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Relationships between Lower-Level Processing Skills and Reading Comprehension of Korean EFL High School Students

한국 고등학생의 영어 읽기 하위 과정 처리 능력과 읽기 이해 능력간의 관계

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서울대학교 대학원

외국어교육과 영어전공

배 주 경

Relationships between Lower-Level Processing Skills and Reading Comprehension of Korean EFL High School Students

by

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배주경의 석사학위논문을 인준함

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ABSTRACT

This study investigated the relationships between lower-level processing skills and L2 reading comprehension. According to the Verbal Efficiency Model, because of the limited capacity of working memory, accurate and efficient lower-level processing is fundamental for fluent higher-level processing and reading comprehension. Based on this model, empirical L1 research has corroborated the importance of automatic lower-level processing skills. However, contrary to the consistently high correlations between lower-level processing skills and reading comprehension among young L1 readers, results have been inconsistent among proficient students. In addition, there has been no extensive research on the subject in L2 and EFL environments, although many L2 readers seem to read texts word-by-word and struggle with comprehension. Thus, this study investigated the relationships among lower-level processing skills and L2 reading comprehension among Korean EFL students. Further, the study explored whether the degree to which lower-level processing skills predict reading comprehension differs depending on the students' level of English proficiency.

In this study, 213 10th grade Korean high school students performed one reading comprehension test and four tasks designed to evaluate their lower-level processing skills: (1) phonological processing; (2) orthographic processing; (3) semantic access, and (4) syntactic processing. The results indicated that the components of lower-level processing skills were correlated with each other significantly. Particularly, they were correlated strongly when processing efficiency was considered. In addition, the components of lower-level processing skills were associated significantly with reading comprehension, with respect to both accuracy and efficiency.

The results also showed that lower-level processing skills accounted to a greater degree for reading comprehension among students with lower proficiency than among those with higher proficiency, although lower-level processing skills did explain a significant degree of reading comprehension among the higher proficiency students. With respect to the components that contribute to reading comprehension, the two groups showed rather different traits. Several possible reasons were provided for these results, and further pedagogical implications were discussed.

Key Words: Lower-level process, L2 reading, L2 word recognition

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CHAPTER 1.
INTRODUCTION

This study investigated the relationships among lower-level processing skills and L2 reading comprehension. It also examined the degree to which lower-level processing skills predict L2 reading comprehension depending on a reader's L2 proficiency. Section 1.1 describes the background and purpose of the study and Section 1.2 presents the research questions. Finally, Section 1.3 outlines the organization of the study overall.

1.1 Purpose of the Study

In the information-oriented society, the amount of text that people must process has increased. Texts, especially those in digital form, are regarded as major sources of an enormous amount of information, and reading competence, in turn, is considered a facilitator in expanding knowledge through written-based interaction. While reading, an individual encounters new information. Reading also is vital with respect to language education. As suggested by Krashen (1985, 1995), the target language is acquired through significant exposure. Thus, reading texts represents a primary source for language learning, and teachers need to encourage students to engage in reading to improve their language acquisition.

However, despite the importance of reading, many EFL readers have difficulty reading English fluently. They tend to read L2 texts word-by-word or, alternatively, read without constructing a coherent meaning of the text, which can discourage them (Nuttall, 1996). According to Pulido and Hambrick (2008), a vicious circle exists in L2 reading: poor L2 readers do not read many books because they cannot read well, and they cannot read well because they do not read many books. This “the rich get richer” phenomenon emphasizes the urgency of identifying possible fundamental factors that underlie reading difficulties (Stanovich, 1986, p. 380).

Nevertheless, reading is not simple. Reading comprehension involves a combination of complicated skills, ranging from lower-level processing abilities, such as decoding words, processing syntactic information, and understanding sentence-level textual information, to higher-level processing abilities, such as integrating background knowledge with a text, and constructing main ideas (Cain & Oakhill, 2006; Grabe & Stoller, 2011). A growing body of research has sought to identify the major factors that contribute to the development of complex reading comprehension ability. For example, Koda (1992) identified four major factors related to reading: 1) linguistic knowledge; 2) background knowledge; 3) cognitive and metacognitive skills, and 4) lower-level verbal processing skills, while other researchers have focused on the effects of affective variables, such as motivation (e.g., Becker, McElvany, & Kortenbruck, 2010; Schiefele, Schaffner, Möller, & Wigfield, 2012).

Although it is almost impossible to list all the factors that underlie the successful development of reading comprehension, contemporary reading researchers have begun to see efficient lower-level processing skills as a fundamental requirement for the development of high reading proficiency (Holmes, 2009; Nassaji, 2003, 2014; Shiki, 2009). Here, lower-level processing skills refer to “the processing skills involved in extracting visual information from print,” (Koda, 1992, p. 502) including word recognition, semantic access, grammatical knowledge, and meaning proposition skills. On the other hand, higher-level processing includes “inter-sentential text integration,” (ibid., p. 502) such as inferencing, as well as integrating textual information with background knowledge.

According to the Verbal Efficiency Model (Perfetti, 1985, 2007), automatic lower-level processing preserves cognitive resources for higher-level comprehension and results in better reading comprehension. Thus, skilled lower-level processing is essential, in that it leaves more cognitive capacity available for higher-level processing skills. Similarly, the Simple View of Reading Model (Gough & Tunmer, 1986) argues that reading comprehension ability consists of decoding ability and linguistic comprehension ability. In this view, lower-level processes, such as extracting information from printed words and accessing a semantic lexicon, are building blocks for fluent reading comprehension.

According to these models, inefficient lower-level processing may retard other reading comprehension processes by slowing down the pace of textual input and occupying more attentional resources. Thus, no matter how proficient one’s higher-level processing skills, without efficient lower-level processing skills, this proficiency will have little value. However, this does not diminish the importance of higher-level processing skills, which has been emphasized frequently by previous researchers (e.g., Hannon & Daneman, 2001; Goodman, 1988; Zwaan &

Rapp, 2006). Rather, the point is that, in order for the higher-level processes to work effectively, lower-level processes must operate rapidly and automatically.

Accordingly, several previous studies conducted in L1 contexts have attended to lower-level processes in reading. To understand the cognitive processes used in word recognition, some researchers have investigated the relationships among lower-level processing components, such as the relationship between phonological and orthographic processing skills (e.g., Cunningham & Stanovich, 1991; Ehri, 1992). Other studies concerned with the relationship between lower-level processing skills and reading comprehension have found that incomplete lower-level skills result in difficulties in reading comprehension, especially among young L1 readers (e.g., Bell & Perfetti, 1994; Kirby, Parrila, & Pfeiffer, 2003). However, contrary to the abundant research in L1 contexts, relatively few studies have attended to lower-level processing in reading in L2 and EFL contexts (e.g., Koda, 1992; Nassaji, 2003), although many L2 readers seem to focus on word recognition or structure analysis while reading, which may disrupt their reading comprehension (Yu, 2014).

In fact, the few studies available on the relationship between lower-level processing skills and reading comprehension have demonstrated results similar to those conducted in L1 context (e.g., Nassaji & Geva, 1999; Shiotsu, 2009). Nevertheless, at the same time, different L1 features in various ESL contexts, such as different phonological and orthographic systems, can have different transfer effects on L2 reading skills. Thus, without empirical evidence, it is hardly reasonable to adopt the results obtained from studies conducted in other linguistic backgrounds to the Korean context. Moreover, unfortunately, relationships among lower-level processing components have not been investigated extensively in L2 and EFL contexts, although understanding such relationships may be an essential first step in investigating the contribution of lower-level processing skills to reading comprehension, as it would deepen the understanding of the cognitive processes involved and provide pedagogical insights for the L2 reading curriculum.

In addition, the results of previous L1 and L2 research has proven inconsistent when advanced participants were involved. For example, some researchers have found that lower-level processing skills do not predict individual differences in reading comprehension among proficient readers (e.g., Holmes, 2009; Kang, Choi, Lee, & Nam, 2011), while others have found that lower-level processing skills do account for skilled readers' comprehension (e.g., Koda, 1992; Nassaji, 2003). Thus, to provide appropriate pedagogical implications, the degree to which lower-level processing components predict reading comprehension depending on English proficiency needs to be researched systematically.

In this context, this study investigated the relationships among lower-level processing skills, including phonological, orthographic, and syntactic processing skills and semantic access skills, as well as the relationships between lower-level processing skills and L2 reading comprehension on the part of Korean EFL high school students. In particular, these relationships were examined with respect to both processing accuracy and efficiency. The accuracy measure was adopted because it may reveal whether participants have appropriate lower-level related knowledge. However, because having adequate accuracy does not necessarily guarantee appropriate processing speed, which is important considering the limited capacity of working memory, a measure of efficiency was adopted as well. Here, efficiency included “two indices of speed and accuracy” (Nassaji, 2003, p. 266) to prevent a potential trade-off between the two (Lim & Godfroid, 2014). Further, the study identified the predictive power of lower-level processing skills in L2 reading comprehension depending upon the students’ English proficiency. Therefore, the results of this study will enhance the understanding of the development of L2 reading comprehension and benefit L2 instruction by helping identify the linguistic problems Korean EFL readers might face.

1.2 Research Questions

To identify possible contributors to L2 reading comprehension by investigating the relationships among lower-level processing skills and L2 reading comprehension, the following research questions were considered:

1. With respect to the accuracy and efficiency of lower-level processing, what are the relationships among lower-level processing components and L2 reading comprehension?
2. To what extent do lower-level processing skills predict L2 reading comprehension depending on the students’ L2 proficiency level?

1.3 Organization of the Thesis

The thesis consists of five chapters. Chapter 1 introduces the purpose of the study and addresses research questions. Chapter 2 presents a literature review of lower-level processes of reading comprehension to provide the theoretical and empirical background for the research. Chapter 3 describes the methodology and data collection procedure adopted in the study. The results of the data analysis are presented and discussed in Chapter 4. Chapter 5 summarizes the major findings and pedagogical implications of the study, discusses some of its limitations, and concludes with suggestions for further research.

CHAPTER 2.
LITERATURE REVIEW

This chapter presents a review of the literature related to lower-level processes of reading comprehension. Section 2.1 discusses previous and current perspectives on reading comprehension processes briefly. Section 2.2 defines lower and higher-level processes in reading comprehension and introduces the theoretical and empirical background of the importance of lower-level processing. Finally, Section 2.3 describes previous studies on the relationship between lower-level processing skills and L1 and L2 reading comprehension.

2.1 Reading Comprehension Processes

Reading is a complex process that incorporates a variety of components (Cain & Oakhill, 2006; Grabe, 1991; Grabe & Stoller, 2011; Just & Carpenter, 1987; Nassaji, 2014). Readers engage in multiple processes, ranging from word to text-level processes. They recognize each word of a text, interpret the text, and reconstruct its meaning (Grabe & Stoller, 2011; Just & Carpenter, 1987). Thus, as noted by Grabe (1991), simple definitions of reading cannot describe fully its multifaceted features. In this context, reading can be represented better with a description of the processes it involves.

Research has suggested a number of perspectives on reading. Those many and varied views can be categorized roughly into three prominent models of reading:

bottom-up, top-down, and interactive (Goodman, 1970; Gough, 1972; Just & Carpenter, 1980; Rumelhart, 1977). As the metaphors of "bottom" and "top" suggest, the first two models include hierarchical stages through which reading proceeds, while the interactive model stresses the integration of the two. A brief review of the three perspectives on reading and the way in which they have influenced reading research will assist in conceptualizing the reading process.

Many early theorists focused on the bottom-up approach, which presupposes that visual information gathered from the text undergoes processing successively (LaBerge & Samuels, 1974; Rayner & Pollatsek, 1989). In this approach, the act of reading consists of "a rapid succession of intricate events - formation of a visual icon, letter-by-letter identification and association with meaning through transposition into abstract phonemic representation - carried out with amazing rapidity and coordination in our complex information processing system" (Gough, 1972, p. 296). Thus, the decoding process is considered the foundation of reading comprehension, as, without it, reading comprehension processes cannot be performed successfully. However, as Rumelhart (1977) and Stanovich (1980) argued, this model seems to dismiss the significant role of higher-level processing, such as using prior knowledge and inferencing.

In the alternative top-down models, reading processes are assumed to begin with readers making and testing hypotheses (Goodman, 1970; Smith, 1971). Within this framework, proficient readers are believed to overcome the obstacles in reading by making hypotheses about what they will be reading using their semantic background knowledge and contextual information from the passage

(Rayner & Pollatsek, 1989). Hence, as Goodman (1973, 1988) demonstrated, in order to understand the reading material, readers engage in the “psycholinguistic guessing game,” which involves five different processes: (1) recognition-initiation; (2) prediction; (3) confirmation; (4) correction, and (5) termination.

In the 1970s and 1980s, much reading research focused on this conceptual aspect of the reading process, almost ignoring the perceptual aspects (Nassaji, 2014). Thus, most relevant studies attributed reading problems to deficiencies in higher-level skills, such as lack of background knowledge or strategic skills, rather than considering deficits in decoding skills. As for this scarcity of studies on lower-level processing skills, especially in the L2 context, Koda (1992) stated that it was due in part to the misconception that, “verbal processing skills develop automatically as linguistic proficiency improves” (p. 502). Lower-level processing skills were assumed to be acquired naturally as one’s language proficiency improved.

Nevertheless, some researchers questioned the ability of the top-down models to explain reading processes of fluent readers, arguing that formulating a hypothesis about an emerging word must take longer than the time necessary for simple visual word recognition (Samuels, Dahl, & Archwamety, 1974; Stanovich, 1980). In other words, as pointed out by Stanovich and West (1979), fluent readers perform rapid word recognition rather than developing a hypothesis for every word they encounter.

More recently, interactive models that compensate for the deficiencies of the previous two models have gained wide popularity in cognitive psychology and the reading research field (Grabe, 1991). As Grabe (1988, 1991) pointed out, the term *interaction* can refer to two complementary perspectives: (1) the interaction between the reader and the text, in which text meaning is constructed from both the information extracted from the text and the reader's background knowledge, and (2) the simultaneous operation of two levels of component skills in the reading process - lower and higher-level skills (Grabe, 1991). Because this study examined reading processes from a cognitive perspective, the term *interaction* assumes the second definition throughout this study.

