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문학석사 학위논문

**The Effects of Visual Input
Enhancement and Working Memory
on Grammar Learning by Korean EFL
Learners**

시각강화와 작업기억이 한국인 영어 학습자의 문법
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Abstract

**The Effects of Visual Input
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Learners**

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Since the research evidence on the importance of attention and noticing in learning a second language has been accumulated, various teaching techniques to draw learners' attention to target forms have been developed and applied in L2 classrooms. Amongst many techniques, such as explicit rule explanation, dictogloss, recasts, prompts, input flooding, etc., visual input enhancement (VIE) has particularly received a lot of attention from L2 researchers as well as classroom teachers. It involves enhancing target features in reading texts for learners to notice

them. Previous studies on the effects of VIE on L2 grammar learning, however, have shown mixed results due to the methodological differences such as the choice of specific target linguistic forms as well as various learner-internal factors. Moreover, another important issue regarding the impact of VIE on reading comprehension has not been resolved and remains controversial.

Over the years, many VIE studies have been carried out; however, few studies have compared the effectiveness of VIE between different target structures and investigated the relationship between learners' working memory and the effectiveness of VIE. Thus, this study aims to investigate the effect of VIE on the learning of two grammatical forms and their impact on reading comprehension. English relative clauses and articles have been chosen as the target features because they have been known as relatively challenging features for Korean EFL learners and there are some similarities and differences in complexity. Finally, individual learners' working memory capacity has been also examined to explore its impact on the effectiveness of VIE.

A total of 48 Korean college learners of English participated in this study. The participants were assigned into three groups: (a) relative group (VIE on relative clauses), (b) article group (VIE on articles), and (c) control group (no VIE). They completed a reading comprehension test and grammar tests, including a grammaticality judgement test (GJT) and a fill-in-the-blank (FIB) test. This study also explored whether the effectiveness of VIE was influenced by each participant's different levels of working memory. Therefore, based on their working memory test results, each group was subdivided into high and low working memory (WM) capacity groups.

The findings showed that reading comprehension test results of the two VIE groups were not significantly different from the control group, which indicates that the enhancement on two grammatical features did not interrupt learners' reading comprehension. However, the grammar test results of the two VIE groups were different from that of the control group, depending on the target form. In the relative group, the immediate posttest result for the GJT was better than that of the control group. The participants in the relative group noticed the enhanced relative clauses more than other groups, and it was found that VIE helped them enhance their receptive knowledge of English relative clauses. As for articles, VIE was shown to improve the participants' productive knowledge of English articles. These results indicate that VIE on target linguistic features has positive effects on their grammar learning.

The individual differences in working memory capacity in general did not affect the reading comprehension or grammar learning for both the VIE-relative and VIE-article groups. However, the result of the processing component of working memory showed that learners with higher WM processing ability performed better than those with lower WM processing ability. In the relative group, participants with high WM processing ability slightly performed better in the GJT than their counterparts; however, it was not statistically significant. In the article group, participants with high WM processing ability had performed better in the FIB, which was statistically significant. These findings suggest that the processing component of working memory might be an important individual variable for grammar learning. Despite not being statistically significant, the trend that the group with high working memory ability outperformed the lower group presents the possibility that the effects of VIE

can differ depending on the learners' WM capacity.

The current study showed that VIE on the target form did not inhibit reading comprehension, but it had a positive effect on grammar learning. Furthermore, the impact of VIE on grammar learning can be influenced by the processing component of the participants working memory capacity, despite its small impact. The findings of this study suggest that by enhancing the target grammatical forms, learners can notice the forms and thereby acquire them without compromising for meaning.

Keyword: noticing hypothesis, attention, visual input enhancement, working memory, grammatical difficulty, reading comprehension, L2 acquisition, grammar learning

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1. Introduction

1.1 Research Background

In second language acquisition (SLA) research, the role of noticing in L2 learning has drawn a lot of interest and attention from SLA researchers and practitioners. Since the noticing hypothesis was proposed by Schmidt (1990), it has been suggested that attention is essential to learning and input is likely to be acquired when learners notice the language. According to this hypothesis, noticing does not in itself result in acquisition, but it is considered an essential starting point.

Based on research findings that showed the positive role of noticing (e.g., Robinson, 1995; Schmidt, 1990, 1993; Tomlin & Villa, 1994), drawing learners' attention in language learning was important in EFL classroom settings, and various techniques have been applied. These range from explicit techniques such as rule explanation to implicit techniques such as input flooding and recasts. Visual input enhancement (VIE) is a specific example of making features salient for the learners to notice. It involves **boldfacing**, underlining, or *italicizing* features that need to be emphasized, and it has been extensively used in EFL textbooks. Due to the perceptual saliency of VIE, learners would pay additional attention to the enhanced target forms. Furthermore, as noticing is a crucial starting point for language learning, VIE on grammar forms is expected to facilitate learners' grammar accuracy.

The efficacy of VIE has been attested in many studies (Alanen, 1995; Cho, 2010; Doughy, 1991; Ha, 2005, 2009; Indrarathne, 2016; Izumi, 2002; Jourdenais, 1998; LaBrozzi, 2016; Lee, 2018; Lee, 2007; Leow, 1997, 2001; Meguro, 2019; Overstreet, 1998, 2002; Park & Nassif, 2014; Shook, 1994; Simard, 2009; White,

1998; Winke, 2013; Wong, 2003); however, the findings showed mixed results. In addition to these inconsistent findings on the efficacy of VIE on grammar learning, reviews of some studies on VIE and reading comprehension showed that VIE may have negative effects on comprehension of a reading text (Lee, 2007; Overstreet, 1998; Park & Nassif, 2014), while others claim that VIE does not affect reading comprehension (DeSantis, 2008; LaBrozzi, 2016; Leow, 1997, 2001; Leow et al., 2003; Winke, 2013). For such different findings, the variations in methodologies have been suggested as one of the major reasons (Lee & Huang, 2008).

Specifically, the findings of these studies have been suggested to be affected by the methodological differences including the type of linguistic forms investigated, prior knowledge of the target form, or instruments used for the task. Many researchers, for example, argued that the nature of target forms may influence the perceived effectiveness of instructional interventions such as VIE (Goldschneider & DeKeyser, 2001; Spada & Tomita, 2010). Language structures differ in complexity, communicative significance, and perceptual saliency (Mackey et al., 2001; Schmidt, 2001). Empirical evidence tends to support that forms with higher communicative value are likely to be learned from VIE, while forms with lower communicative value seem to be the most challenging to be acquired from VIE (Doughty, 1991; Jourdenais et al., 1995; Park & Nassif, 2014; Shook, 1994). However, the evidence is still inconclusive; therefore, it is essential to investigate various targeted structures to better understand how VIE affects the acquisition of a specific feature and whether it affects reading comprehension.

Another factor to investigate is working memory (WM) capacity. When grammar forms are visually enhanced in the reading texts, learners must process two

tasks simultaneously; on the one hand, they should construct meaning, and on the other, they should process grammar forms. The simultaneous tasks caused by the VIE may overburden learners, especially those with a lower level of working memory capacity. Previous studies suggest that there are individual differences in processing with the limited working memory, and only a certain amount of information can be processed within this WM capacity (Alptekin & Erçetin, 2010; Daneman & Carpenter, 1980; Harrington & Sawyer, 1992; Juffs & Harrington, 2011). Thus, it can be assumed that learners with a higher level of WM capacity are more likely to process VIE effectively. In contrast, learners with a lower level of WM capacity may struggle to process both reading comprehension and enhanced grammatical features at the same time. Given the critical role that noticing plays in the effectiveness of VIE, more research into the relationship between working memory capacity and noticing of input enhancement is needed.

The present study aims to investigate whether VIE affects reading comprehension and whether VIE is effective for Korean EFL learners to improve their accuracy on different grammatical features. Another goal of this research is to study whether learners' individual WM capacity mediates the impact of VIE on both reading comprehension and the acquisition of grammatical features.

1.2 Research Questions

This study aims to investigate the effects of visual input enhancement (VIE) and working memory on the acquisition of grammatical features. In order to explore the issue, the following research questions are posed:

- 1) Does VIE on grammar forms affect reading comprehension and grammar learning?
- 2) Does the effect of VIE differ depending on the type of grammatical feature?
- 3) Does working memory capacity affect the efficacy of VIE?

1.3 Organization of the Thesis

The present thesis is organized as follows. Chapter 2 reviews previous studies on the role of VIE on reading comprehension and grammar learning, the background of the selected two grammatical features, and working memory as an important individual variable in SLA. Chapter 3 describes the design and methods used for the experiment. Chapter 4 reports the results of statistical analyses. Chapter 5 discusses the research questions with the findings from the experiment. Lastly, Chapter 6 concludes with the summary of findings, addresses the limitation, and provides suggestions for future research.

2. Literature Review

2.1 Attention in Second Language Acquisition

In second language acquisition (SLA) studies, the importance of input has been greatly addressed by many researchers. Krashen (1985) claims that “comprehensible input”, defined as input containing language forms that are slightly beyond the language learner’s current level of interlanguage competency ($i+1$), is sufficient for L2 acquisition. However, the past decades of SLA research agree with the need for comprehensible input but claims that it is insufficient for language learning (Ellis, 1994; Larsen-Freeman & Long, 1991; Long, 1996). Given that not all of the input learners are exposed to is utilized as an intake for learning, recent research has focused on the function of attention in facilitating input and learning (Leow, 2015; Robinson, 2003; Schmidt, 2001). As a result, drawing learners’ attention to input is critical for input to become intake for subsequent processing and learning (e.g., Schmidt, 1990, 1993, 2001).

Despite the general consensus on the necessity of attention, there is disagreement over the level and type of attention required for learning. First, according to Schmidt (1990, 1993, 2001)’s noticing hypothesis, in order for language learning to take place, learners must first consciously notice the forms in the input with focal attention and awareness. Schmidt originally proposed an extreme version of the noticing hypothesis, claiming that “noticing is the necessary and sufficient condition for the conversion of input to intake” (Schmidt, 1990, p.129). However, in his later version (Schmidt, 2001), this strong hypothesis has been weakened to suggest that noticing is a more facilitative factor rather than a sufficient role in L2

development.

As a second position, Tomlin and Villa (1994) separated the concept of attention into three components: (a) alertness, (b) orientation, and (c) detection. Among the interrelated process of attention, only detection is crucial for learning. Detection relates to the ability of learners to select and process specific information, and it does not require conscious awareness. The other two components, alertness and orientation, serve to increase detection. According to Tomlin and Villa (1994), detection is a prerequisite for subsequent input processing, and language acquisition occurs at this level. They also view that awareness and learning should be separated, and that awareness is not necessary for input to be available for language development.

Robinson (1995, 2003) proposed a model of attention and memory to better understand the role of attention and awareness in language learning. This model reconciled Schmidt's noticing hypothesis and Tomlin and Villa's model of attention. Schmidt's notion of noticing was characterized by Robinson (1995) as what is detected and then further activated as a result of a central executive's allocation of attentional resources. Detection aids the encoding of input in short-term memory, which is then further processed by rehearsal before being transferred to long-term memory. Robinson's theoretical viewpoint is that detection is important in input processing and that linguistic input is available for further processing only at the level of noticing.

The processing of L2 language information is depicted in a model by Leow (2015). It includes three processing stages: the input processing, intake processing, and knowledge processing stage. The input processing stage takes place between the

input and intake of particular linguistic information. The sub-phase in this stage includes attended intake, detected intake, and noticed intake. Learners' peripheral attention determines attended intake, which is not for further processing. Detected intake, which is comparable to the 'detection' by Tomlin and Villa (1994), occurs without learners' attention. Noticed intake is similar to Schmidt's (1990) notion of noticing and requires focal attention. This noticed intake is more likely to be stored and processed in working memory which contributes to the development of the L2 grammar system. In the second stage of the intake processing stage, further processing of attended intake, detected intake, and noticed intake occurs. Lastly, the final knowledge processing stage links the learners' L2 developing system and output production.

The main disagreement between these different theoretical perspectives is the specific role of attention in language learning (Hama & Leow, 2010; Leow, 2001). However, despite the controversy over attention's specific role in the learning process, there is a general agreement that attention is a prerequisite for language learning to take place (Leow, 2001). An important challenge that arises in response to this theoretical description is how language learners' attention can be drawn to input with minimal interruption to the learning process. The attention system is considered a low-capacity mechanism (Just & Carpenter, 1980). Learners with limited attentional resources and processing capacity can only attend to a limited amount of incoming information (Robinson et al, 2012). When these learners are overburdened with incoming data, some of the input is omitted in the information processing system. VanPatten (1996)'s study found that it is challenging to pay attention to both form and meaning at the same time, especially for beginning-level

L2 learners. Some research highlighted the competing relationship between learners' ability to attend to form and their ability to understand meaning (Bransdorfer, 1991; Greenslade et al., 1999; Wong, 2001). Due to the limited attentional resources, different strategies have been utilized to direct learners' attention to language form without interrupting meaning. One of the mechanisms for increasing the perceptual saliency of target forms is input enhancement, which can be constructed in various ways by instructors (Sharwood Smith, 1991).

2.2 Visual Input Enhancement

Sharwood Smith (1991, 1993) first proposed the term "input enhancement", referring to a pedagogical intervention that makes target linguistic features in the input more salient to draw learners' attention to the form. Given the importance of attention in the acquisition process (Leow, 1997, 2001; Robinson, 1995; Schmidt, 1990, 1993; Sharwood Smith, 1991, 1993; Tomlin & Villa, 1994), input enhancement is a strategy that makes the input more perceptible and increases the chance of noticing by learners, potentially leading to learning progress (Doughty & Williams, 1998). Several studies in the field of SLA have investigated the effectiveness of input enhancement in drawing learners' attention to grammatical features.

Visual input enhancement (henceforth VIE), one of the input enhancements, has been widely used in second language learning environments. VIE has been proposed as a useful method of bringing language learners' attention to the linguistic features while keeping the overall focus on the meaning of the input (Sharwood Smith, 1991, 1993). This generally involves some form of typographical

modification such as **boldfacing**, underlining, *italicizing*, CAPITALIZING, coloring, or using different font types (Sharwood Smith, 1991, 1993). This technique aims to make the target grammar more noticeable to L2 learners, thereby facilitating grammar acquisition in meaning contexts (De Santis, 2008; Lee, 2007)

Several studies indicated that VIE aided grammar acquisition (Alanen, 1995; Doughty, 1991; Ha, 2009; Jourdenais et al., 1995; LaBrozzi, 2016; Lee, 2007; Shook, 1994; Simard, 2009). Doughty (1991) examined the effects of VIE on English relative clauses and found positive effects on grammar learning. In this study, three types of instruction were compared: a meaning-oriented instructional treatment, a rule-oriented instructional treatment, and a control treatment. An enhanced target language structure was used in the meaning-oriented instructional treatment to draw learners' attention. The findings of this study revealed that enhancing the target structure promoted the development of learners' grammar knowledge. However, this result should be dealt with caution because the treatment involved not only VIE but also a detailed analysis of the target structure. In Jourdenais et al. (1995)'s experiment, VIE had a beneficial effect on learning Spanish preterit and imperfect verbs. The participants' intake of target forms was measured by a picture-based writing task. The results showed that VIE promoted noticing and had a positive effect on the use of the target form. Ha (2009) examined how visual input enhancement could be used to help Korean participants become more aware of the use of phrasal verbs. The results of this study showed that the experimental group acquired phrasal verbs more than the control group, suggesting that VIE has a positive effect on grammar acquisition. Overall, VIE has been shown to be beneficial in boosting learners' knowledge of target linguistic constructions. Previous studies have shown

that participants whose attention was brought to the grammatical features obtained more linguistic knowledge about the items than those whose attention was not drawn to the forms.

Other studies, however, found that enhancement does not affect grammar learning (Jourdenais, 1998; Leow, 1997, 2001; Leow et al., 2003; Overstreet, 1998; Park & Nassif, 2014; Wong, 2003). White (1998) investigated the relative effect of visual input enhancement and input flood instruction in English possessive determiners. The groups were divided into (a) input enhancement group, (b) enhancement plus input flood group, and (c) input unenhanced group. The tasks were performed before and after the treatment sessions to see how the students have progressed over time. All three groups showed significant process, though there was no significant difference between the three groups. In Izumi (2002)'s study, VIE had a positive effect on noticing the target form, though there was no effect on grammar learning. The participants came from a variety of language backgrounds and were enrolled in adult ESL sessions. The researchers used a variety of measurements, including sentence combination, picture-cue sentence completion, interpretation, and grammaticality judgment task. The students in the VIE condition showed that they were aware of the target feature but could not acquire it correctly. Wong (2003) studied the effects of VIE on the acquisition of past participle agreements in French relative clauses by adult English speakers. The results indicated that the acquisition of the target form was found to be unaffected by VIE.

Three studies by Leow (1997, 2001, 2003) found no positive effect of VIE on grammar learning. In the first study, Leow (1997) utilized text length and VIE to see how these factors affected the acquisition of the Spanish impersonal imperatives.

Participants were randomly assigned to one of four groups: (a) enhanced short text, (b) enhanced long text, (c) unenhanced short text, and (d) unenhanced long text. Reading short materials had a positive effect on comprehension but not on grammar learning. However, VIE had no apparent effect on reading comprehension or grammar acquisition. In the second study by Leow (2001), the target structure was on Spanish formal imperative and command, and the results indicated no effect on intake, noticing, or comprehension. The third study by Leow et al. (2003) investigated the impact of VIE on learning Spanish present perfect and subjective. The data was collected from a multiple-choice recognition task and think-aloud protocols, but the results indicated that VIE did not influence noticing or learning.

