Visual, Lexical, and Contextual Factors Affecting Word Identification During the Reading of Korean

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In order to assess the role of visual, lexical, and contextual information on word identification in Korean, a self-paced reading experiment was conducted. The effects of word length (i.e., number of visual features, letters, phonemes, and syllables), frequency of occurrences in printed text, and word predictability were examined. It was found that the number of syllables and the number of visual features affected reading times significantly, but the other sub-lexical units (i.e., phonemes and letters) did not. Word frequency and predictability affected reading times respectively; however, the interaction between these two variables did not. The results imply that Korean word identification during reading can be affected highly by word frequency and relatively weakly by word predictability. Word frequency also interacted with word length, which is consistent with previous studies. It is concluded that in Korean the relevant processing unit, in the context of reading a sentence, is the syllable, taking internal structure variations into account.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 THE KOREAN AND OTHER WRITING SYSTEMS 4

2.1 THE KOREAN WRITING SYSTEM AND SENTENCE STRUCTURE 4

2.2 OTHER WRITING SYSTEMS 6

2.2.1 English: alphabetic 6

2.2.2 Chinese: logographic and morpho-syllabic 6

2.2.3 Japanese: logography and syllabary 7

3.0 THEORIES AND FINDINGS OF VISUAL WORD IDENTIFICATION 9

3.1 VISUAL WORD IDENTIFICATION: THEORIES 9

3.1.1 Holistic processes vs. hierarchical processes 9

3.1.2 Dual Route model 11

3.2 VISUAL WORD IDENTIFICATION: PREVIOUS FINDINGS 12

3.2.1 Word length effect 12

3.2.2 Word frequency effect 16

3.2.3 Word predictability effect 17

4.0 RESEARCH METHOD 21

4.1 EXPERIMENT 1: CLOZE TASK 22

4.1.1 Participants 23

4.1.2 Stimuli and procedure 23

4.2 RESULTS OF EXPERIMENT 1 23

4.3 EXPERIMENT 2: SELF-PACED READING 24

4.3.1 Participants 27

4.3.2 Stimuli 27

4.3.3 Procedure 30

4.4 RESULTS OF EXPERIMENT 2 31
4.4.1 Set I: Word length (number of syllables) and frequency 31
4.4.2 Set II: Word length (number of letters, phonemes) and visual complexity 34
4.4.3 Set III: Word frequency and predictability 35
5.0 GENERAL DISCUSSION 37
5.1 PROCESSING UNIT AND WRITING SYSTEM 38
5.2 DUAL ROUTE MODEL AND ORTHOGRAPHIC DEPTH 41
5.3 LEXICAL STATUS: WORD FREQUENCY 43
5.4 WORD IDENTIFICATION WITHIN SENTENCES 44
5.4.1 Context effect: word predictability 46
5.5 KOREAN WORD IDENTIFICATION DURING READING 48
5.6 FUTURE DIRECTIONS 50
APPENDIX A 51
BIBLIOGRAPHY 59

LIST OF TABLES

Table 1. Example of Hangul Syllable Blocks Showing Three Levels of Complexity (adapted from Taylor, 1980) and Number of Visual Features..... 14
Table 2. Examples of Target Stimuli Extracted from the Cloze Task in Experiment 1..... 29
Table 3. Multiple Regression Analysis Results from Set I 32

LIST OF FIGURES

Figure 1. Spatial arrangement of letters in Korean syllables and words. 4
Figure 2. Example sentence showing the head final structure of Korean. 5
Figure 3. Reading times for target words in Set I 33
Figure 4. Reading times for target words in Set III 36

1.0 INTRODUCTION

Word identification is the foundation of skilled reading (Gough, 1984; Perfetti & Hogaboam, 1975). Therefore, it is necessary to understand how a reader achieves successful word identification. Although many findings have advanced our understanding about the process of word identification, several questions about the interrelationship of factors that influence word identification still remain unanswered. One major question to be addressed in this study is how Korean readers identify words during reading. This question can be separated into two parts; one aspect of the question concerns the context of cross-linguistic comparisons. The other aspect is the situation of either word identification in isolation or word identification in text. For the first part of question, one might ask what aspects of word identification are universal versus language-dependent? In other words, one might ask if (and if so, how) the nature of a language and its writing system can differentially affect the word identification process (Frost, & Bentin, 1987; Perfetti, 2003; Taylor, 1980). For example, word length is one of main issues in word identification, and many studies have attempted to discover not only how word length affects word identification, but also what types of units have a significant role during word identification. Therefore, one might ask whether the different writing systems (e.g., alphabetic or syllabic) of languages can be reflected in the processing unit or not. The Korean writing system has both alphabetic and syllabic properties, unlike English, which is alphabetic but not syllabic.

Then where does the word length effect come from in Korean? It is possible that a native Korean has psychological reality of letters, letter clusters, or syllables.

The second part of the question arises in the situation of word identification. There are two dimensions of word identification: identifying a word in isolation and identifying a word in text (Tsai, 2001). In the case of the word in isolation, it indicates how people achieve the meaning of the word by access of the mental lexicon. To observe this process, the conventional methods for word identification, such as naming and lexical decision tasks, have been used. However, those conventional tasks are limited in demonstrating word identification in text, which is the other dimension of word identification (Tsai, 2001). Moreover, Kintsch (1998) also stated that word identification in text is different from word identification in isolation because contextual constraints necessarily affect in the case of word identification in text.

The study of word identification in Korean during reading will provide an opportunity to compare Korean word identification with other languages' word identification. In addition, based on previous studies using words in isolation, it will also provide empirical results about whether the word identification is the same or not depending on the task situation.

To examine the degree to which language-specific factors and contextual factors in a sentence affect word identification, this study examined how word identification is affected by three main variables: word length, frequency, and predictability. This study used Korean to allow comparisons with other languages (e.g., English) and the self-paced reading of sentences to address the following four research questions:

1. What are the basic units of processing (e.g., letters, syllables, and/or words) during the reading of Korean?

2. To what degree does lexical variable (e.g., word frequency) play a role in the reading of Korean?

3. To what degree do the sentential constraints imposed by syntax and/or meaning (i.e., word predictability) affect word identification during the reading of Korean?

4. How do the three main variables of interest (word length, frequency, and predictability) interact with each other?

To answer these questions, this thesis is organized as follows. First, I describe the Korean writing system and its orthography. Then I also overview some other writing systems to show the Korean writing system's situation among other languages. Second, I present an overview of some of the theoretical frameworks proposed to understand word identification processes, as well as previous findings relevant to the factors dealt with in this thesis. Two experiments designed to observe Korean word identification during the reading of a sentence are presented. Lastly, I discuss some interesting evidence from this study.

2.0 THE KOREAN AND OTHER WRITING SYSTEMS

2.1 THE KOREAN WRITING SYSTEM AND SENTENCE STRUCTURE

The Korean writing system is generally regarded as being an alphabetic system, and its orthography is generally regarded as being morphophonemic (Lee, 1998). The Korean alphabet, Hangul, consists of 24 primary letters, with 14 consonants and ten vowels. Each phoneme is represented by a letter, and each word is made from letters that are combined into syllables that consist of compact character blocks (see Figure 1). Words consist of one or more syllables and are separated by blank spaces. Korean is thus considered to be a syllabic system that is largely composed of polysyllabic morphemes with an elaborate inflexion system that is based on suffixes. The example in Figure 1 divides the word "책상" (pronounced /*chayk sang*/ which means *a desk* in English) into its parts. Each syllable is also written in a square. As the figure shows, each syllable begins with a consonant, either sounded or silent, and has at least one additional consonant and one vowel, which may represent a CV, CVC, or CVCC syllable.

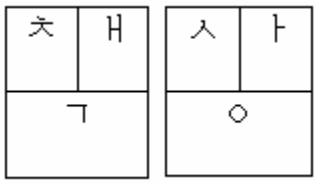

Figure 1. Spatial arrangement of letters in Korean syllables and words. The example in the figure shows the two-syllable word "chayk sang" (desk in English) with the left-most "box" containing the first CVC syllable (i.e., the letters, ㅊ, ㅐ, ㄱ), and the right-most "box" containing the second CVC syllable (i.e., the letters, ㅅ, ㅏ, ㅇ). The boxes are shown to illustrate the spatial arrangement of the individual letters in the syllables.

As described earlier, each consonant and vowel regularly corresponds to a single phoneme in the language. Hangul is also evaluated as an *alphabetic syllabary* writing system because Hangul is an alphabet, with each letter coding a phoneme, and because two or more letters are packaged together into syllable blocks (Taylor, 1980; Wang, 1981).

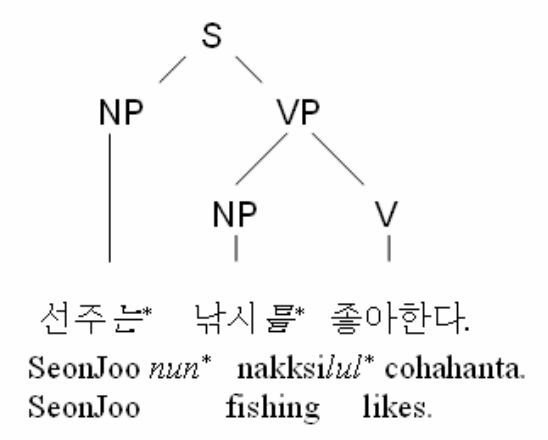

Figure 2. Example sentence showing the head final structure of Korean.
Note: * indicates the case markers for subject and object, respectively.

At a higher, linguistic level, Korean sentence structure is different from many other commonly studied languages (e.g., English) in that it is head-final, which simply means that verbs are placed at the ends of sentences (i.e., SOV word order; see Figure 2). Therefore, many words are shown up earlier than a verb in a sentence. In addition, due to case markers, word order in sentences is thus more flexible than in English, and syntactic categories are represented using by case markers (e.g., '는 –nun' and '를 –lul' in Figure 2). These important characteristics of Korean may influence the word predictability effect because it is determined – at least in part – by the syntactic information that occurs prior to a given word. Thus, one might predict that, in the case of Korean, the head-final syntactic structure and the use of case markers might together provide relatively weak contextual constraints on each word in a sentence, especially weak

syntactic constraints, and thereby reduce the overall size of any word predictability effects that might be observed in the present experiment.

2.2 OTHER WRITING SYSTEMS

Many studies of word identification have been done using Indo-European language (e.g., English). Therefore, previewing other writing systems provides chances not only to understand the differences between Korean and other languages, but also to observe how word identification is achieved in the same or different ways across languages. Next, some other writing systems are overviewed to situate the Korean writing system within a set of languages.

2.2.1 English: alphabetic

In English, there are 26 letters to represent about 44 phonemes. This gross mismatch between the number of letters and the number of phonemes creates confusion within English orthography, that is the rules or conventions for using letters to spell words. This confusion can be exemplified by one of the more salient characteristics in English, that is a single letter can represent a variety of sounds, and a that single sound can be represented by several different letters or letter groups (Taylor & Taylor, 1983).

2.2.2 Chinese: logographic and morpho-syllabic

The Chinese writing system originated from a purely logographic one, but now its characters have come to map onto the language at both syllable and morpheme levels, over its evolution to a morphosyllabic system (DeFrancis, 1989). In Chinese, one character represents one morpheme, which is one spoken syllable. The majority of Chinese morphemes are “free”, that is, each can be used by itself as a word. Only a handful of Chinese morphemes are “bound” morphemes (i.e.,

particles), which are also written as single character. A Chinese word is not always represented by only one character: it may consist of from one to as many as eight morpheme-characters (Taylor et al., 1983).