The early interactive reading model was proposed by Rumelhart (1977) based on the idea that the lower and higher-level processes work in parallel, rather than in series. As Figure 1 shows, Rumelhart (1977) claimed that reading involves both perceptual and cognitive processing, where grapheme input stored in the Visual Information Store (VIS) is combined with the reader's prior knowledge and results in the appropriate construction of text meaning.

Just and Carpenter (1980) provided another model of reading comprehension based on extensive research on eye movements. The authors demonstrated that the reading process begins with eye fixation and then proceeds through the stages of word recognition, lexical access, and activation of prior knowledge. Although this model appears to be consistent with the bottom-up models that focused on the word-decoding process, top-down processes are integrated (e.g., combining old and new information, activating background knowledge) and each stage does not necessarily flow in a serial manner; rather, they can interact simultaneously (Lee, 2014).

FIGURE 1

Rumelhart's (1977) Interactive Model of Reading (Rumelhart, 1977, p. 588)

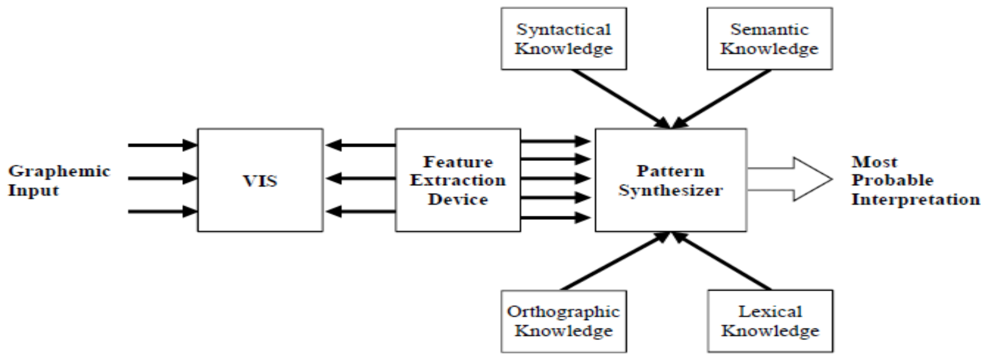
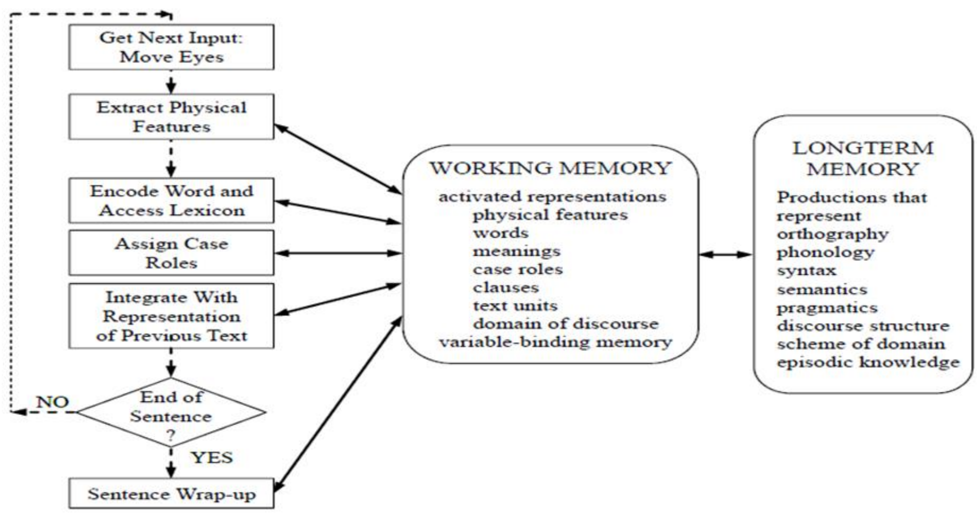


FIGURE 2

Just and Carpenter's (1980) Interactive Model of Reading

(Just & Carpenter, 1980, p. 331)



Finally, Stanovich (1980) developed the interactive-compensatory model, which accounts for individual differences in reading based on the assumption that various component skills of reading can play a compensatory role. In this model, "…process at any level can compensate for deficiencies at any other level" (Stanovich, 1980, p. 36). Thus, according to Stanovich (1980), poor readers who lack lower-level processing skills may depend more on higher-level skills to make up for their deficiencies. He argued further that considering the limited cognitive capacity, rapid and automatic lower-level processes can lead to successful reading comprehension by leaving more memory capacity for higher-level processing.

Although the interactive models outlined above detail the reading process in slightly different ways, what they have in common is that both lower- and higher-level processes are considered essential for adequate reading comprehension. Neither skillful decoding nor guessing alone can lead to the development of skilled reading. Given that these interactive models explain reading process most comprehensively and thoroughly, this study adopted the interactive perspective as the basis for the investigation of reading comprehension.

2.2 Lower- and Higher-Level Processes in Reading

Reading comprehension is a "feat of balancing and coordinating many abilities in a very complex and rapid set of processes that makes comprehension a seemingly effortless and enjoyable activity for fluent readers" (Grabe & Stoller, 2011, p. 23). Readers process numerous kinds of information obtained through two fundamental reading processes: lower and higher-level processes.

2.2.1 Lower-Level Processes in Reading

Fluent readers process lower-level components rapidly and automatically. According to Grabe and Stoller (2011), these processes include three distinctive components: word recognition, syntactic processing, and semantic proposition encoding.

Word recognition, also called *word identification*, refers to the ability to process visual symbols in print using phonological information and recall their meaning from a mental lexicon (Nassaji, 2014). Although in some literature, the term *word* decoding, which is the ability to translate printed forms into spoken forms, is equated with word recognition, it may not necessarily accompany meaning activation or *lexical access*, i.e., the match between the word forms processed and their semantic representation (Grabe, 2009). In fact, according to Schwanenflugel and Ruston (2008), even some L1 readers may not access a word's meaning while they are reading aloud with phonological and orthographic information activated. In addition, Haynes and Carr (1990) and Shiotsu (2009) found that lexical access contributed uniquely to reading comprehension when word decoding ability was controlled. Thus, as one cannot exclude the possibility that encoding a word does not lead to accessing the word's meaning, especially in the EFL context, this study distinguished lexical access skill from word decoding skill.

The word recognition has been discussed by many researchers as a foundation of reading and, in particular, rapid and automatic word recognition has been regarded as a strong predictor of L1 and L2 reading comprehension (Adams, 1990; Just & Carpenter, 1987; Kang et al., 2011; Perfetti, 1985, 2007; Rayner, 1998; Rayner & Pollatsek, 1989). Thus, fluent readers are faster and more accurate in word decoding and lexical access than are less skilled readers (Bell & Perfetti, 1994; Hannon & Daneman, 2009). As for the sub-components of word recognition, much of the current research seems to assume that phonological and orthographic processing skills are the most critical facilitative components of it (e.g., Coltheart, 2006; Grabe, 2009; Perfetti, 1985; Stanovich, 2000; Vellutino, Scanlon, & San Chen, 1995).

Phonological processing skills refer to the ability to use “the speech code to store and retrieve information” (Vellutino et al., 1995, p. 48), which involves the process of converting orthographic patterns into phonological codes (Manis, Szeszulski, Holt, & Graves, 1990). Abundant evidence suggests that phonological processing skills play a preeminent role in word identification (Van Orden & Kloos, 2005), and further, substantial empirical evidence has supported the contribution of phonological processing to reading comprehension (e.g., Adams, 1990; Share & Stanovich, 1995; Snowling, 2000; Stanovich & Siegel, 1994). For example, a longitudinal study conducted by Wagner, Torgesen and Rashotte (1994) found that phonological processing abilities were related causally to the acquisition of beginning reading skills, and Rack, Snowling, and Olson (1992) contended that deficits in phonological processing can potentially cause reading dyslexia.

On the other hand, with respect to orthographic processing skills, another major cue used in the word recognition process, there seems little consensus about how to conceptualize the skill. For example, some researchers have defined orthographic knowledge as the individual's conventional knowledge of spelling patterns (e.g., Conrad, 2008; Perfetti, 1985), while others have used the term to indicate the mental representations of specific words (e.g., Apel, 2010; Rosenthal & Ehri, 2008), or the skills used to recognize words directly without phonological mediation (Stanovich, 2000). Stanovich and West (1989) defined the term from a broader perspective as "the ability to form, store, and access orthographic representations" (p. 404). Nevertheless, despite the lack of unanimous agreement on the definition, considerable studies have provided evidence that orthographic processing is activated during word recognition (Barron, 1994; Jakimik, Cole, & Rudnicky, 1985), and that it is a critical skill in reading comprehension (e.g., Baker, Torgesen, & Wagner, 1992; Cunningham, Perry, & Stanovich, 2001; Cunningham & Stanovich, 1991; Juel, Griffith, & Gough, 1986). For example, Sabet and Ostad (2016) found that enhancing a student's orthographic knowledge improved the reading comprehension of EFL learners significantly.

Several decoding models have been suggested to explain the way in which these two processing skills operate in word recognition. One of the most popular word recognition models, the Dual Route Model, posits two underlying processes: the indirect phonological decoding route and the direct lexical route (e.g., Coltheart, 2000, 2005, 2006; Daneman & Reingold, 2000; Paap, Noel, & Johansen, 1992). According to this model, when readers encounter unfamiliar words, they may rely more on the indirect route (or nonlexical / prelexical route), segmenting string of letters into graphemes, converting the graphemes to sounds using grapheme-phoneme correspondence rules, and establishing a phonological representation of the word. However, when readers encounter words they have practiced and stored in their mental lexicon already, they access their mental lexicon directly through the orthographic representation of words without the mediation of phonological information (Coltheart, 2005; Dehaene, 2010; Olson, Forsberg, Wise, & Rack, 1994; Van Orden & Kloos, 2005).

On the other hand, another explanation of the word recognition process stresses the existence of an intimate interaction between phonological and orthographic information even in the word recognition process of skilled readers (e.g., Frost, 1998; Seidenberg, 2005). These authors assume that phonological computation is mandatory in word recognition, and the differences between skilled and less skilled readers lie in the size of the letter clusters that are converted into phonemes and the speed of the conversion process (Baker et al., 1992). Thus, skilled readers can translate larger orthographic units into phonemic clusters rapidly, and during the process, they may not be aware of the retrieval of the pronunciation due to its enormous speed, while less proficient readers may map graphemes onto phonemes consciously in a slow, one-to-one manner (Dehaene, 2010).

As discussed, word recognition is a complex activity that involves various subcomponent processes, and there is still considerable controversy about which model provides the most appropriate explanation for the word recognition process.

In addition to word recognition skills, syntactic processing skills are obligatory in constructing sentence-level meaning. As Ur (1998) stated, unless one knows how to put words together and how to extract the relationship between them, one cannot compose meaning. In particular, syntactic parsing skills, which refer to the ability to chunk a sentence into meaningful units, allow readers to give selective attention to the units and reduce the processing time considerably (Kim, 2007, 2010). Fluent readers predict the following segments using syntactic knowledge, such as “phrasal groupings, word ordering information, subordinate and superordinate relations among clauses” (Grabe & Stoller, 2011, p. 16), and this ability has been demonstrated to have a positive effect on reading comprehension (e.g., Cain, 2007; Verhoeven, 2000). In addition, Lim and Godfroid (2014) demonstrated empirically that syntactic parsing time is reduced as reading proficiency increases, which highlighted the significance of automatic or rapid processing of syntactic information.

Lastly, lower-level processing involves encoding meaning proposition, i.e., extracting information from words and structures to build clause-level meaning units (Grabe, 2009). The literal meaning of text is an extension of a series of propositions that are based on word meanings and relationships between words. Those semantic propositions are meaningful units of language, as researchers have shown that the number of meaning propositions, rather than the number of words and clauses, accounts for differences in processing time (Kintsch, 1998; Perfetti & Britt, 1995; Perfetti, Landi, & Oakhill, 2005). In addition, information recall occurs on the basis of semantic proposition units. Fluent readers construct meaning propositions as soon as they recognize words and notice grammatical cues, which allows them to connect meaning elements with what they have read before. This process of semantic proposition formation occurs automatically among fluent readers, unless the meaning does not seem to match the text (Grabe & Stoller, 2011).

These three components of lower-level processing are considered essential building blocks for sentence-level meaning construction, i.e., elements without which text comprehension cannot occur. However, one caveat is that this lower-level processing alone may not lead to successful text comprehension. A mental model of the text can be built by integrating other information that has nonpropositional formats. Thus, information gained through inferencing and background knowledge may be required as well, which is discussed briefly in the next section.

2.2.2 Higher-Level Processes in Reading

In addition to forming clause-level meaning, readers engage in a higher-level process during which they interpret the text meaning using their background knowledge and inferencing skills. They also read with some established purpose, monitor their comprehension, and adjust either their reading strategy or reading goal (Grabe & Stoller, 2011). Grabe and Stoller (2011) presented four fundamental processes included in higher-level processing: (1) text model of comprehension; (2) situation model of reader interpretation; (3) background knowledge use and inferencing, and (4) executive control processes.

In the text model of comprehension, the established clause-level meaning units are integrated into an ongoing network of ideas obtained from the textual input, during which simple inferences are required to make the mental text coherent. In this process, “the most strongly activated information reflects the central ideas at that point in the reading,” (Grabe, 2009, p. 40) and readers grasp the gist of a text from the set of main ideas. Thereafter, based on mental models of the text, readers integrate text-based information with their prior knowledge and interpret it according to their attitudes, purposes, feelings, and motivation (i.e., the situation model of reader interpretation). That is, readers who understand the text without great difficulty may interpret it in their own way, as well as understand what the writer is trying to say (Kintsch, 1998; Zwaan & Radvansky, 1998). Therefore, in constructing the two models of higher-level processes aforementioned, both prior knowledge and inferencing play significant roles. Finally, according to Grabe and Stoller (2011), readers also engage in executive control processing, as they monitor their comprehension, apply and adjust reading strategies, and address and solve difficulties.