These inconsistent findings in grammar acquisition and reading comprehension can be attributed to methodological differences. Some studies demonstrated how different VIE methods appeared to vary significantly in effectiveness, with differences in typographical formats yielding inconsistent results. Simard (2009) investigated the impact of several VIE forms on English plural markers. The participants in this study were native French speakers, and different VIE versions of the same text were given to each of the experimental groups. The findings suggested that VIE had a positive impact and the various formats had varying effects on learner intake. LaBrozzi (2016) also investigated the impact of different types of textual enhancements on learning Spanish preterit. According to this study's finding, the group receiving increased font size outperformed the control group and the group receiving capital letters. In addition, it showed that increased font size was more effective than other types, while font change, underlining, bolding, and italicizing were less effective. However, these VIE studies incorporate

a variety of target language features and thereby yielding different results.

Some researchers have investigated whether the degree of effectiveness of VIE on learning a target structure varies depending on the nature of the target form (Alanen, 1995; Park & Nassif, 2014; Simard, 1994). In Shook (1994)'s study, the effects of VIE on the acquisition of Spanish present perfect tense and relative pronouns (*que/quien*) were investigated. Participants were English L1 university Spanish learners and were divided into three groups: (a) control group with no enhancement, (b) enhanced text group, and (c) enhanced text plus an instruction to pay attention to the target form. On both multiple-choice recognition tasks and fill-in-the-blank tests, learners in the VIE condition outperformed the control group, with a significant advantage in the present perfect but not relative pronouns. These findings were interpreted by Shook (1994) that the differences in the degree of meaningfulness of the two target forms could explain the differential gains in the two forms. The speaker's use of present perfect was a more meaningful and aspectual option than relative pronouns, which were less meaningful and governed by syntactic choice.

Alanen (1995) investigated the efficacy of VIE with semi-artificial language as the target feature. English-speaking Finnish learners were randomly allocated to one of four groups: (a) input enhancement, (b) explicit rule instruction, (c) input enhancement and explicit rule instruction, and (d) control group. The target linguistic constructions were locative suffixes (semantically definable content) and consonant alternation (semantically empty feature) of semi-artificial Finnish. The findings of this study showed a partial but positive effect on grammar learning by VIE. The explicit treatment group had significantly improved than the other groups, while

input enhancement aided the learners' recall and usage of locative suffixes but not with consonant alternation. Similar to Shook (1994)'s finding, this study showed that semantically abundant features are better acquired through VIE than semantically empty forms.

Park and Nassif (2014) investigated a possible connection between the efficiency of VIE and the characteristics of target forms. The main goal of this research was to examine how VIE affected textual comprehension and production of Arabic comparative forms (more meaning-bearing structure) and Arabic dual pronouns (less meaning-bearing structure). English-speaking students learning Arabic as a second language were divided into two groups: enhanced and unenhanced. A free recall assignment and a comprehension exam were used to evaluate the learners' comprehension of reading passage. A fill-in-the-blank task and a free production task were used to assess learners' immediate production of target forms. The findings demonstrated that VIE had no effect on noticing the target forms but VIE on less meaningful forms had a negative effect on learners' reading comprehension.

Some researchers (Izumi, 2002; Lee, 2007; Overstreet, 1998; White, 1998) suggested that VIE alone might not be sufficient for language learning and that this strategy should be supplemented with additional pedagogical variables. White (1998) proposed that more explicit information should be accompanied by output activities. Izumi (2002) also recommended output activities for further processing and subsequent learning. Overstreet (1998) and Lee (2007)'s studies investigated the impacts of VIE and topic familiarity. Each study featured four groups with a different combination of [+/-] enhancement and [+/-] topic familiarity. In Overstreet (1998)'s

study, Spanish preterit and imperfect verbs were enhanced, and no effects on intake by VIE were found. On the other hand, Lee (2007)'s study showed that VIE has a positive effect on Korean EFL students' grammar acquisition of English passive voice. Both studies found that VIE had a negative impact on reading comprehension, while topic familiarity aided comprehension but was ineffective in grammar learning. The findings could be taken as an implication that learners were unable to focus their attentional resources on both content and form at the same time.

Taken together, previous studies on the impact of VIE on reading comprehension and grammar acquisition showed mixed results. Some studies (Jourdenais, 1998; Leow, 1997; Overstreet, 2002; Wong, 2003) showed that VIE does not affect reading comprehension, while others (Lee, 2007; Overstreet, 1998; Park & Nassif, 2014) have shown some negative effects. However, many of the studies on VIE were not designed to investigate VIE on learners' comprehension (Alanen, 1995; Doughty, 1991; Izumi, 2002; Shook, 1994). The inconsistent findings of the effects of VIE on grammar learning can be attributed to methodological differences such as the typographical formats of VIE, target grammar features, or pedagogical variables. This study seeks to examine whether the effectiveness of VIE on reading comprehension and grammar learning differs when drawing attention to specific grammatical forms with different grammatical complexity.

2.3 Grammatical Features

2.3.1 Grammatical Difficulty

Despite the interest in the differing impact of various instructional methodologies depending on the type of linguistic features, research on second

language acquisition displays a variety of definitions for “grammatical difficulty.” Different studies utilized different criteria to distinguish between simple and complex features. For example, Spada and Tomita (2010) distinguished the difficulty of the grammatical features in terms of the number of transformation rules. From this perspective, simple features include tense, articles, plurals, and prepositions, while dative alternation, passives, and relativization are categorized as complex features with two or more transformations. DeKeyser and Sokalski (1996), on the other hand, viewed the grammatical difficulty in terms of comprehension and production. They asserted that some grammatical structures are simple to understand but difficult to produce, whereas others are simple to produce but difficult to comprehend. The abundance of grammatical difficulty definitions appears to be a challenge in investigating the effects of different types of instruction.

In order to incorporate the variation of definition, Spada and Tomita (2010) defined complexity in three ways: psycholinguistic, linguistic, and pedagogic perspectives. In psycholinguistic terms, complexity was defined as whether a feature is acquired early or late or if it is more or less difficult to process. For instance, there is evidence in SLA literature that learners progress through a series of predictable stages in their L2 growth (Lightbown, 1980; Pineamann, 1989). One argument is that learners’ psycholinguistic processing ability limits their progress through developmental stages, preventing them from progressing to the next level unless they can cognitively grasp the structures from earlier stages (Meisel et al., 1981). Grammatical difficulty emerges when learners are required to acquire grammatical structures that are not developmentally ready to learn.

In terms of linguistic perspective, Hulstijn and de Graaf (1994) defined

difficulty as “the number (and/or type) or criteria to be applied in order to arrive at the correct form” (p.103). According to this view, complexity is viewed in terms of acquisition ease and duration rather than acquisition order. It has been claimed that the degree of complexity depends on the number or kind of criteria to be implemented to arrive at the correct form. From a linguistic viewpoint, complexity differs according to the number of transformations, markedness, or typologically similar or distinct from the first language. DeKeyser (2005) claimed that there are at least three elements that determine linguistic difficulty: form complexity, meaning complexity, and form-meaning mapping complexity. Form complexity is related to the employment of the current morpheme in the correct location (e.g., plural “s” in English). Articles in English cause potential difficulties for L2 learners because of their abstractness of meaning. The rules governing their use are regarded as too abstract for learners to deduce from the information, and specific instruction on article usage is generally ineffective in acquiring them. Form-meaning mapping relates to the traits when the form is nonmandatory (e.g., null subjects in Spanish), when exposure to the target feature is limited, and when the correlation between form and meaning is low (as with the “s” morpheme in English, which serves several functions). According to Spada and Lightbown (2008), the communicative value of language form can also add to its difficulties. For example, meaning-interfering errors (e.g., errors of possessive pronouns *his/her*) may be easier to correct than non-meaning interfering errors (e.g., the lack of inversion in questions like “Where I go?”).

Perceptuality is another predictor of linguistic difficulties (Ellis, 2017; Gass et al., 2017; Goldschneider & DeKeyser, 2001). According to Doughty and Williams

(1998), the saliency of the form in the input influences whether it is difficult to learn. Schmidt's (1990, 1994, 2001) studies hypothesized that learners could not learn what they did not detect in the input. A meta-analysis of the factors defining the natural order of morpheme acquisition in English supports the role of saliency (Goldschneider & DeKeyser, 2001). Some scholars have suggested that the perceptual saliency of linguistic features may play a significant role in acquiring target features in morphosyntactic studies. Ellis (2017) claims that salient features are more likely to be perceived, cognitively processed, and learned.

From a pedagogical standpoint, the difficulty has been defined in terms of how easy or difficult it is for learners to understand and acquire a grammatical form. Teachers identify problematic grammatical characteristics by observing learners' performance errors. The features that L2 learners fail to apply correctly in a systematic manner in their production are regarded as challenging for them to learn. The complexity of language structures was determined in Robinson (1996)'s study by asking teachers which features are more or less difficult for their students. The problem with pedagogical descriptions of rule complexity, however, is that while a particular rule may be challenging for one student, it may not be difficult for another, and this is likely related to characteristics such as aptitude and L1 background (DeKeyser, 2003).

Taken together, the grammatical complexity can be differentially defined according to different criteria. Since characterizing grammatical complexity itself is difficult, it is essential to look into the different traits of the target grammar form when selecting the features in instructional settings. Given the nature of these different complexity criteria and that target forms may influence the perceived

effectiveness of instructional intervention (Goldschneider & DeKeyser, 2001; Spada & Tomita, 2010), the choice of the target grammatical features is likely to affect the efficacy of VIE.

2.3.2 Target Forms

Empirical studies have tested the efficacy of VIE on forms such as English relative clauses (Doughty, 1991; Izumi, 2002), Spanish present perfect and relative pronouns (Shook, 1994), Spanish preterit and imperfect (Jourdenais et al., 1995), English possessive determiners (White, 1998), and Spanish imperatives (Leow, 2001). The decision about which features to enhance was mainly based on features that cause difficulties for the learners as well as the learners' prior knowledge of the target form (Lee & Huang, 2008). Few studies compared the effectiveness of VIE between differing grammatical features. Research that has investigated the nature of the target forms and whether VIE aids the learning of target structures to varying degrees showed that semantically meaningful features are better acquired through VIE than semantically empty forms (Alanen, 1992; Park & Nassif, 2014; Shook, 1994). However, the empirical evidence remains inconclusive (Jourdenais, 1998; Leow, 1997, 2001; Leow et al., 2003), which needs further research.

With regard to the choice of grammatical features, it is assumed that the efficacy of VIE will differ depending on the complexity of grammatical features. As mentioned in the previous section, defining simple and complex features is controversial. The target grammatical features chosen for the study were relative clauses and articles. These two features are similar in some perspectives but also show different traits of complexity in different criteria. Table 2.1 illustrates the

different characteristics in complexity between relative clauses and articles.

Table 2.1 Complexity differences between relative clauses and articles

	Relative Clauses	Articles
1) Comparison to L1	different	absent in L1
2) Acquisition order	late	late
3) Form-meaning mapping	difficult	difficult
4) Communication value of a form	low	low
5) Saliency of a form	yes	no
6) Reliability of the rule	concrete	abstract
7) Item-learning	no	yes
8) Transformation	complex	simple
9) Complexity of meaning	simple	complex
10) Meaning expressed through a form	no	abstract

First, relative clauses and articles share similarities in some traits. Both forms are considered challenging by many Korean EFL learners in that there are no equivalent forms in Korean, and they are widely used by native speakers of English in writing and speech. Korean relative clauses differ from their English counterparts in that they are used as prenominal modifiers without a relative pronoun. In Korean, the relativizer, such as *-un*, *-nun*, or *-ul*, is always attached to the verb root. These differences between their L1 and English present challenges for Korean EFL learners. Articles and relative clauses are acquired in the later acquisition stage by Korean learners. According to DeKeyser (2005), form-meaning mapping causes complexity

when the relationship between form and meaning is not transparent. The relative clauses in English create problems with the form-meaning mapping because the same form can have multiple meanings. In English, interrogative pronouns and relative pronouns which begins with *wh* share the same morphological form. Articles cause difficulty as it is hard to infer its highly abstract notions from the input. The two features have low communicative value. Semantic value and redundancy are two characteristics that contribute to a form's communicative value which is defined as the meaning it adds to the total meaning of a sentence. As implied by the previous studies (Alanen, 1995; Park & Nassif, 2014; Shook, 1994), VIE on lower communicative value hinders the processing of form and meaning. Thus, it was hypothesized that enhancement on these features in the reading text would be challenging for learners to process both form and meaning simultaneously.

The two features, however, differ in other criteria. Relative clauses have concrete rules and are generally acquired through more rule-based learning, whereas articles are more abstract and generally acquired by item-learning. Gasparini (2004) asserts that abstract rules can be learned better by implicit learning rather than explicit learning. White (1998) claims that VIE is less explicit than rule presentation but more explicit than input flooding. Because of this nature of VIE, articles are expected to benefit from VIE to some extent. According to Spada and Tomita (2010), articles involve only one transformation rule and thus it is considered as simple features, while relativization consists of two or more transformation rules. However, compared to articles, relative clauses are less complex in terms of meaning and do not express meaning through a form. Regarding the saliency of a form, relative clause is perceptually more salient than articles, and thus relative clauses are more

likely to be noticed when it is enhanced.

To summarize, while the two features show similarities in some criteria, they also show differences in other perspectives. Given the difference in nature, it is hypothesized that the two features would have different impacts on reading comprehension and grammar learning when visually enhanced.

2.4 Working Memory Capacity

Working memory has been emphasized in L2 learning as an individual factor mediating the effects of diverse instructional techniques (Goo, 2012, 2014; Harrington, 1992; Harrington & Sawyer, 1992; Juffs & Harrington, 2011; Mackey et al., 2002; Sagarra, 2000, 2017). Researchers in the field of SLA paid close attention to the role of working memory capacity. It has been investigated as individual differences to account for varying outcomes in acquiring different types of L2 knowledge and abilities.

Working memory (WM) is defined as a brain system that stores and manipulates information required for complex cognitive functions (Baddeley, 1992). Short-term memory and working memory are similar in that their capacity is limited. However, short-term memory only serves as a storage function while working memory stores and simultaneously process the information. Baddeley and Hitch (1974) proposed the multicomponent model of working memory and described the construction of working memory, as illustrated in Figure 1.

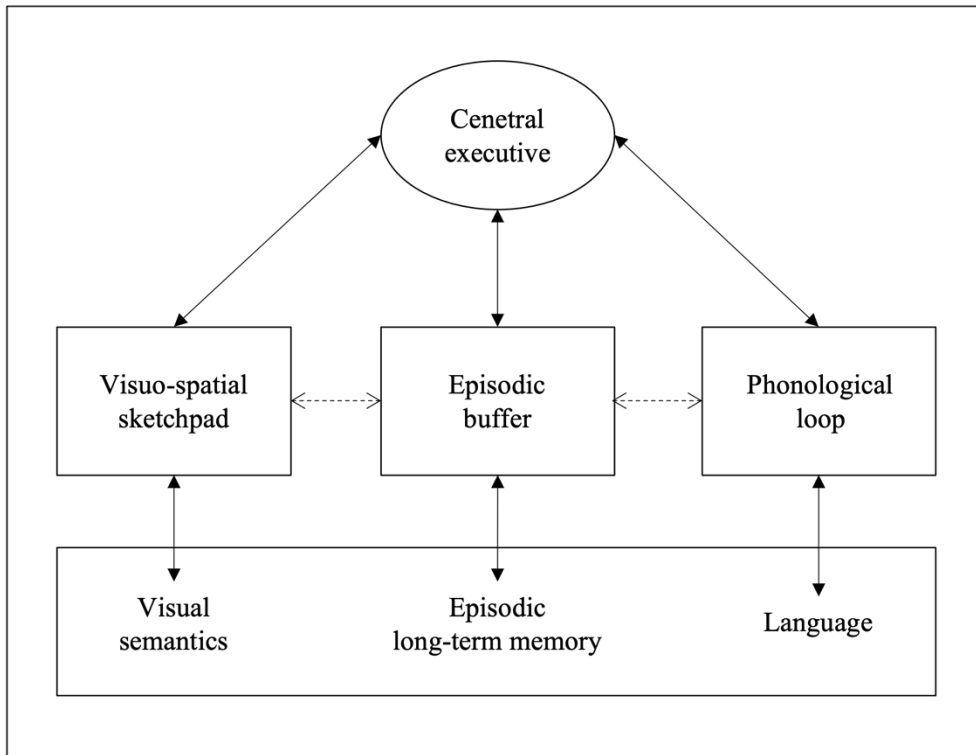


Figure 1 Multicomponent model of working memory (Baddeley, 2003, p.203)

WM consists of subcomponents for information storage and processing that includes the central executive, phonological loop, visuo-spatial sketchpad and episodic buffer (Baddeley, 2002, 2003, 2012). The phonological loop temporarily stores verbal and auditory information, while the visuo-spatial sketch pad stores and processes visual and spatial information. The main component of working memory is the central executive, which controls the amount of attention working memory uses for different information. According to Baddeley (1986, 1996), the major functions of the central executive are: (i) the ability to operate and coordinate two tasks; (ii) the ability to switch and allocate attention to two tasks; (iii) the ability to focus on one task; and (iv) the ability to store and process information in long-term memory. Baddeley (2000) added a fourth component, the episodic buffer, which

combines the three components of working memory and long-term memory. It plays a role in long-term memory, with its primary function to combine auditory and visual codes and integrate information from a range of systems. The multi-component system combines new information with previously stored information into long-term memory. Because the central executive has a limited capacity, it must regulate the flow of information within the processing system's restricted capacity (Carroll, 2008).