Historically, Chinese language has greatly influenced East Asian languages (e.g., Korean or Japanese), and Chinese characters are used in other countries with variations (see, Taylor et al., 1983; Wang, 1981). Before the modern Korean alphabet system was invented in 1443 by King Sei-jong, 100 percent of Korean words were written using Chinese characters (Hanja). Nowadays, about 60% of Korean words still can be written using Hanja, but using Hangul spelling is preferred option because it is easier to read and write. In order to avoid semantic ambiguities by homophones, however, Hanja is still used as well.

2.2.3 Japanese: logography and syllabary

There are two different scripts used in Japanese, Kanji and Kana. Kanji is the name for Chinese characters used in Japan. Although Chinese characters are used in Japanese, Chinese and Japanese are totally unrelated languages in sound system, vocabulary, and syntax (Taylor et al., 1983). The majority of Kanji used in Japan have at least one Chinese-derived and one Japanese-native pronunciation. One is not always sure whether a Kanji is to be read in a Chinese or a Japanese way. The other script used in Japanese is Kana, which also has two different forms called Katakana and Hiragana. Katakana is a fragment or side of a Chinese character and Hiragana is a cursive and greatly simplified form of the same character. Obviously, Kanji is a logography, and Kana is syllabary system. The characters in the Japanese syllabary do not permit any decomposition of a syllable into its initial consonant and following vowel and hence can be considered a true syllabary. First of all, each letter represents the same syllable consistently.

Second, the sound of a syllable sign serves also as the name of the sign. Third, each letter is simple in shape, containing no more than six strokes, with three being the most common number of strokes. Again, in terms of orthographic depth, Japanese can be thought of as being mixed with shallow orthography (i.e., Kana) and deep orthography (i.e., Kanji). Therefore, an interesting characteristic of Japanese is the combined use of two different orthographies in a sentence.

Next, I describe some theories and findings relevant to word identification. Theories of word identification provide explanations of how word identification is achieved, and the findings suggest what kinds of factors affect word identification, and how those factors affect word identification.

3.0 THEORIES AND FINDINGS OF VISUAL WORD IDENTIFICATION

3.1 VISUAL WORD IDENTIFICATION: THEORIES

3.1.1 Holistic processes vs. hierarchical processes

There are two distinctive perspectives on word identification: one is that readers process a word as a single pattern or perceptual unit (i.e., holistic process); the other is that readers process words as collections of individual letters and integrate those letters (i.e., hierarchical process). Johnson (1975) suggested a single-unit pattern model based on the evidence from word or letter search experiments. In these tasks, before single word displays were presented, either a letter or word was presented as a target item. Participants indicated whether or not it was a target word, or whether it contained a target letter. Mainly, the reaction time to identify a word was faster than the reaction time to identify a letter, even the first letter within a word. But words and single letters in isolation were identified equally fast. In addition, no effect of word length (letters or syllable) from this experiment could not be explained by letter-by-letter processes. Therefore, the single-pattern unit model suggested that word identification can be achieved by word-unit, not by sublexical units in a word (e.g., letters).

In contrast to this single-unit pattern model, the other type of model explains the word identification as letter-integration, either serial or parallel. One well-known model in the word identification field is the interactive activation model (McClelland & Rumelhart, 1981). The

interactive activation model consists of three processing levels, -feature, letter, and word,- which are implemented by activation and inhibition processes within the same level and among the levels. There is bottom-up activation from feature-level representations to letter-level representations to word-level representations, as well as top-down activation from word-level representations back to lower-level representations, that is, feedback activation. McClelland and Rumelhart proposed this model to explain the word superiority effect: perception of a single letter (e.g., K) is better when it is part of a word (e.g., WORK) than when it is presented in isolation. Beyond this primary phenomenon, it can further explain word frequency effect due to the fact that the resting level activations of word-level representations are frequency dependent. Therefore, once activated, representations for high frequency words will reach their activation threshold more quickly than representations for low frequency words.

Some studies of Korean word identification (Park, 1996; Nam, Seo, Choi, Lee, Kim, & Lee, 1997) attempted to determine which model can better fit Korean data. Using word in isolation tasks (naming or lexical decision), they found an effect of the number of letters (Park, 1996) or the number of letters and visual features (Nam et al., 1997). However, whether these processes will persist with different types of tasks (e.g., silent reading sentences) is questionable. Reading a word in a sentence might affect the role of sublexical units in single-word identification. In addition, the orthographic property of Korean, which is printed not as a linear arrangement, but as a packaged arrangement within a character space, might affect this process in a sentence reading situation. For example, when native Koreans read a sentence, they might be less affected by detailed features within a single word.

According to Lupker (2005), the interactive activation model also has the potential to explain semantic priming effects, as well as effects due to semantic aspects of the word itself

(e.g., concreteness effect or the fact that imageable words are responded to more rapidly than nonimageable words in lexical decision tasks; De Groot, 1989). These types of effects would be due to “higher-level input” (i.e., semantic information) impacting word-level representations through feedback activation. The “high-level input” can also be invoked for explaining contextual effects, which might reduce the threshold of word identification depending on syntactic and semantic constraints. In terms of processing units in a word, the interactive activation model demonstrated that word identification can be achieved by detecting visual features and letters. Based on this process, an interesting question arises: Do the bottom-up processes of detecting both features and letters also necessarily occur during the reading of Korean?

3.1.2 Dual Route model

The dual route model is an extended version of interactive activation model (Lupker, 2005), because the basic interactive activation system is used to describe the two main actions of the model (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). One of the dual routes is the “lexical route” contains word-level representations (the orthographic input lexicon), and is directly linked to a phonological output lexicon. The phonological output lexicon contains phonological codes of words known to the reader and it is linked to the phoneme system, which allows translation of the phonological codes into speech. The other is the “nonlexical route” which connects the letter-level representations directly to the phoneme system. This route is indirect and involves an intermediate step of converting the orthographic interpretation into a phonological interpretation through the use of rules.

One of the implications in this model is that either the direct or the indirect route can be preferred, based on the orthographic depth of language. According to the Orthographic Depth Hypothesis (Frost, Katz, & Bentin, 1987), orthographic depth is determined by the degree of correspondence between a grapheme and its phonology. English is an example of deep orthography, because many words of English are not pronounced by grapheme-phoneme conversion (e.g., *yacht* or *pint*). In the case of Korean, however, the relationship between Hangul script and its sound is very transparent; therefore it can be regarded as a shallow orthography which can prefer the indirect route during the word identification task.

3.2 VISUAL WORD IDENTIFICATION: PREVIOUS FINDINGS

3.2.1 Word length effect

Word length is thought of as a fundamental constraint to identify a word. The universal importance of word length is suggested by the fact that word length effects have been found in many different languages, such as Korean (Choi, 1986; Park, 1993; Lee & Kim, 1989; Nam et al., 1997), English (Lee, 1999; Lima & Pollatsek, 1983; Spoehr & Smith, 1973; Prinzmetal, Treiman, & Rho, 1985), Hebrew (Lavidor & Whitney, 2005), and French (Juphard, Carbonnel, & Valdois, 2004). These studies have generally found that naming and lexical-decision latencies for target words are longer for long words than for short words. This result is thought to be due to the fact that our visual system has limited visual acuity which makes it more difficult to identify larger objects (e.g., words). In addition, the tasks that have been used (e.g., naming) demand cognitive processes, for instance, matching the printed scripts to their sounds. If the time to complete these processes increases linearly as the number of characters increases (which

would be true as word length increases), then it would take more time to name long words than short words. The explanation of how visual acuity affects word identification is consistent with the results of eye-movement experiments, which also reliably show word-length effects in the eye-movement patterns that are observed during the reading of sentences. For example, Vitu, O'Regan, Inhoff, and Topolski (1995) found an effect of word length on word skipping in their eye-tracking experiment, with short words being skipped more frequently than long words in normal reading. Moreover, this pattern was found even if the "words" consisted of Z-strings (e.g., Zzzzz) and participants were instructed to pretend that they were reading. This result implies that word length can affect word skipping regardless of the task (e.g., normal reading or pretending to read) or the format of the text (e.g., real text or z-text). Also readers tend to read word-by-word. Reading processes are adapted to specific units of printed letter strings, for example, word. But, one might ask whether or not other variations within a word affect reading process. One possible variation within a word can be its internal structure, that is, density or complexity. Different way of writing words might result in different levels of visual complexity.

In terms of the internal structure of Korean words, there are two properties of the Korean alphabet (*Hangul*) system: the first is the different types of CV blocks that can be used to construct words (Taylor, 1980); the second is the number of visual features making up letters and words. In Hangul, the square-like spatial arrangements of the individual letters within each syllable may possibly relate to the complexity of a word, because there can be relative variation of the visual features or the number of CV block types in the limited space. For instance, words consisting of the same number of syllables can consist of different CV blocks, and thus contain different numbers of visual features. According to Taylor (1980), there are five different types of CV combinations that can be categorized into three levels of visual complexity (see Table 1).

Table 1. Example of Hangul Syllable Blocks Showing Three Levels of Complexity (adapted from Taylor, 1980) and Number of Visual Features

Complexity Level	Linear Arrangement	Syllable-Block	Number of visual feature	Syllable and pronunciation	Meaning
I	ㅏ	아	3	V /a/	suffix; ah
I	ㄷㅏ	다	5	CV /da/	all
II	ㅏㄹ	알	8	VC /al/	egg
II	ㄷㅏㄹ	달	10	CVC /dal/	moon
III	ㄷㅏㄹㄱ	닭	12	CVCC /dalg/	hen

Basically, the complexity increases by adding a consonant. These levels of complexity might be predicted to affect word identification simply because increasing the complexity of a word increases the number of visual features, and thereby induces more low-level visual processing necessary to identify the word.

Taylor's prediction is consistent with an experiment that has examined the effects of CV blocks in Korean (Taylor, 1980). Taylor found that Korean native speakers were sensitive to the type of CV blocks. In their experiment, the participants were asked to cancel out one type of target letter among other letters, canceling as many instances of a target letter as they could in a given time. Two experimental conditions were employed: in a homogeneous background condition, the participants had to recognize and discriminate a target letter among other letters of the same complexity level; in a mixed background condition, the participants had to recognize the same target syllable among other letters of all three complexity levels. The target words could come from any of the three complexity levels. The results showed that participants recognized and discriminated target letters better in the mixed- than homogeneous-background condition, and that the simpler target letters of level I were better recognized than the more

complex letters of level III. Although these results empirically showed that native Korean readers are sensitive to letter complexity, it did not demonstrate whether letter complexity affects word identification during natural reading.

Another variable related to the internal structure of Korean words is visual features. This visual feature is very similar to the stroke in Chinese (Wang, 1981). Nam and colleagues (1997) examined the role of sublexical units in Korean as well as visual features, such as horizontal, vertical, and diagonal lines, and circles (see Table 1). Their naming and lexical-decision experiments showed that the reaction times in these tasks increased as the number of visual features in the words increased, even when the number of syllables was controlled. These results may reflect the fact that native speakers of Korean are sensitive to the visual complexity of words, even though these visual features are not related to the linguistic aspects of the language. But, one might still ask whether or not the visual components of the letters (e.g., vertical lines) have a role in word identification within text. Specifically, it is important to note that this finding of Nam and colleagues (1997) was based on naming and lexical decision tasks with isolated word stimuli; therefore, two aspects of the task characteristics can be considered here. The first is a comparison between the naming task and the self-paced reading (i.e., silent reading). In this case, we can predict the naming task could be more sensitive to phonological information of a given word than the silent reading. The second is a comparison of the lexical-decision task using isolated words with the silent reading of words within a sentence. These task differences might be expected to induce a specific priority in word identification, for example, compared to silent reading task, the naming task possibly requires that readers access phonological information from printed words.