Given that the higher-level process of reading comprehension involves such complex and important sub-processes, some individual differences in L1 and L2 reading ability can be attributed to differences in readers’ ability to engage in higher-level processing (e.g., Hannon & Daneman, 2001, 2009; Kintsch, 1998; Lee, 2014). For example, Hannon and Daneman (2001) showed that higher-level processes account for substantial variance in the reading comprehension of skilled readers, which is consistent with the results of Jackson and McClelland (1979) and

Graesser, Singer, and Trabasso (1994). However, it is noteworthy that accurate and automatic lower-level processing, which has been neglected in EFL contexts, is as important as is higher-level processing. In fact, successful reading comprehension is unlikely to occur unless readers negotiate the sentence-building process successfully.

2.2.3 Significance of Lower-Level Processes in Reading

According to the information-processing perspective of reading, both lower- and higher-level processing operate independently and in parallel. Although these two different processes interact in reading comprehension, higher-level processes do not direct those at lower levels (Nassaji, 2014; Stanovich, 1980). Thus, the operation of lower-level processes does not depend on higher-level processes, and proficient predictors are not necessarily good decoders. Instead, each level of processing "seeks to synthesize the stimulus based on its own analysis and constraints imposed by both higher- and lower-level processes" (Stanovich, 1980, p. 35). Consequently, to become a fluent reader, one must be able to process incoming textual input accurately and efficiently (Carr & Levy, 1990; Just & Carpenter, 1980, 1987; Nassaji, 2014; Perfetti, 2007; Rayner & Pollatsek, 1989; Stanovich, 1980, 2000).

This information processing view rests on the assumption of limited cognitive capacity, which supports the need for high competency in lower-level processing. According to this assumption, the limited amount of information that can be processed in working memory can pose obstacles to information processing; accordingly, “the language-processing mechanism should include an efficient cognitive component that can process the incoming data within attentional limits” (Nassaji, 2014, p. 4). Specifically, in reading comprehension processes, if a reader puts all his/her attention on lower-level comprehension processes (e.g., word recognition), little working memory and attention will remain unused. Then, the higher-level processing required for interpretation cannot be performed simultaneously, resulting in incomplete reading comprehension. As noted by Rasinski (2012), many readers, especially novices, have difficulty making sense of text because all of their available cognitive resources are devoted to word recognition. This implies the preeminent contribution of efficient lower-level processing to skilled reading. Thus, as suggested in LaBerge and Samuels’s (1974) automaticity view of reading, to comprehend text fully, the amount of working memory required for word recognition needs to be decreased by making the process automatic, so that the resources remaining can be used for other processes.

In the analysis of the relationship between features of eye fixation and those of the text, Just and Carpenter (1980) provided empirical evidence that corroborated the necessity of efficient lower-level processing. Monitoring eye movements of 14 L1 college students who were reading short passages demonstrated that readers almost never skipped more than two words. The subjects, all fluent readers, read almost 80% of the content words and 40% of the function words. These results suggest that guessing is not a major tool used to extract information, and that a lack of decoding skills can be detrimental to reading comprehension, especially for poor readers (Hoover & Gough, 1990). Furthermore, Rayner (1998) revealed that readers depend on the visual information in words, even if they can predict the words easily using contextual information. Most words are recognized before cues obtained from higher-level processes influence the word recognition process.

This theoretical and empirical evidence has laid the foundation for further studies in the field of reading research. As a result, more direct empirical support has begun to emerge, which is discussed in the following section, although the studies that address the contribution of lower-level processing components in reading comprehension still seem scarce, and some results are contradictory (Koda, 1992; Perfetti & Stafura, 2014).

2.3 Previous Empirical Studies on the Relationship between Lower-Level Processing Skills and Reading Comprehension

As discussed in the previous section, reading comprehension necessitates the combination of a range of sources. It requires multiple layers of processes to operate simultaneously, and its complex nature of reading has made it difficult to identify the sources of individual differences in reading performance. Given this context, several researchers have attempted to examine the potential factors that affect L1 reading comprehension (e.g., Carr, Brown, Vavrus, & Evans, 1990; Cunningham et al., 1990; Shankweiler et al., 1999).

For example, Carr et al. (1990) constructed cognitive skill maps with fifteen components that contributed to the differences in 34 children's L1 reading efficiency and found that word recognition, associated closely with phonological translation, contributed significantly to reading comprehension efficiency when age was controlled. Shakweiler et al.'s (1999) analysis of the performance of 361 L1 children between 7.5 and 9.5 years of age also demonstrated that non-word and word reading are correlated strongly with reading comprehension (r=.79 and .89, respectively). Thus, combined with the earlier findings that showed a strong relationship between word recognition and reading ability in children (e.g., Perfetti, 1985; Stanovich, 1982), these studies supported the assumption that lower-level processes contribute significantly to L1 reading comprehension. Accordingly, this has encouraged more researchers to take interactive approaches with "a strong bottom-up orientation to the processing of lower-level linguistic structure" (Grabe, 1991, p. 384). Thus, currently, more and more L1 scholars and L2 scholars who assumed L2 students would have difficulties in lower-level processing as well due to their limited exposure to L2 reading have begun to attend to lower-level processing.

However, research concerned with the relationship among components of lower-level processes has produced inconsistent results. For example, with respect to the relationship between phonological and orthographic knowledge, some authors have contended that the two skills are intertwined closely, as suggested in the connectionist model, such that phonemic awareness and phoneme-grapheme conversion ability may provide the foundation for orthographic skill development (e.g., Caravolas, Hulme, & Snowling, 2001; Ehri, 1992; Share, 1995; Snowling, 2000; Perfetti, 1992).

According to Ehri (1992), as readers become more accustomed to forming the connections between graphemes and phonemes based on their grapheme-phoneme correspondence knowledge, they can remember a greater number of sight words easily. Thus, according to this supposition, the correct mental image of a specific word (i.e., orthographic knowledge) should be related closely to the accurate grapheme-phoneme conversion rules (i.e., phonological knowledge). Similarly, Perfetti (1992) also contended that skilled readers develop “autonomous” lexicons with fully specified lexical representation, and what may preclude accumulating the autonomous lexicon is inadequate speech codes (p. 162).

On the other hand, as the Dual Route Theory predicts, there is considerable evidence that these two skills are independent, as phonological processing skills alone cannot account for all the variance in word recognition. Orthographic knowledge can account for the unique variance in reading ability when phonological processing skills are controlled (e.g., Baker et al., 1992; Cunningham & Stanovich, 1991; Stanovich & Siegel, 1994; Stanovich & West, 1989; Stanovich, West, & Cunningham, 1991; Wagner & Baker, 1994). In addition, Cunningham and Stanovich (1991) and Cunningham et al. (2001) provided support for the unique contribution of orthographic processing skills by indicating that the ability to “encode, store and retrieve orthographic representations” (Rathvon, 2004, p. 93) can account for the individual differences in reading ability when print exposure and phonological skills are partialled out. Based on these contradictory results, many researchers today seem to assume that phonological processing skills and orthographic skills are statistically independent but conceptually associated skills (Berninger & Abbott, 1994; Foorman, 1994).

Similarly, the exact process by which the syntactic information in lower-level processing is used has not yet met with consensus (Grabe, 2009; Nassaji, 2014). However, most of the evidence available currently seems to indicate that fluent readers engage in syntactic processing after rapid word recognition occurs especially when considering the processing time necessary for fluent word recognition (Grabe, 2009; Nassaji, 2014; Seidenberg, 2005; Stanovich, 2000; Perfetti, 2007). In addition, some researchers have suggested that inaccuracy and inefficiency in syntactic parsing skills may arise from deficient or inefficient word recognition skills (Miyake, Carpenter, & Just, 1994; Perfetti et al., 2005).

However, based on the current literature review, few studies in Korean contexts have investigated the relationships among components of lower-level processing due to the relative lack of attention to lower-level processing overall. Nonetheless, without appropriate understanding of the components of lower-level processing, it would be difficult to embed them in the curriculum properly and effectively.

With respect to the relationship between lower-level process and reading comprehension, there have been several attempts to determine the relative contribution of components of lower-level processing to reading comprehension in L1 contexts. For example, Roman, Kirby, Parrila, Wade-Woolley, and Deacon (2009) conducted a study with Canadian students in grades 4, 6, and 8 to identify the unique effect of four variables in L1 reading comprehension, including morphological, phonological, orthographic knowledge and naming speed. The results showed that among the variables, orthographic knowledge contributed most strongly to reading. The results also suggested that older students tend to depend more on orthographic knowledge as they acquire more irregular words and read words by sight (Sabet & Ostad, 2016). Similarly, Muter and Diethelm (2001) measured the relative roles of orthographic and phonological knowledge in the reading comprehension of 46 children. According to their results, regardless of the children’s linguistic background (either L1 or L2), alphabetic knowledge was the strongest predictor of reading comprehension, followed by phonological segmentation abilities; in contrast, rhyming ability was not correlated with reading comprehension.

Kirby et al. (2003) conducted a 6-year longitudinal study with 79 children to explore the factors that contribute to L1 reading comprehension. The children took annual phonological tests including sound elision, isolation, phoneme blending, and word naming and reading comprehension tests. The authors documented interesting developmental change in the effects of the variables, in that, as the children became second graders, their word-naming speed became a more powerful predictor of reading comprehension than phonological awareness ability, a stronger contributor previously. Nonetheless, to provide pedagogical implications, further research is required as there remains no consensus with respect to the factors that underlie rapid word naming ability (Rathvon, 2004).

In contrast, several studies have demonstrated a weak correlation between lower-level processing skills and L1 reading comprehension in relatively skilled readers (e.g., Gough, Hoover, Peterson, Cornoldi, & Oakhill, 1996; Jackson, 2005; Landi, 2010). For example, a study conducted by Rupley, Willson, and Nichols (1998) on 1,085 elementary school students showed a decreased association between word recognition and reading comprehension ability at grades 5 and 6, although the two variables were correlated strongly in younger students. Instead, for those students, cognitive ability was found to contribute more significantly to reading comprehension.

Similarly, in a study that examined the significant variables affecting the L1 reading ability of American university students, Landi (2010) measured decoding, language exposure, spelling, non-verbal IQ, vocabulary, and reading skills. According to the results of regression analysis and Principal Component Analysis, print exposure experience had a strong relationship with both vocabulary and reading comprehension, while word decoding skills were correlated only weakly with reading comprehension ($r=0.09$).

Based on these studies, which have demonstrated the relatively weaker power of lower-level processing to predict L1 reading comprehension with increasing age, one might argue that lower-level processing skills are less significant for skilled readers. However, it may be too hasty to reach such a conclusion. Rather, as noted by Nassaji (2014), this may indicate that skilled readers are sufficiently proficient to process words rapidly and automatically, such that lower-level processing skills themselves do not cause individual differences among skilled readers. In addition, several previous studies have suggested that lower-level processing skills are still important, even for skilled L1 readers (e.g., Cunningham et al., 1990; Holmes, 2009).

For example, to identify the relationship between word recognition sub-processing skills and reading achievement in proficient L1 readers, Cunningham et al. (1990) conducted an extensive study that examined the reading performance of 76 college students. They used a battery of tests, including a working memory span task, a letter-matching task, a naming task, a listening comprehension test, a vocabulary test, and the Nelson-Denny Reading Test. A confirmatory factor analysis categorized the variables into three principal factors: global verbal comprehension factors, word recognition factors, and reading ability factors; the correlation between word recognition factors and reading ability factors was found to be as strong as .80.

More recently, Holmes (2009) conducted a study based on the assumption that the relationship between word recognition and text reading abilities in highly experienced readers might derive in part from skills related to discriminating unfamiliar shapes. In the study, 76 native English speaking undergraduate students performed a series of tasks (orthographic and phonological decision tasks, letter-name matching task, letter-shape matching task, character discrimination task, and the Nelson-Denny Reading Test), and the analysis demonstrated a substantial correlation between lower-level processing skills, especially orthographic decision skills and passage reading efficiencies. Although the magnitude of the association (r=0.60) was not as high as previous estimates for younger, less-skilled readers (e.g., Badian, 2005; Shakweiler et al., 1999), Holmes' (2009) results still proved that lower-level processing can play a vital role in the reading comprehension of advanced readers.

In summary, the studies reviewed above show that, despite inconsistences in the results pertaining to skilled readers, high correlations between word recognition skills and reading comprehension were observed in young L1 readers. Thus, it appears that deficiencies in word recognition skills might be detrimental to L1 reading comprehension, and one may expect similar effects on L2 students based on the assumption that their word recognition skills are less developed than are those of L1 students. However, it should be remembered that “simply applying the findings from L1 word recognition research to the case of L2 readers is often insufficient and even inadequate, since the nature of L2 reading developments is often quite different from that of L1” (Shiotsu, 2009, p. 16). Most L1 readers start to read texts after they have reached a certain level of oral language proficiency. However, L2 readers tend to engage in reading prior to achieving grammatical maturity or oral language fluency. Thus, L2 reading processes are rather different from the reading process in which L1 readers are involved.

In this context, Haynes and Carr (1990) investigated the effects of orthographic processing and lexical semantic processing skills on L2 reading abilities of Taiwanese EFL learners. The authors employed a series of tests, including five kinds of timed same-different matching (numbers, words, pseudowords, letter strings, and synonym/antonym), timed reading, listening, vocabulary, grammar, and L1 reading tests. The results suggested that while listening comprehension was the most powerful predictor of L2 reading comprehension, lexical semantic access efficiency, measured by the synonym-antonym matching test, was the best predictor of passage reading speed. Shiotsu (2009) used the same variables in his study of 219 Japanese EFL students and found similar results, which indicated that efficiency in accessing meaning had explanatory power in L2 reading comprehension ability when word decoding efficiency was partialled out.