A variety of working memory span measures have been developed to assess an individual's working memory capacity (e.g., Daneman & Carpenter, 1980; Turner & Engle, 1989). Working memory span tasks are categorized into two types depending on the component of working memory: simple span tasks and complex span tasks (Linck et al., 2014). A simple span task measures the capacity of the phonological loop or the visuo-spatial sketchpad to assess the simple storage functions (Gilabert & Muñoz, 2010; Linck et al., 2014). These include digit span, word span, and non-word span tasks, which measure how much information people can remember in a short period of time. For example, participants are provided with a string of letters or digits and then instructed to recall as many items as possible.

Complex span tasks, on the other hand, incorporate an additional task to word/digit recall tasks and measure the processing function as well as the storage function of working memory (Daneman & Carpenter, 1980; Turner & Engle, 1989). These are designed to assess the function of central executive of working memory. In the complex span task, participants are asked to store information while simultaneously performing other types of cognitive activity. In a large number of L2 research, the reading span task has been used as a complex span task. According to

Daneman and Carpenter (1980), the limited capacity of working memory leads to a trade-off between resources that can be allocated for storage and processing and that central executive control is responsible for both functions. Daneman and Carpenter (1980) designed the reading span task (RSPAN), which requires participants to read aloud a series of sentences and recall the last word of each sentence. The reading span task is commonly regarded as a well-established and influential method of evaluating working memory capacity (Wen, 2012). It does, however, require participants to have a certain level of linguistic proficiency. Non-linguistic working memory span tasks, such as an operation span task (OSPAN; Turner & Engle, 1989), have been suggested as a domain-general strategy in which participants complete simple mathematical operations while remembering words or letters for subsequent recall. Both RSPAN and OSPAN demand participants to switch between two tasks based on the provided instruction, and both have been empirically utilized in L2 settings.

An individual's working memory capacity has been suggested to be responsible for their ability to understand and learn new languages (Harrington, 1992; Miyake & Friedman, 1998). One of the key properties of working memory is that it has a limited capacity and individuals differ in terms of the amount of input they can process at once (Just & Carpenter, 1980). It has been investigated as one of the most plausible elements accounting for individual variables in L2 performance and acquisition within the cognitive SLA paradigm. Harrington and Sawyer (1992) were the first to investigate the link between WM and L2 learning. The researchers discovered a positive association between verbal WM and EFL learners' reading proficiency using Daneman and Carpenter's (1980) reading span task.

The relationship between working memory and interactional feedback has also been studied in a few studies (Goo, 2012, 2014; Lee, 2014; Mackey et al., 2002; Révész, 2012; Song & Lee, 2013). Mackey et al. (2002) investigated the relationship between interactional feedback, noticing, WM, and the development of question formation. The results showed a positive relationship between WM capacity, noticing, and interlanguage development, indicating that higher WM capacity learners tended to notice and improve more on the delayed posttest. Song and Lee (2013) investigated the impact of working memory on implicit learning in Korean EFL high school students but found no relation between working memory and grammar accuracy after implicit instruction. However, learners with a higher level of awareness during implicit learning tended to have a higher level of working memory, showing that working memory plays a facilitative function in boosting learners' awareness during implicit learning. In Lee (2014)'s study, the effect of working memory frequently interacted with other elements. The study investigated the relationship between understanding long-distance *wh*-questions and working memory capacity in Korean EFL students. The results support the claim that working memory has a more significant impact on complex structures that require a high level of cognitive load than on simple structures that do not require as much cognitive effort (Boyle et al., 2013; King & Just, 1991).

Working memory has received a lot of attention from L2 scholars who are interested in recast, which requires simultaneous processing of form-meaning links. The L2 learner must hold forms in memory and simultaneously compare the non-target-like utterance and target-like utterance during interaction in order to take in the target form contained in a recast (Doughy, 2001). This cognitive similarity is

closely linked to working memory, which processes and temporarily retains incoming input. As a result, it has been assumed that learners with a high WM capacity benefit from recasts more than others (Robinson et al., 2012). Goo (2012) examined the relative effectiveness of recasts on the acquisition of the *that*-trace filter and the role of individual differences in WM capacity. This study demonstrated that learners benefited from recasts, and WM capacity may mediate the effectiveness of recasts in L2 development. In Révész (2012)'s study, the effectiveness of recasts and the role of WM were examined. The results showed a positive effect of WM capacity on written and oral tests by the recast group. However, a closer examination of the literature on the relationship between WM and recasts revealed that other factors, such as target linguistic form, type of feedback, type of working memory, or instructional context are also interacting. Working memory's effect is not necessarily direct and independent, which further complicates the interpretation.

Previous studies showed the extent to which individual differences in working memory can predict abilities in various aspects of L2, such as reading comprehension (Harrington & Sawyer, 1992; Leiser, 2007; Walter, 2004) and the relationship with recasts (Goo, 2012; Mackey et al., 2002; Révész, 2012). However, the relationship between VIE and WM capacity has not been dealt with in many studies, and it needs further examination. In order to acquire the target form visually enhanced, L2 learners need to hold both form and meaning simultaneously during an interaction. This dual task is closely related to WM capacity, which consists of processing and temporarily storing incoming information. This similarity in procedure leads to the prediction that learners with a higher WM capacity may benefit more from VIE than otherwise. Following this assumption, the current study

investigates whether individual differences in working memory capacity can explain the efficacy of visual input enhancement on grammar learning and reading comprehension.

3. Methodology

3.1 Participants

A total of forty-eight undergraduate students participated in this study. Participants were recruited from “College English 1 (CE1)” courses at Seoul National University (SNU). SNU offers mandatory general English courses for undergraduate students, which aim to develop students’ general English proficiency used in an academic setting. These English courses are divided into four levels depending on the score of TEPS (Test of English Proficiency by Seoul National University). TEPS covers various topics and tests listening comprehension, vocabulary, grammar, and reading comprehension. Those enrolled in CE1 courses have a TEPS score of 298 to 386, which is regarded as an intermediate level in English proficiency.

Fliers (Appendix A) to gather participants were distributed in CE1 courses in the 2021 summer and fall semesters, and students voluntarily participated in this experiment. At the beginning of the study, the participants were given a general introduction and provided with an information sheet explaining (i) the main purpose of the study, (ii) the overall procedures and length of the study, and (iii) the participant's right to withdraw from the study at any time. In addition, the participants were given 10,000 won worth of a coffee coupon as compensation for their participation.

The number of participants who participated in the pretest and the immediate posttest was 48: 16 for relative group, 16 for article group, and 16 for control group. As the experiment lasted for three weeks, some of the students withdrew in the

delayed posttest, resulting in 13 participants for relative group, 15 for article group, and 16 for control group. The working memory test was performed in the last session, and participants were instructed to submit their working memory test results by email. Again, some participants withdrew from the working memory procedure, resulting in 12 students for relative group, 15 for article group, and 13 for control group.

3.2 Procedure

The experiment took place individually, and the responses were collected through Google Forms. All of the sessions were conducted online, so students were able to participate in the experiment at their own timing and environmental setting with their laptop or PC. They were given guidelines on the procedure for each session in Korean, and they performed reading comprehension, grammar tests, and working memory task. The procedure for the study is outlined in Figure 2.

For each participant, the experiment took place on three separate days over three weeks. In the first session, a pretest was administered for reading comprehension and grammar tests. The reading text in the pretest was not enhanced, and all the participants were given the same text. The grammar tests included grammaticality judgment test (GJT) and a fill-in-the-blank test (FIB). After the pretest, participants were randomly assigned to one of the three experimental groups: (a) Relative group (VIE on relative clauses, $n=16$), (b) article group (VIE on articles, $n=16$), and (c) control group (no VIE, $n=16$). In order to assure that the three groups were homogenous in terms of reading and grammatical ability, independent *t*-tests between each VIE group and control group of pretests on reading comprehension

and grammar tests were performed.

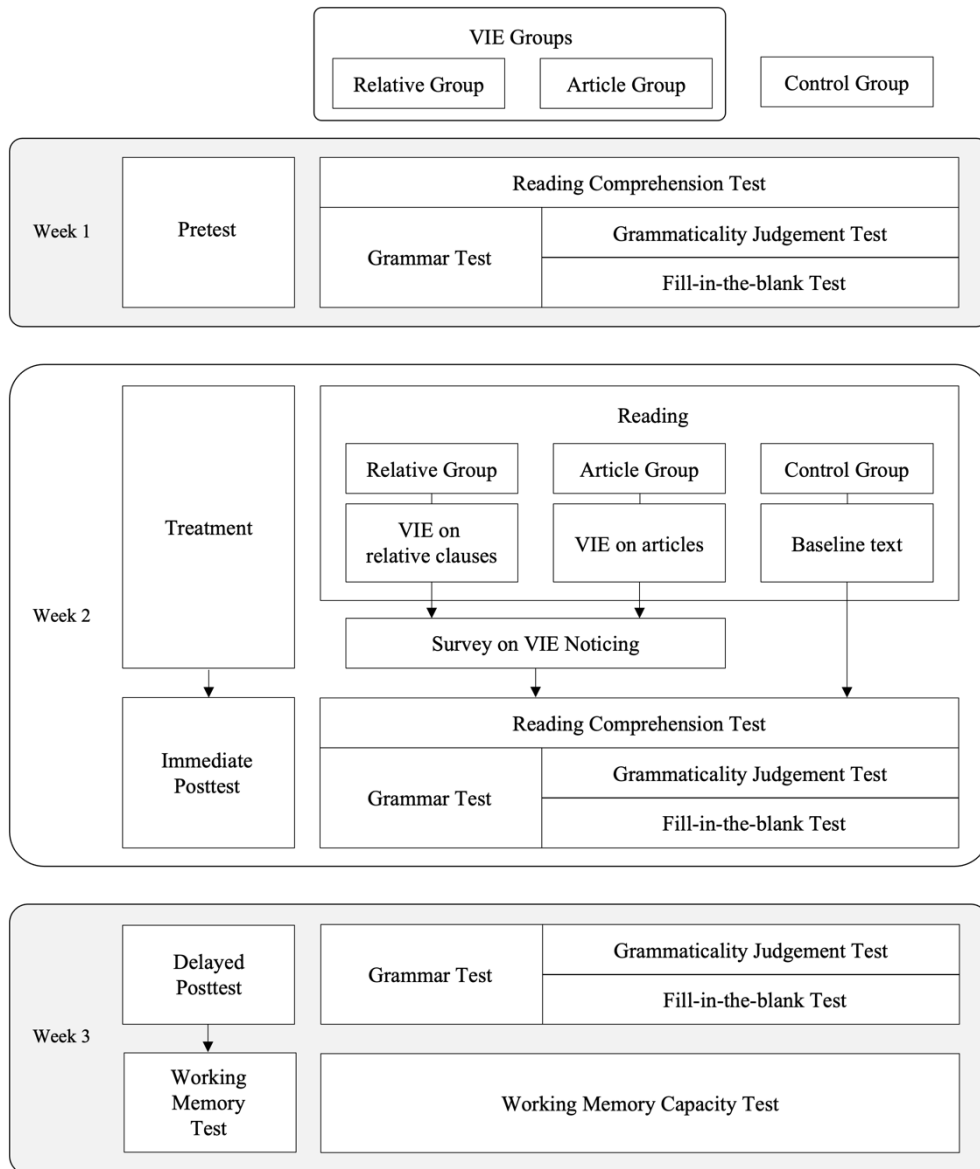


Figure 2 The procedure of the study

In the second week, the two VIE groups were given a text with VIE on each target grammatical feature, and the control group was given a baseline text with no

VIE. After reading the enhanced text, VIE groups completed a survey on VIE noticing: (i) whether they've noticed the VIE and (ii) what they thought about the VIE. Then, an immediate posttest on reading comprehension and grammar tests was followed. After a week, participants took a delayed posttest on grammar and a working memory test. Each session lasted approximately 40 minutes: 10 minutes was allocated to the reading comprehension and 30 minutes to the grammar section. The working memory test lasted approximately 20 minutes.

3.3 Materials

3.3.1 Reading Comprehension

Reading materials were extracted and modified from online articles: one was an article from Wikipedia¹ about the Statue of Liberty, and the other was an online news report² on a burial found in England. The original text did not have sufficient relative clauses; thus, the materials were modified to include more relative clauses. Word count was 512 for the pretest text and 529 for the main text.

In the treatment session, the enhanced texts were used in the immediate posttest for VIE groups, where target forms were enhanced. Bold letters and underlining were the two typographic VIE cues that were most frequently used in previous studies (Lee & Huang, 2008). In order to make the target forms more noticeable, they were first bolded in the reading text. However, because articles are shorter in length, it was difficult to distinguish if the form had been boldfaced or not. As participants had to read the content on the screen, adding VIE cues of red color-

¹ https://en.wikipedia.org/wiki/Statue_of_Liberty

² <https://www.livescience.com/bronze-age-chieftain-burial.html>

coding made the forms stand out more. Thus, both relative clauses and articles were boldfaced and color-coded in red. For the relative group, relative pronouns as well as the following verb or preceding preposition were enhanced depending on the feature of relative clauses. This was to make it easier for participants to understand the function of relative pronoun in the sentence. A total of 21 relative clauses were enhanced in the text. The article group received a text with articles enhanced. Articles were also enhanced with bolding and color-coding in red. Of all articles, 42 articles were enhanced when they are used as the function of “first mention” or “definite article.” According to Park (2009), referential definites were found to be the easiest type for advanced Korean learners. Instruction appears to be helpful in the correct usage of "the" to some extent, while learners should need more teaching in "a/an." Due to their greater reliance on rules than other types, the two English article types of “first mention” and “definite article” were chosen.

Both texts were expository texts and reading comprehension tests were performed on whether the participants could remember certain information written in the text. For reading comprehension tests, different types of comprehension questions, such as true or false questions, multiple-choice questions, and short answer questions were used to assess students’ understanding of the text content. A total of 10 questions were included on each reading comprehension test, and 1 point was given for each correct answer, resulting in a total of 10 points for each test.

3.3.2 Grammar Tests

Participants performed both the grammaticality judgment task (GJT) and the fill-in-the-blank (FIB) test to measure their receptive knowledge and productive

knowledge, respectively. In earlier studies, the receptive knowledge was frequently evaluated using the GJT. These tests are helpful for determining a student's proficiency in a second language since they represent the language competence rather than performance (Gass, 1994). FIB test, on the other hand, is useful, because they "demand test-takers to recall concepts and associations not available in the formulation of the question itself (Rojas, 2014, p.47)". In other words, during these tasks, students are expected to retain knowledge that is not relevant to the questions. The fill-in-the-blank task, which is a constrained construction type test, was utilized to force participants to produce the target form.

The grammatical features chosen for the study were relative clauses and articles. The GJT for this study contained 26 questions: ten items on relative clauses, ten on articles, and six items on distractors such as prepositions, passive forms, and others. All three groups were given the same GJT test, but only the target form for each group was scored. For the relative group, the scores for relative clauses were counted and other grammatical items served as distractors. For the article group, only the scores for articles were calculated. For the control group, both relative clauses scores and article scores were separately counted, and the scores for each grammatical item were compared with that of each VIE group. In the GJT, five items were grammatical and five were ungrammatical. Students were asked to point out the incorrect usage and provide the correct form. One point was given when participants correctly judged the sentence and changed the error. The total score for the GJT was 10 for both relative clauses and article forms.

After taking the GJT, participants took fill-in-the-blank (FIB) tests. They were given 20 questions on relative clauses and other distractors, and they filled out

the blanks for appropriate relative clauses and distractors. FIB on articles was performed at the last session. A short passage was given, and the blanks were provided only for articles. Participants had to write “a/an”, “the,” or “null” articles in 15 blanks. Correct answers on the target articles were given one point. The total score for the FIB was 10 for relative clauses and 15 for articles.

3.3.3 Working Memory Capacity

The participants’ WM capacity was measured with an online reading span task (RSPAN)³ in English. The RSPAN involves a dual-task paradigm, which assesses the component of processing and storage. The task consists of a total of 17 sets, and each set contained WM processing and WM storage tasks. Figure 3 provides an example of the working memory task used in the present study.

In WM processing task, participants first determined whether a given sentence is semantically meaningful or not. The decision had to be made in less than 10 seconds, and when participants did not answer the question in time, it was automatically calculated as an incorrect answer. After one WM processing task, a single word appeared for one second. For WM storage tasks, participants had to memorize all the words that appeared in each set, and they had to write as many words as they could remember at the end of each session. Only the correct judgments on WM processing were calculated, and there was a total of 66 sentences. The correct words for each set were counted for WM storage scores, and the total score was 66. The WM composite score was calculated by combining both WM processing and WM storage scores, and the total score was 132.