3.2.2 Word frequency effect

In addition to word length, another variable considered in the present study is frequency of occurrence. Many previous studies using a variety of different experimental methods have consistently demonstrated word frequency effects (Raney & Rayner, 1995; Monsell, Doyle, & Haggard, 1989; Allen, McNeal, & Kvak, 1992). Allen, McNeal, and Kvak. (1992) examined the effect of word frequency by manipulating stimulus onset asynchrony (SOA), the interval between onset of the prime and the onset of the target. In their lexical decision experiments, word-frequency effects were found across the different SOAs, between the presentation of a letter string and a subsequent pattern mask in a lexical decision task, and no interaction between frequency and SOA. In addition, Monsell, Doyle, and Haggard (1989) designed a series of experiments to compare the effect of word frequency using different types of tasks (e.g., semantic categorization, syntactic categorization, etc.). The results showed a consistent word-frequency effect in lexical identification with little variability of its effect size. Together, these results suggest that word frequency effects are robust and common.

Eye-movement studies also demonstrated the role of word frequency during the reading of sentences by typical patterns of eye movements: fixation duration, gaze duration (i.e., the sum of all forward fixations on a target word prior to a saccade to another word), or skipping. Common words are better represented in memory and easier to identify, and therefore eye-movement patterns would show as shorter fixations on common words than on less common words. For example, Raney and Rayner (1995) found that high-frequency (common) words were fixated for less time than low-frequency (uncommon) words. This result supports the idea that lexical access during on-line processing is achieved more rapidly in frequent words than infrequent words, and reflects how the mental lexicon is constructed.

Thus, based on results showing word frequency effects across a variety of tasks, we can conclude that the time that is needed to access words from the mental lexicon is a function of how frequently the words are encountered in printed text. Therefore, lexical access to acquire a meaning of a given word is significantly affected by word frequency. This word frequency effect can be expected across languages, because this process can be achieved by a language-independent mechanism.

Considering several factors affecting word identification simultaneously, interaction among the factors is necessary to understand the whole process of word identification. The interaction between frequency and word length showed how these two variables jointly affect word identification. For example, Lee (1999) found a main effect of word frequency and an interaction between frequency and word length with native English speakers, with larger word-length effects for low-frequency than high-frequency words. Studies of Korean have also reported this kind of interaction (Choi, 1986; Park, 1993; Nam et al., 1997). For example, Park (1993) showed a larger frequency effect in 2- and 3-syllable words than in 1- and 4-syllable words. The interaction between word frequency and word length suggests the locus of both variables (Balota & Chumbley, 1985). Namely, word length affects not only prelexical processes, but also lexical processes, because the interaction between these two variables can be interpreted as evidence that both variables share a processing stage (Sternberg, 1969).

3.2.3 Word predictability effect

Next, I consider the contextual effect on word identification examined in the present study (i.e., word predictability). In the case of words displayed within a sentence, predictability is at least partially due to semantic association between two words. For example, Meyer and Schvaneveldt

(1971) presented participants with two letter strings, one printed above the other. The task in this experiment was to respond “yes” if both letter strings were English words and “no” otherwise. The degree of semantic association between the two items was varied. Participants responded faster when the two words were semantically associated than when they were semantically unassociated. The facilitation presumably arises because processing the first item in memory allows more rapid processing of other words associated to it. Alternatively, this facilitation may occur because activation spreads to semantically related word as a result of recognition of the other of the stimulus pair (Collins & Loftus, 1975).

Meyer, Schvaneveldt, and Ruddy (1975) also demonstrated that lexical decision latencies for a target word like NURSE are significantly reduced by the prior occurrence of a related prime word like DOCTOR. This facilitation by priming effect also may occur because activation spreads to semantically related words. Similar experimental stimuli in Meyer, Schvaneveldt, and Ruddy (1975) are used in Neely (1977), and the differences from Meyer Schvaneveldt, and Ruddy (1975) are the short and long SOAs used and the target words selected from the expected category or unexpected category. At the long SOA, facilitation occurred for target words selected from the expected category and inhibition occurred for target words selected from the unexpected category. In the sentence situation, contextual information presented prior to a given word also could construct a reader’s expectation of possible words to be fit with sentential context. And then, the latency for target words could be facilitated if the target word fit with the expectancy.

As with word length and frequency, predictability has been studied using eye tracking. For example, Rayner and Well (1996) examined the effect of contextual constraint on the eye movements of readers who encountered predictable versus unpredictable words in a sentence.

Word predictability was defined as the amount of contextual constraint which was manipulated by the sentential information that was shown before the target words. A cloze-task, in which a separate group of participants were asked to complete sentence fragments, was used for defining predictability. Low-constraint (i.e., unpredictable) target words induced longer gaze durations (the sum of all fixations on a word prior to movement to another word) as compared to medium- or high-constraint (i.e., predictable) target words. Participants were also more likely to fixate (i.e., have greater fixation probability) on words in the low-constraint than medium- or high-constraint conditions.

Another point about predictability that is relevant to the present study is that its effect varies considerably with stimulus quality; that is, the more degraded the stimulus, the greater the effect of context (Stanovich & West, 1983). A recent study using Korean also reported a similar interaction between predictability and visual degradation. Lee (2004) manipulated the predictability of target words in sentences and asked native Korean speakers to make lexical decisions on target words that were visually degraded or normal. The results showed that performance improved when target words were highly predictable or visually normal, with the context effects being larger when the target words were visually degraded than when they were normal. This interaction leads to a prediction that predictability affects early stages of visual word identification, namely, a prelexical processing stage. This conclusion is based on the assumption that the interaction with visual degradation indicates that both variables share the same stage of processing (Sternberg, 1969). However, predictability is also expected to influence later stage of lexical processing by confirming the word meaning based on contextual information. Rayner and colleagues (2004) showed that predictability at least does not interact with frequency, which suggests that these two variables influence different stages of word

identification. This result is interesting because it is in contrast to the prediction that the effect of contextual information can be expected to be greater on less frequent words. Moreover, the frequency effect usually has interactions with other variables, for example, age of acquisition (Morrison & Ellis, 1995) and word length (Lee, 1999).

In sum, previous studies relevant to three main variables (i.e., word length, word frequency, and word predictability) have been reviewed. Because of Korean writing system and orthography, internal structure properties should be considered (i.e., visual features and complexity). Together, these word length and internal structure properties will be investigated to examine what levels of sublexical units in Korean play a significant role during reading. In addition, word frequency and word predictability effects will also be investigated in the following two experiments.

4.0 RESEARCH METHOD

Two experiments were conducted to determine how the variables (i.e., word length, frequency and predictability) discussed above affect word identification in Korean. In the first experiment, predictability norms were collected using a cloze-task procedure. In the second experiment, participants were asked to read sentences containing target words that were selected so as to vary along three main dimensions: word length, word frequency, and word predictability. Word length was defined as in previous studies, using the number of letters, phonemes, and syllables. A related variable, script complexity, was also varied using the way the CV syllable block was constructed (Taylor, 1980; see Table 1), and using the number of visual features (Nam et al., 1997; see Table 1). Word frequency was assigned according to the *Korean Word Database* (2002), and the predictability of each target word was determined using the cloze-task norms collected in the first experiment.

To assess the roles played by the variables described above, the stimuli were organized into three distinct sets. The target words in Set I varied in terms of word length (as defined by the number of syllables) and word frequency. Set II also varied in terms of word length (defined by using number of letters and phonemes) and the degree of complexity (using both CV blocks and number of visual features). Finally, Set III varied in terms of word frequency and predictability.

4.1 EXPERIMENT 1: CLOZE TASK

The objective of this cloze task was to select a set of target words that were highly predictable from their sentence contexts so that these items would be used in a self-paced reading experiment (Experiment 2). The cloze task was conducted using pencil-and-paper format. Participants were presented sentence fragments that terminated with a blank [see Example (1), below]. Participants were simply instructed to write down the first word that comes to their mind after reading each fragment.

Example (1)

Sentence fragment: 용욱이는/ 밤새워/ 시험 공부를 하기/ 전에/ 한잔의 _____.
Pronounced: Yongwuk-i-nun/ pam-say-we/ si-hem kong-bu-lul ha-ki/ cen-ey/ han can-uy
English translation: Yong-Wuk/ overnight/ studying for exam/before/ a cup of _____.

Because Korean is a head-final language that allows a more flexible word order within a sentence than English, its sentence structure was expected to affect word predictability differently than in English. In general, the verb in a Korean sentence is frequently placed at the end of the sentence (i.e., after the target word) and thereby provides little constraint on the target word. Due to this difference of sentence structure between Korean and English, the predictability effect in Korean was expected to be weak. Therefore, the stimuli for this cloze task were designed to contain enough semantic constraint before the blanks (i.e., target words) so as to allow some degree of predictability. In Example (1), there was no main verb shown until a target word placement in this sentence fragment yet, so it could be more open to the blank. So, in order to increase the predictability of particular category words (i.e., drinkable words here), definitive words such as “han can uy” (“a cup of” in English) were used. In contrast, the verb in an English

sentence is typically located near middle of the sentence, and thereby provides relatively more constraint on the target word. In the case of Example (1) as English, there should be the verb "drink" before the blank.

4.1.1 Participants

Seventy-eight native Korean speakers from Sogang University (Seoul, Korea) participated in this task. Except for two participants, all had equal language backgrounds (as determined using a demographic questionnaire).

4.1.2 Stimuli and procedure

One hundred twenty partial sentences were presented on sheets of paper with each sentence fragment containing a blank space [as shown in the example of sentence fragment (1)]. This task was conducted as a pencil-and-paper test. Participants were asked to fill in the blank with the first word that came to mind. After finishing responding to all of the fragments, the participants completed a simple questionnaire to report their gender, age, college major, and language-related experiences. The whole experiment took about 20 minutes.

4.2 RESULTS OF EXPERIMENT 1

Two of the respondents in the cloze task were excluded from the analyses because of their language background (i.e., they had lived over 10 years in the United States and sometimes responded in English). Thirty-two responses from the cloze task that were given more than 25%

of the time in sentence fragments were assigned to the *high-predictability* condition (*M* = 60%; range = 25–97%). Note that the absolute range of words that were judged to be "predictable" in Korean was less than in the results of previous studies using English (e.g., Rayner et al., 2004). The mean cloze-probability for highly predictable target words in Korean was 60%, whereas in English it was 78%. One possible reason for this difference is that the head-final structure of Korean sentences promotes a more flexible word order than in English, and may thereby reduce the effect of contextual constraint that comes from syntactic and/or semantic information. In other words, English sentences can provide both semantic and syntactic constraints on a target word in a sentence, and Korean sentences mostly provide semantic but not syntactic constraints on a target word.

4.3 EXPERIMENT 2: SELF-PACED READING

To investigate how word length, frequency, and predictability affect word reading in Korean, it is first helpful to explain how the properties of the Korean writing system and sentence structure would influence natural reading. First of all, a word-length effect is expected, as has been found in previous studies (Choi, 1986; Lee & Kim, 1989; Nam et al., 1997). However, the effective processing units (e.g., letters, phonemes, and/or syllables) may be different from in previous research using Korean because the task involves sentence reading (i.e., self-paced reading) and not naming or lexical decisions of isolated words. This prediction is plausible, if we can assume the following: When people read more than a sentence silently, they do not need to activate phonological information of every single word explicitly (i.e., compared to a naming task), nor do they need to judge whether every given letter string is a word or not (i.e., compared to a

lexical decision task). In addition, the internal structure of the Korean word can affect the latency for word identification, because of the packaged written form of Korean. Two types of internal structure variables can be considered: characters' complexity as defined by the type of CV blocks, and the number of visual features. As mentioned in the Introduction, complexity level is determined by adding a consonant at the final site within a syllable called *Patchim*. Taylor (1980)'s experiment showed Korean native speakers' sensitivity to different complexity levels. Sometimes, the increasing complexity leads to additional phonological information, but not all the time, for instance, the last consonant "C" in CVCC. Therefore, this complexity level can be tested to see Korean native speakers' sensitivity about the Korean syllable's internal structure. If Korean natives are sensitive to the internal structure of Korean, the complexity level could affect the reading time of words. Nam and colleagues (1997) demonstrated that latencies for naming and lexical decision for Korean words increased as the number of visual features increased.

