ABSTRACT

Title of Document: THE PROCESSING OF PAST-TENSE INFLECTION IN FIRST LANGUAGE (L1) AND SECOND LANGUAGE (L2)

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The present dissertation research investigates how morphologically complex words are processed in isolation and in sentential context by native speakers and second language learners, and how four critical factors in morphological processing (regularity, stem frequency, whole-word frequency, and orthographic similarity) influence this processing.

For comparisons between different first languages (Korean L1 and English L1) and between first and second languages (English L1 and English L2), Native Korean Speakers (Exp.1 and 3), Native English Speakers (Exp. 2a and 4a), and Korean Learners of English (Exp. 2b and 4b) were tested. In order to compare the priming effects from words in isolation and words in sentences, sets of inflectional prime and target pairs, one for each language, were used both in a masked priming lexical decision task (Exp.1 and 2) and a self-paced reading task with mask priming (Exp. 3 and 4).

The results showed priming effects from inflectional prime and target pairs in both Korean L1 and English L1 when the pairs were presented in isolation, showing morphological sensitivity in both L1 groups. However, when the pairs were embedded in sentences, the priming effect was found only in native English speakers but not in native Korean speakers, implying language-specific differences between Korean and English in processing of inflectional words in sentences. Moreover, even though a similar pattern of priming effects was found for words in isolation, English L2 showed no significant priming effect for words in sentences, consistent with past literature demonstrating less sensitivity to morphological structure in L2. The different patterns of priming effects between the two tasks as well as across the three language groups in the present research were also analyzed in terms of the four morphological factors, and discussed from the perspective of language-specific characteristics.

In summary, the present dissertation research examined morphological processing of two typologically different languages in two different reading contexts. The results suggest the importance of language-specific characteristics in various reading conditions in enhancing our understanding of morphological processing in the human mind.

THE PROCESSING OF PAST-TENSE INFLECTION IN FIRST LANGUAGE (L1) AND SECOND LANGUAGE (L2)

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Dedication

To My Parents

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Chapter 1: Introduction

1.1. Scope of the Present Study

How the mental lexicon is organized and represented in human mind has been a long-standing question in language science. An understanding of morphology is crucial to answering this fundamental question since the morpheme is the smallest language unit that carries meaningful information. Although a great body of literature has been devoted to this topic, there is yet no agreement in explaining how morphology is represented and processed in the human mind.

In general, most accounts that attempt to explain how a morphologically complex word is represented and processed can be classified into two categories: single-mechanism accounts and dual-mechanism accounts. Each of the single-mechanism accounts hypothesizes only one access in processing a complex word – either decomposition access (i.e., combinatorial rule based) or full listing access (i.e., memory based). For instance, some single-mechanism accounts relying on decomposition access posit that an inflected word *walked* is processed by *walk* and *–ed*, while other single-mechanism accounts with the full-listing account state that *walked* is accessed as a whole word. However, some empirical findings (e.g., Pinker, 1991; Sonnenstuhl, Eisenbeiss, & Clahsen, 1999; Vannest, Polk, & Lewis, 2005) from studies of first language (L1) processing suggest that all morphological processing cannot be achieved solely by one of the two processes exclusively; both the decomposition access and whole-word access are needed for processing morphologically complex words.

On the other hand, the dual-mechanism accounts hypothesize the existence of both decomposition access and full listing access, and word properties such as regularity and frequencies (e.g., stem and whole-word frequencies) determine which route is used to access the meaning of complex words. For instance, regular verbs are accessed via decomposition (or individual morpheme access), and irregular verbs are accessed via full-listing access (or whole word access).

Among the three morphological types (i.e., inflection, derivation and compounding), past-tense inflection in particular has provoked recent debate surrounding whether the single-mechanism account or the dual-mechanism account can better explain processing of English past tense (e.g., McClelland & Patterson, 2002; Pinker & Ullman, 2002). A great deal of evidence collected through various research methodologies (e.g., behavioral experiments, eye movement measures, and electrophysiological/brain imaging techniques) has provided consistent results such as a regularity effect and a frequency effect. For instance, many studies on English past-tense processing found that the whole-word frequency effect is stronger in irregular forms than in regular forms when the stem frequency is controlled (e.g., Burani & Caramazza, 1987; Cole, Beauvillain, & Segui, 1989). However, interpretations of these results have differed depending on either single-mechanism accounts or dual-mechanism accounts. One of the dual-mechanism accounts, the Words-and-Rules Model by Pinker and Ullman (2002) reasoned that regular and irregular verbs in English are processed by two distinctive mechanisms: rule-based access for regular verbs and memory-based access for irregular verbs. In contrast, one of the single-mechanism accounts, the Connectionist Model by McClelland and Patterson

(2002) argued that both regular and irregular verbs can be learned and processed by a single network.