³ <http://www.llupiy.com/working-memory-tests/>

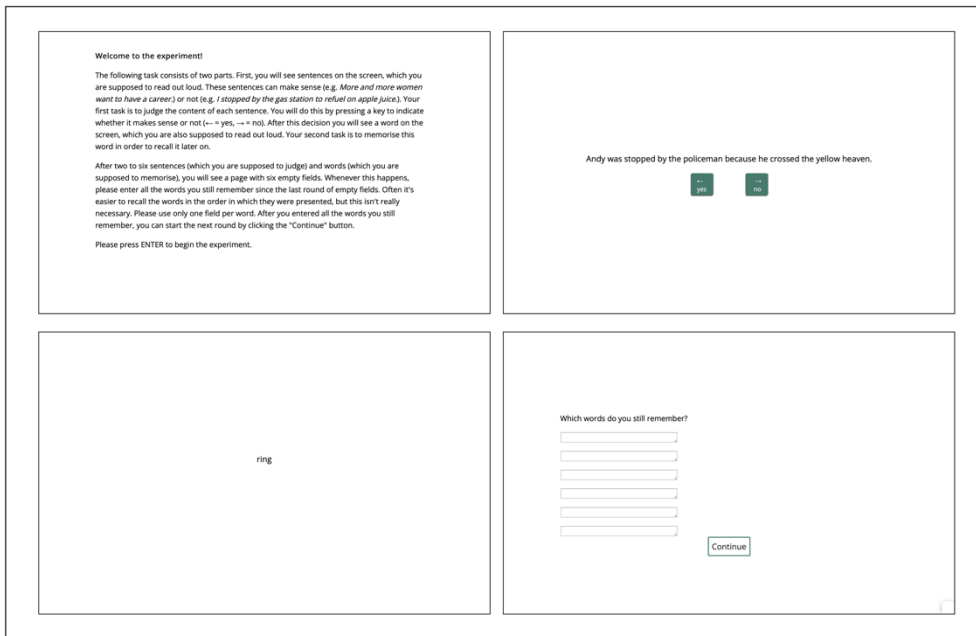


Figure 3 Working memory task

3.4 Method of Analysis

Each VIE group and control group were compared using an independent *t*-test to determine the significant difference in their performance. In addition, students' scores on the pretest and posttests of the reading comprehension and grammar learning tasks were compared using an independent *t*-test. In order to determine the effect of working memory capacity on VIE, a non-parametric test was performed since the sample size was too small. All analyses of the obtained data were conducted using IBM Statistical Package for the Social Sciences (SPSS) Version 26.0.

4. Results

4.1 The Effects of Visual Input Enhancement

4.1.1 Reading Comprehension

The first research question addresses whether visual input enhancement would have a negative impact on reading comprehension. Table 4.1 illustrates the descriptive statistics for reading comprehension scores of the relative group and the control group. In order to see whether the two groups were homogenous in terms of reading comprehension before the treatment, an independent *t*-test was performed on the pretest. The result in Table 4.2 indicates that the two groups were homogenous in reading comprehension pretest ($t=.605$, $p=.55$). The reading comprehension posttest scores of the relative group and the control group were then compared to see whether VIE affected the reading comprehension of the relative group. The difference between the relative group and the control group was not significant ($t=.472$, $p=.64$), indicating that VIE did not affect the reading comprehension of the relative group.

Table 4.1 Descriptive statistics for reading comprehension scores of the relative group and the control group

	Relative Group			Control Group		
	N	M	SD	N	M	SD
Pretest	16	8.50	1.37	16	8.25	0.93
Posttest	16	8.69	1.19	16	8.44	1.75

Note: The total score for the pretest and posttest is 10, respectively.

Table 4.2 Independent *t*-test summary for reading comprehension between the relative group and the control group

	t	df	sig.
Pretest	.605	30	.55
Posttest	.472	30	.64

* $p < .05$

The same procedure was performed to compare the article and control groups. Descriptive statistics for reading comprehension scores of the article group and the control group are outlined in Table 4.3. The reading comprehension pretest and posttest scores of the article and control groups were compared by independent *t*-tests. Table 4.4 illustrates the independent *t*-test summary for reading comprehension. First, the difference in the pretest was not statistically significant ($t=-.857, p=.39$), indicating that the two groups were homogenous prior to the treatment. Next, there was no significant difference in the reading comprehension posttest result ($t=-1.107, p=.28$), which indicates that the VIE did not affect the article group in terms of reading comprehension.

Table 4.3 Descriptive statistics for reading comprehension scores of the article group and the control group

	Article Group			Control Group		
	N	M	SD	N	M	SD
Pretest	16	7.94	1.12	16	8.25	0.93
Posttest	16	7.56	2.63	16	8.44	1.75

Note: The total score for the pretest and posttest is 10, respectively.

Table 4.4 Independent *t*-test summary for reading comprehension between the article group and the control group

	t	df	sig.
Pretest	-.857	30	.39
Posttest	-1.107	30	.28

* $p < .05$

Taken together, the comparison of reading comprehension tests between the VIE groups and the control group did not show any significant differences. This indicates that VIE did not affect reading comprehension in both the relative and the article groups.

4.1.2 Grammar Learning

4.1.2.1 Relative Clauses

The first and second research questions ask whether visual input enhancement (VIE) can help improve EFL learners' receptive and productive knowledge of two grammatical features: English relative clauses and articles. First, the relative group and the control group were compared to examine whether the VIE on relative clauses improved participants' grammatical knowledge. The descriptive statistics for the pretest and the posttests of grammar tests of the relative group and the control group are presented in Table 4.5. Both GJT ($t=.457, p=.65$) and FIB ($t=-.445, p=.66$) pretest results indicate that the two groups were homogenous prior to the treatment (Table 4.6).

Table 4.5 Descriptive statistics for grammar pretest and posttests for relative clauses

		Relative Group			Control Group		
		N	M	SD	N	M	SD
Pretest	GJT	16	6.38	2.39	16	6.00	2.25
	FIB	16	7.88	1.31	16	8.06	1.06
Immediate	GJT	16	6.06	1.57	16	5.00	1.21
Posttest	FIB	16	7.56	1.31	16	7.25	2.41
Delayed	GJT	13	7.00	1.08	16	6.31	1.40
Posttest	FIB	13	6.92	1.55	16	6.94	1.34

Note: The total score for the pretest and posttest is 10, respectively.

Table 4.6 Independent *t*-test summary for the pretest on relative clauses between the relative group and the control group

	t	df	sig.
GJT	.457	30	.65
FIB	-.445	30	.66

* $p < .05$

An independent *t*-test was performed on the immediate posttest to examine the effect of VIE on learning English relative clauses. As shown in Table 4.7, the immediate posttest GJT scores of the relative group and the control group were statistically different ($t=2.14$, $p=.04$), indicating that VIE on relative clauses was effective in improving participants' receptive knowledge on relative clauses. However, the FIB posttest scores of the two groups were not statistically significant

($t=.456, p=.65$).

Table 4.7 Independent *t*-test summary for immediate posttest on relative clauses between the relative group and the control group

	t	df	sig.
GJT	2.14	30	.04*
FIB	.456	30	.65

* $p < .05$

Lastly, to examine the long-term effect of visual input enhancement on the target grammar feature, independent *t*-tests were performed on receptive and productive delayed posttest scores, outlined in Table 4.8. The delayed posttest scores of the relative group and the control group were not statistically different (GJT: $t=1.45, p=.16$; FIB: $t=-.03, p=.98$).

Table 4.8 Independent *t*-test summary for the delayed posttest on relative clauses between the relative group and the control group

	t	df	sig.
GJT	1.45	27	.16
FIB	-.03	27	.98

* $p < .05$

4.1.2.2 Articles

The effects of VIE on articles were examined by comparing the article and the control group. Table 4.9 illustrates the descriptive statistics for the pretest and

posttests of the article and the control group. As shown in Table 4.10, Both GJT and FIB *t*-test results for the pretest indicate that the two groups were homogenous in terms of grammar knowledge before the treatment (GJT: $t=-.357, p=.72$; FIB: $t=.873, p=.39$).

Table 4.9 Descriptive statistics for pretest and posttests for articles

		Article Group			Control Group		
		N	M	SD	N	M	SD
Pretest	GJT	16	5.56	1.21	16	5.69	0.70
	FIB	16	9.50	2.53	16	8.75	2.32
Immediate	GJT	16	3.88	0.96	16	4.19	1.27
Posttest	FIB	16	12.31	2.18	16	9.88	3.91
Delayed	GJT	15	5.00	1.31	16	4.44	1.32
Posttest	FIB	15	12.00	1.31	16	11.00	3.54

Note: The total score for the pretest and posttest for GJT is 10, respectively. The total score for the pretest and posttest for FIB is 15, respectively.

Table 4.10 Independent *t*-test summary for pretest on articles between the article group and the control group

	t	df	sig.
GJT	-.357	30	.72
FIB	.873	30	.39

* $p < .05$

The independent *t*-test summary for the immediate posttest of articles is shown in Table 4.11. The article group did not show any significant improvement in

the immediate posttest for GJT ($t=-.783, p=.44$). However, the participants in the article group showed significant difference compared to the control group in the FIB test scores ($t=.078, p=.038$), which suggests that the VIE on articles were effective in improving participants' productive knowledge on English articles.

Table 4.11 Independent *t*-test summary for immediate posttest on articles between the article group and the control group

	t	df	sig.
GJT	-.783	30	.44
FIB	.078	30	.038*

* $p < .05$

Table 4.12 presents the independent *t*-test results of the delayed posttest between the article group and the control group. The long-term effect of VIE on articles was not observed in this study, as the article and control groups were not statistically different in the delayed posttest (GJT: $t=1.193, p=.24$; FIB: $t=1.029, p=.31$).

Table 4.12 Independent *t*-test summary for the delayed posttest on articles between the article group and the control group

	t	df	sig.
GJT	1.193	29	.24
FIB	1.029	29	.31

* $p < .05$

The effects of VIE can be summarized as follows. First, in both VIE groups, reading comprehension was not affected by the VIE on both relative clauses and articles. Next, with regard to grammar learning, two groups showed different results on two different grammar tests. For the relative group, the receptive knowledge of relative clauses was improved in the immediate posttest, indicated by the significant difference in GJT scores. On the other hand, the article group performed significantly better in FIB test and thus improved their productive knowledge in the immediate posttest. Finally, in the delayed posttest, both VIE groups show no significant difference when compared to the control group, indicating no long-term effects of VIE.

4.2 The Effects of Working Memory Capacity

The third research question addresses whether participants' working memory capacity can mediate the efficacy of VIE. The test used for working memory in this study was RSPAN, developed by Daneman and Carpenter (1980). This test includes storing words and judging semantically meaningful sentences. WM capacity in this study, thus, was subdivided into three parts: (a) WM storage, (b) WM processing, and (c) WM composite, which combines both storage and processing ability. The three groups (relative, article, and control group) were subdivided into two sub-groups according to their working memory test results. Those who were in the upper rank of five in each group were classified as the high WM sub-group, while the lower five were categorized as the low WM sub-group. In all of WM storage, WM processing, and WM composite results, the difference between participants with high working memory and those with low working memory in the pretest was

not significant, indicating that these groups were homogenous in terms of reading comprehension and grammar ability prior to the treatment.

4.2.1 Working Memory Composite

The WM composite result, which combines both WM storage and WM processing scores, is outlined in this section. The descriptive statistics for the relative group are illustrated in Table 4.13. The result from the relative group showed that the participants with low WM composite capacity performed slightly better on both GJT and FIB than high working memory group; however, the non-parametric test results indicate that the differences were not statistically significant (Table 4.14).

Table 4.13 Descriptive statistics for the relative group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Composite		105.4	11.01	82	2.24
Reading	Pretest	9	0.71	8.8	1.64
	Posttest	9	1.22	9	1.22
GJT	Pretest	6	3.08	7.6	2.41
	Immediate Posttest	6.2	1.48	7	1.87
	Delayed Posttest	7	1.41	7.4	0.55
FIB	Pretest	8.6	0.55	8.4	0.89
	Immediate Posttest	7.8	0.84	8.6	1.14
	Delayed Posttest	7	1.87	7.4	1.14

Note: The total score for WM Composite is 132. The total score for the pretest and posttests for reading comprehension, GJT and FIB is 10, respectively.

Table 4.14 Non-parametric test for the relative group

	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	Exact Sig.
Posttest Reading	12.50	27.50	.000	1.000
Immediate Posttest GJT	9.00	24.00	-7.45	.548
Delayed Posttest GJT	12.00	27.00	-.113	1.000
Immediate Posttest FIB	7.00	22.00	-1.193	.233
Delayed Posttest FIB	10.00	25.00	-.537	.690

* $p < .05$

The article group results showed that high WM composite group performed better than low WM composite group in the reading posttest and the delayed posttests for both GJT and FIB. However, the non-parametric test result indicates that this difference was not significant (Table 4.16).

Table 4.15 Descriptive statistics for the article group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Composite		92.6	5.41	68.4	3.58
Reading	Pretest	8.2	0.45	8.2	1.30
	Posttest	8.6	1.14	8.2	1.48
GJT	Pretest	5	1.22	5.8	1.30
	Immediate Posttest	3.8	1.10	4	0.71
	Delayed Posttest	5.4	1.14	5.2	1.64

FIB	Pretest	9.2	2.95	10.2	2.59
	Immediate Posttest	12	2.00	13.8	1.64
	Delayed Posttest	13	0.71	12.2	1.10

Note: The total score for WM Composite is 132. The total score for the pretest and posttests for reading comprehension and GJT is 10, respectively. The total score for the pretest and posttests for FIB is 15, respectively.

Table 4.16 Non-parametric test for the article group

	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	Exact Sig.
Posttest Reading	10.50	25.50	-.430	.690
Immediate Posttest GJT	10.50	25.50	-.443	.690
Delayed Posttest GJT	10.00	25.00	-.546	.690
Immediate Posttest FIB	4.50	19.50	-1.708	.095
Delayed Posttest FIB	7.50	22.50	-1.181	.310

* $p < .05$

In summary, WM composite results did not show any significant difference between high working memory participants and low memory participants in the two enhanced groups. This indicates that WM composite capacity is not a significant factor in mediating the effectiveness of VIE in this study. However, as WM composite ability consists of WM storage and processing ability, the subcomponent of WM composite was separately examined to investigate whether each subcomponent would affect the efficacy of VIE.

4.2.2 Working Memory Storage

First, with WM storage, the descriptive statistic for the relative group is illustrated in Table 4.17. The result from the relative group is inconsistent, where the immediate posttest results for both GJT and FIB are lower in the high WM storage group, but the delayed posttest results are higher in the high WM storage group. A non-parametric test was performed to determine whether the differences were significant, yet it did not show any significant differences between the two groups (Table 4.18).

Table 4.17 Descriptive statistics for the relative group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Storage		54.4	1.52	39.8	6.94
Reading	Pretest	8.6	1.52	9.2	0.84
	Posttest	8.4	1.34	9.6	0.55
GJT	Pretest	5.8	2.77	7.8	2.59
	Immediate Posttest	6	1.58	7.2	1.64
	Delayed Posttest	7.4	0.89	7	1.22
FIB	Pretest	8.6	0.55	8.4	0.89
	Immediate Posttest	7.8	0.84	8.6	1.14
	Delayed Posttest	7.4	1.82	7	1.22

Note: The total score for WM Storage is 66. The total score for the pretest and posttests for reading comprehension, GJT and FIB is 10, respectively.

Table 4.18 Non-parametric test for the relative group

	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	Exact Sig.
Posttest Reading	5.50	20.50	-1.565	.151
Immediate Posttest GJT	7.00	22.00	-1.170	.310
Delayed Posttest GJT	10.00	25.00	-5.65	.690
Immediate Posttest FIB	7.00	22.00	-1.193	.310
Delayed Posttest FIB	11.00	26.00	-.322	.841

* $p < .05$

Table 4.19 demonstrates the descriptive statistics for the article group. The findings from the article group showed that the grammar score from the posttests is higher in high WM storage group than in low WM storage group. Non-parametric test results, however, showed that this difference was not significant (Table 4.20).

Table 4.19 Descriptive statistics for the article group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Storage		48.2	1.79	26.6	7.92
Reading	Pretest	7.2	0.84	8.2	1.30
	Posttest	8.6	1.14	6.8	3.56
GJT	Pretest	5.8	1.79	5.8	1.30
	Immediate Posttest	4.4	1.34	4	0.71
	Delayed Posttest	4.8	0.84	4.2	0.84

FIB	Pretest	9	2.55	10.4	2.30
	Immediate Posttest	10.8	2.59	12.8	2.17
	Delayed Posttest	12.2	1.48	12	1.41

Note: The total score for WM Storage is 66. The total score for the pretest and posttests for reading comprehension and GJT is 10, respectively. The total score for the pretest and posttests for FIB is 15, respectively.

Table 4.20 Non-parametric test for the article group

	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	Exact Sig.
Posttest Reading	9.00	24.00	-.745	.548
Immediate Posttest GJT	10.00	25.00	-.542	.690
Delayed Posttest GJT	8.00	23.00	-1.003	.421
Immediate Posttest FIB	5.50	20.50	-1.485	.151
Delayed Posttest FIB	12.00	27.00	-.108	1.000

* $p < .05$

Taken together, WM storage results did not show any significant difference between the participants with high WM storage ability and those with low WM storage ability. This indicates that WM storage capacity is not directly related to the effects of VIE on both reading comprehension and grammar learning.

4.2.3 Working Memory Processing

WM processing scores were assessed on each correct judgment on semantically meaningful sentences. First, in the relative group, learners with high WM processing ability obtained slightly higher reading comprehension and posttest

scores for GJT and FIB than those with low WM processing ability, as shown in Table 4.21. A non-parametric test was performed to determine whether the differences were significant. However, no significant differences between high and low WM processing ability groups were found (Table 4.22).

Table 4.21 Descriptive statistics for the relative group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Processing		54	7.07	36.8	5.59
Reading	Pretest	9.4	0.55	8.4	1.52
	Posttest	9	1.22	8.8	1.10
GJT	Pretest	6.6	2.30	6.6	3.05
	Immediate Posttest	7	1.73	6	1.73
	Delayed Posttest	7.6	0.89	7.2	0.45
FIB	Pretest	8.2	0.84	8.6	0.55
	Immediate Posttest	8.6	1.14	7.8	0.84
	Delayed Posttest	7.8	1.79	6.8	0.84

Note: The total score for WM Processing is 66. The total score for the pretest and posttests for reading comprehension, GJT and FIB is 10, respectively.

