulus sentence were measured from this procedure.

In order to investigate the effect of L1 (i.e., absence of Subjacency in L1 and the different headedness of VP), Chinese and Korean ESL learners were included in the research as well as the control group. While these two languages are characterized as wh-in-situ languages, they are different in terms of the headedness of VP; Chinese is a head-initial language (i.e., SVO), while Korean is a head final language (i.e., SOV). Korean, in many respects including word order (i.e., headedness of VP) or case marking systems, is similar to Japanese (Fender, 2008; Pritchett, 1992b). Given that, replicating Juffs (2005) with Korean English learners is relevant as a way of confirming L1 effects of the headedness of VP on L2 English wh-filler/gap processing. In addition, Korean learners of English in a foreign language (i.e., EFL) context were also included to investigate the effect of learning environment.

The experiment took place in two places: 1) the SLS (Second Language Studies) testing room in Wells Hall (B100D) at Michigan State University for the ESL and control group experiments, and 2) CSL (Center for the Study of Language) Laboratory at Kyung Hee University in Seoul, Korea, for the EFL experiment. Both places were equipped with desktop personal computers and 15 or 17 inch LCD monitors, and the experiment was carried out individually using those computers.

Individual participants attended a single 40~90 minute session by appointment with the researcher. During this time, all participants except native English speakers completed: 1) Consent form (see Appendix A), 2) proficiency test, 3) background questionnaire (see Appendix B), and 4) moving window task. Participants who participated as control only completed 1) and 4). After completing the moving window task, all participants were given brief information about the present study through the Debriefing form (see, Appendix E), and then, as advertised, were paid either 10 or 15 dollars (USD) cash or the equivalent 15,000 Won (KW) for compensation[4].

*Participants*

Because the goal of this study was to investigate the role of learner processability on second language acquisition by highly proficient late learners, L2 English proficiency was monitored and controlled through the administration of MTELP (Michigan Test of English Language Proficiency). If one's L2 proficiency level is not high enough, and if one's performance in terms of accuracy and reading profiles is poor, then it may become unclear whether those poor outcomes were caused by their initially low proficiency level or their processing problems. As a result, recruiting highly proficient L2 English learners was necessary to avoid this conflict. Participants' proficiency level was assessed through the grammar (section 1: 40 test items) and vocabulary (section 2: 40 test items) section of MTELP, following Juffs and Harrington (1995), White and Juffs (1998), and Juffs (2005).

Through the administration of MTELP, 2 participants in the Korean EFL group were excluded because of their low scores. For this exclusion, proficiency test result of

[4] During the preliminary test, ESL learners spent approximately 80 minutes while native English speakers spent about 35 minutes for the experiment. It was because native Speakers did not take the proficiency test and background questionnaire. Given the differences of time spent, subjects who participated as a control were paid 10 dollars and subjects who are nonnative English speakers were paid 15 dollars.

Chinese ESL group in Juffs (2005) was used to determine the outliers for this study. In Juffs (2005), the Chinese group showed the highest mean scores on the proficiency test among all experimental groups (p. 131). Taking this into consideration, their total mean scores (58.03) minus one standard deviation (12.59) was used as the cut-off score (i.e., 45.44). In addition, if one did not achieve 60 percent accuracy on the three types of filler (declaratives including complex NP or relative clause, and short distance wh-movement) or 50 percent accuracy on their overall grammaticality judgments, then his/her data were excluded in the analysis. The first two fillers were the ones Juffs (2005) used for data exclusion. The reason was that if participants cannot make correct judgment on sentences that are structurally simpler than the targeted structure, it would not be likely that they can judge long-distance wh-extraction correctly (p. 130). With these two types, this study added a structure that includes a short distance wh-movement for the same reason. One participant in the Korean EFL group who achieved 46 percent accuracy overall on the GJT was also taken out from the analysis.

In addition to proficiency, participants' ages at first exposure to communicative English use were controlled during the recruitment process. In the present study, the definition of *late learners* followed Johnson & Newport (1991) and White and Juffs (1998), in which *late learners* were considered as those who were not exposed to communicative L2 use before age of 16. This condition was informed to the participants as they read the eligibility of participation in the consent form, and the specific time at first exposure to communicative English was asked through the background questionnaire.

All except one Korean ESL participant satisfied this condition[5].

Both ESL groups and the control group consisted mostly of graduate students who were enrolled either in the MA TESOL (Teaching English to Speakers of Other Languages) program or SLS (Second Language Studies) Ph.D. program at Michigan State University (MSU). These students are generally considered to be highly proficient in English[6]. One Chinese participant was a graduate student enrolled in the College of Education at MSU and two Korean participants were also graduate students enrolled in the School of Journalism at MSU. For the Korean EFL group, graduate students either in the English Language and Literature department or the English Education department at Kyung Hee University participated in the experiment.

Participants' bio-data and MTELP results were compared using one-way ANOVA with alpha set at .05, a summary of which is shown in Table 1. One noticeable improvement from the original study (i.e., Juffs, 2005) was that all groups showed statistically comparable proficiency level from the test. Length of residence was significantly different because of the Korean EFL group, but the Chinese and Korean groups were not different from each other.

Participants' amount of English use in their daily life was asked through the background questionnaire as a supplementary tool to get more insight on ESL and EFL learners' English usage habits (see, Table 1). The statistical analysis showed that both

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[5] This participant reported that she had a 1 hour English conversation class (3 times a week, for 2 months) in Korea at the age of 13; however, that class was taught by a Korean English teacher, and it was not an entire immersion class, according to the participant. Given that, the data from this participant was kept for further analysis

[6] The minimum TOEFL (Test of English as a Foreign Language) score for admissions to the MA TESOL and SLS program is 600 on the PBT, 250 on the CBT, or 100 on the IBT format. The minimum score for the IELTS (International English Language Testing System) is 7.0 for MA TESOL and 7.5 for SLS program, respectively. (This information can be found at: 1) http://www.msu.edu /~llnglang/tesol /admission.html, and 2) http://sls.msu.edu/index.php/admissions, respectively.

Chinese and Korean ESL learners spent significantly more time in using English than Korean EFL learners. Korean ESL learners used English slightly less time than Chinese ESL learners, but they were not significantly different from one another.

*Stimuli*

The tested sentences used in the present study were developed based on the items used in Juffs (2005)[7] (see Appendix C). The items in the self-paced reading task and the grammaticality judgment task were made up of 27 structure types (6 sentences for each structure, totaling 162 sentences), including 4 types of ungrammatical wh-extraction, 5 types of grammatical LD wh-extraction, 2 types of simple wh-extraction (i.e., short-distance), 3 types of garden path structures, 6 types of declaratives containing reduced relative clauses, 1 type of ungrammatical sentences with overpassivization, 3 types of transitivity related structures, 2 types of declaratives containing complex NP and relative clause, and 1 type of nonsensical sentences . Among these structures, 3 types of ungrammatical wh-extraction[8] and 4 types of grammatical wh-extraction (examples in (12) – (15)) were used for the analysis of the current research. Examples of ungrammatical wh-extraction that violate Subjacency are shown in (16) through (18).

(16) **What*$_i$ did Tom hear the story that Ann cooked $t_i$ for Bill? (*Complex NP island)

(17) **Who*$_i$ did John call his mom after he kissed $t_i$ last week? (*Adjunct clause island)

(18) **What*$_i$ did Sam see the man who wanted $t_i$ from Jane? (*Relative clause island)

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[7] The stimuli were provided by Dr. Alan Juffs at University of Pittsburgh and used in the present research under his permission.

[8] The construction of ungrammatical subject wh-extraction from finite clauses with the complementizer *that* (Structure Type #4) was initially included for analysis. However, it had to be excluded due to low mean accuracy of the control group on sentences of this type, which was below the chance level (41.02%).

Table 1
*Summary of Bio-data and Proficiency Test results*

| | Chinese ESL (n=15) | | Korean ESL (n=15) | | Korean EFL (n=15) | | df | *F* |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | | |
| Age | 29.47 | 5.60 | 31.80 | 4.57 | 30.27 | 5.09 | 2, 42 | .81 |
| Age at First Exposure to L2 | 12.40 | 2.47 | 13.07 | 2.37 | 12.80 | 1.52 | 2, 42 | .36 |
| Age at First communicative L2 use | 18.60 | 2.50 | 19.27 | 3.06 | 20.13 | 2.74 | 2, 42 | 1.18 |
| Length of Residence (months) *** | $31.07_a$ | 17.18 | $26.27_b$ | 14.43 | $5.27_{a,b}$ | 5.02 | 2, 42 | 16.03 |
| MTELP Grammar (100% = 40) | 32.73 | 4.40 | 31.33 | 3.77 | 31.67 | 3.87 | 2, 42 | .61 |
| MTELP Vocabulary (100% = 40) | 31.13 | 4.60 | 29.27 | 4.15 | 31.27 | 3.87 | 2, 42 | .33 |
| MTELP Total (100% = 80) | 63.87 | 8.08 | 60.60 | 6.66 | 62.93 | 6.12 | 2, 42 | .43 |
| Weekly amount in English Reading (hours) ** | $16.87_c$ | 6.81 | $14.87_d$ | 11.06 | $7.47_{c,d}$ | 4.30 | 2, 42 | 5.89 |
| Weekly amount in English Writing (hours) *** | $10.67_e$ | 7.10 | $6.80_f$ | 3.90 | $2.07_{e,f}$ | 3.83 | 2, 42 | 10.41 |
| Weekly amount in English Listening (hours) ** | $21.60_g$ | 15.70 | 14.47 | 13.80 | $4.57_g$ | 4.72 | 2, 42 | 7.18 |
| Weekly amount in English Speaking (hours) * | $15.80_h$ | 16.95 | 8.73 | 8.99 | $3.20_h$ | 6.25 | 2, 42 | 4.41 |
| Weekly total amount of English uses (hours) *** | $64.93_i$ | 33.81 | $44.87_j$ | 32.10 | $17.30_{i,j}$ | 7.29 | 2, 42 | 11.56 |

*Note*. Means that are co-indexed indicate the significant difference between groups.
*** Group means were significantly different at $p < .001$ level.
** Group means were significantly different at $p < .01$ level.
* Group means were significantly different at $p < .05$ level.

Some sentences were revised from the original test items to obtain more precise reading profiles. For example, (19) was one of the original sentences used in Juffs (2005) and it was revised in this study by changing the object DP *her sister* to *his family,* and its antecedent *the girl* to *the boy* respectively: the revised sentence is shown in (20).

(19) Who did the girl expect to invite her sister last night? (Original one in Juffs, 2005)

(20) Who did the boy expect to invite his family last night? (Revised version)

This revision was necessary because of the ambiguity of *her* in terms of its case representation; it can be either genitive or accusative case. Given that the parser processes a sentence incrementally, and that the moving window displays only one word at a time, *her* in (19) will be initially interpreted as an object of the verb *invite* with accusative case assignment; however, this analysis must be revised to genitive when the parser encounter the next word *sister*. Considering this processing aspect, sentences that include genitive *her* within the object DP may require additional processing efforts as compared to other DP types. This may cause the discrepancies between sentences in terms of processing burden and time. To resolve this problem, six sentences that include genitive *her* in the object DPs were revised using another genitive pronoun (e.g., his, your, their).