The second prediction is that an effect of word frequency is also expected because it has been consistently shown across a number of experiments and tasks. This prediction is based on the traditional definition of word identification as a pattern recognition process in which the visual input is encoded and looked up in the mental lexicon to find the best match (Tsai, 2001).

Finally, although an effect of word predictability is predicted, it may be smaller than what has been reported in English because Korean has a more flexible word order than English, which means that the words preceding the target words will provide weaker constraints compared to English. This final prediction is derived from the fact that the strength of predictability determined by the cloze task in Experiment 1 was relatively weak as compared to previous norms collected using English (Korean vs. English: 60% vs. 78%, respectively; Rayner et al.,

2004). This difference is predicted to support a relatively small predictability effect in Experiment 2.

As well as three main effects, we also can predict there will be some interactions among the variables. Previous studies of Korean (Park, 1993; Nam et al., 1997) showed an interaction between word length variables (letters or syllables) and word frequency. In particular, Park (1993) reported an interesting pattern of interaction that depended on the task. Park used one to four syllable words with high- and low-frequency words. In the naming task, reaction time increased as the number of syllable increased in 1–4 syllable words, but the frequency effect was larger in two and three syllable words (21 ms and 31 ms, respectively) than in one-and four-syllable words (1 ms and 10 ms, respectively). This interaction between the number of syllables and word frequency was significant. Similar pattern of results were found for the lexical decision task: Both main effects of syllable and word frequency, and the interaction were significant. But the reaction time for one-syllable words was longer than two-syllable words. Park (1993) suggested a possible reason for this pattern of reaction times might be semantic uncertainty of one-syllable words in Korean. Therefore, in this present experiment using words in a sentence, whether this pattern of reaction time for one-syllable words would be persistent or not is another interesting result to examine. If the sentential context is reliable, then the semantic uncertainty of one-syllable words can be reduced, and the reading time may be faster than two-syllable words. The interaction pattern in the lexical decision task is consistent with the result of the naming task, and it is more salient. Frequency effects were greater in two-and three-syllable words (82 ms and 62 ms, respectively) than in one-and four-syllable words (41 ms and 30 ms, respectively). Based on the previous studies, I predict that an interaction between number of syllables and word

frequency will be found in the current experiment. However, the interaction pattern will be different from the Park (1993)'s result.

Finally, I also predict that there will be no interaction between word frequency and word predictability, due to the relatively weak strength of word predictability in Korean. Therefore, only the robust word frequency effect and weaker predictability effect are expected. If so, this will be consistent with a recent eye movement experiment using English (Rayner et al., 2004) which found no interaction between word frequency and word predictability.

For the purpose of examining how the visual, lexical, and contextual characteristics of Korean affect word identification during natural reading, word length, frequency, and predictability were manipulated among the target words. To do this, three different sets of stimuli were constructed as described in the next section.

4.3.1 Participants

Twenty-one native Koreans in the Pittsburgh community participated in this experiment for $10 each. Twenty-five Koreans in Seoul also participated in this experiment for approximately $7 each. All of the participants had normal or corrected-to-normal vision and thus had no difficulty with reading sentences on a computer monitor.

4.3.2 Stimuli

A set of 108 sentences was generated, and part of this sentence set was originated from the cloze-task norms collected in Experiment 1 (see stimulus Set III). These stimuli consisted of three sets of 32 sentences and 12 filler sentences. (Each set included only a small number of fillers because

each set was expected to function as fillers for the other sets.) More specific information about each set of sentences is given in the following:

Set I consisted of 32 sentences containing target words that varied in terms of word length (i.e., number of syllables: 1–4) and word frequency (high frequency: *Mdn* = 180 per million[1], range = 59–849; low frequency: *Mdn* = 1.3 per million, range = 1–26). Therefore, the properties of the target words in Set I provided the opportunity to evaluate the effect of the number of syllables as a possible unit of word length, and its possible interaction with frequency. Although there are other ways to define word length (e.g., number of letters), the number of syllables in Korean is strongly correlated to these other word-length measures (Nam et al., 1997). Therefore, only the number of syllables was considered in this first stimulus set; the possible roles of the other units of word length are examined in Set II, while controlling for the number of syllables.

Set II consisted of 32 sentences containing two-syllable target words with various numbers of phonemes (*M* = 5.1; range = 3–7) and letters (*M* = 2.6; range = 2–6). The internal structure properties of the Korean words also varied in this set, but they were not directly manipulated (as was frequency in Set III) based on two properties: the various possible syllable-block (CV) combinations (Taylor, 1980), and the number of visual features (e.g., vertical lines, etc.; Nam et al., 1997). As Table 1 shows, CV block combinations can have three levels of complexity based on a single letter, so the complexity of the present stimuli was based on the sum of each syllable's complexity level (*M* = 4.8; range = 3–6). The number of visual features was also based on the sum of all components in each word (*M* = 12.7; range = 7–19).

[1] The database referred here provides the frequency based on 1.5 million, but it is converted based on 1 million for comparing with other general data corpora.

Set III consisted of 32 target sentences extracted from the cloze task used in Experiment 1 and containing four types of target words: (1) high-frequency predictable words; (2) high-frequency unpredictable words; (3) low-frequency predictable words; and (4) low-frequency unpredictable words. The frequency of the target words was determined using the Korean word frequency database (National Academy of the Korean Language, 2002). The frequency of the high-frequency words was over 53 per million (*M* = 149, *Mdn* = 114, *SD* = 134) and the frequency of the low-frequency words was less than 9 per million (*M* = 2.9, *Mdn* = 2.3, *SD* = 2.5). The predictability of each item was determined using the cloze task described above. Predictable target words were selected from the responses that were given more than 25% of the time (*M* = 60.38%, *Mdn* = 63%, *SD* = 17.64%). In sum, as Table 2 shows, each target word (high- or low- frequency) was embedded in sentences that made the words either predictable or unpredictable. In the unpredictable conditions, target words were selected from responses that were given less than 1% of the time. To control word length, all of the target words in Set III were two-syllable words (except for two of the items, both are three-syllable words).

Table 2. Examples of Target Stimuli Extracted from the Cloze Task in Experiment 1

Condition	Example Sentences
HF– P	일요일에는 미뤘던 빨래와 **청소**를 해야겠다. On Sunday, postponed, laundry, and, **cleaning**, have to.
HF – U	차가 더러워졌으니 일요일에는 반드시 **청소**를 해야겠다. Car, dirty, on Sunday, necessarily, **cleaning**, have to.
LF – P	차가 더러워졌으니 일요일에는 반드시 **세차**를 해야겠다. Car, dirty, on Sunday, necessarily, **car wash**, have to.
LF – U	일요일에는 미뤘던 빨래와 **세차**를 해야겠다. On Sunday, postponed, laundry, and, **car wash**, have to.

***Notes*:** Bold indicates target words; HF: high-frequency targets; LF: low-frequency targets; P: predictable targets; U: unpredictable targets.

Fillers consisted of 12 sentences that were presented as longer, multi-word units (e.g., phrase by phrase or a whole sentence at a time) as compared to the experimental sentences to prevent participants' automatic pressing of the button without their possessing or comprehension of the individual words.

4.3.3 Procedure

Participants completed a questionnaire about their gender, age, college major, and language background before being in the experiment. Participants were then instructed to begin the self-paced reading task. The sentences were presented one at a time on a computer software designed for masked, self-paced reading experiments.[2] The initial display consisted of a line of dashes with spaces preserving spaces between words. The participants were instructed to press the space bar to see the first word, and then to press the bar to see each new word of the sentence; thus, whenever participants pressed the space bar, each set of dashes changed to a word (i.e., a self-paced moving window paradigm where each new word replaced a set of dashes). During this process, a presented word changed to a set of dashes when participants pressed the space bar to see the next word. When only one word at a time is presented, this procedure yields a processing time measure for each word in the sentence (Just, Carpenter, & Woolley, 1982). Participants were also instructed to read at a natural rate and to comprehend what they were reading. Before starting the experimental session, each participant read five practice sentences to become familiar with the procedure. During the experimental session, true/false comprehension questions were randomly presented after one fourth of the sentences (on average) to impose on-line comprehension of the sentence and to avoid "mechanical" pressing of the button to move

[2] The program was written by Douglas Rohde and can be obtained from : http://tedlab.mit.edu/~dr/Linger

forward through the text. They answered these questions by pressing the “F” key for “yes” or the “J” key for “no”. They were then given feedback if their answer was incorrect. The computer automatically displayed the onset of the next sentence following each sentence or comprehension question.

4.4 RESULTS OF EXPERIMENT 2

All reading times for target words that were more than 3 *SD*’s from the mean of each stimulus set were excluded from the data analyses. Two participants from the Seoul group were also excluded from the data analyses because they had already participated in our cloze task, and three participants (two from Pittsburgh and one from Seoul) were excluded because they had a significant number of long reading times (i.e., 33% more than 3 *SD*’s from the mean). This meant that 41 participants’ data were analyzed. All of the reading times for target words are re-calculated by dividing the mean times by the number of syllables in each target word. (This was necessary because Korean words are typically combined with case markers; e.g., *un, nun, i, ga* for subjects, and *ul, lul* for objects. Details of this procedure are reported with the results of each stimulus set.)

4.4.1 Set I: Word length (number of syllables) and frequency

Before analyzing the data of Set I, 1.3% of the data more than 3 SD’s from the mean were excluded. Unfortunately, there were not equal numbers of 1-4 syllable words in this stimulus set. Therefore, a stepwise regression analysis was conducted using the order as the number of

syllables, corrected frequency (i.e., logarithmic frequency, because the absolute ranges of frequency was too broad), and the interaction between those two variables as predictors.

Table 3. Multiple Regression Analysis Results from Set I

Variable Input Order	R	R^2	Changes in R^2	F
1. Number of Syllable	.912	.832	.832	148.05 ***
2. Frequency	.926	.857	.026	5.2 *
3. Number of Syllable × Frequency	.936	.879	.021	4.93*

Notes: * refer to p < .05, ***, refer to p < .001

The results are shown in Table 3. The R^2 statistics showed the number of syllable did significantly predict reading times [R^2 = .832, $F(1, 30) = 148.\ 05$, $p < .001$]. As predicted, the effect of word length was reliable, with the reading times for target words increasing with the number of syllables. This result demonstrates the importance of word length in word identification, and the significance of the syllable as a critical processing unit in Korean. Word frequency also significantly accounted for variance [ΔR^2 = .026, $F(1, 29) = 5.20$, $p < .05$]. Finally, interaction between the number of syllable and frequency also accounted for significant proportion of variance [ΔR^2 = .021, $F(1, 28) = 4.93$, $p < .05$]. Figure 3 shows the result of reading times depend on word frequency and number of syllables.