Table 4.22 Non-parametric test for the relative group

	Mann-Whitney U	Wilcoxon W	Z	Exact Sig.
Posttest Reading	10.50	25.50	-.454	.690
Immediate Posttest GJT	9.00	24.00	-.750	.548

Delayed Posttest GJT	7.00	22.00	-1.270	.310
Immediate Posttest FIB	7.00	22.00	-1.193	.310
Delayed Posttest FIB	7.00	22.00	-1.182	.310

* $p < .05$

Next, in the article group, high working memory group for WM processing performed better in posttest reading and FIB on both posttests than low WM processing group, as illustrated in Table 4.23. A non-parametric test was performed to determine whether the differences were significant. The result showed that the delayed posttest FIB scores of high working memory group were statistically higher than that of low working memory group (Table 4.24).

Table 4.23 Descriptive statistics for the article group

		High ($n=5$)		Low ($n=5$)	
		M	SD	M	SD
WM Processing		48.8	2.59	30.8	4.76
Reading	Pretest	8.8	0.84	7.6	1.34
	Posttest	8.4	0.89	6.8	3.42
GJT	Pretest	5.4	1.14	5.8	1.30
	Immediate Posttest	4	1.00	4.2	1.10
	Delayed Posttest	5	0.71	5.2	1.92
FIB	Pretest	11	2.83	9.4	2.51
	Immediate Posttest	12.6	1.52	11.4	2.97
	Delayed Posttest	12.6	0.89	10.6	0.89

Note: The total score for WM Processing is 66. The total score for the pretest and posttests for reading comprehension and GJT is 10, respectively. The total score for the pretest and posttests for FIB is 15, respectively.

Table 4.24 Non-parametric test for the article group

	Mann- Whitney <i>U</i>	Wilcoxon <i>W</i>	<i>Z</i>	Exact Sig.
Posttest Reading	8.50	23.50	-.859	.421
Immediate Posttest GJT	11.50	26.50	-.219	.841
Delayed Posttest GJT	12.50	27.50	.000	1.000
Immediate Posttest FIB	9.00	24.00	-.745	.548
Delayed Posttest FIB	1.50	16.50	-2.410	.016*

* $p < .05$

To summarize the findings above, the results showed that WM processing ability played a role in improving the long-term production of English articles. For the relative group, the difference between learners with high WM processing ability and those with low WM processing ability was not significant. The article group showed a significant difference between high WM processing and low WM processing participants in the delayed FIB scores. This indicates that WM processing ability can be an important factor in facilitating the effectiveness of VIE.

5. Discussions

5.1 The Effectiveness of Visual Input Enhancement

The first and second research questions addressed whether VIE on particular grammatical features would affect reading comprehension and grammar learning. The results have shown that VIE did not affect reading comprehension but facilitated grammar learning. For relative clauses, the receptive knowledge was enhanced by VIE, whereas for articles, the productive knowledge was enhanced.

As learners should engage in dual tasks of processing visually enhanced grammatical forms and meaning comprehension, it was first hypothesized that reading comprehension would be negatively affected by the enhanced features. However, the results in this study did not show any interruption in reading comprehension by VIE. This result is in line with previous studies by Wong (2003), Leow (1997, 2001), Leow et al. (2003) and LaBrozzi (2016), which found no effects of VIE on reading comprehension. No significant differences between groups in reading comprehension test results suggests that comprehension was not interrupted by the enhancement on either English relative clauses or articles.

The two grammatical features selected for this study share the following characteristics: (i) features absent in Korean, (ii) late acquisition order, (iii) absence of semantic redundancy, (iv) difficulty in form-meaning mapping, and (v) low communicative value. Among these similarities, communicative value has been discussed in previous VIE studies (Alanen, 1992; Park & Nassif, 2014), showing that VIE on lower communicative value hinders the processing of both form and meaning. The current result seems to contradict the previous studies. It should be

noted, however, that those studies employed a semi-artificial Finnish consonant alternation (Alanen, 1995) and Arabic forms of dual pronoun (Park & Nassif, 2014), which were not only features with low communicative value but also forms that are unfamiliar for the participants. It can be assumed that learners' prior knowledge of the target form is an important variable in determining the effectiveness of VIE.

As university students who have been studying English for more than 10 years, the participants in the current study are likely to be very well familiar with the target forms (relative clauses and articles). Thus, even though the communicative value of the two forms in this study is low, participants were aware of these two features, and thus they were able to comprehend the text without interference by the enhancement. Even when low salient form such as articles has been enhanced to make them more salient, learners could still process both meaning and form when reading a text.

Another explanation for the lack of impact on reading comprehension can be attributed to the fact that the comprehension test was not challenging enough for the participants. The average score for the pretest reading was 8.26 out of 10, and 8.14 out of 10 for the posttest reading, which are fairly high scores on both tests. The ceiling effect observed in this study may have yielded these results in reading comprehension.

VIE on two features was noticed by participants in two VIE groups. First, in the relative group, fifteen out of sixteen participants commented that they noticed the enhancement on relative clauses. In their comments, several students commented that the enhanced relative clauses were more noticeable, and specifically stated that all of the enhanced features were on "relative clauses" or "preposition and relative

clauses”. Participants pointed out that relative clauses modify the noun that comes before them and provide additional information. The comments, however, were not entirely favorable; some participants complained that using too many relative clauses made sentences lengthier and harder to understand. In the article group, eleven out of sixteen participants commented that they noticed the VIE on articles, and many commented on the usage of articles. They specifically focused on whether the following noun has been first mentioned or has been mentioned before. The two groups' comments indicate that VIE effectively drew learners' attention to the target form and they were aware of the target feature. None of the comments questioned the intent of the enhancement, and they were all made on the target form.

The impact of VIE on grammar learning was found in this current study, though a different type of knowledge improved depending on the specific target grammar forms. Based on the theoretical assumption that noticing aids L2 learning (Schmidt, 1990, 1993, 2001), it was predicted that noticing induced by VIE would result in grammar acquisition. Although some students did not prefer VIE on relative clauses, the result of the immediate posttest GJT scores indicated that the participants in the relative group were able to detect and correct relative clause errors better than they did in the GJT pretest and outperformed the control group without VIE. However, in the FIB tests, the relative group did not outperform the control group. These results imply that VIE on relative clauses were effective in improving receptive knowledge, though it was not effective for productive knowledge. The positive effects of VIE on relative clauses in receptive knowledge may have been attributed to the saliency of the target linguistic forms. According to Goldschneider and DeKeyser (2001), the perceptual salience of a linguistic feature plays an

important role in acquiring the target form. Building on this assumption, the relatively high saliency of relative clauses combined with VIE might have contributed to the improvement of the posttest on the GJT scores. Furthermore, they were able to detect relative clauses in the distractor sentences in GJT. In the FIB test, however, because participants had to fill in a specific word in the blank, the saliency of relative clauses did not affect the accuracy of the answers. The test would be challenging if they have not fully mastered the relative clauses since they were not sure what is being expected of them to write in the blank. Nevertheless, the positive effect found in the GJT scores indicates that a single VIE exposure was effective and thus giving frequent VIE exposure through reading will ultimately improve the productive knowledge as well.

VIE on articles showed different results compared to VIE on relative clauses. Articles are considered as one of the most challenging grammatical features for EFL learners, and even advanced level of Korean EFL learners have difficulties in acquiring the English article system (Park, 2005). DeKeyser (2005) also claims that English articles cause potential difficulties for L2 learners because of their abstractness of meaning, and specific instruction on article usage is generally ineffective in acquiring the article system. Thus, it was first assumed that VIE on articles would be less effective in grammar learning than VIE on relative clauses.

On GJT tasks, the distractors significantly interfered in detecting the article errors. When articles were used incorrectly, both the article and control groups could not detect the errors. Even in the grammatical sentences, the participants made corrections on different grammatical features. A few participants spotted the error in articles, but most participants could not detect the errors in GJT. This can be assumed

from the fact that the article itself is not a salient feature. Surprisingly, however, in the FIB task, the article group outperformed the control group in the immediate posttest. When specifically asked to fill in the blank for articles, participants who received enhancements on articles were able to answer them more correctly than the control group. This result should be treated with caution since the article FIB tests had no distractors, and it was solely asking which articles are placed in each blank. Despite the lack of saliency of the articles, the article group performed better than the control group in the immediate FIB test. The participants' comments in the article group demonstrated that they were aware that the enhancements were on articles and that while reading, they compared the usage of definite and indefinite articles in a given situation. VIE on articles might lead participants to reinforce the basic characteristics of the article usage, and thus they outperformed the control group in the FIB test assessing productive knowledge.

The task design may have contributed to two distinct results for relative clauses and articles on the GJT and FIB scores. Articles must be taken into account within a context, whereas relative clauses can be explained within a single sentence with comparably simpler syntactic constraints. Since the GJT asked for isolated sentences without context, it can be more difficult for students to detect errors in articles that heavily rely on context. On the other hand, FIB on articles was provided in a paragraph with context, and this made it easier to answer for article questions. This finding suggests that participants would have picked up on the article errors in the context if GJT had been administered in a manner similar to that of the FIB task.

The relative group and article group did not show any significant difference compared to the control group in the delayed posttest. According to Truscott (2014),

explicit conceptual grammar knowledge is most active immediately following instruction, resulting in improved performance on target forms directly after grammar intervention. For long-term effects, successful acquisition is determined by the nature of the target form (Spada & Tomita, 2010). Although the VIE on two features did not have a long-term effect in the current experiment, it clearly showed that it had an effect on the immediate posttest. In this study, participants read the text in less than 10 minutes and the enhanced text was provided only once, which may not be sufficient enough to have a long-term effect of the VIE. Nevertheless, the fact that a single VIE treatment was effective in improving grammar learning implies that multiple VIE treatments will have a considerably larger impact. Providing participants with more time and repetitive enhancement as well as various output activities will improve participants' level of grammar learning leading to long-term effect.

5.2 Working Memory Capacity as Individual Variable

The third research question dealt with the relationship between working memory capacity and the effectiveness of VIE. WM capacity as an individual variable has been widely discussed in instructional settings. Given the theoretical assumption that learners' working memory contributes to their allocation of attention (Robinson et al., 2012), possible associations between working memory capacity and the effects of VIE were examined. In this study, it was assumed that learners with high WM capacity would process visually enhanced grammatical forms more efficiently while they are reading for meaning.

In this study, working memory capacity in composite scores did not show

any significant difference in reading comprehension or grammar learning. In both the relative and article groups, there was no discernible pattern between individuals with high and low WM abilities. However, when looking separately in the subcomponent of working memory capacity, certain trend was observable. First, although statistical analyses showed no significant results, the descriptive data of WM storage scores illustrates a general tendency that high WM storage participants outperformed their counterparts in delayed posttests in the relative and article group. WM storage score was assessed by whether participants could memorize given words while processing another task. This task is connected to a memory storage task where, albeit not being statistically significant, students with higher WM storage abilities benefited from VIE over the long term.

As for WM processing ability, it showed a significant result. WM processing score was calculated on how many sentences they could judge as semantically meaningful. While they were judging the given sentences, they were also holding words in memory at the same time, which plays a dual task. The high WM processing participants in the relative group showed slightly higher in both GJT scores, indicating that learners with high WM processing ability would process VIE forms more efficiently. With regard to the article group, it showed a significant difference between participants with high and low WM processing ability in FIB. The trend observed from WM processing ability is in line with Mackey et al. (2002)'s study, where higher WM capacity learners tended to notice and improve more on the posttest. This suggests that working memory plays a facilitative role in grammar learning. The connection between the subcomponent of WM capacity – WM processing ability – and grammar learning has not been dealt with in previous

research. Further empirical investigation is required to understand the connection between VIE and WM processing ability.

The results in this study confirmed the theoretical assumption that learners' working memory is related to how effectively they allocate their attentional resources (Robinson et al., 2012). In this research, significant relationships between individual differences in working memory processing ability and grammar learning were identified. According to Miyake et al. (2000), the central executive functions may not be a single process, and they may rather be separable. Thus, even though this study only witnessed the role of the processing component of working memory in VIE, future studies on the central executive functions of WM would support the evidence for the effectiveness of VIE. The possibility that WM processing and storage ability are linked to VIE cannot be ignored. With more individuals, a stronger association between VIE and WM might be indicated by a statistical value, and this warrants additional investigation.

6. Conclusion

This study examined the effect of visual input enhancement and working memory on reading comprehension and grammar learning by Korean EFL learners. The results from this study showed a negligible effect on reading comprehension but an overall positive effect on grammar learning. When VIE was applied to relative clauses, students noticed the grammar form and outperformed the control group in the grammaticality judgment test. VIE on articles facilitated participants to produce articles appropriately in the sentence. Working memory capacity did not show a significant impact on the efficacy of VIE. Neither reading comprehension nor grammar learning was affected by individual differences in WM capacity. However, the processing component of WM played an important role in effective grammar learning for both the relative group and the article group.

The study supports evidence on theoretical implications. The effects of VIE on noticing the target form was observed through the research. Comments by the two VIE group indicated that the two group noticed the target form. As suggested in the noticing hypothesis by Schmidt (1990, 1993, 2001), noticing is considered an important starting point in language learning. When VIE is applied in the reading text, participants were able to notice the target form and further process them without compromising for meaning. The results confirmed that VIE did not interrupt reading, and thus it supports the limited evidence that even features with low communicative value does not hinder the processing of reading when it is visually enhanced. The hypothesis that enhancement on target form would distract reading process was not verified, and thus this supports the evidence that learner are able to process both form and meaning.

There are several limitations in this study. First, the present study gives only one treatment session for the VIE groups. Multiple treatments of the same test would likely enhance the efficacy of VIE as participants develop their language skills over the repetitive practice but repeating the same tests would influence the consistency and the validity of the tests undertaken. Participants would likely be aware of what they are tested for through repeated tasks. Second, the duration of the treatment session was too short to ensure that VIE operated on long-term memory. Participants read the text for less than 10 minutes, which indicates that the time exposed to the VIE was not enough. Although the relative and article groups showed development in the target grammar knowledge, no long-term effect was verified through this study. Thus, there is a need for future research on the appropriate amount and duration of VIE treatment.

One of the important issues associated with the design of the study is the selection of the target form. The two target features were selected as they are challenging for Korean EFL learners. These two features share similarities as well as differences in their complexity traits. Replication of this study with different target forms is warranted, assuming that the difficulty measurement is diverse with some features more susceptible to the effectiveness of VIE. The final factor to take into account is small sample size for working memory group. In both the relative and article groups, only five participants for both high and low working memory groups, respectively, were compared. It was nevertheless evident that with higher WM storage and processing ability, the better they performed in their grammar learning. If there were more participants, the tendency may indicate that working memory plays a facilitative role when VIE is in the reading text.

Despite these limitations, the present research highlights the value and use of VIE in developing L2 grammatical features and expands on the limited existing research about the relationship between VIE and working memory capacity. It demonstrated that VIE may be beneficial in different grammar learning depending on the target structure. This supports the pedagogical implication that learners can acquire L2 grammar by focusing on target grammatical forms through VIE. Teachers in real classroom settings can apply the enhancing method on the reading text when conducting a reading comprehension session to aid students in learning grammar forms. The results from this study further suggest that VIE is a useful instructional method for language learners. Although working memory capacity did not show any significant effect, this study demonstrates the potential link between VIE and WM processing ability. In the field of SLA, individual differences are considered one of the factors influencing the methods for teaching language. Thus, considering the importance of individual differences, there is a need for future research into the relationship between VIE and working memory capacity in EFL settings.

References

- Alanen, R. (1995). Input enhancement and rule presentation in second language acquisition. In Richard Smith (Ed.), *Attention and awareness in foreign language learning* (pp. 269-302). Honolulu, Hawai'i: University of Hawai'i, Second Language Teaching & Curriculum Center.
- Alptekin, C., & Erçetin, G. (2010). The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. *Journal of Research in Reading, 33*(2), 206-219.
- Baddeley, A. D. (1986). *Working memory*. Oxford: Oxford University Press.
- Baddeley, A. D. (1992). Working memory. *Science, 255*(5044), 556-559.
- Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417-423.
- Baddeley, A. D. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience, 4*(10), 829-839.
- Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*, 1-29.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 47-89). New York: Academic Press.
- Boyle, W., Lindell, A. K., & Kidd, E. (2013). Investigating the role of verbal working memory in young children's sentence comprehension. *Language Learning, 63*(2), 211-242.
- Bransdorfer, R. L. (1991). *Communicative value and linguistic knowledge in second language oral input processing*. Doctoral dissertation, University of Illinois

at Urbana-Champaign, Champaign, IL.

- Carroll, D. W. (2008). *Psychology of language* (5th ed.). London: Thomson/Wadsworth.
- Cho, M. Y. (2010). The effects of input enhancement and written recall on noticing and acquisition. *Innovation in Language Learning and Teaching*, 4(1), 71-87.
- Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, 19(4), 450-466.
- De Santis, P. (2008). Text enhancement and the acquisition of English verbal inflection. *Applied Language Learning*, 18, 27-49.
- DeKeyser, R. M. (2003). Implicit and Explicit learning. In C. Doughty, & M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 312–348). Oxford: Blackwell.
- DeKeyser, R. M. (2005). What makes learning second-language grammar difficult?: A review of issues. *Language Learning*, 55(1), 1-25.
- DeKeyser, R. M., & Sokalski, K. J. (1996). The differential role of comprehension and production practice. *Language Learning*, 46(4), 613-642.
- Doughty, C. (1991). Second language instruction does make a difference: Evidence from an empirical study of SL relativization. *Studies in Second Language Acquisition*, 13(4), 431-469.
- Doughty, C. (2001). Cognitive underpinnings of focus on form. In P. Robinson (Ed.), *Cognition and second language instruction* (pp. 206–57). Cambridge: Cambridge University Press.