*Moving window procedure*

A moving window task was designed using the software package Linger (version 2.94, programmed by Doug Rohde at the Massachusetts Institute of Technology), in which individual words in a sentence were displayed in a sequential order from left to the right as participants pressed the space key to display the next word. In this way, their RTs at each word were recorded. After they read the last word of each sentence, subjects were

asked to make a grammaticality judgment on the sentence by pressing the designated key (green key for 'YES' and the red key for 'NO'), through which individual subjects' accuracy scores were recorded (1 point for correct judgment, and 0 point for incorrect judgment). Tested sentences were programmed to appear on a screen in a random order to avoid potential task effects.

Before the main task, instruction and a practice session were given to all participants in order for them to have better an understanding about the task procedure and to be familiar with the task (see, Appendix D). During this session, participants were instructed 1) to read sentences as naturally as possible, and 2) to focus on the structure of the sentence rather than meaning for their grammaticality decisions. Some participants in the preliminary test reported that they judged some sentences as incorrect because they thought the meaning was strange. Two such examples are given in (21) and (22):

(21) The large birds killed in the garden could not see the cat.

(22) The large birds killed almost every week could not see the cat.

Although these sentences are syntactically well-formed, there was a possibility that readers can encounter a problem in the semantic domain depending on how they interpret the subject of each sentence. That is, if the subject, *the large birds* is interpreted as a direct entity that performs the action of the main verb, *see* (i.e., agent), the meaning of each sentence can be perceived as odd because the modifying clause indicates that the subject is already dead and consequently cannot take any further actions. Taking this into consideration, it was necessary to make readers focus more on processing of structure than appropriateness of meaning.

## Results

*Accuracy scores on ungrammatical wh-extraction*

The inclusion of ungrammatical wh-extraction to the moving window procedure and a GJT was to investigate to what extent late learners whose L1 lacks wh-movement are sensitive and accurate in detecting types of Subjacency violation in English as compared to the control group. In order to scrutinize this aspect, one-way ANOVA (Analysis of Variance) was carried out for all group comparisons at 95 percent confidence level with the Tukey procedure for post hoc analysis. Table 2 shows a summary of the mean accuracy scores on ungrammatical wh-extraction (i.e., Subjacency the score of 1.00 is equivalent to 100 percent accuracy. For example, the overall accuracy violation), in which all numeric values are rounded off to the second decimal place. Given the coding methods (1 point for correct answers and 0 points for incorrect answers), score of Chinese ESL group on ungrammatical wh-extraction was 0.80, which indicates that the group made average 14.4 correct judgments from 18 given sentences.

Table 2
*Mean accuracy scores on ungrammatical wh-extraction*

| | Chinese ESL (n=15) | Korean ESL (n=15) | Korean EFL (n=15) | English (n=13) |
|---|---|---|---|---|
| | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* |
| *Complex NP islands (n=6) | 0.83a (0.19) | 0.76 (0.23) | 0.59a,b (0.23) | 0.94b (0.15) |
| *Adjunct clause islands (n=6) | 0.74 (0.21) | 0.62c (0.12) | 0.67d (0.30) | 0.89c,d (0.16) |
| *Relative clause islands (n=6) | 0.81 (0.15) | 0.80 (0.14) | 0.72 (0.19) | 0.82 (0.08) |
| Total Ungrammatical (n=18) | 0.80e (0.11) | 0.73f (0.13) | 0.66e,g (0.16) | 0.89f,g (0.09) |

*Note.* Means that are co-indexed represent the significant difference between groups.

There was a significant difference in the overall mean accuracy scores among groups, $F(3, 54) = 8.354, p < .001$, in which the Chinese ESL group showed the highest accuracy rates among the learner groups and their mean accuracy was comparable to the control in all cases. On the other hand, the Korean EFL group displayed the poorest performance among groups; the mean accuracy scores of the Korean EFL learners were significantly lower than those of the Chinese ESL ($p < .05$) and the control group ($p < .001$), but they were not different from the Korean ESL group ($p = .467$). The Korean ESL group was not different from the Chinese ESL group ($p = .420$) in any cases, but they were reliably different from the control ($p < .01$)[9].

However, these significant differences between the Korean ESL/EFL learners and the control groups must be interpreted with caution. That is, those learners' relatively lower accuracy rates might be due to the word-by-word sentence reading task, which may require readers (including the native speakers) to experience more processing burden for their comprehensions and grammatical judgments (Juffs, 2005). Furthermore, the means of the control group (i.e., 89 percent) are much higher than the control group in Juffs (2005), who scored approximately 74 percent, which made the level of significance between the L1 Korean groups and the control to be more considerable. Taking these into consideration, all learners groups demonstrated their grammatical sensitivity to the Subjacency violations, at least to some degree, by correctly rejecting these violations at above the chance level.

[9] The source of this difference was their lower accuracy results on the adjunct clause island violation. If compared after excluding this structure from the analysis, then Korean ESL group also showed comparable accuracy to the control.

*Accuracy scores on grammatical wh-extraction*

The inclusion of four types of grammatical LD wh-extraction (i.e., wh-filler/gap procedure, which is expected to experience TRC) was to investigate how syntactically distinct L1 characteristics (i.e., wh-in-situ and the different headedness of VP) and different learning environment (i.e., ESL and EFL) affect late learners' wh-gap filling processing. Table 3 provides a summary of each group's mean accuracy scores on these structures. All groups except Chinese ESL showed the greatest difficulty in subject wh-extraction from finite clauses, and object wh-extraction from nonfinite clauses were the easiest for all groups. The Chinese ESL group had the lowest scores on object wh-extraction from finite clauses, but they also showed comparably low accuracy scores on

Table 3
*Mean accuracy scores on grammatical wh-extraction*

| | Chinese ESL (n=15) | Korean ESL (n=15) | Korean EFL (n=15) | English Control (n=13) |
|---|---|---|---|---|
| | *M (SD)* | *M (SD)* | *M (SD)* | *M (SD)* |
| Subject extraction (finite), (n=6) | 0.66 (0.17) | 0.59 (0.25) | 0.32 (0.28) | 0.73 (0.20) |
| Object extraction (finite), (n=6) | 0.64 (0.23) | 0.68 (0.16) | 0.52 (0.33) | 0.83 (0.20) |
| Subject extraction (nonfinite), (n=6) | 0.72 (0.19) | 0.68 (0.16) | 0.61 (0.23) | 0.79 (0.26) |
| Object extraction (nonfinite), (n=6) | 0.76 (0.11) | 0.78 (0.12) | 0.74 (0.18) | 0.86 (0.15) |
| Total (n=24) | 0.69 (0.11) | 0.68 (0.11) | 0.55 (0.15) | 0.80 (0.14) |

subject extraction from finite clauses[10]. While these results are consistent with the results of Juffs (2005), they were different from the prediction made by Principle-based Parsing that assumes subject wh-extraction from nonfinite clauses to be the most difficult structure in the incremental processing, as in (12). Furthermore, all learner groups were slightly less accurate in filling object gaps in finite clauses than in filling subject gaps in nonfinite clauses. This result was not only inconsistent with the Principle-based Parsing account, but it was also different from that of Juffs (2005), in which all groups, including the control, performed slightly better on object-extraction from finite clauses than subject extraction from nonfinite clauses. In the present study, although learners showed subject-object asymmetry within the same clausal condition, the processing problems of learners seem to be closely associated with the finiteness.

In order to further explore the effect of first language and learning environment, a 3 x 4 GLM (General Linear Model) repeated measures ANOVA was implemented at 95 percent confidence level. If any significance was found between groups, then the Tukey procedure was used for all post hoc comparisons. In this analysis procedure, the two between-subject independent variables (i.e., different L1 and different learning environment) were separated into two sets of statistical analysis (i.e., 2 sets of ANOVAs), The separation of those two variables was necessary because the current research did not include a Chinese EFL group (i.e., no interactions between L1 and learning environment). If the L1 factor (2 values: Chinese Korean, and the control) and learning environment factor (3 values: Korean ESL, Korean EFL, and the control) were included as between-subject variables in a single statistical analysis, then the outcomes would be conceptually

[10] The low mean score of Chinese group on this structure was due to extremely low score of one Chinese participant who received a zero score. Mean scores after excluding this participant were higher than those from subject wh-extraction.

problematic due to inappropriate group combinations during the statistical analysis (i.e., Chinese ESL and Korean ESL group combination as opposed to the Korean EFL group for learning environment effect analysis, or Korean ESL and Korean EFL group combination as opposed to the Chinese ESL group for L1 effect analysis).

*a) The effect of L1: Accuracy comparison of Chinese ESL and Korean ESL*

The Chinese ESL, Korean ESL, and the control group were included to explore the effect of L1. In this analysis, L1 was the between-subject independent variable and four types of grammatical wh-extraction were within-subject independent variables. The results showed a main effect of L1, $F(2, 40) = 4.529$, $p < .05$, in which the mean accuracy of the Chinese ESL and Korean ESL group were significantly lower than the control, but not different from each other ($p = .944$); the mean accuracy of the Chinese ESL group were slightly higher than those of the Korean ESL group (see Figure 1).

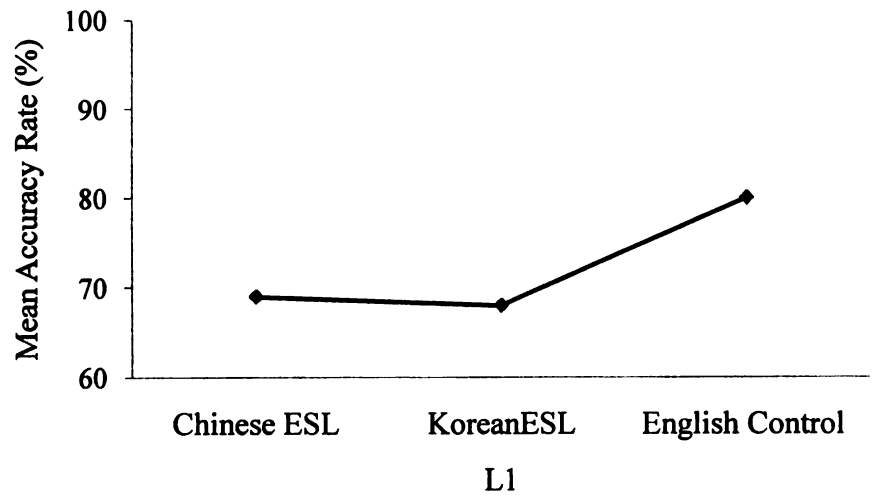


*Figure 1*. Comparison of mean accuracy scores by L1

There was also a main effect of structure, $F$ (3, 120) = 4.856, $p$ < .05, indicating that accuracy scores between structures were significantly different from one another; subject wh-extraction from finite clauses were the least accurate while object wh-extraction from nonfinite clauses were the most accurate (see Figure 2). There was no significant interaction of L1 and structure, $F$ (6, 120) = .539, $p$ = .778, in which all participants show similar accuracy patterns to those of four structures.