Nassaji (2003) also explored the factors that discriminate skilled and less-skilled L2 readers using diverse variables and measured the phonological, orthographic, and syntactic processing, vocabulary, and L2 reading comprehension skills of 60 adult ESL readers (graduate students at a Canadian university whose L1 was Farsi). The results revealed that all variables were correlated at least moderately with reading comprehension. Specifically, word recognition and reading had correlation of .53 and orthographical skills were related to reading slightly more strongly by comparison to phonological skills. In addition, syntactic knowledge had a correlation of .44. These findings are congruent with the author's earlier study, which also demonstrated that fluent lower-level processing skills could have a significant effect on reading comprehension and reading rate (Nassaji & Geva, 1999).

In the Korean context, Kang et al. (2011) studied the relative contribution of L2 decoding and listening comprehension skills to L2 reading comprehension in 99 5th grade Korean students. The study was conducted using the Gates-MacGinite Reading Test for decoding and reading comprehension; the authors also designed a listening comprehension test. The results of regression analyses showed that decoding ability was a better predictor of text reading ability than listening ability, although the latter also demonstrated a moderate correlation with reading ability. Interestingly, however, despite the significant effects of decoding abilities on reading, only 60% of the decoding test items were answered correctly in the study, which highlights the need for more attention to the phonological aspects in L2 reading curricula.

In contrast, a study by Kang (2013) that targeted 96 Korean high school students yielded rather different results, in which listening ability was found to be a strong predictor of L2 reading, while decoding ability was insignificant in reading comprehension when considered together with listening ability. Although this result seems to be consistent with some earlier findings (e.g., Jackson, 2005), to generalize the results and provide pedagogical implications, further studies need to be conducted, because this study included only students who had no particular difficulty in decoding, so most of the participants can be assumed to have already developed adequate decoding skills.

It is true that the relationships between lower-level processing skills, especially word recognition, and reading comprehension have been investigated by many researchers in the L1 context, which has been paralleled by a growing number of recent studies addressing lower-level processing in L2 contexts. Nevertheless, an extensive literature review suggested that only a few studies in the Korean context have focused on lower-level skills. Languages differ in their orthographic, phonological, morphological, and syntactic systems and demonstrate “cross-linguistic variations” (Nassaji, 2014, p. 16), such that the properties of L1 linguistic features could affect the development of L2 lower-level processing skills and strategies (Abu-Rabia & Siegel, 2002). Thus, further and more thorough research is needed in the Korean context. In addition, previous studies have tended to adopt a narrow definition of lower-level processing, regarding lower-level processing only as word recognition or phonological decoding skills. Thus, it still remains difficult to achieve a full picture of the relationships among sub-skills of lower-level processing and reading comprehension and their relative contributions to reading comprehension. Furthermore, most studies have targeted kindergarten or elementary school students, even though there seem to be many L2 high school students who are not skilled at word-level processing in reading (Koda, 2007). Thus, studies conducted on high school students seem to be necessary.

Therefore, based on the literature review outlined above, this study followed Grabe (2009) and adopted a holistic view of lower-level processing skills. The study examined a wide variety of skills, including semantic access, syntactic parsing, phonological and orthographic skills and investigated the relationships among them. In addition, to identify the possible causes of L2 reading problems in high school students at different levels of L2 proficiency, this study also examined the degree to which those skills predict L2 reading comprehension depending on L2 proficiency levels to provide pedagogical insights for L2 reading classrooms with the goals of improving reading instruction and practical teaching methodologies.

CHAPTER 3.
METHODOLOGY

This chapter outlines the research method used in the study. Section 3.1 describes the participants, and Section 3.2 introduces the instruments and materials used. The data collection procedure is presented in Section 3.3 and finally, Section 3.4 describes the data analysis methods briefly.

3.1 Participants

The participants in this study were 213 Korean 10th grade high school students attending the same public girls' high school in Seoul, South Korea. The students were from 8 intact classes (n=242). 20 students who had studied in English-speaking countries for more than a year and 9 students who did not complete the tasks were excluded from the sample.

The students had studied English as a foreign language for at least 8 years as part of their regular school curriculum, and all students had engaged in four, 50-minute intensive reading classes a week in the Korean high school EFL setting. Through teacher-led instruction, the classes address primarily linguistic knowledge using passages from the English textbook, High School Practical English I. In addition, once a week, the students read 3 short passages (shorter than 200 words) and answer reading comprehension questions to prepare for the CSAT (College Scholastic Aptitude Test).

All students in this school took the Nationwide Sample Test (NST)[1] in March, 2016, Their grades were organized from 1st to 8th grade out of 9 grades[2] and the average grade of the students was between 3rd and 4th grade.

3.2 Instruments

To investigate the relationships between lower-level processing skills and reading comprehension, five tasks were introduced. Specifically, the instruments consisted of four tasks that measured the major components of lower-level processing, i.e., phonological and orthographic processing, semantic access, and syntactic parsing, and one reading comprehension task. Although meaning proposition encoding skill is also a critical element of lower-level processing, the relationship between this skill and other variables was not investigated in this study, as the skill is based on word recognition and syntactic parsing skills, so there might be a collinearity effect (Perfetti et al., 2005).

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1 The test was designed to prepare high school students for the CSAT in Korea. The test, which is assumed to assess the student's overall English competence, consists of 17 listening comprehension questions and 28 reading comprehension questions.

2 The cut-off scores of 1st-9th grade of NST are as follows.

Grade	1st	2nd	3rd	4th	5th	6th	7th	8th
Minimum Raw Score	90	80	70	60	50	40	30	20

3.2.1 Phonological Processing Task

The ability to segment phonemes and match graphemes with phonemes using grapheme-phoneme correspondence rules is regarded as a good predictor of word recognition (Ehri, 1992; Rathvon, 2004; Vellutino, Scanlon, & Tanzman, 1994). This phonological processing ability is known to be accessed by a pseudoword reading task, given that pseudowords have “no lexical entry” (Rathvon, 2004, p. 138), so that phonemic segmentation skills and grapheme-phoneme correspondence rules are necessary to pronounce them correctly (Bowers, Golden, Kennedy, & Young, 1994). Although asking students to pronounce the words and assessing their accuracy would be ideal, because of practical constraints, this study measured the processing ability indirectly using phonetic symbols.

In designing the task, the following were considered to minimize the influence of external variables. First, to avoid the possible interference of knowledge related to phonetic symbols, whether students had appropriate knowledge of the phonetic signs was confirmed in the following ways: 1) examining the class curriculum; 2) interviewing the teachers in charge informally, and 3) asking students to match phonetic symbols with alphabetic representations in the pilot study. Secondly, the task included only pseudowords, as a test composed of real words may measure the amount of print exposure, rather than phonological decoding ability (Rathvon, 2004). Although some students might use analogies to read pseudowords, segmentation skills and grapheme-phoneme conversion rules are still necessary to read a pseudoword correctly (Siegel, 1998).

In the task, a pseudoword (e.g. *bix*) was presented with two phonemic representations (e.g. 1. /*bɪk*/, 2. /*bɪks*/), one of which is correct pronunciation of the stimulus. Thereafter, students were asked to press either key 1 or 2, as quickly and accurately as possible, to choose which phonemic representation matched the given stimulus. As soon as they answered the question, the students were asked to press the space bar to move to the next page. If no response was made within 7 seconds, the display was removed automatically, and the next trial appeared. The task began with three practice trials, after which 30 sets of words were presented (see Appendix 1). The total number of correct responses and response latencies were measured using the DMDX program.

3.2.2 Orthographic Processing Task

The orthographic processing task was designed to measure "word-specific representation stored in memory" (Berninger, 1994, p. 5), as the sensitivity to specific letter patterns is a strong indicator of one's orthographic knowledge (Bowers et al., 1994; Dreyer, Luke, & Melican, 1995). Therefore, the pseudohomophone choice task used in several previous studies (e.g., Barker et al., 1992; Olson et al., 1994; Lee, 2014; Sabet & Ostad, 2016) was chosen, given that Hagiliassis, Pratt, and Johnston (2006) found this task could assess one's orthographic processing ability with little extraneous phonological operations.

The task was adapted by considering the following. First, to minimize the use of phonological processing skills, a pair of words was constructed to sound identical, so that students could rely only on their memories of the word-specific orthographic pattern of the target words (Hagiliassis et al., 2006). In addition, the tasks included exceptional words (i.e., words with irregular spelling patterns), so that the response would be based on orthographic knowledge rather than spelling-sound translation rules. Second, to reduce the influence of vocabulary knowledge on the measurement of orthographic processing skills, target words were selected based on the following criteria: (1) the words were included in the 2009 Revised National Curriculum; (2) they were included in Fry's (2000) 1000 high-frequency words, and (3) they were within student's vocabulary range to ensure that the task measured the students' orthographic skills, not the breadth of their lexical knowledge (Willows & Geva, 1995).

In this task, a pair of words was presented on the computer screen, one of which was a real target word, while the other was a pseudohomophone of the target word (e.g., 1. *rain*, 2. *rane*). The students were informed that the two written forms are pronounced identically. Then, they were requested to press either key 1 or 2 to indicate which letter string was a real word in English and then press the space bar to move to the next page within 7 seconds. As in the phonological processing task, 30 pairs of trials followed three practice trials (see Appendix 2). The response time and the number of correct answers were recorded through the DMDX program.

3.2.3 Semantic Access Task

This task was developed to estimate the speed required to access lexical meanings. Thus, this study used a synonym/antonym matching task adapted from Haynes and Carr (1990) and Shiotsu (2009). Because the purpose of this task was not to evaluate students' word knowledge, but to measure their efficiency in accessing the meanings of familiar words, the words were selected based on the following two standards: (1) the words appeared in the 2009 Revised National Curriculum, and (2) they were within the students' vocabulary range.

In the task, the students were given 30 sets of items after three practice pairs and asked to decide within 7 seconds whether the words were synonyms or antonyms. For example, if two words were synonymous (e.g., 1. *over*, 2. *under*), the students were asked to press key 1; if not, they pressed key 2. The students were required to complete the task as quickly as possible and to press the space bar to go on to the next page immediately after choosing their answers (see Appendix 3). The responses and response times were recorded using the DMDX program.

3.2.4 Syntactic Processing Task

To measure syntactic parsing skills, a sentence construction task was adapted from Hulstijin, Van Gelderen and Schoonen (2009) and Lim and Godfroid (2014). This task required students to use word order information to predict the word that would follow a given phrase. In the pilot study, this task proved to be correlated highly with another, more direct syntactic parsing task, which asks the students actually to chunk the sentences into meaningful units (r=.81). In developing the task, to partial out the possible effects of semantic knowledge, the stimulus was kept simple; the sentence fragment did not include more than 4 words, and each option constituted one or two words. In addition, the same criteria were used as in the lexical access task to ensure the familiarity of the words used in the stimulus.

In this task, the first part of a sentence (e.g., *Jane's cat*) was presented on the screen for 5 seconds, and the students were asked to read the sentence fragment. Thereafter, two options (e.g., 1. *is* 2. *cute*) were displayed below the stimulus, so that students could choose the words most likely to complete the stimulus sentence. After giving their response, the students were asked to press the space bar to move to the next page within 7 seconds. The task consisted of 30 items with three additional practice trials, and to estimate the accuracy and efficiency of the syntactic processing skills, both responses and response times were measured through the DMDX program (see Appendix 4).

3.2.5 L2 Reading Comprehension Test

The reading comprehension test was adapted from the reading comprehension section of the TOEFL JUNIOR trial test, which was developed to prepare for a standardized test of the English proficiency of middle and high school students. This test was chosen for the following two reasons: (1) the topics of the passages do not require specific background knowledge, and (2) in general, the passages were assumed to be at an appropriate linguistic level for the students, whose average Lexile score[3] was 752. The original test consists of six passages with forty-two questions, but here the test was simplified because of possible interference effects caused by lack of attention, given that most students were not accustomed to answering over forty reading comprehension questions at one time.

Thus, the students were provided with five reading passages, three non-academic and two academic texts, followed by 30 multiple-choice questions. Each passage ranged from 180 to 420 words, and their Lexile measures varied from 700L to 1100L. The test included various types of questions that measure skills such as finding a main idea, making a conclusion, inferencing, and finding details in the passage; each question included four answer options (see Appendix 5). The students were asked to read the passages and answer the questions within 40 minutes. The test was administered in a paper and pencil format in a regular classroom, and one point was assigned for each correct answer, for a maximum score of 30.

3.3 Procedures

To develop appropriate tasks for the main study, pilot studies were conducted

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[3] The Lexile measure was developed by MetaMetrics® to represent an individual's reading ability (Lexile reader measure) and text readability (Lexile text measure) numerically. The Lexile reader score is measured through a reading comprehension test, while the Lexile text measure deals with the syntactic and semantic aspects of the text. The score ranges from below 0 Lexile to above 2000 Lexile.

two months before the main study. Thereafter, the main study was administered for two weeks to 213 participants who had not participated in the pilot studies.

3.3.1 Pilot Study

The pilot studies were conducted with 61 students from two intact classes who attended the same high school as those who participated in the main study. These students were assumed to have similar language competence as those in the main study, as the average scores on the NST for the two groups did not differ significantly ($F=.12$, $p=.81$). The study was conducted during two classes.

In the first study, students were given 150 words that were included in the 2009 Revised National Curriculum and were asked to mark the words that they did not know. As a result, 36 words that more than 6 students (10% of the total students) marked as unknown were excluded when developing the tasks for the main study. In addition, to assess the appropriateness of the word difficulty for the reading comprehension test, the same students were asked to answer the reading comprehension questions and underline any words they had not seen before. Then, using the data obtained from this study, passages and questions were chosen, and two words in the questions were replaced with words within their vocabulary range, while two words were given in a footnote.

In the second study, to confirm the validity of the phonological processing task, the students also were asked to match phonological symbols with graphic representations. In addition, 15 students chosen randomly were asked to sound out the phonological symbols to ensure that the students had no difficulty understanding the phonological symbols.