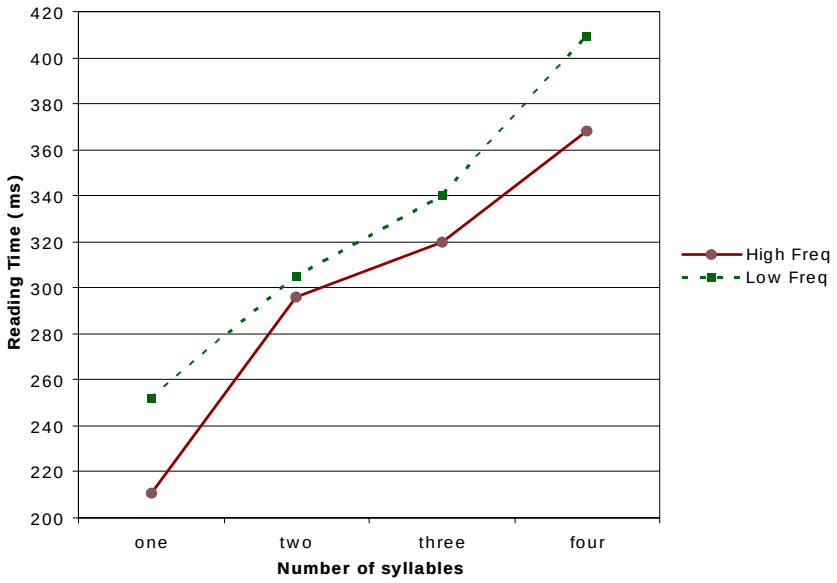

Figure 3. Reading times for target words in Set I a function of the word frequency and the number of syllables. Reading times linearly increase as the number of syllables increases, and the latencies are faster for high-frequency words than for low-frequency words. An interaction indicates that the frequency effects are larger for one- and four-syllable words than two- and three-syllable words.

In general, as far as word frequency is concerned, high-frequency words received shorter reading times than low-frequency words (*M*= 298.9 ms vs. 326.9 ms, respectively). This result replicates findings that frequent words were represented more accessible status than infrequent words, as many previous studies shown.

In addition, the mean differences between high- and low- frequency words across syllables imply that the frequency effect size is different depending on the number of syllables. This result is basically consistent with interactions between frequency and length as shown in previous English or Korean studies using naming and lexical decision (Lee, 1999; Park, 1993; Nam et al., 1997). Interestingly, however, the pattern of the effect sizes of frequency in this experiment is different from a previous study (Park, 1993) which also reported the interaction between those two variables in Korean. Park (1993) found effects of word length (defined as the number of syllables), word frequency, and an interaction between these two factors when

participants were asked to name and make lexical decisions about target words. However, there is one difference between Park's (1993) results and those of the present experiment: Park (1993) showed a larger frequency effect for two- and three-syllable words compared to one- and four-syllable words, but he did not suggest any interpretation about this tendency of frequency effect.

In contrast, the present experiment showed the different pattern of interaction as Figure 3, namely, word frequency effects were greater in one- and four- syllable words than in two- and three- syllable words. For the different effect sizes of frequency depending on the number of syllables, I examined the numerical ratio of 1–4 syllable words in the database that has used in this study. The ratio is 1: 17: 14: 5, as respectively. Therefore, I can conclude that the larger effect of frequency in one and four syllable words in the present experiment is because one and four syllable words are expected to used relatively less frequently as compared to two-and three-syllable words, and it possibly made Korean native speakers' sensitivity to one-and four-syllable words much higher compared to two-and three-syllable words. It is possible thought that latency of word identification is a function of not only the syllabic types (1-4 syllable), but also token frequency of each syllabic type.

Although the effects of other units like phonemes or letters could also be considered here, both of these units are highly correlated with the number of syllables (Nam et al., 1997). The effect of the number of letters and phonemes (controlling for the number of syllables) will therefore be examined in the analyses of the Set II sentences.

4.4.2 Set II: Word length (number of letters, phonemes) and visual complexity

1.5% of data more than 3 *SD* from the mean were excluded from the analyses. Because each of the target words of Set II was a two-syllable word, only the number of phonemes (and letters,

since in Korean the two are highly correlated) varied across the target words (in contrast to the target words in Set I). The visual complexity level of each word was also defined using the CV block measure (see Table 1) and the number of visual features (Nam et al., 1997). Both of these measures are based on the characteristics of the Korean script's internal structure. Taylor (1980) suggested three types of CV blocks corresponding to three levels of complexity, whereas visual features, suggested by Nam and colleagues (1997), can be thought to be another processing unit. Visual features can be decomposed into primitive components (e.g., vertical lines) in each word as previously shown in Table 1.

A stepwise regression analysis as a order of the number of letters, phonemes, and visual features, along with visual complexity showed that only the number of visual features reliably predicted reading times ($r = .373$, $p < .05$). These results are partially consistent with results from experiments using words in isolation, such as with a lexical decision task or a naming task (Nam et al., 1997) both of which showed the effects of other sublexical units (i.e., phonemes, letter) as well. Thus, sublexical units' effect might be different dependent on the task, for example, when native speakers of Korean read a sentence, they may be sensitive to the internal structure, but not phonemes and letters. The task in this experiment was self-paced reading, word by word, and silent reading might not ask to use the phonological information explicitly.

4.4.3 Set III: Word frequency and predictability

In Set III, 1.7% of the data in excess of 3 *SD*'s of the mean were excluded from analyses. A 2 (high vs. low frequency) × 2 (predictable vs. unpredictable) ANOVA indicated reliable effects of word frequency [$F(1, 40) = 5.54$, $p < .01$] and a marginal effect of predictability [$F(1, 40) = 3.80$, $p = .058$], but no interaction ($F < .5$). Figure 4 represents the pattern of these results.

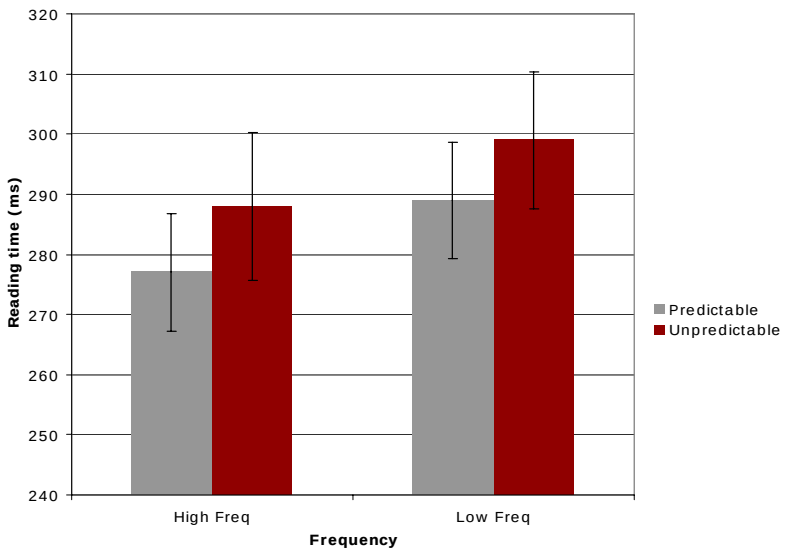

Figure 4. Reading times for target words in Set III as a function of word frequency and predictability additively. Both variables showed main effects, but no interaction.

A power analysis indicated that the latter was not likely to be a Type II error (power = .055). The overall findings from Set III were thus consistent with previous eye-tracking experiments that have examined the same variables (Lavigne, Vitu, & d'Ydewalle, 2000; Altarriba, Kroll, Scholl, & Rayner, 1996; Rayner, Binder, Ashby, & Pollatsek, 2001; Rayner et al., 2004). As in these experiments that used English, Korean also showed the effects of word frequency and predictability, but no interaction. Therefore, we can conclude that word frequency and predictability affect lexical access additively or that the effect different stages of lexical processing (e.g., pre-lexical vs. post-lexical processing). The fact that there was a relatively weak effect of word predictability in Korean can be linked to flexible word order within a sentence in Korean.

5.0 GENERAL DISCUSSION

In the present study, a self-paced reading task was administered to examine how three types of factors-visual, lexical, and contextual factors-affect word identification during reading Korean. Results provided some interesting findings as follows: reading times of Korean words within a sentence were affected by the number of visual features and the number of syllables, but not by number of phonemes or letters.

Word frequency, representing a lexical variable, also had a significant effect on reading time for target words, as many other previous studies have shown; therefore, we can conclude that people rapidly access the meaning of frequent words as compared to infrequent words. In addition, the interaction between frequency and the number of syllables was significant.

Another major finding of the present study was a sentential context effect on word identification. For the contextual effect, predictability of target words was controlled by the syntactic and semantic information shown prior to the target words. Word predictability reliably affected the reading times of target words. However, an interaction between word frequency and word predictability was not found.

Results of the present experiment can provide an opportunity to compare word identification phenomenon in Korean with findings from studies using other languages. By comparing empirical findings from different languages, we can delineate the universal properties of word identification and language dependent process in word identification as well.

Perfetti (2003) stated that reading has universal properties that can be seen across all writing systems. Specifically, Perfetti suggested the universal principle that reading requires the reader to make links to language at the phonological and morphemic levels. At the same time, the nature of the writing systems and orthographies that instantiate them do make a difference for important details of the reading process. In terms of universality in reading, we also speculate about word identification as the foundation of skilled reading (Gough, 1984), focused on its universal properties and language-dependent constraints.

To address comparisons of Korean and other languages, I focus on only a few highly distinct languages that represent different writing systems. Languages may be distinguished from one another via their writing systems and orthographies. As Perfetti (2003) illustrated, writing systems can be understood at two levels; mapping principle as a higher level and orthographic constraint as a lower level. Writing systems can be generally classified in three ways: Alphabetic, Syllabic, and Logographic. In addition, one of the approaches to individual writing system could be the analysis of its orthography, and this approach might be useful to observe language dependent process (Perfetti, 2003).

5.1 PROCESSING UNIT AND WRITING SYSTEM

One of the underlying goals of the present experiment was to suggest evidence of what reading units have a significant role in word identification in Korean. Among the various reading units, what types of units seriously affect word identification process? In addition, one might ask whether the preference of processing unit depends upon the type of writing system.

According to Taylor et al. (1983), various definitions of a reading unit are possible on the broad level. For example, a reading unit could be physically separable from others of its kind; it may have a sound; it may have a meaning. Several types of units can be summarized to two different types of processing units in a word. The first is the meaningless or sublexical units, such as letters, letter clusters, and syllables. The syllable is the unit of writing in a syllabary, such as the Japanese Kana, and syllables represent morphemes in the Chinese language and writing. The second type of units are meaningful or lexical units which are morphemes. Morphemes are the smallest meaningful units, and they may consist of a few alphabetic letters or one Chinese character. Stems, as free morphemes, and affixes, as bound morphemes, are also recognized as morpheme units.

Korean, having an alphabetic syllabary, shares properties with both English (alphabetic) and Chinese (morpho-syllabic). This property is shown in the processing unit of Korean. First, compared to Chinese writing system, both Korean and Chinese have similar written form as square-shaped characters. In particular, Korean words consisting of CVCC type is more similar to Chinese logographs (Taylor, 1981; see Table 1). Although the internal structure variables are not directly related to word reading units, it has been reported its influence. With respect to the internal structure, visual factors might play a role of in both Chinese and Korean. In Chinese, there is a complexity of character which is measured by the number of strokes (Taylor, 1983). A stroke is a dot, an L-shape, or a horizontal, vertical, or diagonal line, and there are about 20 stroke types (Wang, 1981). A stroke in Chinese character is very similar to a visual feature in Korean (Nam et al., 1997). Neither stroke nor visual feature relates any lexical or semantic information in Chinese and Korean. But, Yeh and Liu (1972) reported an adverse effect of complexity on recognition: latency for recognition was longer for complex characters (15 or

more strokes) than for simple ones (10 or fewer strokes). A similar effect was found in a previous study of Korean using a lexical decision task (Nam et al., 1997) and the current experiment using self-paced reading task supports this conclusion. These results support the conclusion that both native speakers of Chinese and Korean are sensitive to this sort of visual factor, even if it is not directly related to word reading units.