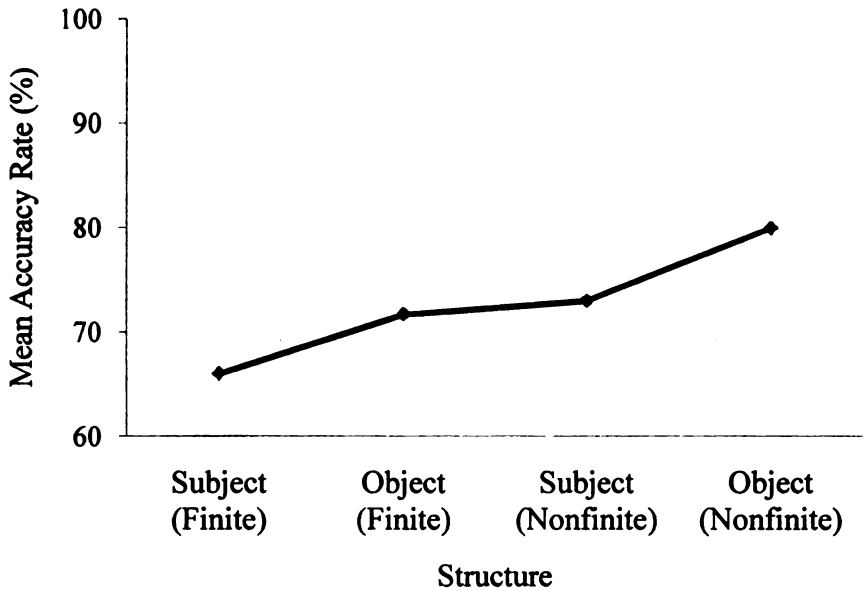


*Figure 2*. Comparison of mean accuracy scores by structure

*b) The effect of learning Environment: Comparison of Korean ESL and EFL*

The Korean ESL/EFL groups and the control group were compared to examine the effects of learning environment. The analysis showed a main effect of learning environment, $F$ (2, 40) = 13.017, $p$ < .001; while both groups were significantly inferior to the control group, Korean EFL group also performed significantly less accurately than the Korean ESL group (see Figure 3). There was also a main effect of structure, $F$ (3, 120)= 10.918, $p$ < .001, in which accuracy patterns on the given structures were identical

to those of L1 effect analysis (see Figure 2). There was no significant interaction between learning environment and structure, $F$ (6, 120) = 1.738, $p$ = .118, implying that both groups had similar patterns on their grammaticality judgments to the given structures.

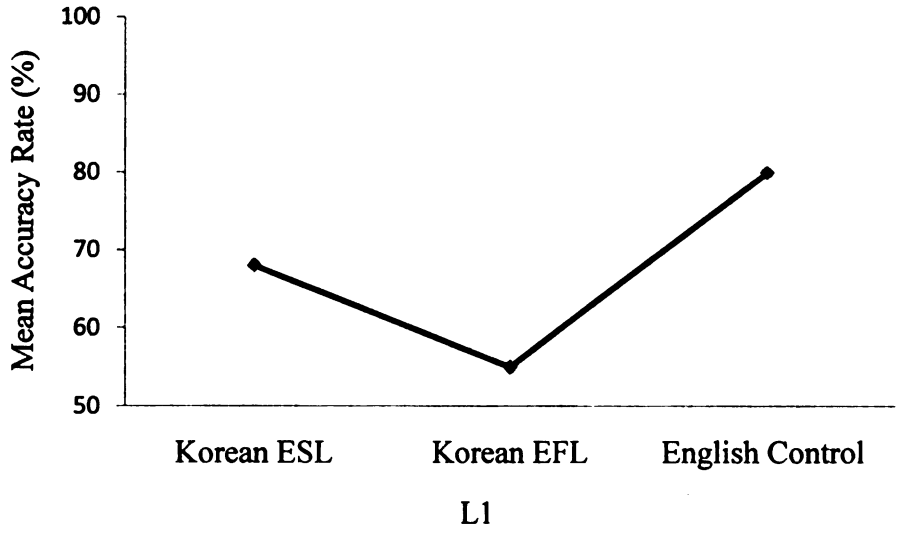


*Figure 3*. Comparison of mean accuracy rates by learning environment

*Reading profiles on grammatical wh-extraction*

Individual participants' word-level RT data on the four types of grammatical wh-extractions were analyzed to gain more insight on late learners' processing patterns. The data from the control group were not included in the RT analyses. As noted by Juffs (2005), the inclusion of native speakers in RT analyses always tend to make the comparisons highly significant because their reading patterns are generally much more stable and faster than those of L2 learners.

In addition, several treatments were made following general RT analysis paradigms. First, only RTs that were correctly judged were included for the statistical analyses. Thus those that were answered incorrectly were coded as missing values and

eventually excluded during the individual mean RT calculation process (e.g., Fender, 2008; Juffs, 1998a, 2005; Juffs & Harrington, 1995; 1996). From this exclusion process, approximately 36 percent of error data from the learner groups had to be eliminated in the analyses. In addition, RTs that went beyond more than three times standard deviation from the group mean of that region were also excluded, following the method implemented in Juffs (2005).

Secondly, the remaining RT data in the analyses had to be log transformed to compensate for the positively skewed characteristic of RT data (Juffs, 1998a, 2004, 2005, 2006). The values for skewness with the raw data at the critical region (Word 5 & 6 in the finite clausal condition, Word 7 & 8 in the nonfinite clausal condition) ranged from 1.908 to 9.376. Those highly skewed values were adjusted through the data log transformation, after which all the skewness values used in the analyses fell into the moderately acceptable range of -/+2.

*RT analyses on grammatical wh-extraction: finite clausal condition*

As was expected, reading profiles of the control group were much faster and flatter than the learner groups across the structures (see Figure 4, 5, 7, and 8) In addition, both the Korean ESL and EFL learners represented much sharper increased RTs than the Chinese ESL learners whenever they processed verbs. Figures 4 and 5 show each group's word-level reading profiles on wh-extraction from finite clauses; subject and object gap, respectively. In this clausal condition, the two places were selected as critical regions for RT analyses following Juffs (2005). These are the fifth and sixth word positions where the parser makes initial posit and reanalysis, as shown in Table 4.

Table 4
*Procedural description of parsing at the critical region: extraction from finite clause*

| | W5 | W6 |
|---|---|---|
| LD Subject extraction | Initial posit:<br>Object of the matrix clause | Reanalysis<br>→ Subject of the embedded clause |
| LD Object extraction | Initial posit:<br>Object of the matrix clause | Reanalysis<br>→ Object of the embedded clause |

In the case of subject wh-extraction, all learner groups apparently spent longer time at the subject wh-gap (i.e., *pass*, the verb of the embedded clause in Figure 4) where the parser is supposed to experience the TRC. One remarkable result at this region was that the mean RT of the Korean EFL group was not only faster than that of the Korean ESL group, but also slightly faster than that of the Chinese ESL group. Furthermore, this RT pattern appeared similarly at the critical region in the object extraction (i.e., *his*, determiner of the subject NP of the embedded clause in Figure 5) in which, while all learner groups spent much less time as compared to the subject extraction, the Korean EFL group was slightly faster than the other learner groups. Looking at other regions, all learner groups displayed increased RTs in the object gap in the embedded clause in Figure 5 (i.e., *passed*, the verb of the embedded clause), where the parser confirms the previously made reanalysis at the Word 6 position in which the two Korean groups were slightly slower than the Chinese group, but not statistically different from one another (from one-way ANOVA statistics: $F$ 2, 39, = .818, $p$ = .449).

In order to further examine these different reading profiles, two sets of 2 x 2 x 2 GLM repeated measures ANOVAs were carried out at 95percent confidence level with one between-subject variable (L1 in one set, and learning environment in another,

independently) and two within-subject variables (2 structure types; subject & object gap, and 2 places as a critical region: word 5 & 6). The RTs used in this statistical procedure are shown in Table 5.

Table 5
*Means of RTs at the critical region in the finite clausal condition*

| | Group | Raw Mean (SD) | Log-transformed Mean (SD) | N[11] |
|---|---|---|---|---|
| Subject W5 | 1 (Chinese ESL) | 525.27 (146.09) | 6.22 (.28) | 14 |
| | 2 (Korean ESL) | 732.51 (338.32) | 6.51 (.42) | 15 |
| | 3 (Korean EFL) | 707.13 (315.05) | 6.59 (.41) | 10 |
| Object W5 | 1 | 503.92 (135.29) | 6.19 (.27) | 14 |
| | 2 | 727.58 (380.82) | 6.46 (.52) | 15 |
| | 3 | 837.24 (437.51) | 6.61 (.50) | 10 |
| Subject W6 | 1 | 1344.05 (873.83) | 6.99 (.59) | 14 |
| | 2 | 1903.67 (974.77) | 7.37 (.60) | 15 |
| | 3 | 1230.63 (732.03) | 7.01 (.61) | 10 |
| Object W6 | 1 | 652.68 (235.80) | 6.42 (.37) | 14 |
| | 2 | 696.61 (269.86) | 6.49 (.33) | 15 |
| | 3 | 584.39 (148.69) | 6.36 (.30) | 10 |

*a) The effect of L1: Chinese and Korean ESL RTs (Finite)*

The analysis demonstrated no main effect for L1 in the finite clausal condition, but it was very close to the significance level, $F(1, 27) = 4.138$, $p = .052$. There was a significant effect of structure, $F(1, 27) = 36.292$, $p < .001$, effect of region, $F(1, 27) = 57.867$, $p < .001$, and reliable interaction between structure and region, $F(1, 27) = 33.475$, $p < .001$.

[11] There were a few participants who did not make any correct answers on one of the given structures: Subject extraction: 1 Chinese ESL and 2 Korean ESL participants; Object extraction: 2 Korean EFL participants. There was 1 Korean EFL participant who had 1 correct answer on the subject extraction, but the RT at the critical region of the structure was replaced with a missing value because it surpassed the cutoff line (i.e., 3 times the SD from the mean).