Thereafter, another pilot study was conducted to assess the validity of the syntactic parsing task. The students were given two types of the task. First, they were given a two-paragraph passage (200 words) that was adopted from Leslie and Caldwell (2006) and asked to chunk each sentence into meaningful units. The students' parsing skill was assessed using the scoring rubric developed by Kim (2010). For the second task, students were given the same syntactic processing task used in the main study, and the correlation between the results from the two tasks was calculated (r=.81).

As a final preliminary step, three native English speakers were asked to perform all the tasks used in the main study. One was from the Western U.S., another was from England, and the third was from India. Thus, having English speakers with quite different accents examine the tasks helped ensure that they were linguistically appropriate.

3.3.2 Main Study

A quasi-experimental research design was used to examine the relationships among the participants' reading-related components. The instruments were administered during two, 50-minute sessions, with a one-week interval between sessions. Before the experiment, the students were informed of the purpose of the study and the experiment began with a general introduction.

In Session 1, as described in table 3.1, the students participated in four tasks except the reading comprehension test using the DMDX program in a computer lab. The order of all component measures was counterbalanced, so that half of the students took the orthographic and syntactic processing tests before the phonological and lexical access tests, while the other half performed the tasks in the reverse order. Detailed explanations and practice trials were provided prior to each test, and then each task was conducted for approximately 5 minutes. During each task, the stimulus was displayed on the screen, and students were asked to press the answer key as quickly and accurately as possible. Before starting the next task, the students were given one-minute breaks to refresh themselves.

Table 3.1

Data Collection Procedures

Session	Task	Time (min)
Session 1	General Introduction	5
	Phonological Processing Task	10
	Orthographic Processing Task	10
	Lexical Access Task	10
	Syntactic Processing Task	10
Session 2	Reading Comprehension Test	40

Session 2 was administered to the same students one week later. The students received a package consisting of 5 reading passages and 30 related questions, asked to read each passage and then answer the questions that followed on the answer sheet provided. After 40 minutes, the researcher collected and scored all of the answer sheets.

3.4 Data Analysis

The study was designed to investigate the relationships between lower-level processing components and L2 reading comprehension. Specifically, the study was conducted to examine (1) the correlations among components of lower-level processing and L2 reading comprehension, and (2) the degree to which each component predicts L2 reading skills depending on the students' L2 proficiency.

To this end, the entire sample first was divided into two groups based on the students' raw scores on the NST. On the basis of the mean (70.12), those who obtained above 70 (3rd grade) on the NST were assigned to the high proficiency group, while those who scored less than 70 were assigned to the low proficiency group. There were 101 students in the high proficiency group and 112 students in the low proficiency group (Table 3.2). Although this did not guarantee that the two groups were totally heterogeneous, the range between the maximum and minimum scores was large enough (min=20, max=100), and as Table 3.3 shows, the results of a *t*-test demonstrated that there was a statistically significant difference between the two groups' NST scores ($F=120.64$, $p=.000$).

Table 3.2

Number and Percentage of Students in Each Group

	N	percent
Low Proficiency	112	53
High Proficiency	101	47
Total	213	100

Table 3.3

Differences between the Groups

	Groups	N	M	SD	*t*	Sig.
Raw Score of NST	Low	112	48.14	19.52	-19.562	.000
	High	101	87.83	7.35		

In addition, to analyze the efficiency and the accuracy of the students' lower-level processing skills, efficiency scores for each task were calculated using the formula "response time taken for correct answers / the number of correct answer," as the concept of efficiency involves both speed and accuracy (Grabe, 2009). On the other hand, to indicate the accuracy of processing skills, the number of correct answers out of 30 questions was used.

Then, to answer the first research question, Pearson product-moment correlation analyses were carried out to examine the relationships among variables with respect to accuracy and efficiency measurements. For the second research question, several *t*-tests were performed using SPSS v. 22.0 to demonstrate that the two proficiency groups performed differently on all of the tasks. Then, to identify the meaningful variables that explained L2 reading comprehension, stepwise regression analyses were conducted for each group, as this regression analysis is used commonly to “evaluate the order of importance of variables and to select useful subsets of variables entry” (Lewis, 2007, p. 2).

CHAPTER 4.
RESULTS AND DISCUSSION

This chapter describes the results of the statistical analyses and discusses the findings based on the research questions presented in Chapter 2. Section 4.1 reports the results of the correlation and regression analyses. Section 4.2 discusses the results.

4.1 Results

Section 4.1.1 presents the descriptive statistics for all the tasks used in the study, and Section 4.1.2 addresses the results related to the first research question, the relationships among a series of lower-level processing components and L2 reading comprehension. In Section 4.1.3, the results regarding the second research question are presented, the predictors of L2 reading comprehension depending on L2 proficiency level.

4.1.1 Descriptive Statistics

To investigate the relationships in the accuracy and efficiency of lower-order processes in reading and L2 reading comprehension, a series of lower-level processing tasks was administered, and the means, standard deviations and ranges of the scores, total response times and response times per correct answer were calculated and are presented in Table 4.1.

The table shows that among the four lower-level processing tasks, the mean score on the phonological processing task (m=24.43) was the lowest, followed by the syntactic processing task (m=24.67) and the orthographic processing task (m= 25.37), while the highest percentage of correct answers was found on the semantic access task (m=27.60).

With respect to the total response time, the students tended to spend most time on the syntactic processing task (m=110.5 seconds) and the least time on the lexical access task (m=75.07 seconds). However, it is implausible to compare the means of the response times between these tasks because of task-related variables, such as the number of words in each question and the length of the stimuli (Rathvon, 2004). In addition, the total response time may not truly measure efficiency, which is a concept based on both speed and accuracy. In other words, it was not the goal of this study to analyze the processing efficiency of incorrect trials (Lim & Godfroid, 2014).

Thus, the efficiency values were calculated by dividing the response time for correct trials by the number of correct answers. Similar to the results from the comparison of the total response time, the students processed the lexical access task most efficiently (m=2.86) and the syntactic processing task least efficiently (m=4.92). On the other hand, although the means of the total response times in the phonological and orthographic processing tasks were similar (m=107.2, 108.3 respectively), when considering only the response time per correct trial, students tended to spend less time on the orthographic task (m=3.67) than on the phonological task (m=4.52). Finally, on the reading comprehension task, the students answered an average of 16.63 out of 30 questions correctly.

Table 4.1

Descriptive Statistics of the Component Variables

		N	Min.	M	SD	Max.
Phonological processing	Accuracy	213	13	24.43	2.74	30
	Response time	213	56	107.2	19.16	156
	Efficiency	213	1.4	4.52	1.16	9.85
Orthographic processing	Accuracy	213	13	25.37	3.78	30
	Response time	213	43	108.3	23.05	160
	Efficiency	213	1	3.67	1.59	12.30
Semantic access	Accuracy	213	12	27.60	3.84	30
	Response time	213	30	75.07	18.77	150
	Efficiency	213	0.9	2.86	1.24	9.17
Syntactic processing	Accuracy	213	9	24.67	5.23	30
	Response time	213	45	110.5	27.95	210
	Efficiency	213	1.6	4.92	2.52	15.5
Reading Comprehension		213	2	16.63	7.20	30

4.1.2 Relationships among Lower-Level Processing Components and L2 Reading Comprehension

To determine the relationships among lower-level processing skills and L2 reading comprehension, correlation analyses were conducted with respect to both accuracy and efficiency.

In general, the correlations among variables were significant both in accuracy and efficiency as shown in Tables 4.2 and 4.3. Examining accuracy first, all of the components of lower-level processing were correlated with each other moderately. For example, orthographic processing accuracy was associated with semantic access accuracy (r=.53) and syntactic processing accuracy (r=.58) significantly, and semantic access accuracy was correlated significantly with syntactic processing accuracy (r=.50) as well. Phonological processing accuracy was also associated significantly with other processing skills, such as orthographic processing accuracy (r=.41), semantic access accuracy (r=.30) and syntactic processing accuracy (r=.44).

As the second step in answering the first research question, additional correlation analyses were performed to examine the relationships among the components of processing efficiency and reading comprehension, as adequate accuracy does not necessarily indicate adequate efficiency in language processing operations (Nation, 2005). Thus, the response latency may reveal additional information about the relationship that is not provided by the accuracy data alone (Olson et al., 1994).

Table 4.2

Correlations among Accuracy-Related Variables

	PA	OA	SAA	SA	RC
PA		.41**	.30**	.44**	.59**
OA			.53**	.58**	.78**
SAA				.50**	.57**
SA					.72**

**p<0.01

Note. PA= Phonological Processing Accuracy; OA= Orthographic Processing Accuracy; SAA= Semantic Access Accuracy; SA= Syntactic Processing Accuracy; RC= Reading Comprehension

Table 4.3

Correlations among Efficiency-Related Variables

	PE	OE	SAE	SE	RC
PE		.52**	.50**	.57**	-.72**
OE			.65**	.68**	-.76**
SAE				.68**	-.64**
SE					-.74**

**p<0.01

Note. PE= Phonological Processing Efficiency; OE= Orthographic Processing Efficiency; SAE= Semantic Access Efficiency; SE= Syntactic Processing Efficiency; RC= Reading Comprehension

In this study, variables related to efficiency were found to be correlated strongly with each other, suggesting that a reader who processes one component highly efficiently is likely to do so with other components as well. In contrast, lack of automaticity in one skill may be associated closely with deficits in the automaticity in the other skills.

Specifically, syntactic processing efficiency was associated strongly with semantic access efficiency (r=.68) and orthographic processing efficiency (r=.68). According to the results, if students spend less time accessing their mental lexicons, they will spend less time in recognizing the structure and predicting the components following the stimulus. On the other hand, phonological processing efficiency was related relatively less strongly to orthographic processing efficiency (r=.52) and semantic access efficiency (r=.50).

In addition to the significant relationships among components of lower-order processing, this study showed that all the lower-level components were correlated strongly with L2 reading comprehension, which seems to corroborate the previous studies (e.g., Cunningham et al., 1990; Holmes, 2009; Nassaji, 2003; Shiki, 2009). Specifically, the reading comprehension variable was correlated significantly and positively with phonological (r=.59), orthographic (r=.78), semantic access (r=.57) and syntactic processing accuracy (r=.72). Reading comprehension was also correlated strongly and negatively with efficiency-related variables, such as phonological (r=-.72), orthographic (r=-.76), semantic access (r=-.64) and syntactic processing efficiency (r=-.74). Thus, a student who has better lower-level processing skills is more likely to have better L2 reading comprehension. Also, proficient L2 readers are more likely to process the lower-level skills accurately and efficiently.

4.1.3 Meaningful Predictors of L2 Reading Comprehension Depending on L2 Proficiency Level

To investigate the degree to which lower-level processing skills predict L2 reading comprehension depending on the students' L2 proficiency level, the entire sample was divided into two groups as explained in Section 3.4, and a *t*-test was performed to determine whether there was a significant difference between the scores each group obtained. As Table 4.4 illustrates, the results from the *t*-test indicated that the two groups performed significantly differently on all tasks. For example, among the lower-level processing tasks, the syntactic processing task resulted in the most significant differences in performance, both in accuracy ($F=79.61$, $p=.000$) and efficiency ($F=56.16$, $p=.000$), while the difference between the two groups was the smallest in the semantic access task, both in accuracy ($F=30.31$, $p=.000$) and efficiency ($F=39.92$, $p=.000$), although the difference remained statistically significant. The two groups also showed substantial differences in reading comprehension scores ($F=7.56$, $p=.006$).

Next, a series of stepwise multiple regression analyses was conducted with L2 reading comprehension as the dependent variable to identify the predictors of reading comprehension according to the students' L2 competence. To confirm that the analyses did not have a multicollinearity issue, the Tolerance and Variance Inflation Factor (VIF) of the variances were examined, and the results showed that all variances had the tolerance value above .50, and VIF value lower than 2, which indicated that the variances had no problems of multicollinearity.

Table 4.4

Differences between Proficiency Groups

		Groups	N	M	SD	*t*	Sig.
Phonological processing	Accuracy	Low	112	22.9	2.5	-10.58	.008
		High	101	26.12	1.86		.000
	Efficiency	Low	112	5.48	1.03	11.57	.000
		High	101	3.46	.751		
Orthographic processing	Accuracy	Low	112	23.05	3.59	-12.60	.000
		High	101	27.95	1.88		
	Efficiency	Low	112	4.52	1.73	10.29	.000
		High	101	2.73	.64		
Semantic access	Accuracy	Low	112	26.05	4.65	-6.71	.000
		High	101	29.31	1.33		
	Efficiency	Low	112	3.41	1.44	7.97	.000
		High	101	2.26	.49		
Syntactic processing	Accuracy	Low	112	21.95	5.51	-9.47	.000
		High	101	27.68	2.67		
	Efficiency	Low	112	6.21	2.57	10.41	.000
		High	101	3.49	.94		
Reading comprehension		Low	112	10.77	4.09	-24.31	.006
		High	101	23.13	3.21		

Table 4.5

Regression Analysis for Low Proficiency Group

MODEL	Variables Entered	R	R^2	Adjusted R^2	SE of the Estimate	Change Statistics: R^2 Change	F Change	Sig. F Change
1	SA	.67	.44	.44	2.87	.44	81.24	.000
2	SA+OA	.77	.59	.58	2.47	.15	36.31	.000
3	SA+OA+OE	.82	.67	.66	2.24	.08	22.80	.000
4	SA+OA+OE+PE	.83	.70	.68	2.15	.03	9.23	.003
5	SA+OA+OE+PE+SAE	.84	.71	.70	2.10	.02	5.88	.017

The first regression analysis was conducted to examine the power of the variables to explain the reading comprehension of the lower proficiency students. As Table 4.5 shows, among various independent variables, i.e., phonological, orthographic, lexical access, and syntactic processing skills, syntactic processing accuracy was found to be the most influential in predicting reading comprehension, accounting for 44% of its variance. Then, when orthographic processing accuracy was entered as the next step, the magnitude of the change in R^2 was .15, indicating that this variance explained additional 15% of the variation in reading comprehension that was not explained by the syntactic processing skills alone. Thereafter, orthographic and phonological efficiency were found to have the next strongest explanatory power. According to the final, complete model, the combination of syntactic processing accuracy, orthographic accuracy and efficiency, phonological efficiency and semantic access efficiency contributed significantly in predicting the variation in L2 reading comprehension and in combination, accounted for 71% of the reading comprehension measures.