Next, considering a purely alphabetic language, such as English, results from experiments showed the effect of word length, which can be measured in the number of letters (Lee, 1999; Rayner & McConkie, 1976) or in the number of syllables (Lovatt, Avons, & Masterson, 2000). These results indicate that short words (e.g., one syllable) gain a benefit not only from working memory span (Baddeley, Thomson, & Buchanan, 1975), but also from their decreased load on the phonological memory system (Lovatt et al., 2000).

In Korean, previous studies (Choi, 1986; Lee & Kim, 1989; Nam et al., 1997) found that the number of syllables affect the latencies for naming or lexical decision tasks. In addition, Nam and colleagues (1997) found effects based on other sublexical units, such as the number of letters or phonemes. In contrast to the experiments using naming or lexical decision tasks, the present study employed self-paced reading and only found an effect of the number of syllables. Therefore, considering both the characteristics of the Korean writing system (i.e., alphabetic syllabary) and task difference (self-paced reading), these findings suggest that the preferred processing unit of printed Korean words can be the syllable, which takes the internal structure of Hangul variation into account. This conclusion is also supported by previous results which found that the frequency of syllable and the number of syllables that were *Kulca* (i.e., the Hangul orthographic units which corresponds to a single syllable) (Yi, 1993; Lee & Kim, 1989).

5.2 DUAL ROUTE MODEL AND ORTHOGRAPHIC DEPTH

According to the Dual Route Model (Patterson & Coltheart, 1987), a reader has two ways to go from the printed word to its meaning (semantics) stored in memory. One route is direct and involves accessing the printed word's meaning on the basis of its orthographic interpretation (i.e., the letters and letter combinations that compose it). The other route is indirect and involves an intermediate step of converting the orthographic interpretation into a phonological interpretation through the use of rules. Readers of different languages may rely upon these different routes to differing degrees, depending upon their language. The Orthographic Depth Hypothesis (Frost, 2005) suggests that shallow orthographies can easily support a word-identification process that involves the printed word's phonology. In contrast, in deep orthography like English, readers are encouraged to process printed words making use of larger units (e.g., whole words). Therefore, in the case of word identification in languages with shallow orthography, they probably use the indirect route, which depends upon the Grapheme Phoneme Conversion rule, the process of translating each grapheme into its corresponding phoneme. In contrast, word identification in deep orthography is achieved, most likely, through the direct route, because of the irregularity between grapheme and its phonology. Although the orthographic depth hypothesis originally referred to the alphabetic writing system, we can apply this hypothesis to other writing systems as well. As I noted earlier, Korean has a transparent relationship between letters and sounds, that is, a shallow orthography. The relationship between the orthographic depth hypothesis and the dual route model discussed above is additionally linked to an assumption that word frequency effects can be predicted by the degree of orthographic depth. For example, if words from a deep orthography are processed via the direct route, which is more rely on the mental lexicon, and then a word frequency effect would be

found. And, obviously, as shallow orthography words are processed via the indirect route, the word frequency effect would remain but would be significantly weaker (Frost et al., 1987). Frost, Katz, and Bentin (1987) found a strong effect of frequency on word identification in Hebrew, which has a deep orthography, a moderate effect in English, and non-significance in Serbo-Croatian which has a very shallow orthography.

In contrast to these results, studies of word identification in Korean, which is also considered to have a shallow orthography, have produced a frequency effect consistently in the literature (Park, 1993; Lee, 1998; Nam et al., 1997), and so has the present experiment. According to Lee (1998), this might be explained by some unique properties of Korean, such as a consonant assimilation phenomenon and a morphophonemic script. The consonant assimilation reflects many Korean words, more than two syllables length, having an alteration in pronunciation. For example, the pronunciation of "난" and "리" are "/*nan*/" and "/*li*/," respectively, but they change when both syllables are combined to produce a single word "난리" as "/*nalli*/". With respect to the morphophonemic property, Korean also can contain morpheme then, it probably leads to access to a mental lexicon (like deep orthography) although the Korean writing system is orthographically shallow. Therefore, the consonant assimilation phenomenon and morphophonemic property might be used as new metrics to evaluate a writing system. Unfortunately, the present experimental stimuli were not systematically manipulated to observe whether both factors are involved in word identification processes or not.

5.3 LEXICAL STATUS: WORD FREQUENCY

Not surprisingly, the effect of word frequency has been found robust across different experimental methods, such as naming, lexical decision, and across many languages. The present experiment also showed an effect of frequency of Korean words on reading time. In the results of the present experiment, morpheme frequencies in Chinese and Korean can deserve to be discussed because most of target words in this experiment were two-syllable words originated from Chinese-borrowed words. Therefore, the effect of free morpheme frequency could be expected to be different. For Chinese, Zhou and Marslen-Wilson (1994) found an effect of morpheme frequency. Namely, the logographic characteristic of the Chinese writing system can make it *visually semantically transparent*, and this is linked to the consistent effect of morpheme frequency. The fact that most morphemes in Chinese are free morphemes makes this result plausible. However, we expected a different situation in Korean which has a *phonologically transparent* orthography. Korean morphemes have a large number of homophones, originating from Chinese-borrowed words or native Korean words. Therefore, the morphemes within a word cannot be determined prior to identifying the word, and this constraint in Korean might not be linked to the effect of morpheme frequency within a word. For example, 學校 (*school* in Chinese) which can be written as 학교 (*hak-gyo*) in Korean with same meaning. In the case of writing in Chinese characters, the meaning of each character is clear (學 mostly implies *study*) by its logographic property, but in Korean "학" can have several different meanings depending on combined other morphemes. The meaning of "학" within a word "학교" can be accessible probably after complete processing of a whole word. In other words, a single syllable in disyllabic words has relative semantic uncertainty. Therefore, we can predict that the morpheme effect of Korean words, especially for disyllabic words, should be different from the Chinese

disyllabic words: no effect or reduced morpheme effect in Korean disyllabic words. Unfortunately, the data from the present experiment were not analyzed in terms of morpheme frequency because a morpheme frequency database is not accessible at present.

So far, I have attempted to demonstrate the commonality of word identification across the different writing systems and orthographies. I have also pointed out the language-specific results and related them to the orthographical characteristics of those languages based on evidence from the present experiments.

Next, I discuss the other issues based on the task properties in the current experiment, and results based on the contextual constraints.

5.4 WORD IDENTIFICATION WITHIN SENTENCES

The task situation in this experiment, words within a sentence, was reflected in some of the results. The first relevant result is reading time across words with different numbers of syllables, which was linearly increased as the number of syllables increased (i.e., 1-4 syllables). This is inconsistent with the results from Korean studies (Choi, 1986; Park, 1993). A previous study done by Park (1993) showed the same pattern in a naming task, but not in a lexical decision task. Latency for one-syllable words in the lexical decision is much longer than two-syllable words. Park interpreted this result to mean that one-syllable words have greater semantic uncertainty compared to words with different numbers of syllables. However, if a word was embedded in a sentence, it might eliminate the semantic uncertainty of one-syllable words, so the reading time for one-syllable words may have been faster than two-syllable words in this experiment.

Likewise, the naming task is also less related to semantic processing of the word (Meyer et al., 1975), therefore the result of fast latency for a one-syllable word in the naming task is plausible.

Another result related to having the word in a sentence is that the current experiment did not find the effects of the number of letters or phonemes. A previous study (Nam et al., 1997) found both main effects in naming and lexical decision. It is possible that the effects of both sublexical units can be reduced in words in text. Silent reading also implies the inner articulation of words. It is also possible, however, to diminish the resource for referring to the phonemic information to process word meaning. In other words, readers are expected to not necessarily access all of phonological information from the printed words during silent reading task. In addition, we also can consider a relationship between task characteristics and orthographic depth. This effect could be more salient in shallow orthographic scripts (i.e., Korean), and, as a result, there could be no effect of the number of phonemes as seen in this experiment, differently from Nam and colleagues (1997) findings. The naming task (e.g., Nam et al., 1997) explicitly demands to convert all graphemes into phonemes. Therefore, it is expected to readers affected by phonemic information. However, the task used in the present study was not only silent reading, but also self-paced reading by press a button to see word-by-word in a sentence. This task property might make readers to press the button somewhat automatically, namely before the all of available phonemic information are activated.

Next, interaction between word length and frequency can be discussed. Regression analyses from Set I showed main effects of both word-length and frequency, and an interaction between them as well. In regard to the reliable interaction between word length and frequency, the frequency effects were larger in one-and four-syllable words than in two-and three-syllable words. This pattern of interaction reflects the existence of syllabic types (1–4 syllable) in the

corpus that was referred for selecting stimuli. The ratio of one-syllable word: two-syllable word: three-syllable word: four-syllable word in the corpus is to 1: 17: 15: 4. Therefore, it is plausible that the processing latency for one-and four-syllable words is more sensitive to word frequency than for two-and three-syllable words. This is possible because native Korean readers have more experience with two-and three-syllable words than with one-and four-syllable words in their reading situations, and these different experiences may influence Korean readers different sensitivity to word frequency depending on the number of syllables. Note that this tendency of interaction was different in previous studies (Nam et al, 1997, Park, 1993).

5.4.1 Context effect: word predictability

The other question in this study was whether the sentential constraints imposed by syntax and/or semantic would affect word identification during the reading of Korean. The strength of sentential constraints was normalized as the predictability of target words. As mentioned in the Introduction, Korean sentence structure is different from English, namely it has a head final structure. As described earlier, it was hypothesized that there exists a weak effect of predictability in Korean word identification, due to the head-final structure of Korean sentences, and the result showed a significant but a slightly smaller effect of predictability compared to English studies. There are two dimensions of word identification (Tsai, 2001): the word identification in isolation which is more directly affected by structure of the mental lexicon, and the word identification in text which is also affected by textual information. The conventional methods for word identification, such as naming and lexical decision are limited in demonstrating word identification process in a sentence. Another variable embedded in the present experiment, word predictability, could provide additional information about this

dimension of word identification. The main effect of word predictability and the fact there was no interaction with word frequency are consistent with a previous eye-tracking experiment that has examined the same variables, but using English (Rayner et al., 2004).

Next, the question about interaction between the predictability effect and frequency effect arises. First of all, a word frequency effect was shown robustly, implying that we probably have easier access to the mental lexicon in frequent words than in infrequent words. Word predictability determined by sentential constraints also had a reliable significance although the degree of predictability in the present experiment was relatively smaller than in Rayner et al. (2004) the 60% vs. 78% as a mean value from each norming task. Interestingly, however, there was no interaction between these two variables in the present experiment. This is also consistent with a recent eye tracking study (Rayner et al., 2004). It might be explained by logic of interaction patterns (Sternberg, 1969). According to Sternberg, if there is an interaction between two factors, both factors affect cognitive processes at the same stage. Otherwise, if there is no interaction, both factors share a processing stage at least.

Finally, it is adequate to discuss how the three main variables of interest (word length, frequency, and predictability) affect the reading of Korean. Based on all of the findings from the current study, a comprehensive understanding of the reading of Korean could be described in the following. In the early stage of reading Korean, word length (i.e., syllable) and visual complexity (or perceptual difficulty) influence word identification. At the same time, word predictability, which is heavily constrained by the prior syntactic and/or semantic context, also impacts this process. This is plausible because a previous study using Korean (Lee, 2004) showed a reliable interaction between predictability and visual gradation. Therefore, we can conclude that predictability is also involved in the early stage of processing with Korean. After this prelexical

processing, a reader acquires the word meaning by accessing the lexical information of the given words. At this stage, the word-frequency effect plays a critical role for achieving this process, and the degree of frequency effect varies with the word length. Again, the word-length effect lasts from the prelexical processing stage to the lexical processing stage.