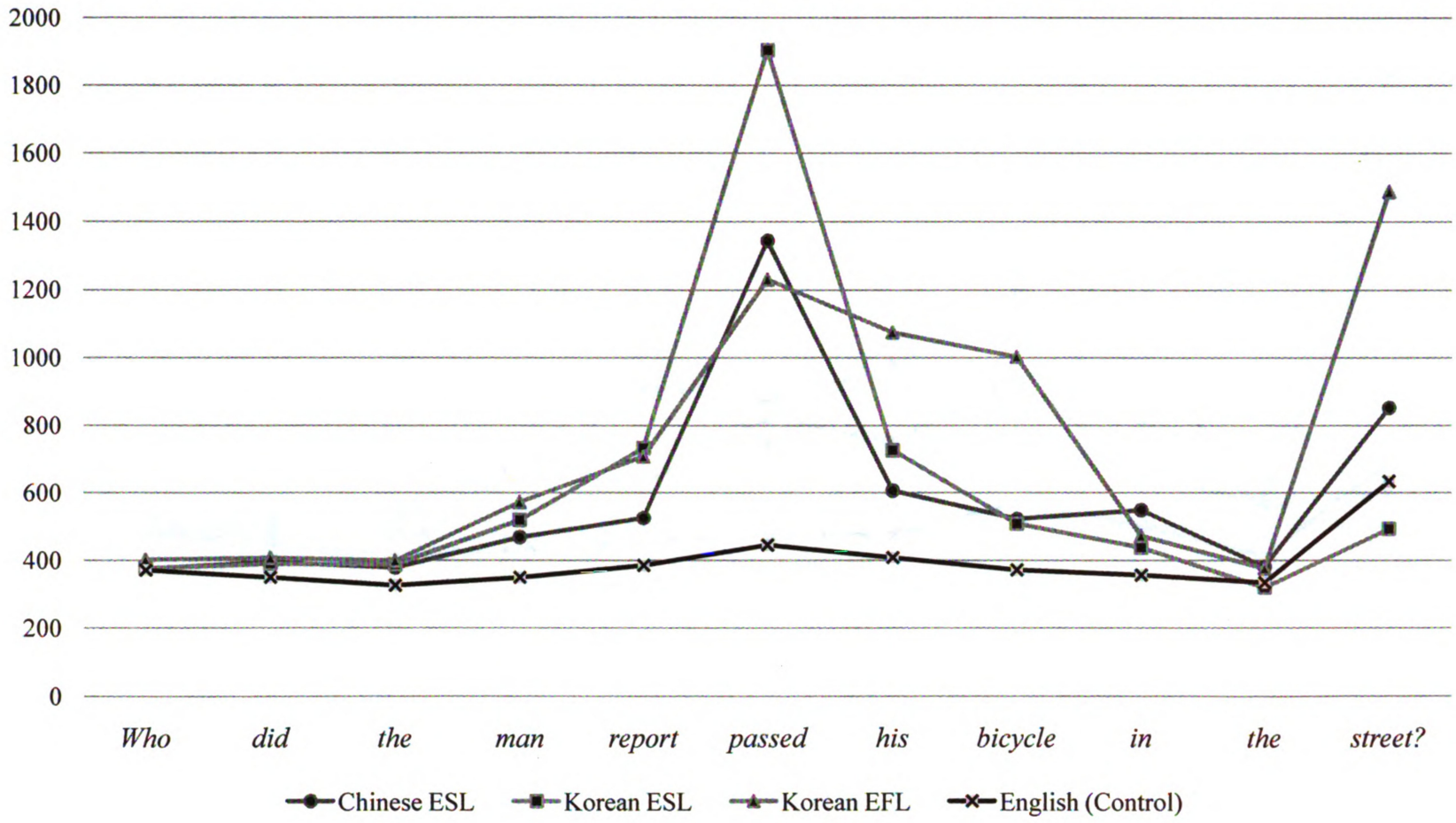


*Figure 4.* Mean RTs on the subject wh-extraction from finite clauses

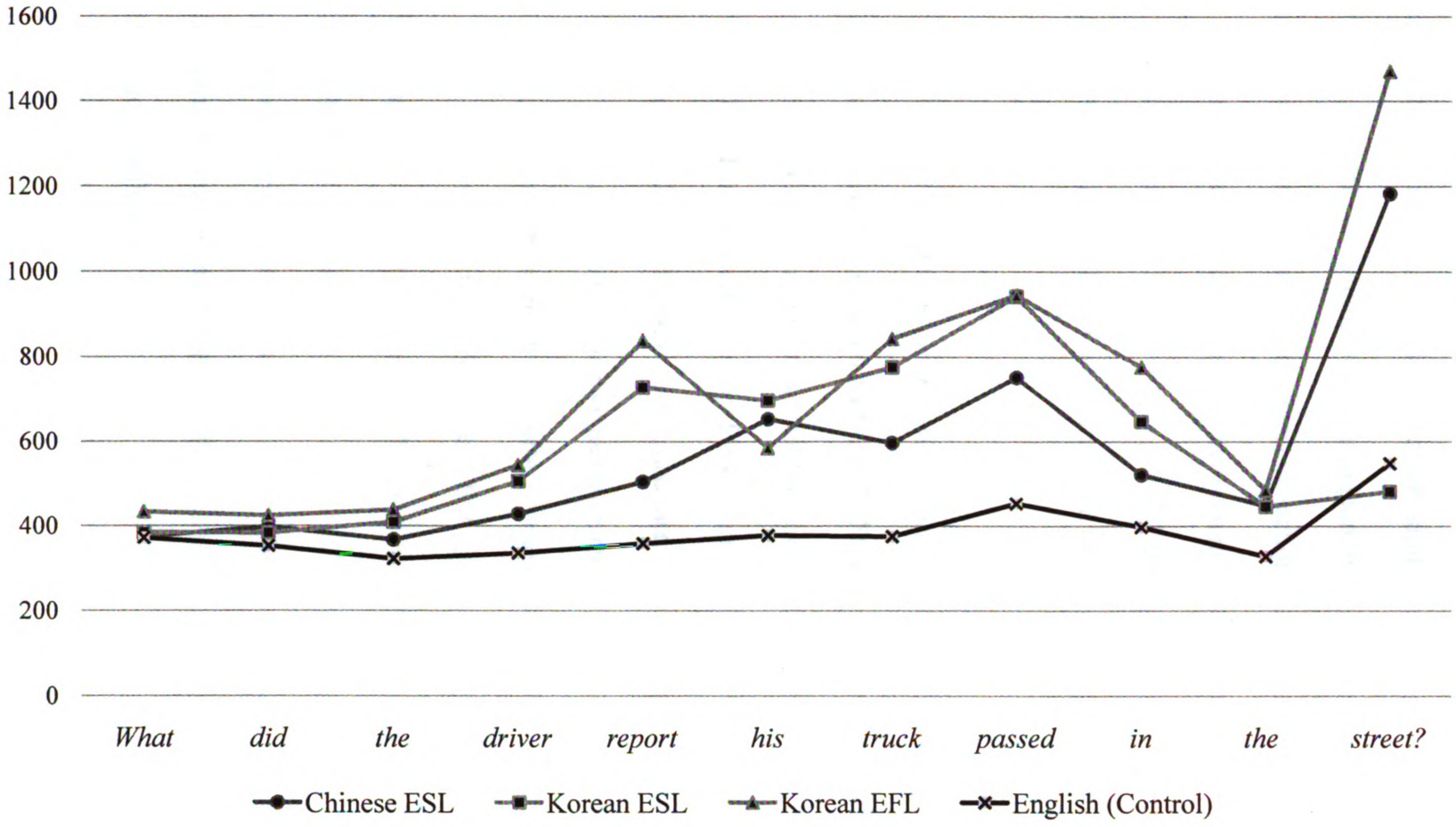


*Figure 5.* Mean RTs on the object wh-extraction from finite clauses

These results indicate that while the Chinese ESL group was slightly faster than the Korean ESL group, both groups showed very similar reading profiles in the given structures, specifically within the critical region; both groups spent significantly longer time for parsing reanalysis in the subject extraction than in the object extraction. Because of such similarities in reading patterns between groups, there was no reliable L1 by structure interaction, $F(1, 27) = 1.675, p = .207$, no significant L1 by region interaction, $F(1, 27) = .197, p = .661$, and no significant L1 by structure by region interaction, $F(1, 27) = 1.528, p = .227$.

*b) The effect of learning environment: Korean ESL and EFL RTs (Finite)*

Reading profiles of Korean ESL and EFL learners were analyzed to see if there was any effect for learning environment. Similarly to the previous analysis of the L1 effect on RT, there was a main effect for structure, $F(1, 23 = 24.042, p < .001)$, an effect for region, $F(1, 23) = 16.284, p <. 001$, and interaction of structure by region, $F(1, 23) = 33.475, p <.001$, exhibiting subject-object asymmetry in the finite clausal circumstance. However, the result revealed no main effect for learning environment $F(1, 23) = .211, p = .651$; in both structure types, the Korean EFL group was slightly faster than the Korean ESL group at the subject gap (i.e., word 6), but they were slightly slower than the Korean ESL group in the initial gap (i.e., word 5), which brought a significant learning environment by region interaction ($F$, 1, 23 = 7.535, $p < .05$). It seems that such different RT patterns by region might decrease the group differences in RT to some degree, thus making no significance.

Although the two groups were not different each other in their reading times at the critical regions, the reading profiles of the Korean EFL group showed spillover effects

after the critical region. In order to explore if these spillover effects are unique to the Korean EFL group, one-way ANOVA was conducted with the three regions within the structure: Word 7, Word 8, and the sum of Word 7 & Word 8 in the subject wh-extraction. The results showed a significant effect of learning environment on Word 8 ($F$ 1, 23 = 14.838, $p < .001$) and on the sum of Word 7 & Word8 ($F$ 1, 23 = 13.304, $p = .001$).

*RT analyses on grammatical wh-extraction: nonfinite clausal condition*

While Principle-based Parsing analysis predicts subject wh-extraction from nonfinite clauses to be the most difficult structure for parsing, the subject-object asymmetry in the nonfinite clausal condition may occur after the parser encounters the object gap and the consequent word in the lower clause in each case (i.e., *invite* in Figure 6, *hire* in Figure 7), from which the parser in both cases must revise its previous analysis (subject →object trace, as in 12c and 13c), as shown in Table 6. Then, in processing the following word in subject extraction (i.e., *his*, the determiner of the object DP), the parser must rapidly go back to its previous analysis because the object gap is already filled with another DP (as in 12d), which eventually adds additional burden to the parser. On the

Table 6
*Procedural description of parsing at the critical region: extraction from nonfinite clause*

| | W7 | W8 |
|---|---|---|
| Subject gap | Reanalysis from the previous trial<br>(Subject of the embedded clause)<br>→ Object of the embedded clause | Reanalysis<br>→ Subject of the embedded clause |
| Object gap | Reanalysis from the previous trial<br>(Subject of the embedded clause)<br>→ Object of the embedded clause | Parsing Termination<br>→ Confirm the previous analysis |