The second analysis was carried out with the data obtained from the higher proficiency group. As seen in Table 4.6, in the constructed model, syntactic processing efficiency was found to predict reading comprehension most (26%). Then, when orthographic accuracy was added, an additional 12% of the reading comprehension variance was explained, the combination of which accounted for the 38% of the reading comprehension measures.

Table 4.6

Regression Analysis for High Proficiency Group

MODEL	Variables Entered	R	R^2	Adjusted R^2	SE of the Estimate	Change Statistics		
						R^2 Change	F Change	Sig. F Change
1	SE	.51	.26	.26	2.99	.26	37.92	.000
2	SE+OA	.61	.38	.37	2.76	.12	19.53	.000

4.2 Discussion

Section 4.2.1 addresses the relationships among the lower-level processing components and L2 reading comprehension. Section 4.2.2 discusses the meaningful predictors of L2 reading comprehension according to the language proficiency level.

4.2.1 Relationships among Lower-Level Processing Components and L2 Reading Comprehension

According to the statistical analysis, each component of lower-level processing associated with each other significantly, which appears to support previous studies (e.g., Holmes, 2009; Nassaji, 2003). On the other hand, the relatively moderate correlation between phonological processing accuracy and orthographic processing accuracy seems to support previous studies only partially that demonstrated a strong association between phonological processing skills and orthographic processing skills (e.g., Caravolas, 2005; Caravolas et al., 2001; Ehri, 1992; Snowling, 2000).

One possible reason for this result may be the deep orthographic characteristics of English, in which letters do not always have a one-to-one relationship with speech sounds. In English, a single phoneme may be visualized with several graphemes and a single grapheme may have varied pronunciations. In fact, almost 80% of English words have irregular spelling patterns

(Shankweiler & Fowler, 2004), and reflecting this deep orthographic feature of English, the current orthographic task included words with doubled letters, silent letters, and irregular spelling patterns (Ehri, 1998).

Thus, the relatively less strong correlation found between the variables than expected from previous research may indicate that students need more than phonological knowledge to develop their knowledge of letter sequences in English, although the grapheme-phoneme conversion rules may have assisted to some degree (Sabet & Ostad, 2016). Thus, the finding that students can accurately identify "the word *sheap* as a misrepresentation of the word *sheep*" (Baker et al., 1992, p. 336) may indicate that they used specific orthographic information stored in their memory, and accumulation of the accurate recognition words might necessitate more than the mnemonic system provided by letter-sound relations. In addition to the grapheme-phoneme correspondence rules, other factors, including sufficient print exposure (Stanovich & West, 1989) or systematic orthographic instructions (Sabet & Ostad, 2016) might have influenced the development of orthographic knowledge.

Similarly, the relatively weak correlations among efficiency in phonological processing and other tasks may be related to different cognitive processes caused by differences in the familiarity of the words (Rau, Moeller, & Landerl, 2014). According to the dual-route theory, when faced with high-frequency words they have practiced already, most skilled readers may use a visual form of the word and access the mental lexicon directly, while when faced with unfamiliar words, they may have to employ the spelling-sound conversion process (Coltheart, 2006;

Dehaene, 2010; Frost, 1998; Hawelka, Gagl, & Wimmer, 2010). Ehri's (1992, 1998) amalgamation theory suggests similarly that as readers become more proficient at reading specific words through the phonological recoding process, they establish access routes for those words, and thereafter, they may not apply the phonological rules. Instead, orthographic information alone activates its pronunciation and meaning.

Given that all of the present tasks, except the phonological task, included only frequent and familiar words, most of the skilled readers might have relied more on orthographic information in the word recognition process, even though some students still might have relied more on grapheme-phoneme conversion rules. On the other hand, in the phonological task used here, most students likely depended on phonological strategies to read the pseudowords.

However, what should not be overlooked is that, even though different cognitive processes may affect the strength of the correlations between variables, lower-level components are still associated significantly. This result suggests that the component skills may be based on some common basic skills, such that efficiency in processing a lower-level component may act as either a steppingstone or bottleneck in developing efficiency in processing other lower-level components.

In addition to the significant relationships among components of lower-order processing, this study showed that all the lower-level components were correlated strongly with reading comprehension. This result seems to corroborate the previous studies (e.g., Cunningham et al., 1990; Holmes, 2009; Nassaji, 2003; Shiki, 2009).

To discuss the results more specifically, in this study, orthographic processing skills were associated strongly with reading comprehension. In fact, this result seems to buttress previous studies that have suggested the significant relationship between orthographic knowledge and reading comprehension (Cunningham et al., 2001; Roman et al., 2009).

For example, according to Taylor and Perfetti (2016), readers with more lexical representations had shorter eye fixation durations for frequent words, which suggested that individual differences in lexical representations may cause differences in reading fluency. In addition, according to Apel (2011), learners with a substantial amount of lexical mental representations may find orthographic patterns in the language more easily and then use the information to accumulate more lexical forms in their memory (Storkel, 2009). As words "precisely represented by their letters" (Bowers et al., 1994, p. 175) are recalled quickly, the accumulation of accurate lexical forms may be related to better reading comprehension. In turn, such well-specified lexical forms are believed to develop with increasing exposure to the written language (Berninger, 1994; Stanovich & West, 1989; Ehri, 2005; Taylor & Perfetti, 2016). Thus, as learners are exposed repeatedly to the written code, they may recognize spelling sequences and finally establish "the fully specified orthographic representations" in their mental lexicon (Conrad, 2008, p. 869).

In terms of orthographic processing efficiency, some students with high proficiency may have remembered the words based on their orthographic images and retrieved them from their memories based on the orthographic cues, rather than using an effortful decoding process (Ehri, 1992; Nassaji, 2003; Rau et al., 2014). On the other hand, other students without fully developed word recognition skills may have engaged in the decoding process automatically even when the spelling did not follow spelling conventions, resulting in impoverished phonological representation (Rittle-Johnson & Siegler, 1999). Given that it takes less time to recognize words by sight than to perform the decoding process (Ehri, 2005), the readers who performed the conversion process may have wasted limited cognitive resources. In turn, this inefficiency in orthographic processing might have prevented other reading comprehension processes from operating efficiently by assigning more attention to the operation of the lower-order processes and less attention to other reading-related processes.

On the other hand, EFL readers cannot be able to encode every word in their memory as recognition words. When they confront unfamiliar words or pseudowords, even skilled readers, not to mention novices, may need to sound out the words using grapheme-phoneme rules either consciously or unconsciously (Rau et al., 2014). This may explain the significant correlation between phonological skills and reading comprehension both in terms of accuracy and efficiency as found in previous studies (e.g., Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Grant, Gottardo, & Geva, 2001; Kang et al., 2011). Thus, when students do not decode words accurately, they are less likely to select the word in their mental lexicon and comprehend the meaning of sentences and texts.

In addition, as Perfetti (1994) stated, an inefficient word decoding process compromises reading comprehension, regardless of the accuracy of decoding, as supported by several previous studies (e.g., Bruck, 1990; Perfetti, 1985; Perfetti & Hogaboam, 1975). Effortful application of conversion rules may require additional dedication of attentional resources to this process, leaving fewer resources available for the reading comprehension process. Also, this efficient decoding skill is known to develop through sufficient exposure to written input (Nassaji, 2003). Thus, whether readers can translate large units of letters into sounds without much attentional effort can be significantly associated with reading comprehension.

The significant correlation between semantic access efficiency and reading comprehension found in this study also appears to support previous studies (e.g., Shiotsu, 2009). Although whether the students could access the lexicon on sight or relied more on phonological computations may have contributed to the individual differences in semantic access efficiency (Van Orden & Kloos, 2005), it is noteworthy that individual differences in lexical access efficiency may not result simply from differences in word decoding speed. The rate of meaning activation also may explain the differences in reading comprehension when the word decoding rate was partialled out.

In fact, in Shiotsu (2009), compared to skilled readers, less-skilled readers showed more severe delays in the process when they were required to use semantic judgment than when they were not. In addition, Nation and Snowling (1998) showed that despite having similarly adequate and efficient decoding skills, less-skilled readers were significantly less efficient in a synonym judgment task than were their skilled counterparts, which may imply that less efficient semantic processing is another potential cause of problems in reading comprehension in the absence of decoding problems.

Apart from word-level processing skills, in this study, syntactic processing skill was also associated strongly with reading comprehension. Reading comprehension involves the ongoing integration of words into phrases and sentences, and the "sensitivity to the syntactic and semantic constraints of the language might be viewed as a resource that bootstraps literacy development" (Nation & Snowling, 2000, p. 229). However, this finding may seem inconsistent with the results obtained by Lee (2014). In her study, syntactic processing was not correlated significantly with measures of L2 reading comprehension, and neither was it associated with other lower-level processing skills, such as phonemic and orthographic processing. These different results might be due to the complexity of the syntactic knowledge measured in the task. The syntactic judgment task Lee used required rather sophisticated syntactic knowledge, such as rules related to the subjunctive mood and complicated structures, rather than simple syntactic parsing knowledge, which might have produced the low correlation between syntactic knowledge and reading comprehension.

In contrast, as found in this study, other research that measured syntactic parsing accuracy (i.e., the ability to recognize phrase boundaries using some basic syntactic knowledge) showed a high correlation between syntactic processing skills and L1 and L2 reading comprehension accuracy (e.g., Kim, 2007, 2010; Klauda & Guthrie, 2008, Nation & Snowling, 2000). For example, in Klauda and Guthrie (2008), among six components, including word recognition speed, background knowledge, and inferencing, the syntactic processing skills of L1 fifth graders were correlated most highly with L2 reading comprehension. Van Gelderen et al. (2004) also demonstrated similar results with a strong relationship between grammatical knowledge and reading comprehension in L2 settings.

Consistent with the previous studies, the results shown here likely support the assumption that deficient syntactic knowledge is related to reading comprehension and reading experience can contribute to internalizing syntactic knowledge (Dreyer et al., 1995). In this study, some students seemed to lack the appropriate syntactic ability required to assemble the components and construct the meaning of sentences. One possible source of this lack of syntactic knowledge might be the different features of their L1 and L2, in that Korean is a head-final language, while English is a head-initial language (Koda, 2005; Lim & Godfroid, 2014). This distinctive syntactic structure of the two languages may have had a negative L1 transfer effect in the beginning stages of learning English as a foreign language, which also may have influenced the automaticity of the syntactic parsing process as well as the accuracy of processing.

4.2.2 Meaningful Predictors of L2 Reading Comprehension Depending on L2 Proficiency Level

As hypothesized, the results indicated that the power of lower-level processing skills to explain L2 reading comprehension differed demonstrably between students in the two proficiency groups. Specifically, the lower-level skills appeared to contribute more in explaining the variation in reading comprehension in the low proficiency group than in the high proficiency group. In other words, a greater degree of reading comprehension could be accounted for by lower-level processing skills in the low proficiency group.

Nonetheless, it is noteworthy that although the lower-level processing skills may not account for reading comprehension as strongly for proficient students, lower-level processing skills still accounted significantly for the individual differences in reading comprehension of the advanced learners. Thus, lower-level processing is not an insignificant factor in developing reading proficiency among advanced learners (Koda, 2005). In the same sense, it might be premature to argue that higher-level processing is more important than its lower-level counterpart for advanced learners.

In examining the possible reasons for the relative differences in the predictive power of lower-level processing skills depending on language proficiency, one plausible explanation might be the effect of automaticity. Reading involves both automatic and controlled processes (Segalowitz & Hulstijn, 2009). In skilled reading, lower-order aspects, i.e., word recognition and syntactic parsing, are processed automatically and unconsciously, while the controlled processes are related more to higher-order components, such as understanding the context of the text. Put differently, inefficient lower-level processing could take up a significant amount of the limited capacity of working memory and prevent readers from employing reading strategies associated with higher-level processing. On the other hand, efficient lower-level processing may contribute to successful higher-level processing and reading comprehension by liberating mental resources.

Nonetheless, this effect of automaticity on reading comprehension may not be unlimited. According to Van Gelderen et al. (2004), when lower-level processing speed exceeds a certain level, “additional gains may not determine the quality of text comprehension of the reader” (p. 28). Thus, based on the existence of a maximum level, the weaker association between lower-order processes and reading comprehension in advanced students may be explained by the assumption that most of the advanced readers might already have developed sufficient automaticity in the process. They might have been sufficiently efficient to process the lower-level components to a certain level, with the result that lower-level processing skills had less predictive power in the reading comprehension of the high proficiency group.

The different kinds of sub skills that account for the reading comprehension in the two groups also could be explained similarly. Specifically, in this study, all of the components related to efficiency, except syntactic processing efficiency (i.e., phonological, orthographic, and lexical access efficiency), and syntactic and orthographic accuracy were significant factors in predicting reading comprehension in the low proficiency group, while only syntactic processing efficiency and orthographic accuracy had a significant predictive power in reading comprehension in the high proficiency group.

According to Anderson’s skill acquisition theory, novice and intermediate learners are more likely to focus on rule acquisition and skill development, while advanced learners seem to be able to fine tune their knowledge, and automatize their processing skills (Anderson, 1983). Thus, whether or not the low proficiency students had acquired adequate syntactic parsing knowledge seemed to be a more powerful variable in predicting the individual differences in reading comprehension than did syntactic efficiency. On the other hand, the automatization of syntactic parsing is a feature that usually occurs only in relatively advanced learners, and therefore, the presence or absence of the automatic execution of syntactic components seems to predict their reading proficiency. Thus, skilled readers might exhibit differences in efficiency with respect to making use of “word order and probabilistic information expeditiously” (Lim & Godfroid, 2014, p. 22) to predict the syntactic category following a given phrase.