- Doughty, C., & Williams, J. (1998). Pedagogical choices in focus on form. *Focus on Form in Classroom Second Language Acquisition*, 3, 197-262.
- Ellis, N. (2017). Salience in usage-based SLA. In S. Gass, P. Spinner, & J. Behney (Eds.), *Salience in second language acquisition* (pp. 21-40). London: Routledge.
- Ellis, R. (1994). *The study of second language acquisition*. Oxford: Oxford University.
- Gasparini, S. (2004). Implicit versus explicit learning: Some implications for L2 teaching. *European Journal of Psychology of Education*, 19(2), 203-219.
- Gass, S. M. (1994). The reliability of second-language grammaticality judgments. In E. Tarone, S. M. Gass, & A. Cohen (Eds.), *Research methodology in second language acquisition* (pp.303-322). Hillsdale, NJ: Lawrence Erlbaum.
- Gass, S. M., Spinner, P., & Behney, J. (2017). Salience in second language acquisition and related fields. In S. Gass, P. Spinner, & J. Behney (Eds.), *Salience in second language acquisition* (pp. 1-18). London: Routledge.
- Gilabert, R., & Muñoz, C. (2010). Differences in attainment and performance in a foreign language: The role of working memory capacity. *International Journal of English Studies*, 10(1), 19-42.
- Goldschneider, J. M., & DeKeyser, R. M. (2001). Explaining the “natural order of L2 morpheme acquisition” in English: A meta-analysis of multiple determinants. *Language Learning*, 51, 1-50.
- Goo, J. (2012). Corrective feedback and working memory capacity in interaction-driven L2 learning. *Studies in Second Language Acquisition*, 34(3), 445-474.
- Goo, J. (2014). Corrective feedback and phonological short-term memory in the

- acquisition of the English that-trace filter: A conceptual replication of Goo (2012). *English* 21, 27(1), 231-257.
- Greenslade, T., Bouden, L., & Sanz, C. (1999). Attending to form and content in processing L2 reading texts. *Spanish Applied Linguistics*, 3(1), 65-90.
- Ha, J. (2005). *Developing English determiners through Internet chat: An experiment with Korean EFL students*. Doctoral dissertation, University of Florida, Gainesville, FL.
- Ha, J. (2009). Enhancing Korean students' use of English phrasal verbs. *Linguistics Studies*, 14, 191-207.
- Hama, M., & Leow, R. P. (2010). Learning without awareness revisited: Extending Williams (2005). *Studies in Second Language Acquisition*, 32(3), 465-491.
- Harrington, M. (1992). Working memory capacity as a constraint on L2 development. In R. J. Harris (Ed.) *Advances in psychology* (Vol. 83, pp. 123-135). Elsevier.
- Harrington, M., & Sawyer, M. (1992). L2 working memory capacity and L2 reading skill. *Studies in Second Language Acquisition*, 14(1), 25-38.
- Hulstijn, J. H., & de Graaff, R. (1994). Under what conditions does explicit knowledge of a second language facilitate the acquisition of implicit knowledge?: A research proposal. *AILA Review*, 11(97-112).
- Indrarathne, B. (2016). *Attentional processing of different types of written L2 input and its relationship with learners' working memory capacity*. Doctoral dissertation, Lancaster University, Lancaster.
- Izumi, S. (2002). Output, input enhancement, and the noticing hypothesis: An experimental study on ESL relativization. *Studies in Second Language Acquisition*, 24(4), 541-577.

- Jourdenais, R. (1998). *The effects of textual enhancement on the acquisition of the Spanish preterit and imperfect*. Doctoral dissertation, Georgetown University, Washington, DC.
- Jourdenais, R., Ota, M., Stauffer, S., Boyson, B., & Doughty, C. (1995). Does textual enhancement promote noticing?: A think-aloud protocol analysis. *Attention and Awareness in Foreign Language Learning*, 183, 216.
- Juffs, A., & Harrington, M. (2011). Aspects of working memory in L2 learning. *Language Teaching*, 44(2), 137-166.
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, 87(4), 329.
- King, J., & Just, M. A. (1991). Individual differences in syntactic processing: The role of working memory. *Journal of Memory and Language*, 30(5), 580-602.
- Krashen, S. D. (1985). *The input hypothesis: Issues and implications*. Addison-Wesley Longman Limited.
- LaBrozzi, R. M. (2016). The effects of textual enhancement type on L2 form recognition and reading comprehension in Spanish. *Language Teaching Research*, 20(1), 75-91.
- Larsen-Freeman, D., & Long, M. (1991). *An introduction to second language acquisition research*. London: Longman.
- Lee, M. (2014). Relative contribution of working memory capacity to L2 reading comprehension. *English Language Teaching*, 69(1), 119-146.
- Lee, M. (2018). *Exploring the learning potential of multimodal input-based tasks: The effects of captioning, textual enhancement and working memory on grammatical development*. Doctoral dissertation, University College

London, London.

- Lee, S.-K. (2007). Effects of textual enhancement and topic familiarity on Korean EFL students' reading comprehension and learning of passive form. *Language Learning, 57*(1), 87-118.
- Lee, S.-K., & Huang, H.-T. (2008). Visual input enhancement and grammar learning: A meta-analytic review. *Studies in Second Language Acquisition, 30*(3), 307-331.
- Leeser, M. J. (2007). Learner-based factors in L2 reading comprehension and processing grammatical form: Topic familiarity and working memory. *Language Learning, 57*(2), 229-270.
- Leow, R. P. (1997). The effects of input enhancement and text length. *Applied Language Learning, 8*(2), 151-182.
- Leow, R. P. (2001). Do learners notice enhanced forms while interacting with the L2?: An online and offline study of the role of written input enhancement in L2 reading. *Hispania, 496*-509.
- Leow, R. P. (2015). *Explicit learning in the L2 classroom: A student-centered approach*. London: Routledge.
- Leow, R. P., Egi, T., Nuevo, A. M., & Tsai, Y.-C. (2003). The roles of textual enhancement and type of linguistic item in adult L2 learners' comprehension and intake. *Applied Language Learning, 13*(2), 1-16.
- Lightbown, P. (1980). The acquisition and use of questions by French L2 learners. *Second Language Development: Trends and Issues, 151*-175.
- Linck, J. A., Osthus, P., Koeth, J. T., & Bunting, M. F. (2014). Working memory and second language comprehension and production: A meta-analysis.

Psychonomic Bulletin & Review, 21(4), 861-883.

- Long, M. H. (1996). The role of the linguistic environment in second language acquisition. In W. C. Ritchie, & T. K. Bhatia (Eds.), *Handbook of second language acquisition* (pp. 413-468). New York: Academic Press.
- Mackey, A., Gass, S., & McDonough, K. (2001). How do learners perceive interactional feedback?. *Studies in Second Language Acquisition*, 22(4), 471-497.
- Mackey, A. J., Philp, J. J., Egi, T., Fujii, A., & Tatsumi, T. (2002). Working memory capacity, noticing of interactional feedback and L2 development. In P. Robinson (Chair), *New directions in second language learning aptitude research*, Colloquium at AILA.
- Meguro, Y. (2019). Textual enhancement, grammar learning, reading comprehension, and tag question. *Language Teaching Research*, 23(1), 58-77.
- Meisel, J. M., Clahsen, H., & Pienemann, M. (1981). On determining developmental stages in natural second language acquisition. *Studies in Second Language Acquisition*, 3(2), 109-135.
- Miyake, A., & Friedman, N. P. (1998). Individual differences in second language proficiency: Working memory as language aptitude. *Foreign Language Learning: Psycholinguistic Studies on Training and Retention*, 339-364.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49-100.
- Overstreet, M. (1998). Text enhancement and content familiarity: The focus of

- learner attention. *Spanish Applied Linguistics*, 2(2), 229-258.
- Overstreet, M. (2002). *The effect of textual enhancement on second language learner reading comprehension and form recognition*. Doctoral dissertation, University of Illinois at Urbana-Champaign, Champaign, IL.
- Park, E. S., & Nassif, L. (2014). Textual enhancement of two L2 Arabic forms: a classroom-based study. *Language Awareness*, 23(4), 334-352.
- Park, T.-S. (2005). English article use by advanced Korean EFL learners. *Foreign Languages Education*, 12(1), 32-59.
- Pienemann, M. (1989). Is language teachable?: Psycholinguistic experiments and hypotheses. *Applied Linguistics*, 10(1), 52-79.
- Révész, A. (2012). Working memory and the observed effectiveness of recasts on different L2 outcome measures. *Language Learning*, 62(1), 93-132.
- Robinson, P. (1995). Attention, memory, and the “noticing” hypothesis. *Language Learning*, 45(2), 283-331.
- Robinson, P. (1996). Learning simple and complex second language rules under implicit, incidental, rule-search, and instructed conditions. *Studies in Second Language Acquisition*, 18(1), 27-67.
- Robinson, P. (2003). Attention and memory during SLA. In C. Doughty, & M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 631-678). Oxford: Blackwell.
- Robinson, P., Mackey, A., Gass, S. M., Schmidt, R., & Gass, S. (2012). Attention and awareness in second language acquisition. In C. Doughty, & M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 247-267). Oxford: Blackwell.

- Rojas, S. A. (2014). Towards automatic recognition of irregular, short-open answers in fill-in-the-blank tests. *Tecnura*, 18(39), 47-61.
- Sagarra, N. (2000). *The longitudinal role of working memory on adult acquisition of L2 grammar*. Doctoral dissertation, University of Illinois at Urbana-Champaign, Champaign, IL.
- Sagarra, N. (2017). Longitudinal effects of working memory on L2 grammar and reading abilities. *Second Language Research*, 33(3), 341-363.
- Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics*, 11(2), 129-158.
- Schmidt, R. (1993). Consciousness, learning and interlanguage pragmatics. *Interlanguage Pragmatics*, 21(42), 1-31.
- Schmidt, R. (2001). *Attention*. Cambridge: Cambridge University Press.
- Sharwood Smith, M. (1991). Speaking to many minds: On the relevance of different types of language information for the L2 learner. *Interlanguage Studies Bulletin (Utrecht)*, 7(2), 118-132.
- Sharwood Smith, M. (1993). Input enhancement in instructed SLA: Theoretical bases. *Studies in Second Language Acquisition*, 15(2), 165-179.
- Shook, D. J. (1994). FL/L2 reading, grammatical information, and the input-to-intake phenomenon. *Applied Language Learning*, 5(2), 57-93.
- Simard, D. (2009). Differential effects of textual enhancement formats on intake. *System*, 37(1), 124-135.
- Song, B., & Lee, J.-H. (2013). Exploring the relationship between working memory and implicit learning of English. *English Language Teaching*, 25(3), 173-192.

- Spada, N., & Lightbown, P. M. (2008). Form-focused instruction: Isolated or integrated?. *TESOL Quarterly*, 42(2), 181-207.
- Spada, N., & Tomita, Y. (2010). Interactions between type of instruction and type of language feature: A meta-analysis. *Language Learning*, 60(2), 263-308.
- Tomlin, R. S., & Villa, V. (1994). Attention in cognitive science and second language acquisition. *Studies in Second Language Acquisition*, 16(2), 183-203.
- Truscott, J. (2014). *Consciousness and second language learning*. Bristol, Blue Ridge Summit: Multilingual Matters.
- Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language*, 28(2), 127-154.
- VanPatten, B. (1996). *Input processing and grammar instruction in second language acquisition*. Greenwood: Greenwood Publishing Group.
- Walter, C. (2004). Transfer of reading comprehension skills to L2 is linked to mental representations of text and to L2 working memory. *Applied Linguistics*, 25(3), 315-339.
- Wen, Z. (2012). Working memory and second language learning. *International Journal of Applied Linguistics*, 22(1), 1-22.
- White, J. (1998). Getting the learners' attention: A typographical input enhancement study. *Focus on Form in Classroom Second Language Acquisition*, 85-113.
- Winke, P. M. (2013). The effects of input enhancement on grammar learning and comprehension. *Studies in Second Language Acquisition*, 35(2), 323-352.
- Wong, W. (2001). Modality and attention to meaning and form in the input. *Studies in Second Language Acquisition*, 23(3), 345-368.
- Wong, W. (2003). Textual enhancement and simplified input: Effects on L2

comprehension and acquisition of non-meaningful grammatical form.
Applied Language Learning, 13(2), 17-46.

Appendices

Appendix A

Flier for Participant Recruitment

작업기억과 영어 독해, 문법 시험 간의 관계

연구 참여자 모집

본 연구의 목적은 대학영어 1 (CE1) 수강자를 대상으로
작업기억과 영어 독해, 문법 시험 간의 관계를 알아보기 위함입니다

- 모집대상** 서울대학교 대학영어 1 (CE1) 수강 학생
- 소요시간** 약 2시간 소요 예정 (3주간 매 1회)
- 1주차 40분 / 2주차 40분 / 3주차 40분
- 해당 날짜에 구글폼 링크를 통해 실험 진행

1차 집단	2차 집단	3차 집단
1주: 2021.09.09 (목)	1주: 2021.09.10 (금)	1주: 2021.09.11 (토)
2주: 2021.09.16 (목)	2주: 2021.09.17 (금)	2주: 2021.09.18 (토)
3주: 2021.09.23 (목)	3주: 2021.09.24 (금)	3주: 2021.09.25 (토)
4차 집단	5차 집단	6차 집단
1주: 2021.09.27 (월)	1주: 2021.09.28 (화)	1주: 2021.09.29 (수)
2주: 2021.10.04 (월)	2주: 2021.10.05 (화)	2주: 2021.10.06 (수)
3주: 2021.10.11 (월)	3주: 2021.10.12 (화)	3주: 2021.10.13 (수)

* 응답해주신 자료는 본 연구 목적의 결과를 측정하는데 유용하게 활용될 것입니다.

* 본 실험의 내용은 연구 이외의 다른 목적으로 사용되지 않으며, 언제든지 중도에 연구 참여를 철회할 수 있습니다.

- 신청방법** 구글폼 링크를 통하여 1~6차 집단 중 하나만 선택하여 참여신청
- 신청기간** 각 집단별 3일 전까지 구글폼 링크로 신청바랍니다
(예: 1차 집단 신청마감 9월 6일 (월) / 6차 집단 신청마감 9월 26일 (일))
- 참여보상** 소정의 기프티콘 증정

많은 참여 부탁드립니다

Appendix B

Reading Materials and Reading Comprehension

2.1 Pretest

2.1.1 Reading Material

The Statue of Liberty is probably the most famous icon of the USA. It was built to celebrate the end of slavery, and later became a symbol for freedom among immigrants. Libertas, which the statue depicts, is the Roman goddess of liberty. The torch which she carries high above her outstretched arm represents a light that guides people along the path to freedom. Interestingly, however, Liberty looks different from the way the designer first intended.

The idea for the statue came from a poet, Édouard de Laboulaye. When the American Civil war ended, he wanted to celebrate the end of the slave trade with a gift. He and other people who opposed slavery raised money and hired a sculptor, Frédéric-Auguste Bartholdi, to design the statue. Bartholdi later employed the French engineer, Gustave Eiffel, to devise its structure. Eiffel, who would subsequently build the famous tower in Paris, was already a well-known designer of railway bridges. So he knew how to build robust structures that are flexible and safe in strong winds. This feature was necessary because the winds in New York harbor are extremely strong. Today, the top of her torch swings over 15cm when the wind is blowing at 50 miles per hour.

Eiffel designed the statue to be built around a massive metal skeleton, which were similar to the Eiffel tower. Huge pieces of copper were fixed onto this to form its shape. Until recently, two copies of the plans were believed to exist. But recently, a third copy was discovered, which revealed some interesting information. In 2018, a map dealer bought some historic papers at an auction in Paris, which included original plans, calculations, and drawings of the statue. At first, the documents were too fragile to read. But after special treatment, the papers clearly showed that Eiffel's plans had been changed by Bartholdi with red ink. Liberty's arm, which was thick and vertical in Eiffel's drawing, was adjusted to be slimmer, less upright, and generally more attractive than Eiffel's design.

The changes in the plans are dated July 28, 1882, after the construction of the tower had begun. We don't know what Eiffel thought of Bartholdi's changes. By then, Eiffel was working on other projects, and only his assistants were working with Bartholdi in New York. Maybe Bartholdi thought he could make the changes because Eiffel was not there and would not complain.

However, the changes made the arm not only more attractive but also weaker, which has created problems over the years. At first, visitors could climb a ladder to the torch in Liberty's arm, but in 1916, there was an explosion on a nearby island. It damaged the statue and made it unsafe, and the stairway to the torch has been closed ever since. During restoration work in the 1980s, engineers noticed that the structure inside Liberty's head, shoulders, and arm were different from how they were shown on Eiffel's plans. They thought that the builders had made mistakes, but some historians believed that Bartholdi had changed Eiffel's design. The newly discovered papers confirm those theories.

2.1.2 Reading Comprehension Test

1. The Statue of Liberty was constructed to welcome immigrants to the USA.
 - a. True
 - b. False
 - c. Not Mentioned
2. What does the torch of the Statue of Liberty represent?
3. Who is Édouard de Laboulaye?
 - a. a sculptor
 - b. an engineer
 - c. a poet
 - d. an assistant
 - e. a map dealer
4. Eiffel designed the Statue of Liberty before designing the Eiffel Tower.
 - a. True
 - b. False
 - c. Not Mentioned
5. Why was it important to build robust structures that are flexible and safe in strong winds?
6. Three known copies of Eiffel's plans of the Statue of Liberty exist today.
 - a. True
 - b. False
 - c. Not Mentioned
7. What was revealed in the last copies of the plan?
 - a. a poem about American Civil war
 - b. drawings of the statue
 - c. a design of railway bridges
 - d. a change in Eiffel's plan by his assistant
 - e. auction records of the first copy
8. Who found the last copy of the plan for the statue of Liberty?
9. What was the changes on Eiffel's plans?
10. What is NOT mentioned according to the text?
 - a. The changes in the plans were made after the construction of the tower had begun.
 - b. The new design is not as strong as Eiffel's original design.
 - c. People had been allowed to climb the arm before 1916.
 - d. In the 1980s, engineers noticed the mismatch of Eiffel's design.
 - e. In 2018, the stairway to the torch were fixed and re-opened.