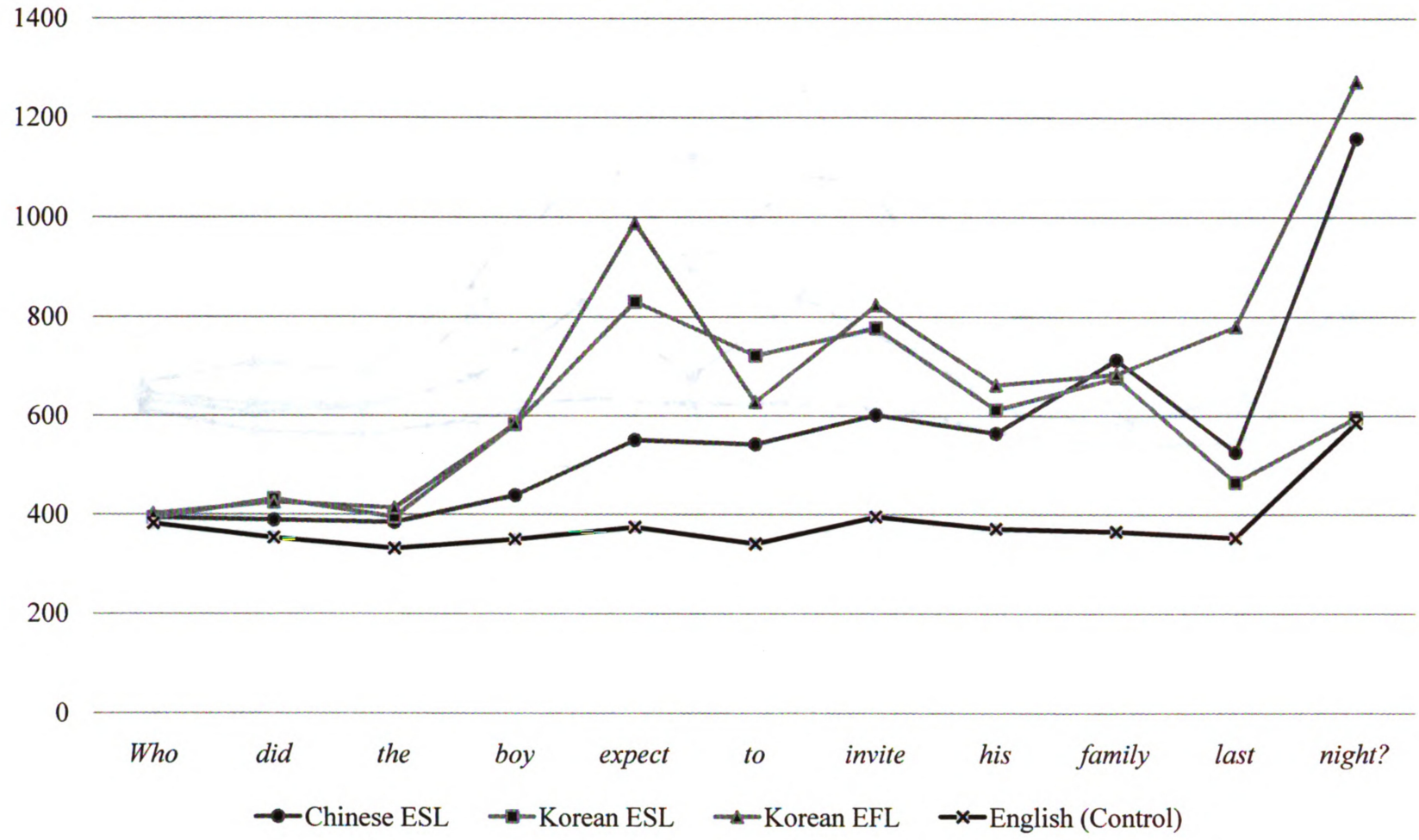


*Figure 6.* Mean RTs on the subject wh-extraction from nonfinite clauses

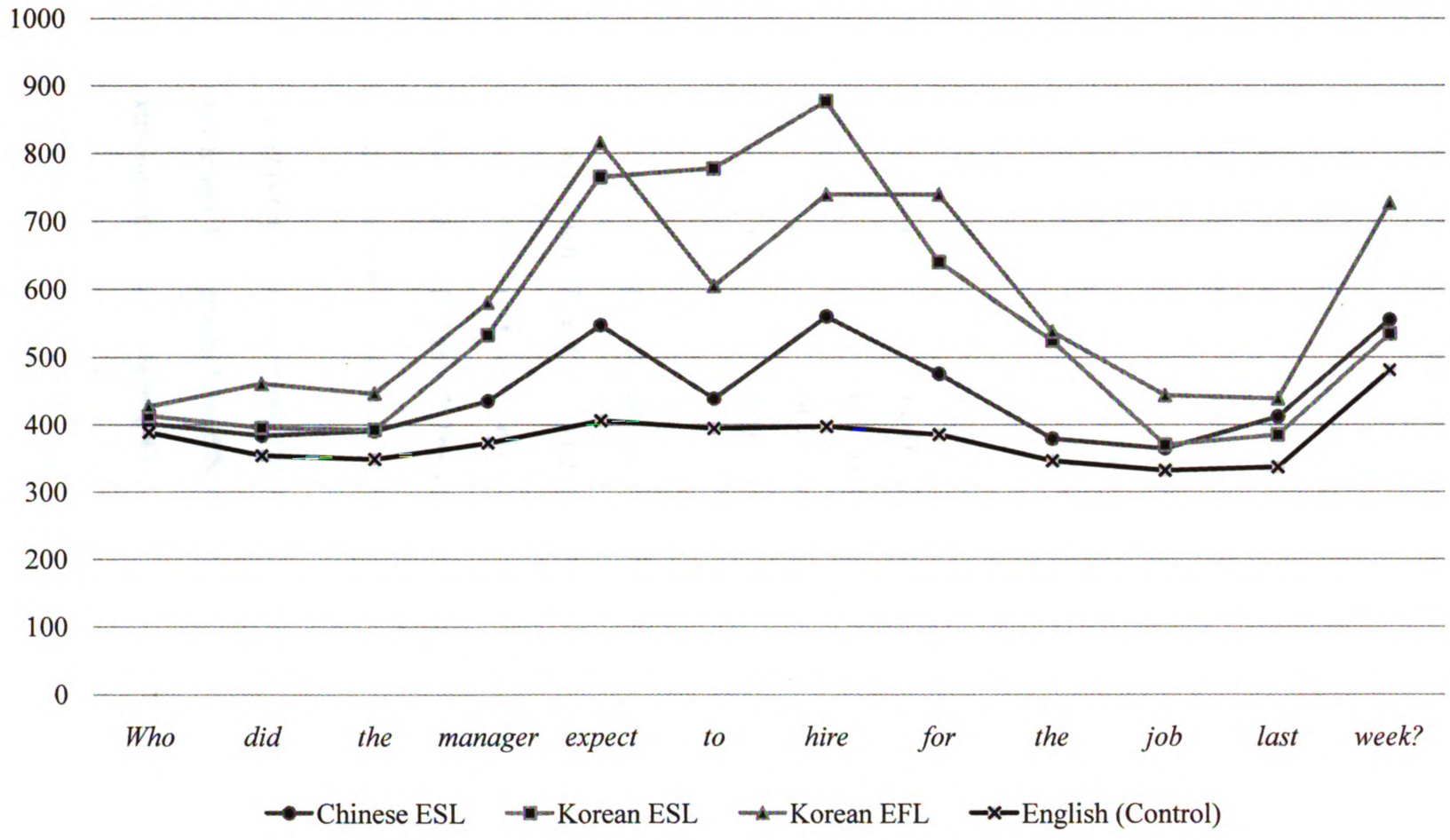


*Figure 7.* Mean RTs on the object wh-extraction from nonfinite clauses

Table 7
*Means of RTs at the critical region in the nonfinite clausal condition*

| | Group | Raw Mean (SD) | Log-transformed Mean (SD) | N |
|---|---|---|---|---|
| Subject W7 | 1 (Chinese ESL) | 601.68 (160.46) | 6.36 (.28) | 15 |
| | 2 (Korean ESL) | 777.32 (291.58) | 6.59 (.39) | 15 |
| | 3 (Korean EFL) | 823.62 (367.20) | 6.62 (.47) | 15 |
| Object W7 | 1 | 559.86 (204.37) | 6.27 (.27) | 15 |
| | 2 | 876.79 (467.07) | 6.65 (.51) | 15 |
| | 3 | 774.77 (444.14) | 6.52 (.53) | 15 |
| Subject W8 | 1 | 564.46 (170.24) | 6.30 (.27) | 15 |
| | 2 | 612.11 (221.07) | 6.36 (.35) | 15 |
| | 3 | 662.47 (222.89) | 6.44 (.35) | 15 |
| Object W8 | 1 | 475.50 (96.84) | 6.15 (.19) | 15 |
| | 2 | 640.26 (265.79) | 6.40 (.36) | 15 |
| | 3 | 799.14 (275.87) | 6.54 (.40) | 15 |

other hand, in case object extraction, the parser can confirm its analysis after the next word (i.e., *for* in Figure 7) and terminates its parsing. For this reason, Word7 and Word 8 were placed as a critical region for further analyses, following Juffs (2005). The RTs for these regions are shown in Table 7. The statistical procedures were the same as those used in the analysis of wh-extraction from finite clauses.

*a) The effect of L1: Chinese and Korean ESL RTs (Nonfinite)*

While the Chinese ESL group showed faster RTs in almost all regions both in subject and object extraction, there was a main effect of L1 in the critical region, $F(1, 28) = 5.322, p < .05$. There was also a main effect of region, $F(1, 28) = 10.112, p < .01$, in which Chinese ESL and Korean ESL learners spent longer time at the object gap in both

structures; differently from the prediction by Principle-based Parsing, learners in both groups did not show much difficulty when they encountered the object DP in figure 6, and thus their reading profiles at this region became similar to those in the object wh-extraction. Influenced by this, there was no main effect of structure $F(1, 28) = .574, p = .455$, no significant structure by region interaction, $F(1, 28) = .013, p = .574$, no significant L1 by structure interaction, $F(1, 28) = 3.334, p = .079$, and no significant L1 by region interaction, $F(1, 28) = 1.984, p = .170$.

In addition to the L1 effect in the critical region, the Korean ESL learners also spent much longer time than the Chinese ESL learners at the object gap of the matrix clause (i.e., *expect* in Figure 6 & 7) and at the subject trace (i.e., *to* in Figure 6 &7) in the embedded clause in both extraction cases, which were significantly different from one another, $F(1, 28) = 11.722, p < .01$.

*b) The effect of learning environment: Korean ESL and EFL RTs (Nonfinite)*

The analysis of reading profiles of the two Korean groups (ESL and EFL) in the nonfinite clausal conditions showed no significant effect of learning environment $F(1, 28) = .058$, $p = .811$., no significant learning environment by structure interaction, $F(1, 28) = .189, p = .667$, and no significant interaction between learning environment and region, $F(1, 28) = .206, p = .206$. These results demonstrate that the reading profiles of the two L1 Korean groups were fairly comparable to one another in both structures and both regions.

There was also no main effect of structure, $F(1, 28) = .165, p = 688$, and no significant interaction between structure and region. Although the parsing prediction was that learners would spend more time on subject wh-extraction, especially at the place where the parser must perform its third reanalysis (i.e., Word 8 in Figure 6, a constituent

of an object DP in the embedded clause; see Table 6 for procedural description), the appearance of an object DP did not make learners spend longer time at all.

Furthermore, a similar phenomenon was found at the subject trace in the nonfinite clauses (i.e., *to*, Word 6, in Figures 6 and 7). While it was assumed that learners might experience processing difficulties at this point due to TRC, it was much faster than even the object gap in the main clause (i.e., *expect,* the main verb where the initial posit occurs).

## General Discussion

The main goal of this replication study was to explore the role of syntactically distinct L1 features and L2 learning environment on highly-proficient adult learners' processing of wh-constructions in English. Given different degrees of parsing complexity during the incremental wh-filler/gap procedure, the underlying hypothesis of the present study was that late learners would experience relatively greater parsing difficulty as compared to native English speakers when they perform wh-filler/gap analysis through incremental processing.