In addition to the syntactic parsing skills, in the low proficiency group, there might have been individual differences among students with respect to the degree to which they effortlessly applied their phonological, orthographic, and semantic access knowledge to the related tasks. In contrast, most of the students in the high proficiency group may have used a similar cognitive process to perform the tasks and already have reached the maximum level of automaticity, so that the variables may no longer have acted as a discriminating factor.

On the other hand, orthographic processing accuracy was found to be the significant factor in reading comprehension in the both proficiency groups, which seems to support the Lexical Quality Hypothesis. According to the Lexical Quality Hypothesis, “low quality code retrieval with effort would jeopardize comprehension processes that depend on a high quality representation” (Perfetti & Hart, 2002, p. 190). Having precise knowledge of word forms and meanings and being able to process them rapidly is central to reading comprehension. More recently, Perfetti and Stafura (2014) introduced the Reading Systems Framework, which places lexicon at the center of the reading comprehension system. According to this framework, what connects the word identification and comprehension system is the ability to access the mental lexicon based on word form and activate word meaning rapidly and automatically, which was empirically confirmed in this study.

To summarize, Korean EFL high school students in two different proficiency groups seemed to be in different stages in the acquisition of lower-level processing, and thus, students with different L2 proficiencies may need to focus on developing different aspects of lower-level processing skills. Nevertheless, the thing to note in these results is that in developing L2 reading comprehension, in general, the acquisition of automatic word recognition skills and syntactic processing skills could be a critical issue for these students, not to mention the initial accumulation of the related knowledge.

CHAPTER 5.
CONCLUSION

This chapter consists of two sections. Section 5.1 presents a summary of the major findings and pedagogical implications of the study, while Section 5.2 discusses the limitations of the study and makes suggestions for future research.

5.1 Major Findings and Pedagogical Implications

The primary objective of this study was to investigate the relationships between lower-level processing skills and L2 reading comprehension in Korean EFL high school students. Accordingly, the study addressed two research issues: 1) the relationships among the accuracy and efficiency of lower-level processing skills and reading comprehension and 2) the ability of lower-level processing skills to predict reading comprehension ability depending on the students' L2 proficiency level. The key findings of the study can be summarized as follows.

First, all components of lower-level processing were associated with each other significantly, and particularly, they were correlated strongly when processing efficiency was considered. Thus, when a student is inefficient in one skill, he or she is likely to process other skills in a similarly inefficient way. Also, lower-level processing skills were correlated highly with L2 reading comprehension. This finding supports the results of previous studies that have shown high correlations between lower-order processing skills and reading comprehension (e.g., Holmes, 2009; Nassaji, 2003). Especially, the finding that lower-level processing efficiency as well as accuracy was strongly correlated with reading comprehension seems to support the assumption that accurate processing may be a necessary component of reading comprehension, but not the sufficient one. Both appropriate accuracy and efficiency might need to be established for skilled reading.

The study also confirmed the hypothesis that the degree to which lower-level processing skills predict L2 reading comprehension may manifest differently depending on the L2 proficiency level. Although lower-level processing skills accounted to a significant degree for reading comprehension in both proficiency groups, they explained approximately 30% more of the variance in reading comprehension in the low proficiency group than in the high proficiency group. In addition, with respect to the components that constitute L2 reading comprehension, the two groups showed rather different traits that indicated that the students were in different developmental stages. In the low proficiency group, a substantial amount of L2 reading comprehension could be explained by variables such as syntactic and orthographic accuracy and orthographic, phonological, and semantic access efficiency, while syntactic efficiency and orthographic accuracy were shown to be the meaningful variables in explaining the L2 reading comprehension of the high proficiency group.

Nevertheless, despite the significance of lower-level processing in L2 reading comprehension, as confirmed empirically in this study, until recently, not much attention has been given to the development of lower-level processing components, both in research on Korean EFL reading and in schools. Instead, the focus has been on the development of higher-level processing skills, assuming that high school students have already developed sufficient lower-level processing skills, such that they may no longer affect their reading comprehension. However, the findings here seem to provide empirical evidence of the importance of accurate and efficient lower-level processes on reading comprehension, even in high school students. Thus, considering that the primary goal of L2 reading instruction is to help students focus on the contents of the reading material without paying much attention to the effortful reading process, there should be greater pedagogical awareness of this lower-order facet of reading (Grabe, 2009). Based on the major findings described above, this study proposes the following pedagogical implications.

First, for fluent L2 reading, students need to accumulate large amounts of precise recognition words in their lexicons, so that they can recognize words automatically and devote more attention to other reading processes. This accumulation of a recognition vocabulary can be realized through fluency-based activities, such as repeated exposure to printed languages. However, in the case of beginning readers, they may firstly need to become aware of grapheme-phoneme correspondences and practice until they can perform the matching process expeditiously. This practice may prevent them from being distracted severely by imperfect phonological representations or slow decoding processes while attempting to comprehend what they are reading.

In addition, efficient syntactic parsing skills should not be overlooked in EFL contexts. In the Korean educational field, much effort has been placed on grammar instruction, and as a result, students have been assumed to have a significant amount of explicit grammatical knowledge. Indeed, grammatical knowledge is crucial in reading comprehension, without which readers cannot construct sentential meaning. Nonetheless, grammatical knowledge only has value as a means to read fluently; it does not consist of the knowledge to be learned. The significance of syntactic knowledge lies in the fact that it helps readers connect separate pieces of information to understand the text. Thus, “a detailed and comprehensive grammar curriculum” (Grabe, 2009, p. 37) that includes structures or single details that are used rarely might not be what L2 readers need most urgently. Instead, automatic application of simple and basic grammatical knowledge to the text comprehension process might be what they need. Thus, rather than focusing on unmarked or minor grammar information and overlooking the importance of automatic syntactic processing skills, students firstly need to attend to the foundational grammatical knowledge and be exposed to extensive contexts for internalizing it. Relatively advanced students also may need to have opportunities to automatize the syntactic knowledge they acquire.

As for the instructional methods necessary to implement the suggestions above, specially designed intensive instruction for component skill practice sometimes might be necessary for beginning readers. However, in the end, efficient lower-level processing skills for fluent reading cannot be achieved without “countless hours of exposure” to comprehensible input (Grabe & Stoller, 2011, p. 18). Dreyer et al. (1995) stressed that a great deal of reading may help readers to store representations of words and syntactic information, which may encourage them to read more. More recently, Taylor and Perfetti (2016) also indicated that lexical quality is “both a mediator and consequence of experience” (p. 1100). In other words, students acquire lexical items through reading and at the same time, the word representations acquired enable readers to read a greater number of books more efficiently.

However, in EFL contexts, learners encounter the target language rarely in their everyday lives. Furthermore, according to Lee (2014), throughout their 6 years of formal English education in middle and high school, Korean students are exposed to only 43,200 words in their English textbooks. On the other hand, paradoxically, third grade Korean high school students are required to read texts with approximately 1000~1300L, which are difficult enough for L1 secondary school students to read (Lee, 2014). This situation seems to contradict the widely accepted assumption that reading materials appropriate in developing and testing reading fluency are those in which students can recognize the words with over 95 percent accuracy (Hudson, Lane, & Pullen, 2005).

Clearly, therefore, it is imperative to provide learners with more opportunities to be exposed to the target language at their appropriate level and to interact with it to build a solid basis for reading ability (Rau et al., 2014). The introduction of extensive reading would provide students with the opportunities to use various subcomponent processes simultaneously and synthetically, which can consolidate their basic knowledge and enhance processing efficiency implicitly (Nassaji, 2003). In addition to extensive reading, repeated reading, in which students read the same text until they achieve an appropriate level of fluency, would help them acquire words and phrases and transfer them securely to long-term memory (Gorsuch & Taguchi, 2010). Thereby, readers would develop word recognition and syntactic parsing skills and finally be able to focus on higher-level reading comprehension processes.

5.2 Limitations and Suggestions for Further Research

Although the study was designed with care, it still has certain limitations.

First, although the study included a relatively large number of participants, it is still impossible to generalize the findings beyond the context of this study, as the subjects in the study were selected from only one school in Seoul. Thus, to generalize the findings, future studies should incorporate larger sample sizes with more varied proficiency levels.

Second, inherent features of the variables may limit the findings. Although it was beneficial to include various processing components to identify the relationships among them and between reading comprehension, some underlying collinear skills may have existed. For example, the study could not completely exclude the possibility that lack of the syntactic processing skill is attributable to inefficient word recognition skills in addition to the deficient syntactic knowledge. Thus, tasks that are designed more meticulously to measure the pure and distinctive aspects of each component skill are called for in future research.

Finally, in terms of the measurements, due to practical constraints, the study included only written tasks that measure the processing skills indirectly. However, in addition to written measures, introducing additional oral measures would be of more value. For example, assessing the students' phonological skills directly with oral tasks may have provided more valid and detailed information about their component skills by eliminating any confounding effects caused by the written measures.

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APPENDICES

APPENDIX 1. Phonological Processing Task

		1	2
1	zan	/zæ n/	/zoun/
2	cel	/kɛl/	/sɛl/
3	pey	/peɪ/	/paɪ/
4	bix	/bɪk/	/bɪks/
5	rool	/rul/	/ral/
6	heer	/heɪr/	/hir/
7	scag	/sæ g/	/skæ g/
8	vell	/vɛl/	/vil/
9	tash	/tæ ʃ/	/tæ s/
10	werk	/weɪrk/	/wərk/
11	sniz	/snɪz/	/snuz/
12	chim	/sɪm/	/tʃɪm /
13	zack	/zæ k/	/zæ s/
14	shimp	/sɪhɪmp/	/ʃɪmp/
15	capch	/cæ pʃ/	/cæ ptʃ/
16	trepe	/trɛpeɪ/	/treɪp/
17	thring	/θrɪŋ/	/trɪŋ/
18	sigbap	/sɪgbapeɪ/	/sɪgbap/
19	cheedle	/tʃidl/	/khidl/
20	ketbeam	/kɛtbeɪm/	/kɛtbim/
21	thindelp	/thɪndɛlp/	/θɪndɛlp/
22	brigbert	/brɪgbərt/	/brɪgbrɛt/
23	smilcrit	/smɪlkrɪt/	/smɪlsrɪt/
24	bramisk	/bramɪk/	/bramɪsk/
25	shranklit	/ʃræ nklɪt/	/sɪhræ nklɪt/
26	strempick	/strɛmpɪk/	/strɛmpɪks/
27	phlinders	/pɪlɪndərs/	/flɪndərs/
28	matlopeen	/mæ tlopin/	/mæ tlopɛn/
29	crambring	/tʃræ mbrɪŋ/	/kræ mbrɪŋ/
30	camdestine	/kamdɛstɪn/	/kamdɛsteɪn/

APPENDIX 2. Orthographic Processing Task

	1	2
1	rane	rain
2	fild	field
3	rume	room
4	climb	clim
5	travel	travle
6	listen	lissen
7	weiht	weight
8	frend	friend
9	corect	correct
10	rhythm	rythm
11	certain	sertain
12	sience	science
13	leisure	leesure
14	region	reegion
15	enough	enouf
16	sevral	several
17	measure	meshure
18	receive	recieve
19	foriegn	foreign
20	promise	promice
21	qwestion	question
22	explain	explane
23	machine	mashine
24	compare	compair
25	necesary	necessary
26	seperate	separate
27	increase	increese
28	through	throogh
29	expirience	experience
30	Wenesday	Wednesday

APPENDIX 3. Lexical Access Task

	A	B
1	alike	same
2	sick	ill
3	over	under
4	false	true
5	arrive	reach
6	asleep	awake
7	dark	light
8	better	worse
9	road	street
10	copy	original
11	shop	store
12	borrow	lend
13	all	none
14	rich	wealthy
15	rest	relax
16	complex	simple
17	house	home
18	child	adult
19	stone	rock
20	full	empty
21	push	pull
22	start	begin
23	cry	laugh
24	near	close
25	throw	catch
26	fail	pass
27	father	dad
28	present	gift
29	dry	wet
30	get	give

APPENDIX 4. Syntactic Processing Task

	Sentence Fragments	Options	
1	Jane’s cat…	1) cute	2) is
2	Does he…	1) Jane	2) know
3	The students…	1) went	2) angry
4	I expect…	1) them	2) go
5	In the past…	1) go	2) she
6	Does…	1) Jane	2) come
7	Aren’t…	1) busy	2) you
8	Would you…	1) a book	2) bring
9	It is not true…	1) go	2) what
10	He gave me…	1) to	2) a letter
11	Mr. and Ms. Smith…	1) go	2) their
12	Isn’t it…	1) true	2) can
13	Students are…	1) leave	2) asked
14	These students…	1) are	2) angry
15	Yesterday…	1) read	2) Jane
16	Would you…	1) do	2) going
17	The boy who…	1) kind	2) is
18	Jane let him…	1) home	2) go
19	The letter…	1) was	2) writing
20	Football players…	1) make	2) lots
21	After some time…	1) woke	2) she
22	It is…	1) not	2) does
23	They are…	1) expected	2) expect
24	You think that…	1) Jane	2) do
25	I wonder…	1) if	2) he
26	They believe that…	1) exists	2) ghost
27	The fact that…	1) lives	2) he
28	Let’s…	1) do	2) he
29	It’s impossible…	1) to	2) go
30	Where…	1) do	2) go

APPENDIX 5. Reading Comprehension Test

Questions 1-5 are about the following note from a teacher.