2.2 Immediate Posttest

2.2.1 Reading Materials

(1) Baseline text

In 2017, archaeologists discovered some remains of a Bronze Age chief in Lechlade, which is located in the west of England. The finding is historically interesting as the artefacts with which he was buried indicate that he was very important. Plus, the manner of his burial was significantly different from other burials at the time. Even more fascinating was the discovery of an older man's remains which are close to the chief's. Archaeologists are puzzling over what the relationship between the two men could be, and why they were treated so differently from the norm at the time.

Interestingly, the chief was buried with heads and hooves of four cattle around 4,200 years ago. The remains that archeologists has investigated were found in an area in which a skate park is to be built, and carbon dating has revealed that it dates back to the Bronze Age. Archaeologist Andy Hood, who helped to excavate the site, said that it was common for Bronze Age chiefs to be buried with the skull and hooves of a single cattle. However, until now none had been uncovered with multiple cattle remains in the UK, which seems to indicate that this chief was especially important. Hood and his colleagues, by whom these remains were found, consider it likely that the animals were killed as part of the burial ceremony. The loss of four of them would have been a considerable sacrifice by which the chief's importance in his culture can be assumed.

Other artefacts which were found near the chief include a copper dagger, a stone wrist guard, a fire-making kit and some jewellery. These items were typically buried alongside members of the "Beaker culture". These people, whose name was given due to the tall pots which looked like beakers which were typical of this culture, arrived in Britain from mainland Europe in around 2400BC. Usually, a pot with which prominent people from this culture were buried was not discovered near the chief. Archaeologists assumed that this chief was especially admired among this Beaker society and was not symbolised by the typical pot.

The chief was buried at the centre of a circular pit on the top of which soil would have been piled. Near him, within the circle, were the remains of the older man, who was about 50-60 years old when he was sacrificed for the chief. Newspapers have suggested that this older man was a priest whose role was to help the chief, with whom he was buried, in the afterlife. However, archaeologists say there is no evidence to support the idea that some journalists argued. Even so, this older man's burial in which one head and one hoof were also placed is strange, as he was buried in an unusual seated position. The position which showed the legs pointing downwards into the earth is different from other burials at the time. Bronze Age people, including the chief, were almost always buried on their sides. The reason for this unique position, the status of this chief and the relationship between the two men is still unknown. The puzzle that archaeologists are still trying to reveal may remain a mystery forever.

(2) VIE on relative clauses

In 2017, archaeologists discovered some remains of a Bronze Age chief in Lechlade, **which is** located in the west of England. The finding is historically interesting as the artefacts **with which** he was buried indicate that he was very important. Plus, the manner of his burial was significantly different from other burials at the time. Even more fascinating was the discovery of an older man's remains **which are** close to the chief's. Archaeologists are puzzling over what the relationship between the two men could be, and why they were treated so differently from the norm at the time.

Interestingly, the chief was buried with heads and hooves of four cattle around 4,200 years ago. The remains **that** archeologists has investigated were found in an area **in which** a skate park is to be built, and carbon dating has revealed that it dates back to the Bronze Age. Archaeologist Andy Hood, **who** helped to excavate the site, said that it was common for Bronze Age chiefs to be buried with the skull and hooves of a single cattle. However, until now none had been uncovered with multiple cattle remains in the UK, **which seems** to indicate that this chief was especially important. Hood and his colleagues, **by whom** these remains were found, consider it likely that the animals were killed as part of the burial ceremony. The loss of four of them would have been a considerable sacrifice **by which** the chief's importance in his culture can be assumed.

Other artefacts **which were** found near the chief include a copper dagger, a stone wrist guard, a fire-making kit and some jewellery. These items were typically buried alongside members of the "Beaker culture". These people, **whose name** was given due to the tall pots **which looked** like beakers which were typical of this culture, arrived in Britain from mainland Europe in around 2400BC. Usually, a pot **with which** prominent people from this culture were buried was not discovered near the chief. Archaeologists assumed that this chief was especially admired among this Beaker society and was not symbolised by the typical pot.

The chief was buried at the centre of a circular pit on the top **of which** soil would have been piled. Near him, within the circle, were the remains of the older man, **who was** about 50-60 years old when he was sacrificed for the chief. Newspapers have suggested that this older man was a priest **whose role** was to help the chief, **with whom** he was buried, in the afterlife. However, archaeologists say there is no evidence to support the idea **that** some journalists argued. Even so, this older man's burial **in which** one head and one hoof were also placed is strange, as he was buried in an unusual seated position. The position **which showed** the legs pointing downwards into the earth is different from other burials at the time. Bronze Age people, including the chief, were almost always buried on their sides. The reason for this unique position, the status of this chief and the relationship between the two men is still unknown. The puzzle **that** archaeologists are still trying to reveal may remain a mystery forever.

(3) VIE on articles

In 2017, archaeologists discovered some remains of a Bronze Age chief in Lechlade, which is located in **the** west of England. **The** finding is historically interesting as **the** artefacts with which he was buried indicate that he was very important. Plus, **the** manner of his burial was significantly different from other burials at the time. Even more fascinating was **the** discovery of **an** older man's remains which are close to **the** chief's. Archaeologists are puzzling over what the relationship between **the** two men could be, and why they were treated so differently from the norm at the time.

Interestingly, **the** chief was buried with heads and hooves of four cattle around 4,200 years ago. **The** remains that archeologists has investigated were found in **an** area in which a skate park is to be built, and carbon dating has revealed that it dates back to the Bronze Age. Archaeologist Andy Hood, who helped to excavate **the** site, said that it was common for Bronze Age chiefs to be buried with **the** skull and hooves of **a** single cattle. However, until now none had been uncovered with multiple cattle remains in the UK, which seems to indicate that this chief was especially important. Hood and his colleagues, by whom these remains were found, consider it likely that **the** animals were killed as part of **the** burial ceremony. **The** loss of four of them would have been **a** considerable sacrifice by which the chief's importance in his culture can be assumed.

Other artefacts which were found near the chief include **a** copper dagger, **a** stone wrist guard, **a** fire-making kit and some jewellery. These items were typically buried alongside members of the "Beaker culture". These people, whose name was given due to the tall pots which looked like beakers which were typical of this culture, arrived in Britain from mainland Europe in around 2400BC. Usually, **a** pot with which prominent people from this culture were buried was not discovered near **the** chief. Archaeologists assumed that this chief was especially admired among this Beaker society and was not symbolised by **the** typical pot.

The chief was buried at the centre of **a** circular pit on the top of which soil would have been piled. Near him, within **the** circle, were **the** remains of **the** older man, who was about 50-60 years old when he was sacrificed for the chief. Newspapers have suggested that this older man was **a** priest whose role was to help **the** chief, with whom he was buried, in **the** afterlife. However, archaeologists say there is no evidence to support **the** idea that some journalists argued. Even so, this older man's burial in which one head and one hoof were also placed is strange, as he was buried in **an** unusual seated position. **The** position which showed the legs pointing downwards into **the** earth is different from other burials at the time. Bronze Age people, including the chief, were almost always buried on their sides. **The** reason for this unique position, **the** status of this chief and **the** relationship between **the** two men is still unknown. The puzzle that archaeologists are still trying to reveal may remain **a** mystery forever.

2.2.2 Reading Comprehension Test

1. What was discovered in a park in Lechlade, UK?
 - a. The chief
 - b. The older man
 - c. Both the chief and the older man
 - d. Chiefs from the Beaker culture
 - e. Important members of the Beaker culture

2. What was NOT found near the chief?
 - a. some jewelry
 - b. a stone wrist guard
 - c. a tall pot
 - d. a copper dagger
 - e. a fire-making kit

3. Why does the name “Beaker culture” given to the people who arrived in Britain from mainland Europe in around 2400BC?

4. Why were the animals killed?

5. The typical pot of the “Beaker culture” was found near the chief.
 - a. True
 - b. False
 - c. Not Mentioned

6. How can it be assumed that the chief was especially important?

7. What does the newspaper suggest about the older man?

8. Archaeologists provided evidence to support the old man’s role.
 - a. True
 - b. False
 - c. Not Mentioned

9. Why is the older man’s burial strange?
 - a. it was buried on its sides
 - b. the legs were buried downwards
 - c. it was buried with no arms
 - d. the head were buried facing up
 - e. it was buried on the top of the chief

10. What has remained a mystery according to the text?

Appendix C

Grammaticality Judgement Test

3.1 Pretest

(1) Relative Clauses

1	Tim received extra vacation time when he renewed his contract at work, which was a significant factor in his decision to stay.	O
2	A grammar school in the UK is usually a selective private school which teaches students aged 11 through 18.	O
3	Ernest Hemingway, a novelist and short-story writer, developed a prose style by which influenced an entire generation of authors.	X
4	If you don't have the time to have your teeth whitened, natural alternatives such as peppermint in which contain enough acid to whiten your teeth are considered useful.	X
5	Architecture is an academic subject in which many European people have an interest.	O
6	Music programs are one area which many school districts often make cuts during periods of budgetary difficulty.	X
7	France and Germany see a lot of numbers of immigrants and much more diversity in the countries from which they come.	O
8	The confidence with which he spoke embarrassed her.	O
9	Recently, there are many pictures of famous celebrities in magazines who styles teens want to follow.	X
10	From time to time, we must look up words whose meanings we do not know.	O

(2) Articles

1	John's friends had a farewell party for him last Friday.	O
2	Emily tried hard to get good grade on the test.	X
3	It is always difficult to make the decisions.	X

4	They gave me an electric typewriter for my birthday.	O
5	To tell a truth, a bank savings account may not be the best place for your money.	X
6	He wanted to try on a pair of jogging shoes at the store.	O
7	She does not have an understanding of the subject yet.	O
8	I just saw boys from Africa that I met at the International House party last week.	X
9	I wrote my name at the top of the page.	O
10	I never listen to the radio, and in fact, I haven't got the radio.	X

(3) Distractors

1	The National Museum used not to be allowed visitors to take photos and record them on video.	X
2	Each chapter include questions that will help individual readers apply the ideas to their own classrooms.	X
3	A large percentage of patients with diabetes consume moderate amounts of sweets.	O
4	I was sitting among my two sisters when he came in.	X
5	We drove the car into the driveway.	O
6	The albatross is the largest in the web-footed birds.	X

3.2 Immediate Posttest

(1) Relative Clauses

1	All cows over 30 months which may have been exposed to the disease must be destroyed.	O
2	Insufficient sleep boosts the levels of a hormone, of which researchers say can make you hungrier and slow your metabolism.	X
3	Sports drinks, which are intended to replace fluids and nutrients lost during exercise, can be high in calories.	O

4	A homeless man, of whom accused stealing two mobile phones form ABC store, was arrested last night.	X
5	A rise in energy price will mostly affect businesses whose energy consumption is high.	O
6	Well-adjusted and responsible students are educated by parents who care balances affection and strong disciplines.	X
7	He will call the patrons whom the package was delivered.	X
8	Ask native speakers questions whenever you encounter any unfamiliar words the meanings which you don't understand.	O
9	University students should ensure that their abilities and skills match the exchange student programs for which they apply.	O
10	Art programs are one area which many school districts often make cuts during periods of budgetary difficulty.	X

(2) Articles

1	A comet was seen in the western sky last night.	O
2	After lunch, we went for a walk by sea.	X
3	My brother is married to a Russian.	O
4	Did you lock the door when you left a house?	X
5	We walked to the city entre, but we got a taxi back to a hotel.	X
6	I went into the shop and asked to speak to the manger.	O
7	Jess is buying "previously owned" car, and he is checking it over carefully.	X
8	They've changed a date of the meeting. It's next Tuesday now.	X
9	I borrowed a pencil from your pile of pencils and pens.	O
10	An app called Jigsaw allows you to make a puzzle on your tablet, and when the app opens, it shows a wooden tabletop.	O

(3) Distractors

1	Annual death rates declined during the years of downturn.	O
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2	Professor Stevenson’s career has dedicated to fostering international research.	X
3	The number of Korean tourists traveling to Spain are expected to increase 30 percent.	X
4	The effects the volcano eruption will have on diverse ecosystems is a great source of concern.	O
5	All the food was kept in the freezer before being cooked.	O
6	Barbara enjoyed to work as a bank teller for one summer.	X

3.3 Delayed Posttest

(1) Relative clauses

1	Any employee which wants to leave the company is asked to give a month’s notice to the Human Resource Department.	X
2	Most of the people who go to Alaska in the summer are surprised that it is warmer than they expected.	O
3	Jacob can speak Chinese, which is a great advantage when working with Chinese clients.	O
4	Mayberry Research Institute offers staff benefits for which include dental coverage and a pension plan.	X
5	The computer, which only the President or Vice President could run, came back with half a dozen errors.	O
6	College students should ensure that their abilities and skills match the internship programs for which they apply.	O
7	Ask native speakers questions whenever you see any difficult words the meanings of which you don’t understand.	X
8	The respected mayor, whom most of the citizens in the city voted, have resigned when journalists found out the crime he had committed.	X
9	Recently, there are many pictures of famous influencers in social media who styles teens want to follow.	X
10	Joseph Figueroa, whose books have all been best-selling titles, has	O

	released his newest publication on the topic of the national election system.	
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(2) Articles

1	Kate has been talking to a customer who has just come into the shop.	O
2	You won't like that restaurant, because the food isn't very good there.	O
3	The teacher gave us a first question and it was the easy one.	X
4	Jerry works in an office in the center of London.	O
5	I saw the interesting documentary on TV the other day.	X
6	Angela is looking for the romantic holiday somewhere in the south	X
7	I prefer swimming in the sea to swimming in pools	O
8	As I was walking along the street, I saw a 10\$ note on the pavement.	O
9	Major changes have taken place in financial services industry.	X
10	Taking a hot bath is the good way to relax.	X

(3) Distractors

1	The final decision will be made after a scheduled meeting today.	O
2	Fiona has been taught at the college for five years by the time she leaves for London.	X
3	It's not surprising that the documentary movie won the award for Best Picture at the Sundance Film Festival last year.	O
4	None of the students was able to submit their assignments by the due date.	X
5	90% of the people living in Okinawa have been severely affected by a strong typhoon.	O
6	The property was divided equally among his son and daughter.	X

Appendix D

Fill-in-the-blank Task

4.1 Pretest

(1) Relative Clauses

1	The mayor's son _____ is known to be intelligent flunked in his math course.	who
2	The population of London _____ was once the largest city in the world is now falling.	which
3	The new stadium, _____ holds 90,0000 people, will be opened next month.	which
4	John did not want to do business with a man _____ had been in prison.	who
5	College student should ensure that their abilities and skills match the internship programs _____ they apply.	for which
6	They saw the student _____ they had a higher score than.	whom
7	The storm, _____ nobody had been expecting, caused a lot of damage.	which
8	When the thunder strikes, he looked up to find the nest _____ the birds had fallen.	from which
9	That man over there, _____ name I don't remember, is an artist.	whose
10	Mr. Edwards, _____ health hasn't been good recently, has gone into hospital for some tests.	whose

2.2 Distractors

1	The students had a dispute _____ politics.	about
2	You have a responsibility _____ your fellow residents.	to
3	Since she graduated, Anne is no longer dependent _____ her parents for financial support.	on
4	If I have enough apples, I (bake) an apple pie this afternoon.	will bake

5	I (give) you a cigarette if I had one but I'm afraid I haven't.	should give
6	Dianne left the room without (give) Bryan a chance to explain everything.	giving
7	Jamie felt sick after she (eat) a whole box of chocolates.	had eaten.
8	I (finish) my homework by the time I go out.	will have finished
9	I can't afford (buy) a new car.	to buy
10	I (lose) my key yesterday, so I couldn't get into the house.	lost

(3) Articles

Sometimes, names can be confusing in different languages. Much to (1) _____ confusion of many English learners, Europa is not the name of (2) _____ continent, but rather (3) _____ moon which orbits Jupiter. And although many people have never heard of it, it is (4) _____ especially important moon. Scientists have discovered that (5) _____ surface is entirely covered with (6) _____ ice, but researchers hope that beneath (7) _____ frozen layer lies (8) _____ ocean. Nobody knows if (9) _____ center of the moon is frozen solid or if it is liquid water.

If some vast, undiscovered ocean does exist, it would be a cold and harsh environment; however, some scientists believe that (10) _____ life might exist there just like it does at (11) _____ bottom of Earth's oceans. Some say that (12) _____ only way to find out is to send (13) _____ probe to drill down into (14) _____ ice and see what's there. Such a mission would be (15) _____ expensive project indeed.