Concerning the first research question that specifically asked to what extent late learners were sensitive to Subjacency, confirming learners' having relevant L2 syntactic knowledge of wh-movement was necessary in this study to exclusively observe the effects of learner processability on L2 performance by late learners. With this in mind, all L2 learner groups were fairly sensitive in detecting Subjacency violations in English, in which especially the L1 Chinese ESL learners were not statistically different from the native English speakers, who achieved 89 percent accuracy. The L1 Korean ESL and

EFL learners were reliably different from the control; however, they rejected ungrammatical wh-constructions at a rate much above the chance level (73 percent and 66 percent, respectively). Consequently, although wh-movement and the consequent Subjacency constraints are not operative in their L1s, late learners both in the L1 Chinese and Korean groups demonstrated that they understood syntactic rules of wh-movement in English to a great extent. These results provide an important implication when interpreting individual learners' performance (both accuracy and RT data) on grammatical wh-extraction. That is, even if they incorrectly judge the grammatical wh-constructions as ungrammatical, their wrong judgments might be due to their processing problems, rather than their lack of L2 competence on English wh-structures.

Despite this evidence, however, the accuracy scores and reading profiles of the experimental groups on the four types of grammatical wh-extraction revealed that, as compared to the control group, learners had considerably heavier processing difficulty in reading and comprehending these filler-gap related constructions (i.e., significantly lower accuracy scores and longer RTs). Moreover, they represented different levels of processing difficulty depending on the type of gap argument (i.e., more difficulty in subject gap than in object gap), as hypothesized through the second research question that was asked to investigate whether late learners showed predictable processing difficulty based on Principle based Parsing.

However, such different degrees of parsing complication indicated by learners seem to only partially correspond with the predictions made by Principle-based Parsing analysis. That is, although all groups showed subject-object asymmetry within the same clausal condition (i.e., more parsing problems in subject wh-extraction than in object wh-

extraction, following Principle-based Parsing), the overall results did not obey Principle-based Parsing accounts. In particular, all participants, including the control, showed the greatest parsing problems in subject wh-extraction from finite clauses. While this result is consistent with the results shown by Juffs (2005), it is different from the Principle-based Parsing account that assumes subject wh-extraction from nonfinite clauses to be the most difficult structure to process. For such discrepancies between learner performance and the prediction of Principle based Parsing account, Juffs's (2005) explanation that participants might have experienced garden path effects when parsing two adjacent finite verbs in a word-by-word moving window task may be a better explanation.

Furthermore, learners' accuracy scores on object wh-extraction from finite clauses were comparable (Korean ESL) or slightly lower (Chinese ESL, Korean EFL) than those on subject wh-extraction from nonfinite clauses, and their reading profiles were not significantly different from one another. Given these results, as Juffs (2005) also mentioned, English learners' processing difficulty might be more closely related to the finiteness of the verbs (or tense morphology) over the parsing complexities made from incremental processing.

In responding to the third research question about the effect of first language, the lack of wh-movement and consequent wh-filler/gap procedure in L1 processing was apparently disadvantageous for both the Chinese ESL and the Korean ESL group as compared to the control group, in that all learner groups were significantly less accurate on grammatical wh-extraction and their reading profiles were significantly slower than the control.

In addition, the study confirmed that the different headedness of VP between L1 and L2 put additional burden on Korean ESL learners' processing and understanding of wh-constructions in English. Although the proficiency-matched Chinese ESL and Korean ESL learners were not statistically different from one another in their grammaticality judgments on the given structures, Korean EFL learners' reading patterns were significantly slower than Chinese ESL learners not only at the critical regions, but also at every verb in the sentence where gap reanalysis is required. Such reading profiles as those of the Korean group are consistent with those of the Japanese ESL learners in Juffs (2005) and Fender (2003, 2008).

The study also found an effect of learning environment (i.e., research question 4). While their proficiency and age factors (both mean age at the time of the test and at first exposure to nonformal L2 learning environment) were matched with the Korean ESL learners, Korean EFL learners displayed much heavier processing difficulty compared to Korean ESL learners, especially when they processed subject and object wh-extraction in the finite clausal condition; the Korean EFL group's mean accuracy scores were even below the chance level on subject extraction (32 percent), and close to the chance level on object extraction (52 percent), which were considerably poorer than those of the Korean ESL learners (59 percent and 68 percent, respectively). As hypothesized, this might be due to Korean EFL learners' limited amount of exposure to L2 in their daily life. As shown in Table 1, the weekly amount of English use for Korean EFL learners (total average 17.30 hours per week) was significantly less than that of Korean ESL learners (total average 44.87 hours per week).

The reading profiles of the two groups (Korean ESL and EFL) were not much different from one another. However, when considering the extremely low accuracy scores of the Korean EFL group in the finite clausal condition and the consequent elimination of such a large amount of error data in the RT data, it is questionable if the represented RTs of the Korean EFL learners in these structures can purely reflect their general processing patterns or ability.

In addition, the Korean EFL learners showed some evidence that they did not consistently employ incremental processing strategies for filling wh-gaps as soon as possible (i.e., GTA). In examining their reading patterns, Korean EFL learners showed much flatter or even faster reading profiles than expected, specifically at the regions where the parser is assumed to meet heavier processing load from wh-gap reanalysis (i.e., Word 6 position in Figures 5, 6, and 7). These findings are similar to the claim made by Marinis et al (2005) that L2 learners may not fully bring syntactic information into play in real-time processing. If this were the case for the EFL learners, it might be because of their significantly less L2 processing experience specifically on English wh-filler/gap structures, as compared to the ESL learners. Moreover, the targeted test items in the current study were all interrogative sentences containing long-distance wh-movement, which might not be likely to be used often especially in the EFL setting. Consequently, those learners in the EFL condition would have had more processing problems, compared to learners in the ESL condition, from their inconsistent (or unfamiliar) implementation of relevant L2 processing strategies and/or their irrelevant use of L1 processing strategies (i.e., delay of gap-filling until the verb is processed at the end of the sentence; SOV) in real time processing.

*Limitations and Future Research*

There are a few limitations in the present study. First, the present study only investigated English learners whose L1s are wh-in-situ. Consequently, the analysis was not fully able to respond to the question of to what extent the wh-in-situ characteristic of L1s can be more disadvantageous for those L2 learners as compared to other L2 learners having wh-movement operation in their L1s (e.g., the L1 Spanish ESL group in Juffs (2005)). Secondly, the current study was not able to examine the interaction of L1 and learning environment because Chinese EFL learners were not included in the research design. Therefore, in future research, it would be beneficial to include ESL and EFL groups from various L1 backgrounds (including both wh-movement and wh-in-situ L1s) in order to have more insight into and reliable generalization about the role of first language and learning environment on L2 processing.

In addition, the question of why the different headedness of VP between L1 and L2 makes integrating arguments into phrases more difficult for L2 learners needs to be further investigated. Both in Juffs (2005) and the present study, the L1 Japanese and L1 Korean English learners, respectively, showed, through their reading profiles, greater difficulty whenever they processed verbs. In English, overt case marking only appears in several pronouns (e.g., *his*, *him*, or *her*) and wh-words are generally ambiguous in terms of their case representation until the parser find the gap. In the case of Korean, on the other hand, although case marking can be optional in colloquial speech, wh-phrases generally take overt case morphology in both in writing and speaking, as in (6). One speculation is that such cross-linguistic differences in overtness of case morphology can make integration of arguments into verb phrases more difficult for Korean English

learners, because they must put additional effort to assign unmarked cases to each argument. With this in mind, in future research, it would also bea useful to further study the role of cross-linguistically distinct features of cases and case morphology in L2 sentence processing.

APPENDIX A

Participant Consent Form A
(For Native English Speakers)

You are being asked to participate in a research study about second language sentence processing. This consent form is provided to give you information about the study and to explain risks and benefits of participation. Also it should be noted that participation is voluntary, and you can withdraw or refuse to answer any particular questions in any tasks. Please, feel free to ask the researchers any questions at any time. You may use the contact information below.

**Research study title:** "Experimental second language processing of wh-constructions in English: The effects of first language and learning environment"

**Department and Institution:** Department of Linguistics and Germanic, Slavic, Asian and African Languages, Michigan State University.

**Contact Information:** If you have any questions or concerns, you may contact with **Dr. Spinner** via email at ***spinnerp@msu.edu*** or by phone at ***517-353-0754***. You can also make contact with **Se Hoon Jung** via email at ***jungse@msu.edu*** or by phone at ***517-575-5885***. Contact via mail is also available and you can mail at A-714 Wells Hall, Michigan State University, East Lansing, MI 48824

**Purpose of Research:** The study aims at investigating to what extent English learners whose native languages are syntactically different from English process English sentences similarly or differently from native speakers.

**Eligibility:** You are able to participate in this study if you speak English as your first language.

**What you will do:** The study will involve 1 session, which will take approximately 40-50 minutes. During the session, you will be asked to read sentences (one sentence at a time) on a computer screen and to judge if each one of those are grammatically acceptable.

**Compensation:** By participating in this study, you will receive $10 (USD) cash payment.

**Potential benefits:** You will not directly benefit from your participation in this study. However, your responses will be used to investigate to what extent foreign and second language learners process the target language differently from the native speakers of that language. The information gained from the study could have implications for second language acquisition theories.

**Potential risks:** There are no risks or discomforts expected as a result of your participation. Your participation in the study will not affect your enrollment in the university, and your performance during the tasks will not affect your grades in your classes. The data will be used only for research purposes.

**Confidentiality:** You will not be required to provide your name or any other personally identifiable information. Your performance in this study will be kept confidential and your information will be safely secured by the researchers. All the data will be accessible only to the assigned investigators and will be kept securely. No personal information such as your name will be given in public. Instead, you will be identified only by a number throughout the data collection process as well as any further publication.

If you have any questions that are not answered on this consent form, please feel free to ask at any time. If you have any questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, Michigan State University Human Research Protection Program at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or regular mail at: 202 Olds Hall, MSU, East Lansing, MI 48824.

Thank you for your participation.

Your signature below indicates that you have read this consent form, and that you volunteer to participate in this study.

| Participant's signature | Printed name | Date (mm/dd/yy) |
|---|---|---|

Participant Consent Form B
(For Learners of English)

You are being asked to participate in a research study about second language sentence processing. This consent form is provided to give you information about the study and to explain risks and benefits of participation. Also it should be noted that participation is voluntary, and you can withdraw or refuse to answer any particular questions in any tasks. Please, feel free to ask the researchers any questions at any time. You may use the contact information below.

**Research study title:** "Experimental second language processing of wh-constructions in English: The effects of first language and learning environment"

**Department and Institution:** Department of Linguistics and Germanic, Slavic, Asian and African Languages, Michigan State University.

**Contact Information:** If you have any questions or concerns, you may contact with **Dr. Spinner** via email at ***spinnerp@msu.edu*** or by phone at ***517-353-0754***. You can also make contact with **Se Hoon Jung** via email at ***jungse@msu.edu*** or by phone at ***517-575-5885 (Lansing)*** and ***at 017-555-6838(Seoul)***. Contact via mail is also available and you can mail at A-714 Wells Hall, Michigan State University, East Lansing, MI 48824. It is recommended that contact via email for Dr. Spinner or via email/phone will be the fastest way to talk to the investigators.

**Purpose of Research:** The study aims at investigating to what extent English learners whose native languages are syntactically different from English process English sentences similarly or differently from native speakers.

**Eligibility:** You are eligible to participate in this study if
1) you speak Korean or Chinese as your first language and English as your second language, AND
2) you did not learn English in communicative contexts before 16 years old.