> Dear Cathy,
>
> Thanks for volunteering to clean up the science laboratory this afternoon. Usually, when a student does **<u>this</u>** for the first time, I go to the lab to show him or her exactly what to do. However, today I have a teacher's staff meeting at 3:30, so I can't be there. Still, I'm sure everything will be fine, since you have worked in the lab many times. Here is what you should do:
>
> 1. Clean all the glass containers that were used in class today.
> 2. After washing the containers, place them upside down on a towel to dry.
> 3. Wipe down all the worktables with a wet cloth.
> 4. Put all the microscopes that have been left out back on the equipment shelf.
> 5. Sweep the floor.
> 6. Put the trash outside the door.
> 7. Turn off the lights and lock the door when you leave.
>
> If you have any questions, please ask Ms. Edwards in the classroom next door. You can return the key to me tomorrow when we have class at 10:30.
>
> Thank you so much for your help!
>
> — Mr. Marston

1. In line 2 of the note, the word **<u>this</u>** refers to ________.
   (A) saying thank you
   (B) finishing homework
   (C) going to the science laboratory
   (D) cleaning the science laboratory

2. Where will Mr. Marston probably be when Cathy cleans the lab?
   (A) In the lab
   (B) In his office
   (C) At a meeting
   (D) In the classroom next door

3. Where should Cathy put the glass containers?
   (A) On a towel
   (B) Near the door
   (C) Next to the sink
   (D) On the equipment shelf

4. What should Cathy do immediately after sweeping the floor?
   (A) Lock the lab door
   (B) Put away any microscopes
   (C) Clean the worktables
   (D) Take the trash out of the lab

5. When should Cathy give the key back to Mr. Marston?
   (A) On her way home
   (B) In class the next day
   (C) Right after she cleans the lab
   (D) Before school begins the next morning

Questions 6-11 are about the following story.

Cricket—how I **<u>detested</u>** this game when I was young! My family would spend hours and hours watching it on television while I angrily waited for it to end. Every game seemed the same. Yes, one team won and the other one lost, but it was always the same game—some men pitching a ball, some running back and forth.

Then something happened. I became old enough to start playing cricket myself with the other kids in my neighborhood. We found a place to play wherever we could put up a wicket. We played on the street, in the backyard—even on the tops of buildings, believe it or not! Whenever we had the chance, we brought out the bat and ball. And we played like there was no tomorrow.

I can recall so clearly the sounds of the ball hitting the bat and the quick running feet. I can still feel the sun on my face as I played and the bruises and scratches from falling down.

I can still see the blue sky fading to darkness behind the buildings as our games continued into the night. It became my favorite thing in the world. Now I watch it not with anger, but with fond memories of the endless days and nights spent playing the game.

6. What title best summarizes the main idea of the passage?
   (A) Cricket: A Game for All Ages
   (B) How I Learned to Love Cricket
   (C) The Dangers of Playing Cricket
   (D) Learning the Rules of a Difficult Game

7. In line 1, the word **detested** is closest in meaning to _______.
   (A) hated
   (B) played
   (C) wanted
   (D) watched

8. What best describes the author's attitude toward cricket when he was very young?
   (A) It was boring to watch.
   (B) It was difficult to learn.
   (C) It was fun to talk about.
   (D) It was dangerous to play.

9. According to the author, what was surprising about some of the cricket games he played?
   (A) They were played without bats.
   (B) They were played on rooftops.
   (C) No one cared who won them.
   (D) No one got hurt playing them.

10. The author describes memories of all of the following EXCEPT _______.
   (A) how the sun felt on his skin
   (B) how the ball sounded hitting the bat
   (C) how the sky turned from light to dark
   (D) how the rules of the game caused arguments

11. What change does the author describe?
   (A) He could not remember the rules of cricket at first, but then he decided it did not matter.
   (B) He was afraid of getting hurt playing cricket at first, but then he stopped being afraid.
   (C) He did not like cricket at first, but then he began to enjoy it.
   (D) He liked playing cricket at first, but then he grew tired of it.

Questions 12-17 are about the following newspaper article.

Marina Hills High School is fighting pollution in an unusual way. It's planting trees!

In an effort to fight pollution and help the environment, the Marina Hills Ecology Club offers free trees to institutions willing to plant them on their grounds. Among those that took advantage of the offer was Marina Hills High School. After consulting with his teachers on where to plant the trees, Principal Max Webb contacted the Ecology Club.

But when the seedlings arrived, Webb had an idea. Instead of planting the young trees in front of the school, he thought it would be better to put **them** behind the school, where the sun gets very hot in the afternoon.

"It gets so hot inside the building that the students start to sweat during their afternoon classes," said Webb. "Now the shade from our trees will bring them some relief."

"There was no argument from the teachers," he added. "When I proposed the idea, everyone said, 'Now why didn't I think of that!'"

The relief won't come until the trees grow taller, but the school will not have to wait long because it requested two species of trees that grow quickly.

"Time is key, and we wanted our trees to get big fast," said Webb. "We were given a wide choice, from shrubs to fruit trees. We requested eucalyptus and willow trees."

Webb said he is also looking forward to finally seeing some wildlife in the school yard at Marina Hills High School.

"If all you have is a grass lawn with no trees, you can't expect the local birds to come and visit," said Webb. "They have no place to make their nests. Now that will change, and we'll be able to see birds from our classroom windows."

12. What would be the most appropriate headline for this article?
    (A) Local School Gets Greener
    (B) Student Wins Science Award
    (C) Principal Discovers New Tree
    (D) Teacher Leads Ecological Club

13. What did the Ecology Club do for Marina Hills High School?
    (A) It helped design the school yard.
    (B) It put flowers in the classrooms.
    (C) It sold seeds to the school.
    (D) It provided free trees.

14. In line 9, the word **them** refers to _______.
   (A) trees
   (B) classes
   (C) students
   (D) teachers

15. What decision was changed?
   (A) Which trees should be dug up
   (B) When the old trees should be cut down
   (C) Where the new trees should be planted
   (D) Which type of tree should be chosen

16. What can be inferred from the article about eucalyptus and willow trees?
   (A) They grow quickly.
   (B) They become extremely tall.
   (C) They are less expensive than fruit trees.
   (D) They do not grow flowers in the springtime.

17. What does Principal Webb imply about the local birds?
   (A) They make their nests on the ground.
   (B) They are not often seen at the school.
   (C) There are fewer of them due to the pollution problem.
   (D) They fly into the classrooms when the windows are open.

Questions 18-23 are about the following passage.

The longer food is kept, the more likely it is to attract insects. Even foods stored in containers often attract bugs. To solve this problem, scientists have been working with different odors in an attempt to find **one** strong enough to keep insects from going near food. One possibility would be to use plants with strong smells, like garlic or pine to keep insects away. Unfortunately, however, using these smells might keep some people away too!

A more promising repellent is citronella oil, which comes from a type of lemongrass. An experiment was done using this oil with a certain insect, the red flour beetle. Scientists sprayed cardboard boxes with citronella oil and noticed that the beetles did not enter those boxes. They were much more interested in boxes that were not sprayed.

One problem with using citronella oil as a repellent, however, is that it simply does not last very long. After a few months it loses its smell, and bugs no longer find it unpleasant. Scientists hope to improve citronella oil so that its scent remains strong for a longer time. It will also be necessary to make sure that the oil is not harmful to people, as scientists are still not sure whether it is safe to use around food. * repellent: 방충제

18. What is the passage mainly about?
(A) Oils used in cooking
(B) Ways of protecting food
(C) The behavior of a kind of beetle
(D) Smells produced by different grasses

19. In line 3, the word **one** refers to___________.
(A) an odor
(B) an insect
(C) a scientist
(D) a container

20. What does the author imply about the odors of garlic and pine?
(A) They last for a long time.
(B) They are not always very strong.
(C) They can be unpleasant to people.
(D) They attract certain species of beetles.

21. Which substance is NOT mentioned as being unpleasant to insects?
(A) Pine
(B) Flour
(C) Garlic
(D) Citronella oil

22. Why does the author talk about the experiment with red flour beetles?
(A) To contrast red flour beetles with other bugs
(B) To describe the effectiveness of citronella oil
(C) To give an example of an insect that does not like garlic
(D) To explain why citronella needs more research

23. What are scientists hoping to do in the future?
(A) Breed larger beetles
(B) Produce better-tasting foods
(C) Grow lemongrass in greater quantities
(D) Make the odor of citronella oil last longer

Questions 24-30 are about the following passage.

Being able to land safely is a critically important skill for all flying animals. Whereas terrestrial animals face no particular challenge when they need to stop running or crawling, flying animals move at much higher speeds, and they must be careful about how they land. Hitting the ground, or even water, at full flight speed would be quite dangerous. Before touching down, they must decrease their speed in order to land safely. Both bats and birds have mastered the skill of landing, but these two types of flyers go about it quite differently.

In the past it was believed that, in terms of flying mechanics, there was little difference between bats and birds. This belief was based only on assumption, however, because for years nobody had actually studied in graphic detail how bats move their wings. In recent years, though, researchers have discovered a number of interesting facts about bat flight. Bats are built differently from birds, and their wings incorporate both their front and hind limbs. This makes coordinating their limbs more difficult for bats and, as a result, they are not very good at flying over longer distances. However, they are much better at maneuverability: a bat can quickly change its direction of flight or completely reverse **it**, something a bird cannot easily do.

Another interesting characteristic of bat flight is the way in which bats land—upside down! Unlike birds, which touch down on the ground or on tree branches, bats can be observed flying around and then suddenly hanging upside down from an object overhead. How do they do it? A group of researchers recently used video cameras to film bats landing on nets suspended from the ceiling of their laboratory and studied the recordings in slow motion. They painted spots on the bats' wings to see in detail what happens to the wings in flight and during touchdown. It turns out that the bats flew in a straight line up to the net and then quickly flipped over and attached themselves to it upside down. One downside to this landing routine is that the bats often slam into their landing spot with some force, which probably causes pain. However, not all bats hit their landing spots with the same speed and force; these will vary depending on the area where a bat species makes its home. For example, a cave bat, which regularly perches on a hard stone ceiling, is more careful about its landing preparation than a bat more accustomed to landing in leafy treetops.

* maneuverability: 기동성

24. What is the main topic of the passage?
(A) Places where flying animals choose to land
(B) Why scientists have difficulty observing bats
(C) Differences in the eating habits of bats and birds
(D) Ways in which bats move differently from birds

25. According to the passage, what skill is important for flying animals?
(A) Diving underwater
(B) Slowing down to land
(C) Flying over great distances
(D) Balancing on high branches

26. Which of the following is a false assumption about bats that was recently corrected?
(A) They cannot hear.
(B) They sleep upside down.
(C) They fly similarly to birds.
(D) They hide in tree branches.

27. According to the passage, what is an advantage that bats have over birds?
(A) Bats can land on a greater variety of surfaces.
(B) Bats can turn in the air more quickly.
(C) Bats can eat while flying.
(D) Bats are lighter.

28. In line 18, the word **it** refers to ________.
(A) bat
(B) bird
(C) direction
(D) maneuverability

29. The researchers used all of the following to study bats EXCEPT _____.
(A) nets
(B) paint
(C) cables
(D) cameras

30. According to the passage, what helps determine a bat's landing speed?
(A) What it eats
(B) How old it is
(C) How big it is
(D) Where it leaves

국 문 초 록

본 연구의 목적은 영어 읽기 하위 과정을 처리하는 능력과 읽기 이해력 간의 관계를 규명하는 것이다. 선행연구에서 작업 기억력의 한계로 인하여 정확하고 효율적인 하위 과정 처리가 읽기 이해에 중요함을 밝혀 냄에 따라서 영어를 모국어로 하는 학습자를 대상으로 읽기 하위 과정에 관한 상당한 연구가 진행되어 왔다. 하지만, 하급 수준 학습자를 대상으로 한 대부분의 선행연구에서 일관되게 하위 과정 처리 능력과 읽기 이해력 간에 높은 상관관계가 있음을 도출해낸 것과는 달리, 상급 수준 학습자를 대상으로 한 연구들에서는 일관된 결과를 도출해내지 못하였다. 더욱이 영어를 외국어로써 학습하는 많은 학습자들이 글을 읽을 때 어휘 및 구문 분석에 집중하고, 글의 전체적인 의미를 파악하는데 어려움을 보임에도 불구하고, 이들을 대상으로는 읽기 하위 과정에 관한 연구가 거의 이루어지지 않았다. 이러한 한계를 보완하기 위하여, 본 연구는 한국어가 모국어인 영어 학습자의 영어 읽기 하위 과정 처리 능력과 읽기 이해력 간의 관계를 규명하고, 나아가 학습자의 영어 숙련도에 따라 하위 과정 처리 능력이 읽기 이해력을 예측해주는 정도를 파악하고자 한다.

연구 대상은 고등학교 1학년 학생 213명으로, 음성 정보 처리 능력, 철자 정보 처리 능력, 의미 정보 처리 능력, 통사 정보 처리 능력과 같은 읽기 하위 과정 처리 능력의 구성 요소들 서로간의 관계를 측정하는 한편 이러한 읽

기 하위 과정 처리 능력과 읽기 이해력과의 상관관계를 분석하였다. 그 결과, 읽기 하위 과정 처리 능력의 구성 요소 간에 유의미한 상관관계가 있는 것으로 나타났으며, 특히 하위 과정 처리의 효율성 간의 상관관계가 높게 나타났다. 한편, 영어 읽기 이해력과 읽기 하위 과정 처리의 정확성 및 효율성도 의미 있는 관계를 갖는 것으로 나타났다.

아울러 본 연구는 학습자의 영어 숙련도를 기준으로 상급 학습자와 하급 학습자 그룹으로 나누어, 읽기 하위 과정 처리 능력의 영어 읽기 이해력 예측도를 파악하였다. 그 결과, 하급 학습자의 경우 읽기 하위 과정 처리 능력이 읽기 이해력을 상대적으로 더 잘 예측해주나, 상급 학습자의 읽기 하위 과정 처리 능력 또한 그들의 읽기 이해력 예측에 상당 부분 기여하는 것으로 분석되었다. 한편, 그룹별로 읽기 이해력을 예측해 주는 유의미한 하위 과정 처리 능력의 세부 구성 요소는 각각 다르게 나타났다. 이러한 연구결과에 근거하여, 본 연구는 영어 읽기 수업에 대한 시사점과 후속 연구에 대한 제언을 결론부에 제시한다.

주요어: 영어 읽기, 영어 읽기 하위 과정, 영어 단어 인지
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