The present dissertation research focuses on the mechanism underlying past-tense processing in first languages (Korean and English) and second language (Korean learners of English) by investigating three major issues. The first issue is whether the recognition of past-tense words in Korean L1 and English L1 are affected by regularity, frequency (stem frequency, which is also called base frequency or cumulative frequency, meaning the sum of frequencies of all inflected forms of a certain stem, including frequency of the stem itself and whole-word frequency which is also called word frequency or surface frequency), and form similarity (i.e., orthographic similarity between the stem and irregular verbs), and how the three factors interact with each other. The second issue is how the recognition of past-tense verbs in English L2, in comparison to English L1, is affected by regularity, stem and whole-word frequencies, and form similarity. The third issue is whether task differences (i.e., using words in isolation vs. words in sentence context) affect the recognition of past-tense words in Korean L1, English L1, and English L2, using two different tasks - a masked priming lexical decision task and a self-paced reading task with masked priming.

1.2. Past-Tense Inflection and Three Critical Factors

According to Pinker (1991, 1997, 1999), English morphology is separable from other linguistic subsystems such as phonology, syntax, and semantics, and English past-tense inflection, as one morphological structure, is computed independently of those other subsystems. That is, phonology determines systematic organization of sound in words, and it does not affect how different past tense forms (e.g., ripped, ribbed, and ridded) are pronounced. Likewise, syntax governs how phrases and sentences are formed, and it does not work differently depending on verbs' regular or irregular formation. In addition, there is no relationship between how regular and irregular verbs are formed and what their meanings are. For example, three different types of past-tense inflections, *hit-hit*, *strike-struck*, and *slap-slapped,* have a similar related meaning. In contrast, *stand* can have unrelated meanings within the same forms in *stood* and *understood*. Therefore, past-tense inflection is great research material to investigate how the mental lexicon is organized and processed (Pinker, 1991) independently of other linguistic subsystems.

When it comes to what factors affect the processes of past-tense inflection, considering regularity seemed most reasonable because regularly inflected past-tense words are generated by a rule of adding past-tense suffix –ed to their stems, while irregularly inflected past-tense words are generated in various unpredictable ways. Previous studies with English (e.g., Marslen-Wilson, Hare & Older, 1993; Stanners, Neiser, Hernon, & Hall, 1979) reported a significant regularity effect on morphological priming, showing only processing of regular words was facilitated by morphologically related primes, and proposed there may be different underlying mechanisms for processes and representations of regular and irregular verbs.

Later, however, a series of the follow-up studies (Alegre & Gordon, 1999; Burani, Salmaso, & Caramazza, 1984; Kelliher & Henderson, 1990; Prasada, & Pinker, 1993; Stemberger & MacWhinney, 1984, 1988; Taft, 1979) suggested that frequency interacts with regularity in recognition of past-tense inflection. The results converged into two major findings. First, stem frequency affects processing of regular verbs, but not irregular verbs in English. In the lexical decision tasks, regular verbs with high stem frequency (e.g., *depended*) were recognized more rapidly than those with low stem frequency (e.g., *implied*). In contrast, no difference was found in recognition latencies between irregular verbs with high and low stem frequencies. Second, a whole-word frequency effect was found in the processing of irregular verbs (Pinker, 1991; Prasada & Pinker, 1993; Ullman, 1999). For instance, Ullman (1999) showed that acceptability ratings for irregular verbs are correlated with whole-word frequency and phonological neighborhood, but this is not true for regular verbs. Conversely, there is no difference in response between regular verbs with high and low whole word frequencies. Based on these results, the researchers proposed that regular verbs are processed via decomposition (i.e., rule based) so that stem frequency, rather than whole-word frequency, plays a more significant role in the processing of the regular inflectional verbs. In contrast, irregular verbs cannot be decomposed into their constituents, so only whole-word frequency affects their recognition performance. However, this argument was questioned by evidence of a significant effect of whole-word frequency in regular forms when the whole-word frequency is greater than 6 per million and the stem frequency was controlled (Alegre & Gordon, 1999). The result is not consistent with the dual-mechanism account. Therefore, the dual-mechanism account needs to be revised to incorporate the possibility of whole-word processing in regular verbs, such that frequent regular verbs can be processed as a whole form as well, and only regular verbs with low whole-word frequency (less than 6 per million) tend to be decomposed.