4.2 Immediate Posttest

(1) Relative Clauses

1	The town hall clock played a different tune at twelve every day, _____ amused the locals and attracted tourists.	which
2	Tom and his girlfriend, _____ got engaged last winter after _____	who

	dating for 10 years, married in California on Saturday night.	
3	Janet showed me a photograph of her son _____ is a policeman.	who
4	The family _____ house burned down was on television.	whose
5	This school is only for children _____ first language is not English.	whose
6	Brad told me her address _____ I wrote down on a piece of paper.	which, that
7	France and Germany see a lot of numbers of immigrants and much more diversity in the countries _____ they come.	from which
8	The person _____ you refer is the new executive assistant in our department.	to whom
9	The child ate the sandwich _____ his mother made for lunch.	which, that
10	Chris _____ I have known for eight years is one of my closest friends.	whom

(2) Distractors

1	Ms. Balla substituted _____ our regular teacher yesterday.	for
2	The class size is limited _____ twenty-two.	to
3	Jake was aware _____ the regulation against smoking in this area.	of
4	If I (have) enough money, I would go with you.	had
5	If you (not go) to bed so late every night, you wouldn't be so tired all the time.	didn't go
6	The jury found Mr. Smith guilty in (take) money from the company he worked for.	to loan
7	After the doctor (examine) the child he had a talk with the mother.	had examined
8	As soon as it stops raining we (leave)	will leave
9	My mother avoids (speak) in public.	speaking
10	I (see) the movie Titanic three times. I'm going to see it again.	have seen

(3) Articles

I just received (1) ___ postcard from the Robinsons, a family I met last year. It made me start thinking: When was (2) _____ last time I actually sent (3) ___ letter or (4) ___ postcard to someone? It's strange, (5) ___ postal service has been part of daily life for centuries. And suddenly, within (6) ___ single generation, the postal system is on its way to becoming a thing of the past. These days, few people send letters.

Today, email is a far more common way to communicate with friends and family. It's also a faster and cheaper way to communicate. When I send (7) ___ email to (8) ___ friend in a distant country, (9) ___ friend will receive (10) ___ email almost immediately. What's more, I have the ability to attach (11) ___ photograph, (12) ___ video, or (13) ___ MP3.

But (14) _____ world is changing quickly. In a decade or two, we might all be using (15) ___ totally different kind of technology to communicate.

4.3 Delayed Posttest

(1) Relative Clauses

1	The machine _____ broke down a month ago has been repaired now.	which, that
2	The doctor examined the sick child _____ couldn't sleep well last night.	who
3	John James Audubon, _____ was a naturalist and an artist, wrote great work which is called "Birds of America"	who
4	New cars are more efficient in fuel consumption than old cars _____ are slow and noisy.	which
5	The hotel _____ we stayed last night was not comfortable and quite.	in which

6	Architecture is an academic subject _____ many European people have an interest.	in which
7	The waiter handed a menu to a man _____ his friend had given a watch.	to whom
8	The lawyer met with the actress' children _____ she gave little attention	to whom
9	Villagers like swimming more than skiing _____ equipment is expensive.	whose
10	A boss gave a prize to employees _____ work was great.	whose

(2) Distractors

1	The accused woman was innocent _____ the crime.	of
2	The secretary provided me _____ a deal of information	with
3	This summer he will be eligible _____ a three-week vacation.	for
4	If I had enough apples, I (bake) an apple pie this afternoon.	would bake
5	If you (go) to bed earlier, you wouldn't be so sleepy in the morning.	went
6	My little sister can't resist (tell) everyone my secrets.	telling
7	Mary (finish) her homework when her father had come home from his office.	finished
8	They (play) for three hours by the time we have dinner.	will have been playing
9	The teacher promised (take) us to the zoo if we worked well.	to take
10	When Chris was a child, he (live) in New York.	lived

(3) Articles

<p>Dear Judy,</p> <p>Sorry that I didn't email you earlier to tell you about (1) _____ trip, but I've had a bunch of things to do since we got back. We had (2) _____ fantastic time in South</p>

Africa. Although this is (3) _____ first time I've ever traveled to (4) _____ foreign country, I feel confident saying that it's one of (5) _____ most beautiful places on (6) _____ planet.

We began the trip in Cape Town as you suggested. It's such (7) _____ beautiful city. And I'm so glad you recommended that we take the cable car up Table Mountain. While we were taking in (8) _____ spectacular views, we met (9) _____ man who runs (10) _____ lodge just outside Kalahari National Park. He invited us to stay in (11) _____ lodge for free, so we rented (12) _____ car and slowly drove up to (13) _____ west coast to (14) _____ park and spent our time exploring Kalahari Desert. What (15) _____ adventure!

Take care,

Diane

Appendix E

Noticing Comments

5.1 Relative Group Comments

○	긍정적 / 선행사를 수식하여 더 자세하게 내용을 알 수 있게 해주고 또한 문장을 자연스럽게 이어주기 때문에 주목하게 되었다.
○	빨간색으로 표시된 부분은 문법적으로 의미가 있는 것 같아 주목하게 되었습니다.
○	which 등을 활용한 수식의 반복 활용으로 비슷한 구문이 반복된다는 느낌이 든다.
○	표시된 부분을 읽으며 해당 부분의 문법적인 부분이나 해석방법 등을 생각하게 되었습니다.
○	주로 전치사와 관계대명사의 결합부분으로서 부연 설명을 하고 있는 부분이었기에 더 주목하게 되었다.
○	앞에 언급한것을 꾸며준다는 것에 대해 주목하였다.
○	which, that, whose 처럼 관계대명사가 쓰인것같다. 주어들을 짧게 줄여서 대신 쓸수 있기 때문에 문장을 읽을때 더 좋은것같다.
○	표시된 부분들 모두 관계대명사의 형태를 띠고 있어 신경 써서 읽었을 때 문장의 흐름을 보다 쉽게 이해할 수 있어 긍정적으로 생각했습니다. 다만, 자주 반복되어 나와서 같은 방식으로 글이 더 길어질 경우 읽기 불편할 수 있겠다는 생각도 들었습니다.
○	표시된 부분이 모여있는 부분에서 문장이 길게 늘어진다는 느낌을 받았고, 가독성이 조금 떨어질 수 있겠다는 생각이 들었다.
○	해석을 하는데에 시간이 조금 걸리는 느낌이 들어 부정적인 느낌이 들었다. 특히 전치사와 함께있을 때는 해석에 시간이 더 소요되었다.
○	생략하여도 문장 자체의 의미나 해석에는 영향을 주지 않으므로, 해당 부분을 삭제하여 가독성을 높일 수 있다.
○	관계대명사가 많이 나오고 문장이 길어져서 읽는 데 힘들었다.
○	문법적 오류가 있다
○	
○	
X	

5.2 Article Group Comments

○	관사를 통해서 알고 있는 정보, 처음 등장한 정보를 좀 더 명확히 구별해주는 것 같았다.
○	관사, 특히 the에 주목을 하였다, 빨간색으로 색칠하였기 때문에 주목하였다, 빨간색으로 되어있어서 쉽게 위치를 주목할 수 있었다
○	그 뒤의 단어를 강조하는 느낌을 받았습니다
○	색이 강조되어 있기 때문에 주목하게 되었으며, 보며 그 관사가 맞는지 생각해 보며 관사 사용에 대한 예시를 추가하였다.
○	관사이기 때문에 앞에서 언급된 것인지 주목하게 되었다
○	The가 어떤 경우에 사용되는지와, a와 the가 사용되는 점이 어떤 차이가 있는지에 주목하며 읽었습니다.
○	해당 부분 뒤에 명사가 올 것이라는 생각을 하면서, 문장구조를 분석하면서 읽었습니다.
○	빨간색이라 우선 주목을 하였습니다. 또한 표시된 부분 뒤에 어떤 단어가 오는지에 주목하였습니다.
○	표시
○	관사에 빨간색이 쳐져 있는것이 문장마다 나뉘는게 아니여서 읽기 불편하였습니다.
○	해당 관사 뒤에 나오는 명사를 강조하는 느낌이 들었습니다. 다만, 강조된 관사의 색이 빨간색이라 전반적인 글과 다소 분리된 느낌을 받았습니다.
X	
X	
X	
X	
X	

Appendix F

Working Memory Capacity Materials

Set 1		
1	Andy was stopped by the policeman because he crossed the yellow heaven.	ring
2	During winter you can get a room at the beach for a very low rate.	music
3	People in our town are more giving and cheerful at Christmas time.	bag
Set 2		
1	During the week of final spaghetti, I felt like I was losing my mind.	carrot
2	After final exams are over, we'll be able to take a well-deserved break.	sleeve
3	After a hard day at the office, Bill often stops at the club to relax.	light
Set 3		
1	No matter how much we talk to him, he is never going to change.	system
2	The prosecutor's dish was lost because it was not based on fact.	dress
3	Every now and then I catch myself swimming blankly at the wall.	tunnel
Set 4		
1	We were fifty lawns out at sea before we lost sight of land.	kitchen
2	Throughout the whole ordeal, the hostages never appeared to lose hope.	grass
3	Jerry is afraid of heights and refuses to travel by plane.	devil
4	The young pencil kept his eyes closed until he was told to look.	arm
5	Most people who laugh are concerned about controlling their weight.	fault
Set 5		
1	When Lori shops she always looks for the lowest flood.	project
2	When I get up in the morning, the first thing I do is feed my dog.	tea
3	After yelling at the game, I knew I would have a tall voice.	bliss
Set 6		
1	The cook lunged with the ladle and hit the tulip on the shoulder.	bed
2	You really cannot give socks as Christmas presents every year.	fork
3	Many people would agree that small is the prettiest colour for a bike.	soldier
4	The smoke noticed that something was not right with the saleswoman.	nature
5	The next morning the van with all the goods was suddenly gone.	wolf
6	The weather was extremely short on this afternoon in September.	jewel
Set 7		
1	Mary was asked to stop at the new mall to pick up several items.	test
2	When it is cold, my mother always makes me wear a hat on my head.	hammer
Set 8		
1	All parents hope their list will grow up to be intelligent.	closet

2	When Tom and Amy moved to Canada, their wish had a huge garage sale.	helmet
3	In the fall, my gift and I love to work together in the yard.	problem
4	At church yesterday morning, Jim's daughter made a terrible plum.	speed
5	Unaware of the hunter, the deer wandered into his line of fire.	ice
Set 9		
1	Since it was the last game, it was hard to cope with the loss.	nest
2	Because she gets to knife early, Amy usually gets a good parking spot.	rat
3	The only furniture Steve had in his first bowl was his waterbed.	title
4	Last year, Mike was given detention for running in the hall.	heat
Set 10		
1	The huge clouds covered the morning slide and it began to rain.	table
2	After one date I already knew that Linda's sister was simply not my type.	quarter
Set 11		
1	The only cup of this week was to clean up the bathroom.	price
2	The first thing Simon would get rid of was the ugly, old carpet.	window
3	Some plants only need very little calendar in order to survive.	brain
4	It was very obvious to everyone that she had read an eye on him.	apple
5	I can only work well if everything is structured and organised.	doubt
6	On Monday evening a young man from Cameroon was attacked by teenagers.	future
Set 12		
1	Jason broke his arm when he fell from the tree onto the ground.	wheel
2	Most people agree that Monday is the worst stick of the week.	pig
3	On warm sunny afternoons, I like to walk in the park.	dream
4	With intense determination he overcame all the obstacles and won the race.	rose
Set 13		
1	A person should never be discriminated against based on their race.	ghost
2	My mother always tells me that it is not polite to shine.	forest
3	The lemonade players decided to play two out of three sets.	culture
Set 14		
1	Raising children requires a lot of dust and the ability to be firm.	summer
2	The gathering crowd turned to look when they heard the gunshot.	concept
3	As soon as I get done taking this envy, I am going to go home.	land
4	Sue opened her purse and found she did not have any money.	stone
5	Jill wanted to have a garden in her backyard, but the soil was mostly clay.	temple
Set 15		
1	I had no idea why my girlfriend was mad at me.	garden
2	After dressing very warmly, I finally stopped feeling cold.	youth

3	When I looked out of the window, the whole street was covered in stench.	talent
4	Our whole time in France, there was a cold wind from the North.	butter
5	When she came out of the shop she was drunk by a pedestrian.	madness
6	The player hit the goal much better than I had ever expected.	sheep
Set 16		
1	Stacey stopped dating the light when she found out he had a wife.	weight
2	I told the class that they would get a surprise if they were orange.	pond
Set 17		
1	Jim was so tired of studying, he could not read another page.	art
2	Although Joe is sarcastic at times, he can also be very sweet.	pants
3	Carol will ask her sneaker how much the flight to Mexico will cost.	comfort
4	The sugar could not believe he was being offered such a great deal.	winter

국문초록

시각강화와 작업기억이 한국인 영어 학습자의 문법 학습에 미치는 영향

제 2 언어를 습득함에 있어 주의집중의 중요성에 관한 연구가 축적된 이후 실제 교실에서는 학습자의 관심을 문법 형태로 유도하기 위한 다양한 교수기법이 개발되었고 또한 적용되고 있다. 명시적으로 규칙을 설명하거나 간접적으로 문법을 제시해 주는 기법 등과 같은 많은 학습 방법 중에서 시각적 입력 강화(VIE)은 제 2 언어를 연구원들과 교실에서 수업하는 교사들로부터 많은 관심을 받았다. 이는 학습자가 알 수 있도록 독해 텍스트 내에서 해당 문법 사항을 강조하는 기법을 의미한다. 하지만 시각강화가 문법 학습에 미치는 영향에 대한 앞선 연구들은 학습자의 다양한 내부 요인 뿐만 아니라 특정 문법 항목의 선택과 같은 방법론적 차이로 인해 혼합된 결과를 보여주었다. 게다가 시각강화가 독해력에 미치는 영향과 관련된 또 다른 중요한 문제는 해결되지 않았고 논란의 여지가 남아 있다.

수년에 걸쳐 많은 시각강화 연구가 수행되었지만, 서로 다른 문법 항목 사이에 시각강화의 효과를 비교하고 학습자의 작업 기억과 시각강화 효과 사이에서의 상관관계를 조사한 연구는 거의 없었다. 따라서 본 연구는 시각강화가 두 가지 문법적 형태의 문법 학습에 미치는 영향과 독해력에 미치는 영향을 조사하고자 하였다. 영어 관계사절과 관사를 해당 문법 항목으로 선정한 것은 그동안 한국인 영어 학습자들이 상대적으로 어렵게 여기는 특징을 나타냈으며 여기에는 유사점과 차이점이 존재하기 때문이

다. 마지막으로 개인변인이 시각강화의 효과성에 미치는 영향을 파악하기 위해 개별 학습자의 작업 기억 능력도 연구되었다.

실험에는 총 48명의 한국인 대학 영어학습자들이 참여했다. 참가자들은 (a) 관계사절 그룹(관계사절에 대한 시각강화), (b) 관사 그룹(관사에 대한 시각강화), (c) 통제 그룹(시각강화 미제공)의 세 그룹으로 배정되었다. 이들은 독해 시험과 문법 시험을 치루었다. 본 연구는 또한 시각강화의 효과가 각 참가자의 작업 기억 수준에 따라 영향을 받는지의 여부를 분석하였다. 따라서 이들의 작업 기억 능력 결과를 바탕으로 각 그룹을 높은 작업 기억 그룹과 낮은 작업 기억 그룹으로 세분화하였다.

두 시각강화그룹의 독해력 테스트 결과는 통제 그룹과 비교하여 유의한 차이가 없는 것으로 나타났으며, 이는 두 문법 항목에 대한 텍스트 내에서의 강조가 학습자의 독해에 방해하지 않았음을 의미한다. 두 시각강화 그룹의 문법 시험 결과는 문법 대상에 따라 통제 그룹과의 문법 시험 결과와 다르게 나타났다. 관계사절 그룹에서는 수용성 지식(receptive knowledge)에 해당하는 문법 시험에서 통제 그룹보다 더 높은 점수를 받았다. 관계사절 집단 참가자들은 다른 집단에 비해 관계사절에 시각적으로 강화된 점에 주목하였고, 시각강화는 영어 관계사절 대한 수용적 지식을 향상시키는데 도움을 주는 것으로 나타났다. 관사의 경우, 시각강화는 참가자들의 영어 관사에 대한 생산적인 지식(productive knowledge)을 향상시키는 것으로 나타났다. 이러한 결과는 문법 항목을 시각적으로 강화하면 문법 학습에 긍정적인 영향을 미치고 있음을 나타낸다.

작업 기억 능력의 개인차는 관계사절 그룹과 관사 그룹에서 독해나 문법 학습에 영향을 미치지 않았다. 그러나 작업기억을 세분화하여 살펴본 결과, 처리 능력이 높은 학습자들이 낮은 학습자들보다 더 우수한 성적을

보였다. 관계사절 그룹에서 높은 처리 능력을 가진 참가자들은 낮은 그룹보다 GJT에서 약간 더 나은 성과를 보였지만, 통계적으로 유의하지 않았다. 관사 그룹에서, 높은 처리 능력을 가진 참가자들은 통계적으로 유의미한 수준으로 FIB에서 더 나은 성과를 보였다. 이러한 결과는 작업 기억의 처리 구성 요소가 문법 학습에 중요한 개인 변수가 될 수 있음을 시사한다. 통계적으로 유의하지 않음에도 불구하고 작업기억능력이 높은 집단이 하위 집단보다 우수한 경향은 학습자의 작업 기억 능력에 따라 시각강화의 효과가 달라질 수 있는 가능성을 제시한다.

본 연구는 두 개의 다른 특징을 가진 문법 항목 대한 시각강화가 독해를 저해하지는 않았고 문법 학습에 긍정적인 영향을 미치는 것으로 나타났다. 또한, 문법 학습에 대한 시각강화의 효과는 작은 영향에도 불구하고 참가자의 작업 기억 능력의 처리 구성 요소에 의해 영향을 받을 수 있다는 점이다. 이 연구 결과, 문법 형태를 시각적으로 향상시킴으로써 학습자가 형태를 알아내고 의미의 손상 없이 습득할 수 있음을 시사해주고 있다.

주요어 : 시각 입력 강화(VIE), 작업 기억 능력, 문법 항목 난이도, 독해 학습, 문법 학습, 제 2 언어 습득

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