5.5 KOREAN WORD IDENTIFICATION DURING READING

As I described in the Introduction, there are two different positions on understanding the word identification process: holistic vs. hierarchical. The interactive activation model (i.e., a hierarchical process) suggested a plausible process of word identification using feedback activation in both bottom-up and top-down mechanisms among processing layers. Previous studies of Korean (Lee & Kim, 1989; Nam et al., 1997), which reported the effect of number of letter and visual features, supported that this interactive activation model can explain the Korean word identification process. Evidence of the present study, however, partly supported this conclusion because there was a significant effect of visual features, not letters. It is probably only because of task properties (silent reading of a sentence), or combined influence with internal structural property of Korean word (packaged written form). Therefore, an alternative model can be suggested. It primarily follows the interactive activation model, but there should be different activation thresholds for each level. Based on this present study, the threshold of letter processing should be decreased. This is also controlled by top-down process, because we can postulate “higher-level” input by semantic constraints. Sentential context prior to a target word can play a role as a higher-level input to adjust the activation level of word.

In relation to computational model for word identification, eye-movement control model can be a good example. Recently, two main eye-movement models were proposed: *E-Z Reader* model vs. *SWIFT* model (Reichle, Rayner, & Pollatsek, 2003; Engbert, Nuthmann, Richter, & Kliegl, 2005). Both models attempt to explain eye-movement control when people read. One of the major differences between the two models, which is related to current discussion, is different assumptions on the order of processing. They propose serial processing vs. parallel processing, respectively. Considering evidence from the current study, especially findings from word length variables, eye-movement control during the reading of Korean can address interesting questions. Is the processing within a packaged syllable serial or parallel? How can eye-movement control be done across a Korean sentence containing the multi-syllable words with spacing between words?

In conclusion, the evidence from the present study has some implications: as alphabetic syllabary writing system, Korean word identification is reliably affected by the number of syllables and visual features. It indicates that the status of Korean writing system, because its writing system shares the properties of neighbor writing system (alphabetic, syllabic, and logographic). Therefore, both visual features as a logographic property and syllables as an alphabetic property influence on Korean word identification. The reason why there is no effect of letter and phoneme on reading times cannot be currently determined, now, but the task situation, word in text, can imply that the sublexical units' role could be reduced in that situation. Word frequency is a strong factor for Korean word identification regardless of task. Word predictability also has a significant role in this process, but the effect is weak. This is probably because of the nature of Korean sentence structure. Finally, better understanding about the

relationship between language-specific details and task characteristics, by the systematic manipulations, will provide more accurate assessments of word identification processes.

5.6 FUTURE DIRECTIONS

First of all, more systematic manipulation of stimuli can be expected in follow-up experiments. For example, the stimuli set in the current experiment contained three types of complexity level. However, there are five types of complexity level are possible for a disyllable word which is most of target words in the current experiment. (each syllable can has 1-3 level of complexity, and complexity level of disyllabic word can be 2-6).

In addition, sentential context can be manipulated in different ways. Word predictability in the present experiment was manipulated by how many people answered a specific word after a sentence fragment. There are different types of contextual constraints, such as phrasal expression or pragmatic context, and those different types of context may affect word identification differently.

Second, additional experiments using other methods for the stimuli in the present experiment can be considered. Naming or lexical decision tasks with same stimuli will provide another opportunity to directly compare the results from different task situations (i.e., words in isolation vs. words in text). In order to examine word identification in more natural reading situations, an eye-tracking experiment with a whole sentence should be considered. In the case of the Korean, alphabetic syllabary, how the internal structure of Hangul and Korean sentence structure affect eye movements (e.g., the parafoveal benefit) can be an interesting question.

Appendix A

STIMULI SENTENCES FROM EXPERIMENT 2

The stimuli from Experiment 2 are shown below. English translations for each word and/or phrase are presented below each sentence.

A.1 STIMULI FOR SET I: 1–4 SYLLABLE WORDS WITH CASE MARKER PRINTED ITALICS ARE TARGET WORDS.

유럽 방문을 / 무사히 마치고 / 돌아온 / *대통령이* / 환영을 받았다.
Europe visiting / safely finishing / come back / *president* / welcomed

진용은 / 자신의 미래를 / 고민하다가 / 마침내 / *선생님이* / 되기로 / 결심했다.
Jin-Yong / his future / thinking about / finally / *teacher* / becoming to / decided

기업이 / 성공하기 위해서는 / 무엇보다 / *소비자의* / 욕구를 / 파악해야 한다.
A company / to success / most of all / *customer* / needs / have to know

신영이는 / 하루종일 / 피곤하셨을 / 엄마를 위해서/ *발을* / 주물러 드렸다.
Shin-Young / all day long / should be tired of / to mother/ *foot* / massaged

승용이는 / 엄마를 닮아서인지 / 음식을 먹을 때 / *땀을* / 많이 흘린다.
Seung-Yong / mother same as / when eat food / *sweat* / too much

지영이는 / 스무 살이 넘도록 / *비행기를* / 타보질 못했다.
Ji-Young / twenty years over / *airplane* / take did not/

열심히 운동하는 / 도연이도 / 나이가 드니 / 별수없이 / *배가* / 나오기 시작한다.
Hard working out / Do-Youn / getting old/ unavoidable / *belly* / develop start

오늘 / 아침 밥상에는 / 예상치 못했던 / *미역국이* / 올라와 있었다.
Today / morning breakfast / unexpected / *Mi-Yek soup* / was there

어릴 때와는 달리 / 조카는 / 이제 잠자기 전에는 / *양치질을* / 하는 / 습관이 생겼다.
Childhood different / nephew / now go to bed before / *brushing* / do / habit accustomed

우리나라의 산이 / 아름다운 / 또 다른 이유는 / 수많은 / *문화재를* / 보유하고 / 있기 때문이다.
Our country's mountain/ beautiful/ another reason/ lots of/ *cultural-assets*/ having / because

아침에 / 일어나보니 / 지난 밤 / 내내 / *함박눈이* / 내린 것을 / 알 수 있었다.
Morning / get up / last night / during / *snowflake* / coming down / was able to know

영식이는 / 어머니 생신을 위해서 / 좋아하시는 / *제비꽃을* / 선물로 / 골랐다.
Young-Shik / mother birthday to / like / *violet* / gift / chose

그 엄청난 규모의 도시를 / 한마디로 표현하자면 / *교통지옥이* / 가장 잘 어울릴 것이다.
The tremendous scale city/ one word expression/ *traffic-jammed-hell* / most plausible

먼 조상이 만들었다는 / 그 도자기가 / 집안의 / *가보로* / 전해져 내려온다.
Ancestry made / the pottery/ family/ *heirloom* / handed down

인수는 / 대학을 졸업한 / 늦은 나이에 / *담배를* / 피우기 시작했다.
In-Soo / college graduated / old age / *cigarette* / smoking started

광식이의 취미는/ 호숫가에서/ 한가롭게/ *산책을*/ 즐기는 것이다.
Kwang-Shik's hobby/ in the lake/ leisurely/ *take-walk* / enjoying is

영어가 익숙해진/ 수진이는/ 이제 /*일상용어를* / 쓰는데 / 문제가 / 없다.
English accustomed to/ Soo-Jin/ now/ *everyday words* / to use / problem / not

언제나 그런 것은 아니지만/ *뜬소문이* / 사실일 수도 있다.
Always not though / *unfounded-rumor* / true possibly

나의 어린시절을 / 떠올리면 / 언제나 / *할아버지의* / 추억이 / 먼저 생각난다.
My childhood / remembering / always / *grandfather* / memory / first come

내가 무슨 잘못을 하든지 간에 / 그것은/ 집안에 /*먹칠을* / 하는 것이다.
Whatever I did wrong/that/ family / *dishonor* / to do

운동을 하기로/ 결심한 이후에/ 지금까지/ *산에* /오르는 것을/ 계속하고 있다.
Working out planned/ decide after/ so far/ *mountain* / climbing/ keep continuing

꾸준히 하다 보면/ 언제가/ 나에게도/ *빛이* / 보이지 않을까 한다.
Working hard/ sometime/ even for me/ *light* / can be seen

그 기업의/ 판매전략은/ 소비자들의 자발적인/ *불매운동을* /부추기고 있다.
That company/ marketing strategy/ customers' voluntary/ *boycott* / instigating

옛날에는/ 마을에 급한 일이 생기면/ *종을*/ 울려서 사람들에게 알리기도 했다.
Long time ago/ village emergency happen/ *bell*/ ringing to inform people

산에 갔다가 / 갑작스럽게 날아든 / *벌에* / 깜짝 놀랐다.
Mountain climbing/ suddenly attack/ *bee* / shocked

긴 여행을 마친 / 그 여객선이/ *닻을* / 내리고/ 항구에 정박했다.
Long travel finishing/ the passenger-ship/ *anchor* / down/ in the harbor

마음이 고운/ 그 아이는/ 친구의/ *꾐에* / 빠지고 말았다.
Warmhearted/ the boy/ friend's/ temptation / into the way

선경이는/ 여행갈 때는/ 언제나/ *빗을* / 반드시 챙긴다.
Sun-Kyung / when traveling / always / *comb* / necessarily check

그는 언제나 자신의 미래를/ 생각할 때/ *백만장자를* / 꿈꾸곤 했다.
He always his future/ think about/ *millionaire*/ dreamed

부모는/ 자식을/ 가르치는데 있어서/ *독립심을* / 키워줄 수 있도록 해야 한다.
Parents/ child/ educate something / *independence* / raise have to

하루종일/ 전시회 구경을 하고 나왔는데/ 어떤 / *작품도* / 기억 나질 않는다.
All day long/ exhibition seeing/ any/ *work*/ cannot remember

사회가 급속도로 서구화되면서/ 우리의/ *대중문화도* / 상당히 변질되었다.
Society rapidly Westernization/ our / *popular-culture* / considerably changed

A.2 STIMULI FOR SET II: 2-SYLLABLE WORDS WITH CASE MARKER PRINTED ITALICS ARE TARGET WORDS. THE NUMBER OF PHONEMES, LETTERS, AND THE NUMBER OF VISUAL FEATURES ARE VARIED.