Another critical variable is form similarity between a stem verb and its past-tense form, especially for irregular verbs. Irregular forms do not explicitly consist of a stem and a past-tense suffix, and their form similarities between their present and past tense forms vary (e.g., *fall-fell* vs. *teach-taught*). Note that form similarity can be either phonological similarity or orthographical similarity depending on the task employed. For example, several recent studies (e.g., Basnight-Brown, Chen, Hua, Kostić, & Feldman, 2007; Feldman, Kostić, Basnight-Brown, Durdevic, & Pastizzo, 2010) have examined the role of form similarity between stems and their past-tense words in the processing of the irregular verbs, using both visual masked priming and cross-modal priming paradigms. These studies showed that native English speakers elicit significant morphological priming effects not only in regular verbs but also in irregular verbs with high form similarity between the stems and their past-tense form (e.g., *fell-fall*). This finding raises the question of whether the processing of regular and irregular verbs are mutually exclusive. If there is a graded morphological priming effect in the irregular forms depending on the form similarity between the stem and their irregularly inflected form, then the regularity-based dichotomous distinction should be critically challenged. In other words, how the inflected forms, including regular and irregular verbs, are processed can be explained by the function of form similarity between the stems and their inflected form, and the dual-mechanism accounts supporting distinct regular vs. irregular inflectional processes are not necessary.

1.3. Major Issues and Research Questions of the Present Study

Note that the aforementioned studies (Basnight-Brown et al., 2007; Feldman et al., 2010) used both past-tense form (e.g., *fall*-*fell*) and past participles (e.g., *draw*-*drawn*) as past-tense inflection and presented a limited sample set per condition. The usage of the mixed stimuli of past tense and past participle could be problematic, as it is not clear that the two types of past-tense formations are processed in the same fashion. Therefore, the present study included more trials and used only past-tense forms in order to avoid any potential confounds related to using both past-tense and past participle forms.

In addition to the mechanism underlying past-tense processing, the present research addresses whether a certain pattern of past-tense inflectional processing is universal or language-specific. As Frost and Grainger (2000) emphasized, languages differ in representation and processing of morphological structures. Moreover, the morphological systems in different languages are governed by different principles. Indeed, there have been a limited number of studies conducted with non-Indo-European languages, and cross-linguistic analyses should be pursued in a more systematic manner than in the past (Frost, Grainger, & Carreiras, 2008). Cross-language comparison between Korean and English in past-tense inflection was conducted as part of the present research to investigate whether the findings from English or other Indo-European alphabetic languages are applicable to non-Indo-European languages' inflectional processing. Korean has an alphabetic orthography, but there is no direct resemblance to English orthographically or phonologically. Therefore, Korean would be a good candidate to be compared with a well-studied language, English.

A series of experiments in this dissertation make systematic comparisons between different morphological properties in English and Korean. For example, irregulars in English could be regarded as partially systematic (Pinker, 1991). That is why researchers can categorize English irregular verbs into several types as will be reviewed later in Chapter 2 (Bybee & Slobin, 1982; Pinker, 1999; Yang, 2002). In terms of partial systematicity, Korean irregular verbs are even more systematic than English irregular verbs, and there is no case of identical past-tense forms (e.g., *hit-hit* in English) in

Korean. Therefore, as Korean irregular past-forms are more predictable than English irregular forms, the processing of Korean irregular verbs should be more similar to the processing of regular verbs. Past cross-language studies using languages with rich morphological systems suggest that the account for English past-tense might not be applicable for other languages such as Italian (Orsolini & Marslen-Wilson, 1997), French (Meunier & Marslen-Wilson, 2004), and German (Smolka, Komlósi, & Rösler, 2009). This language-specific perspective was investigated by accounting for form similarity (e.g., Feldman et al., 2010), as Korean irregular past-tense forms differ less from the stems as compared to English irregular verbs (see Chapter 2 for review). Therefore, the morphological account for English past-tense inflection cannot fully explain the case of Korean past-tense inflection based on its language-specificity.