**What you will do:** The study will involve 1 session, which will take approximately 90 minutes. During the session, you will be asked
1) to take the grammar and vocabulary sections of the Michigan Test,
2) fill out a short questionnaire about your language learning history, and
3) to read sentences (one sentence at a time) on a computer screen and to judge if each one of those are grammatically acceptable.

**Compensation:** By participating in this study, you will receive 15 dollars (US) cash payment or the equivalent in Korean Won (KWC).

**Potential benefits:** You will not directly benefit from your participation in this study. However, for non-native English speakers, you will be able to practice reading in English. In addition, your responses will be used to investigate how second language learners process the target language online. The information gained from the study could have implications for second language acquisition theories.

**Potential risks:** There are no risks or discomforts expected as a result of your participation. Your participation in the study will not affect your enrollment in the university, and your

performance during the tasks will not affect your grades in your classes. The data will be used only for research purposes.

**Confidentiality:** You will not be required to provide your name or any other personally identifiable information. Your performance in this study will be kept confidential and your information will be safely secured by the researchers. All the data will be accessible only to the assigned investigators and will be kept securely. No personal information such as your name will be given in public. Instead, you will be identified only by a number throughout the data collection process as well as any further publication.

If you have any questions that are not answered on this consent form, please feel free to ask at any time. If you have any questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, Michigan State University Human Research Protection Program at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or regular mail at: 202 Olds Hall, MSU, East Lansing, MI 48824.

Thank you for your participation.

Your signature below indicates that you have read this consent form, and that you volunteer to participate in this study.

| Participant's signature | Printed name | Date (mm/dd/yy) |
|---|---|---|

Appendix B

Background Questionnaire

※ All information you provide will be kept confidential and will be reported anonymously.

**Section 1. Basic Information**

1. Subject No: _____ (Assigned by the researcher)

2. Gender (Check one): □ Male □ Female

3. Age: _____ years old.

4. What is your native language? _____ .

5. (For MSU students)
How long have you been studying in the United States? □ Yes □ No
For _____ years _____ months.

6. Academic Status
(Check one, or two if needed; for example, if you are currently taking classes at ELC while you are a senior at college in your home country check both at ELC and Senior)
□ ESL student □ Freshman □ Sophomore □ Junior
□ Senior □ Graduate □ Other (please specify)_____

7. Have you learned any foreign languages other than English?
※ If yes, please specify all information 1) including which language, 2) length of study
I have learned _____ for _____ month(s)
I have learned _____ for _____ month(s)

8. Have you ever studied or lived **ABROAD**? □ Yes □ No
※ If yes,
1) Where? _____, 2) How long? _____, 3) Main Purpose:
_____

1) Where? _____, 2) How long? _____, 3) Main Purpose:
_____

*** **[Example]** 1) Where? ***Australia,*** 2) How long? ***6 mth*** 3) Purpose: ***Univ. exchange program***
1) Where? ***Canada,*** 2) How long? ***2 years*** 3) Purpose: ***Degree Program***

**Section 2. English learning experience**

9. When did you start learning English?
   I was (about) _____ years old when I started learning English.

10. How many years have you studied English?
    - □ Less than 1 year □ 1 year □ 2 years □ 3 years □ 4 years
    - □ 5 years □ 6 years □ 7 years □ 8 years □ 9 years
    - □ More than 9 years (for about _____years)

11. How old were you when you were first exposed to English communication environments? What was the context of that situation? (For example, taking conversation classes, study abroad program, or ESL classes would be such cases).

    I was _____ years old. The context was _____.

12. How much time do you usually spend using English from outside of the classroom?

| Language Skills | Description | Use of time (Weekly) |
|---|---|---|
| **Reading** | Newspaper (including online or internet news), magazine, book (including textbooks), academic journal, and any other types of reading activities in English | (about _____ hours) per week |
| **Writing** | Homework assignment, essay, diary, English chatting, and any other types of writing activities in English | (about _____ hours) per week |
| **Listening** | Pop music (in English), lecture, TV, radio, and any other types of listening activities in English | (about _____ hours) per week |
| **Speaking** | Conversing with native speakers of English, in-class discussion in English, and any other types of speaking activities | (about _____ hours) per week |

**Again your privacy will be secured. Thank you for your participation.**

## Appendix C

### Experimental sentences for moving window procedures

※ These test items were obtained from Dr. Alan Juffs at University of Pittsburgh, and revised under his permission.