서울의 여름이 괴로운 이유는 / 무엇보다 높은 / *습도에* / 있다고 할 수 있다.
Seoul summer painful reason/ most of all high / *humidity* / there is

시민단체는/ 기업들의/ 담합행위에 대한/ *반대를* /분명히 표명했다.
The citizen group/ enterprises/ conferring acting/ *objection*/ clearly pronounced

교수의/ 사정에 의해서/ 강의 계획에는/ 약간의 / *차질이* / 생기고 말았다.
Professor/ personal commitment/ class schedule/ slight / *problem* / happened

저녁 식사 후에는/ 남산타워에/ 올라가/ 멋진/ *야경을* 보여줄 것이다.
After dinner/ Nam-San tower/ go to/ fantastic/ *night-view*/ will show

지난밤에/ 돼지 꿈을 꿨으니/ *복권을* / 사야겠다.
Last night/ good dreamed/ *lottery* / should buy

부지런한 동생은/ 아침마다 오는/ *신문을* /맡아서 챙겨둔다.
Industrious brother/ every morning/ newspaper / in charged of

소풍은/ 날씨가 나빠졌기/ 때문에/ 결국/ *취소가* / 되고 말았다.
Picnic/ weather got bad/ because/ finally/ *cancel* / resulted

현준은/ 어느새/ 머리가 희긋한/ *중년이* / 되어 있었다.
Hyun-Joon/ without awareness/ hair grey/ *middle-age* / became

군것질을/ 좋아하는/ 수빈이는/ 영화를 볼 때 주로/ *팝콘을* / 먹는다
Candy/ like/ Soo-bin/ during watch movie usually / *popcorn* / eat

유원이는/ 배고플 때/ 집안에/ 밥이 없으면/ 주로/ *라면을* / 먹는다.
Yoo-won/ hungry/ home/ rice empty/ usually/ *Ramen*/ eat

용욱이는 밤새워 시험 공부를/ 하기 위해서/ 한잔의/ *커피를* /마시기로 했다.
Yong-Wook/ overnight exam studying/ to do/ a cup of / *coffee* / drink

강의는/ 교수의/ 학회 참석의 사정으로/ 인해서/ *휴강이* / 되고 말았다.
Class/ Professor/ conference visiting reason/ by/ *no-class* / resulted

그나마/ 다행인 것은/ 이런 고민을 털어놓을/ *친구가* /있다는 것이다.
Nevertheless/ lucky thing/ this anguish confess/ *friend*/ there is

요새/ 화제가/ 되고 있는/ 그 영화의 소재는/ 알고 보니/ *실화로* / 밝혀져 충격을 주었다.
Recently/ topic/ becoming/ the movie material/ revealed/ *true-story*/ discovered/ shocked

각자의 생활이 바쁘다 보니/ 온 가족이 함께 아침마다/ *식사를* /하기가 어렵다.
Individual life busy/ all family together every morning/ *breakfast* / doing difficult

밖에/ 나가보니/ 비가 오길래/ 다시 들어가/ *우산을* / 챙겨서 나왔다.
Outside/ go to/ raining/ again come in/ umbrella / taking go out

집에/ 와보니/ 우체통에/ 친구가 보낸 선물/ *상자가* / 들어 있었다.
Home/ back/ mailbox/ friend sent present/ box / there was

불우 이웃 돕기 행사에/ 시민들의 자발적인/ *참여가* / 계속해서 이어졌다.

Campaign to help unfortunate/ the citizens voluntary / *participation*/ continuously went

군대에 있는 친구를 위해서 준비한/ 선물을/ *소포로* /보내기로 했다.
Prepared to friend in army/ present/ *parcel* / sent

용석이는/ 어른이 되면/ 아픈 사람을 돕는/ *의사가* / 되고 싶어했다.
Yong-seok / after grown-up/ sick people help / *doctor* / want to be

새로운 경험을 추구하는 사람들의/ 아프리카 /*탐험이* 유행처럼 번지고 있다.
People who eager to new experience/ Africa / *exploration*/ become to be fashioned

많은 사람들이/ 인구 과밀의/ 서울을 벗어나 / *교외로* /주거지를 옮긴다.
Many people/ big population/ escape from Seoul/ *suburb*/ move to

그 정치범은 결국/ 생명을 걸고/ 제 3 국으로 / *망명을* / 시도하게 되었다.
The political prisoner finally/ at the risk of his life/ to the third nation/ *exile*/ tried

어머니는/ 자식의 성공이 대견한 나머지 / *눈물을* / 흘리고 말았다.
Mother/ her son's success/ so proud of / *tear*/ downed

살면서/ 공부하는 것도 중요하지만/ 다양한/ *경험을* / 쌓는 것도 중요하다.
Everyday life/ studying hard important/ various / *experiences* / important too

술을 마시다가/ 시간이 늦어져서 가까스로 /*막차를* / 타고 돌아왔다.
Because of drinking/ time is late / *the-last-bus* / came back

부동산 의혹이/ 제기된/ 그 장관은/ 결국/ *사임을* / 밝히고/ 물러났다.
Illegal real estate rumor/ proposed/ the minister/ finally / *resignation* / expressed/ left

희정이는/ 스무 번째 생일도 되었으니/ 이제/ 어엿한 / *숙녀가* / 된 기분이 들었다.
Hee-jeong/ twenty year's birthday/ now / *lady* / felt / to be

앉는 자세가/ 삐딱하면/ 흔히/ *척추에* /문제가/ 생기기 쉽다.
Seating posture/ not good/ commonly/ *backbone*/ problem/ occurs easily.

의대에서/ 유급 당하지 않으려면/ 한과목이라도/ *낙제를* /당해서는 안 된다.
Medical school/ not to remain/ even one subject / *failure* / not allowed

승식이는 사춘기가 되면서/ 여드름이/ 잔뜩 난/ *피부가* /고민이다.
Seung-shik/ becoming adolescence/ pimples/ many /*skin* / concerns

강한 햇빛을/ 너무 오래/ 쬐는 것은/ *얼굴에* /좋지 않다.
Strong sunshine/ too long/ taking / *face* / not good

A.3 STIMULI FOR SET III

A.3.1 Low-Frequency Predictable (LFP) or High-Frequency Unpredictable (HFUP)

최근 들어/ 극장가에서는/ 한국영화가/ 기록적인 [*흥행을/인기를*]끌고 있다.
Recently/ film market/ Korean movie/ record-breaking [*sensation/ popularity*] catching

구원투수가/ 역전을 허용하자/ 홈팀 관중들의 [*야유가/분노가*] 쏟아져 나왔다.
Relief/ allow reverse match/ home team fans [*ridicule/anger*] poured

차가 더러워졌으니/ 일요일에는/ 반드시 [*세차를/청소를*] 해야겠다.
Car got dirty/ on Sunday/ necessarily [*car-wash / cleaning*] have to

선생님께/ 칭찬 받으려고/ 다음주 수업을 [*예습/공부*] 하기로 했다.
From teacher/ applauded/ next week class [*preview/study*] decided to do

시험기간만 되면/ 평소에는 텅텅 비었던 [*도서관이/고시원이*] 학생들로 꽉 찬다.
During exams/ usually empty [*library/examination-room*] students/ full of

오늘도/ 늦는 걸 보니 남편은/ 또/ 직원들과 [*회식이/모임이*]있는 것 같다.
Today/ late husband/ again/ with staffs [*mess/meeting*] likely to be

그 회사는/ 간신히 부도의 위기를 [*모면/해결*]할 수 있었다.
The company/ hardly/ dishonor crisis [*evade/solve*] was able to

엄마는/ 아빠의 숙취/ 해소를/ 위해서/ 한잔의[*꿀물을/우유를*]드리기도 한다.
Mom/ dad's hangover/ resolve/ in order to/ a glass of [*honeyed-water/milk*] serve

지난해/ 성적이 좋았던/ 야구 선수에게/ 높은 금액의 [*연봉이/임금이*]약속될 것이다.
Last year/ record good/ to baseball player/ great amount of [*annual-salary/wages*] will be promised

선거가/ 불리해 지자/ 상대편 후보에 대해/ 끊임없는 [*비방을/공격을*]멈추지 않았다.
Election/ disadvantageous/ to the other candidate/ ceaseless [*abuse/attack*] do not stop

그 펀드매니저는/ 자신의 퇴직금을/ 모두 [*기부할/투자할*]곳을 결정했다.
The fund manager/ ones' retirement pay/ all [*donation/investment*] decided

이번 대회의/ 좋은 성적은/ 알고 보니/꾸준한 [*연습을/합숙을*]했던 결과였다.
This series/ good record/ discovered/ industrious [*training/ joint-billet*] resulted by

방학이 되면/ 그 동안 가보고 싶었던/ 바닷가로 / [*여행을/일출을*] 즐기러/ 갈 것이다.
Vacation comes/ wanted to go/ the seaside / [*trip/sunrise*] to enjoy / will go

최하위였던 팀이/ 우승 후보를/ 꺽는/ 놀라운 [*이변이/결과가*]다시 한번 나타났다.
The lowest ranked team/ champion favorite/ beating/ surprising [*extraordinary-event/result*] once again/ shown

혼자서 오래 자취생활을 하다 보니/ 남자이지만 [*요리에/취사에*]자신이 있다.
Living alone for a long time/ even man [*cooking/kitchen-work*] be good at

자기 마음에 들지 않는다고 해서 / 이러쿵 저러쿵 [*불평은/판단은*] 좋지 않다.
Even if you don't like something/ this and that-like [*complain/judge*] not good

A.3.2 Stimuli for Set III: High-Frequency Predictable (HFP) or Low-Frequency Unpredictable (LFUP)

유행에 민감한 엄마는/ 요즘엔/ 어떤 배우가 /가장 [*인기를/흥행을*]끌고 있는지 알고 계신다.
Fashioned sensitive mom/ recent/ which actor/ the most [*popularity/ sensation*] be knowing

사회 저명인사의/ 친일 행적에 대해서/ 국민들의/ [*분노가/야유가*]쏟아져 나왔다.
Society celebrity/ to pro-Japanese/ people [*anger/ridicule*] poured

일요일에는/ 그 동안/ 미뤘던/ 빨래와/ [*청소를/세차를*]해야겠다.
On Sunday/ for a while/ postponed/ washing and [*cleaning/car-wash*] have to

고 3 이 된/ 은희는/ 대학에 가기 위해서/ 열심히/ [*공부/예습*]하기로 했다.
High school 3 year/ Eun-Hui/ to enter college/ hard [*study/preview*] decided

사법시험을/ 준비하는 사람들은/ 학원가/ 근처의/ [*고시원이/도서관이*] 공부하기 좋다.
Law examination/ preparing people/ institute-street/ nearby [*examination-room/library*] good for studying

한 달에 한번씩은/ 어릴 적 친구들과/ [*모임이/회식이*]있는 것 같다.
Once a month/ with old friends [*meeting/mess*] likely to be

가끔/ 전문가에게/ 조언을/ 구하는 것이/ 문제를 [해결/모면] 할 수 있는 길이 되기도 한다.
Sometime/ expert/ advice/ to ask/ problem [*solve/evade*] can be a way

나는/ 아침을/ 안 먹는/ 대신에/ 한잔의 [*우유를/꿀물을*] 마시기도 한다.
I/ breakfast/ not eat/ instead of/ a glass of [*milk* / *honeyed-water*] drink

회사측은/ 노조의/ 입장을/ 받아들여서/ 내년부터 [*임금을/연봉을*] 올려주기로 했다.
Company/ union/ opinion/ accept/ next year/ [*wages/ annual-salary*] will increase

미국과 영국 군대는/ 이라크에 대한/ 끊임없는 [*공격을/비방을*] 멈추지 않았다.

U.S and British army/ to Iraq / ceaseless [*attack/abuse*] never stop

신기술 개발 경쟁에서/ 앞서기 위해서/ 기업들은 막대한 [*투자를/기부를*] 하고 있다.
New technology development competition/ to advance/ company/ great [*investment/donation*] doing

국가 대표 선수들이/ 대회를/ 앞두고/ 3 개월 간의[*합숙을/연습을*] 했던 것이 효과를 보았다.
National player/ game/ in prior to/ 3 months [*training/ joint-billet*] effect was shown

새해의/ 첫날에는/ 동해에 가서 [*일출을/여행을*] 즐길 것이다.
New year/ first day/ East sea going to go [*sunrise/travel*] will enjoy

그 연구팀의/ 반복된 실험에서/ 예상하지 못한/ 놀라운 [*결과가/이변이*] 다시 한번/ 나타났다.
The research team/ repeated experiments/ unexpected/ surprising [*result/extraordinary-event*] again/ come up

모든 국립공원은/ 산불을 방지 위해서/ 산에서의 [*취사를/요리를*] 금지하고 있다.
All national parks/ to prevent fire/ in the mountain [*kitchen-work/cooking*] not permitted

잘 모르는 사람에/ 대해서 섣부른 [*판단은*/ 불평은] 좋지 않다.
Unknown person/ about/ early [*judge/complain*] not good

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