※ Total 27 Structures, 162 Sentences

# N-WHM-CompNP 1 1 What did Tom hear the story that Ann cooked for Bill?

# N-WHM-CompNP 2 1 Who did Bill believe the story that Ann hated at work?

# N-WHM-CompNP 3 1 Who did Tom believe the claim that Ann painted at home?

# N-WHM-CompNP 4 1 What did Bill believe the story that Ann studied at school?

# N-WHM-CompNP 5 1 What did Ann hear the news that Jane received from Tom?

# N-WHM-CompNP 6 1 Who did Sam hear the news that Jane called last night?

# N-WHM-AdjunctC 7 2 Who did John call his mom after he kissed last week?

# N-WHM-AdjunctC 8 2 What did Ann leave the kitchen after she cooked last night?

# N-WHM-AdjunctC 9 2 What did John begin his homework after he studied last night?

# N-WHM-AdjunctC 10 2 Who did Tom confuse his wife when he invited last night?

# N-WHM-AdjunctC 11 2 What did Tom break his glasses when he played last night?

# N-WHM-AdjunctC 12 2 What did John sell his bicycle when he needed last week?

# N-WHM-RC 13 3 What did Sam see the man who wanted from Jane?

# N-WHM-RC 14 3 What did Tom meet the woman who rented last week?

# N-WHM-RC 15 3 What did Bill buy the bicycle which needed last year?

# N-WHM-RC 16 3 What did Ann lend the student who studied at school?

# N-WHM-RC 17 3 Who did Tom see the woman who collected in hospital?

# N-WHM-RC 18 3 Who did Jane like the man who carried for Tom?

# N-WHM-SubjFinTHAT 19 4 Who did Ann suggest that liked the manager at the office?

# N-WHM-SubjFinTHAT 20 4 What did Sam report that passed his bicycle in the street?

# N-WHM-SubjFinTHAT 21 4 Who did Ann know that studied the textbook in the library?

# N-WHM-SubjFinTHAT 22 4 Who did John know that watched the patient in the hospital?

# N-WHM-SubjFinTHAT 23 4 Who did Jane report that saved the driver from the crash?

# N-WHM-SubjFinTHAT 24 4 Who did Bill know that visited the woman at the hotel?

# Y-WHM-ShortObjExt 25 5 What did Mary need when she planned a party last week?

# Y-WHM-ShortObjExt 26 5 What did Tom lock after he packed his bag last night?

# Y-WHM-ShortObjExt 27 5 What did John earn when he painted the house for Mary?

# Y-WHM-ShortObjExt 28 5 Who did Bill meet after he parked his car at school?

# Y-WHM-ShortObjExt 29 5 Who did Ann call when she stayed with Tom last week?

# Y-WHM-ShortObjExt 30 5 Who did Tom fight when he played soccer last night?

# Y-WHM-FinSubj 31 6 Who did the woman suggest liked the manager at the office?

# Y-WHM-FinSubj 32 6 What did the man report passed his bicycle in the street?

# Y-WHM-FinSubj 33 6 Who did the teacher know studied the textbook in the library?

# Y-WHM-FinSubj 34 6 Who did the nurse know watched the patient in the hospital?

# Y-WHM-FinSubj 35 6 Who did the sailor report saved the woman from the ship?

# Y-WHM-FinSubj 36 6 Who did the police know visited the woman at the hotel?

# Y-WHM-FinObjWithoutThat 37 7 Who did the woman suggest the manager liked at the office?

# Y-WHM-FinObjWithoutThat 38 7 What did the driver report his truck passed in the street?

# Y-WHM-FinObjWithoutThat 39 7 What did the teacher know the student studied in the library?

# Y-WHM-FinObjWithoutThat 40 7 Who did the nurse know the police arrested at the hospital?

# Y-WHM-FinObjWithoutThat 41 7 Who did the woman report the sailors saved from the ship?

# Y-WHM-FinObjWithoutThat 42 7 Who did the police know the thief visited at the hotel?

# Y-WHM-FinObjWithThat 43 8 What did Tom know that his friend studied in the library?

# Y-WHM-FinObjWithThat 44 8 Who did John think that his sister invited to the party?

# Y-WHM-FinObjWithThat 45 8 Who did Bill know that the police arrested at the airport?

# Y-WHM-FinObjWithThat 46 8 What did Jane suggest that the student studied in the library?

# Y-WHM-FinObjWithThat 47 8 What did John report that the teacher corrected in the exam?

# Y-WHM-FinObjWithThat 48 8 What did Tom know that his mother cooked for the party?

# Y-WHM-NonFSubj 49 9 Who did the students want to teach the course last year?

# Y-WHM-NonFSubj 50 9 Who did the teacher want to learn the rules last week?

# Y-WHM-NonFSubj 51 9 Who did the boy expect to invite his family last night?

# Y-WHM-NonFSubj 52 9 Who did the manager expect to meet the customer last month?

# Y-WHM-NonFSubj 53 9 Who did the woman want to arrest the thief last week?

# Y-WHM-NonFSubj 54 9 Who did the actor report to like his movie very much?

# Y-WHM-NonFObj 55 10 What did the students want to learn in the course this term?

# Y-WHM-NonFObj 56 10 Who did the police want to arrest at the airport last night?

# Y-WHM-NonFObj 57 10 Who did the manager expect to hire for the job last week?

# Y-WHM-NonFObj 58 10 Who did the teacher expect to meet at the school last week?

# Y-WHM-NonFObj 59 10 What did the police report to know about the crime last night?

# Y-WHM-NonFObj 60 10 Who did the student report to like in the movie last week?

# Y-GP 61 11 When the manager served the wine splashed his jacket and tie.

# Y-GP 62 11 Before the student guessed the answer appeared on the next page.

# Y-GP 63 11After the students played the game stayed very popular at school.

# Y-GP 64 11 After the children cleaned the house looked very neat and tidy.

# Y-GP 65 11 Before her sister parked the car needed some gas and oil.

# Y-GP 66 11 When the teacher helped the learned the rules last week.

# Y-NGP 67 12 After the president talked the guests offered him some red wine.

# Y-NGP 68 12 Before the man shouted the thief climbed through the small window.

# Y-NGP 69 12 After the woman died her husband married a woman from England.

# Y-NGP 70 12 When the student arrived the professor asked her about her trip.

# Y-NGP 71 12 When the actor appeared the crowd pushed towards his big car.

# Y-NGP 72 12 Before the teacher agreed the students played soccer in the yard.

# Y-GP 73 13 The doctor knew the nurse liked the man from England.

# Y-GP 74 13 The student heard his teacher hated the book about cars.

# Y-GP 75 13 The teacher knew the student studied the lesson on birds.

# Y-GP 76 13 The manager reported the woman earned the money last year.

# Y-GP 77 13 The sailor heard his friend the ship last year.

# Y-GP 78 13 The police reported the thief visited the house last week.

# Y-RRC 79 14 The famous man known by every student was a very nice person.

# Y-RRC 80 14 The large birds eaten in the garden could not see the cat.

# Y-RRC 81 14 The black horse chosen at the stadium won five prizes this year.

# Y-RRC 82 14 The bad boys seen in the afternoon were playing in the park.

# Y-RRC 83 14 The small child flown from his home was very sick last night.

# Y-RRC 84 14 The young teacher driven to the school started to teach this week.

# Y-RRC 85 15 The famous man known almost every place was a very nice person.

# Y-RRC 86 15 The large birds eaten almost every week could not see the cat.

# Y-RRC 87 15 The black horse chosen nearly every week won five prizes this year.

# Y-RRC 88 15 The bad boys seen almost every day were playing in the park.

# Y-RRC 89 15 The small child flown almost every day was very sick last night.

# Y-RRC 90 15 The young teacher driven nearly every day started to work this week.

# Y-RRC 91 16 The famous man invited by every student was a very nice person.

# Y-RRC 92 16 The large birds killed in the garden could not see the cat.

# Y-RRC 93 16 The black horse noticed at the stadium won five prizes this year.

# Y-RRC 94 16 The bad boys criticized during the morning were playing in the park.

# Y-RRC 95 16 The small child moved from his home was very sick last night.

# Y-RRC 96 16 The young teacher hired at the school started to teach this week.

# Y-RRC 97 17 The famous man invited almost every time was a very nice person.

# Y-RRC 98 17 The large birds killed almost every week could not see the cat.

# Y-RRC 99 17 The black horse noticed nearly every time won five prizes this year.

# Y-RRC 100 17 The bad boys criticized almost every day were playing in the park.

# Y-RRC 101 17 The small child moved almost every day was very sick last night.

# Y-RRC 102 17 The young teacher hired nearly last year started to teach this week.

# Y-RRC 103 18 The famous man painted by every student was a very nice person.

# Y-RRC 104 18 The large birds attacked in the garden could not see the cat.

# Y-RRC 105 18 The black horse raced at the stadium won five prizes this year.

# Y-RRC 106 18 The bad boys watched during the afternoon were playing in the park.

# Y-RRC 107 18 The small child visited at his home was very sick last night.

# Y-RRC 108 18 The young teacher helped at the school started to teach this week.

# Y-RRC 109 19 The famous man painted nearly every month was a very nice person.

# Y-RRC 110 19 The large birds attacked almost every week could not hear the cat.

# Y-RRC 111 19 The black horse raced nearly every month won five prizes this year.

# Y-RRC 112 19 The bad boys watched almost every day were playing in the park.

# Y-RRC 113 19 The small child visited almost every day was very sick last night.

# Y-RRC 114 19 The young teacher helped almost every day started to work this week.

# N-Overpass 115 20 Mary knew that the book was disappeared from the shelf yesterday.

# N-Overpass 116 20 Tom said that an accident was happened in the street yesterday.

# N-Overpass 117 20 Mary knew that the guests were arrived late at the party.

# N-Overpass 118 20 John said that the apples were fallen because of the wind.

# N-Overpass 119 20 Tom knew that the dog was died because it was old.

# N-Overpass 120 20 Jane said that the problem was existed before the bad storm.

# Y-UNACCUSATIVE 121 21 Tom knew that the book disappeared from the shelf last week.

# Y-UNACCUSATIVE 122 21 Jane said that the accident happened suddenly in the dark street.

# Y-UNACCUSATIVE 123 21 Mary knew that the guests arrived late at the party yesterday.

# Y-UNACCUSATIVE 124 21 John said that the apples fell because of the strong wind.

# Y-UNACCUSATIVE 125 21 Ann knew that the dog died because it was very old.

# Y-UNACCUSATIVE 126 21 Sam said that the problem existed because of the bad storm.

# Y-TRANSITIVE 127 22 In the summer the student changed his work for three months.

# Y-TRANSITIVE 128 22 Three months ago the owners closed the factory near the town.

# Y-TRANSITIVE 129 22 In the morning the policeman started the search for the thief.

# Y-TRANSITIVE 130 22 In the morning the teacher stopped the computer for a break.

# Y-TRANSITIVE 131 22 In the winter the manager reduced the pollution from the factory.

# Y-TRANSITIVE 132 22 In the summer the farmers grew the tomatoes in the fields.

# Y-OPTRAN-INTRAN 133 23 After several weeks his work changed at the new store.

# Y-OPTRAN-INTRAN 134 23 After several months the factory closed for the summer vacation.

# Y-OPTRAN-INTRAN 135 23 After several hours the search started in a different place.

# Y-OPTRAN-INTRAN 136 23 After several minutes the computer stopped due to a problem.

# N-OPTRAN-INTRAN 137 23 In some cities the pollution reduced due to new laws.

# Y-OPTRAN-INTRAN 138 23 In the north the tomatoes grow best in the sun.

# Y-FILL-DeclCompNP 139 24 Ann heard the news that Tom needed a car last week.

# Y-FILL-DeclCompNP 140 24 Jane believed the story that Bill cooked a chicken last night.

# Y-FILL-DeclCompNP 141 24 Tom believed the story that Ann borrowed a bicycle last week.

# Y-FILL-DeclCompNP 142 24 Ann heard the news that Jane wanted a present from Tom.

# Y-FILL-DeclCompNP 143 24 John believed the story that Ann painted the kitchen last week.

# Y-FILL-DeclCompNP 144 24 Tom heard the news that Jane called the manager at home.

# Y-FILL-DeclRC 145 25 Sam married the woman who solved the problem for him.

# Y-FILL-DeclRC 146 25 Tom called the woman who rented the house last week.

# Y-FILL-DeclRC 147 25 Bill repaired the bicycle which needed new tires last night.

# Y-FILL-DeclRC 148 25 Ann helped the student who studied the Indians last year.

# Y-FILL-DeclRC 149 25 Tom invited the woman who visited the patient in hospital.

# Y-FILL-DeclRC 150 25 Jane liked the man who carried the bag for Ann.

# Y-FILL-ShortWH 151 26 When did the teacher leave?

# Y-FILL-ShortWH 152 26 What did the manager earn?

# Y-FILL-ShortWH 153 26 Who did the police arrest?

# Y-FILL-SimpDecl 154 26 The student studied the chapter on animals.

# Y-FILL-SimpDecl 155 26 The manager called the customers.

# Y-FILL-SimpDecl 156 26 The teacher helped the students.

# N-FILL-Nonse 157 27 Who did at the kitchen Mary see in the kitchen last week?

# N-FILL-Nonse 158 27 The parents of the brought a cake in morning the crown.

# N-FILL-Nonse 159 27 Who policeman the did see sailor the called last week?

# N-FILL-Nonse 160 27 Helped teacher last week the should man in the summer.

# N-FILL-Nonse 161 27 Into the studied went the policeman woman night the in.

# N-FILL-Nonse 162 27 Before week in Mary for Ann changed rules the into.

Appendix D

Instruction and practice script in the Moving Window procedure

1. Instruction

Welcome! You are invited to an experiment in which you will be reading several types of sentences on the computer screen. Before you encounter each sentence, you will first see a row of dashes like this: ---- -- --- ---- -- --- ---- ----- ----- ---- ---- -- - ---------

These dashes are covering the words in the sentence. When you press the SPACE BAR, the first word will appear. Then with every press of the SPACE BAR, the next word will appear and the previous word will be changed to dashes again. In other words, you will see only one word of the sentence at one time.

When you read each sentence, you can control your reading at your own pace. You should read as quickly as you can, but BE SURE that you UNDERSTAND the meaning. If you think you did not understand the sentence because you pushed the space bar TOO FAST, then you may SLOW DOWN for the next items.

When you finish reading the last word of each sentence, press the SPACE BAR again. The dashes will go away and you will see a question about the sentence you just read. The question will ask you whether or not the sentence is a grammatically acceptable sentence of English.

For your answer, press the GREEN key if you think the sentence was grammatically CORRECT/ACCEPTABLE in English, or press the RED key if you think the sentence was grammatically INCORRECT/UNACCETABLE in English.

When you make a judgment for each sentence, please ingnore the PUNCTUATION. For example, for some sentences you may not see a comma where you expect it. Your decision about the grammaticality must not be influenced by PUNCTUATION.
Also, please focus more on the structure of the sentence than the meaning. Some sentences might be somewhat illogical in meaning. It is expected that you concentrate on the STRUCTURE.

Try to answer as quickly and accurately as possible. If you are NOT sure of the answer, try to pick the better answer.

You can take a rest after every 30 sentences you read. You can also have a short break before you start each sentence. When the experiment is over, a screen will appear telling you to stop. At that point, let the experimenter know you are finished.
If you have any questions about the procedure, ask the experimenter now.

2. Practice
# practice 1 –
This sentence is a practice sentence to help you get used to a moving window display.

# practice 2 -
This sentence is also for practice, and is followed by a question. // Are you following this so far?

The next few practice items will be more like real experimental sentences.

# practice 3 - Where did Ann go for breakfast last Sunday? // Is this correct?

The sentence you just have read is, "Where did Ann go for breakfast last Sunday?"
This is a correct and grammatical sentence, asking where Ann went for breakfast last Sunday, so you would press the GREEN KEY for YES.

# practice 4 - The man will bought a new car yesterday evening. // Is this correct?

The sentence you just have read is ..."The man will bought a new car yesterday evening."
This is not grammatical English, so you might press the RED KEY for NO.

Here are some more practice sentences. For those examples, you would not receive any feedback. Remember that in the main experiment you will not receive any feedback about the answer.}

# practice 5 - What does Sam do on his day off every Tuesday? // Is this correct?
# practice 6 - The dog jumped over the fence into the river. // Is this correct?
# practice 7 - Who did Tom see on the bus? // Is this correct?
# practice 8 - Where did about Ann tell the story the in classroom? // Is this correct?
# practice 9 - What is the best saw Tom on his vacation in Chicago? // Is this correct?
# practice 10 -Who was horse at the news that bird met? // Is this correct?

That's all for the practice. If you have any question, ask the experimenter now.
Otherwise, you may begin the experiment.

## Appendix E

## Debriefing form

Debriefing

The study you have participated in is interested in how second language learners process second language sentences, specifically sentences which contain wh-words (in English). While some languages such as Chinese or Korean do not make any movement of wh-word in wh-questions, some other languages such as English or Spanish must move the wh-word from its original place to the beginning of sentence. Generally, it is well known that native English speakers try to find the original place of moved wh-word as soon as possible as they process the sentence incrementally. Taking this into account, this study seeks to find answer to the question, "to what extent do Korean and Chinese speaking English learners process English wh-structures similarly to or differently from native English speakers?"

You were asked to read a number of sentences that appeared on the computer screen, and you could read only one word at a time. From this experiment, your word-level reading time was measured. The word level reading time indicates the time you spent before you read the next word. At the end of every sentence, you were asked to make a judgment about the correctness of the sentence. This was to see how sensitive you are to grammatical and ungrammatical English wh-constructions.

As compensation for my participation in the research study,

I acknowledge receipt of (10USD, 15USD, 15,000 Won) cash from Se Hoon Jung.

_____

Your Signature

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