The second issue addressed by this research is whether and in what fashion L2 past-tense processing by Korean learners of English is different from L1 past-tense processing by native English speakers. Recent L2 studies have attempted to answer the question of whether L2 morphological processing is fundamentally different from L1 morphological processing (Basnight-Brown et al., 2007; Clahsen & Neubauer, 2010; Dipendaele, Dunabeitia, Morris, & Keuleers, 2011; Neubauer & Clahsen, 2009; Portin, Lehtonen, & Laine, 2007; Portin, Lehtonen, Harrer, Wande, Niemi, & Laine, 2008). However, there has been little agreement on the underlying mechanisms of L2 learners' processing of inflectional morphology (Gor, 2010). The present study compared Korean learners of English and native English speakers to provide systematic evidence as to whether L1 and L2 past-tense inflectional processing is affected by regularity, stem and whole-word frequencies, and form similarity (i.e., orthographic similarity). If so, how do the factors affect L1 and L2 past-tense processing? Although there have been several studies on L2 morphological processing, only a few studies recruited L2 learners with first languages that were not alphabetic (e.g., Chinese or Japanese learners of English). Thus, the testing of Korean learners of English in this study can contribute to understanding how L2 learners handle inflectional morphology in both Korean and English. Due to the differences in past-tense formation in Korean and English, the evidence for Korean L1 and English L2 inflectional processing was expected to provide additional evidence on whether the same account can serve to explain the patterns of L1 and L2 inflectional processing.

The third issue this research investigated is whether task differences (word in isolation vs. word in sentence context) affects the recognition of past-tense verbs in Korean L1, English L1, and English L2 in addition to the three factors (regularity, frequency, and form similarity). The majority of previous studies on inflectional processing employed tasks with words in isolation (e.g., a lexical decision task or a production task). In particular, research in L2 morphological processing has relied heavily on methods with words in isolation. However, it is rare that a reader encounters a single word in isolation in real world settings. Thus, an experimental situation with words in isolation would be ecologically less valid (Paradis, 2009). To clarify, a lexical decision task with isolated words forces a participant to check whether a given letter string is a real word or not, and is thus limited to observing how a reader actually processes words. In contrast, such lexicality checks are typically not required during sentence reading task. Although several studies on past-tense inflection have been conducted using sentence contexts (Lima, 1987; Luke & Christianson, 2011; Paterson, Alcock, & Liversedge 2011; Sereno & Rayner, 1992), no conclusive evidence has been presented to show how sentence context affects inflectional processing as compared to words in isolation. For example, Luke and Christianson (2011) showed a different pattern of effects of stem and whole-word frequencies depending on the task demands (i.e., word in isolation and word in sentence context). However this study focused only on regular verbs, not irregular verbs.

To address the aforementioned theoretical and methodological issues, the research questions for the present study are as follows:

1) Is the recognition of past-tense verbs in Korean L1 and English L1 affected by regularity, stem and whole-word frequencies, and form similarity (i.e., orthographic similarity between the stem and irregular verbs), and if so, how do the three factors interact with each other?
2) How is the recognition of past-tense verbs in English L2 in comparison to English L1 affected by regularity, stem and whole-word frequencies, and form similarity?
3) Do task differences (i.e., word in isolation vs. word in sentence context) affect the recognition of the past-tense verbs in Korean L1, English L1, and English L2 in addition to the three factors (regularity, frequency, and form similarity)?

The remainder of the dissertation is organized as follows. The next chapter (Chapter 2) provides a contrastive analysis of inflectional morphology in Korean and English, and reviews some major accounts for the representation and processing of past-tense inflection and empirical findings regarding the past-tense inflectional processing in both L1 and L2. Chapters 3 to 6 present experimental designs of the four experiments used in the present study to examine the effects of regularity, frequency (both stem frequency and whole-word frequency), and form similarity in past-tense processing. The first two experiments employed a masked priming lexical decision task with regular and irregular verbs in Korean (Experiment 1) and English (Experiment 2). The other two experiments employed a self-paced sentence reading task with masked priming to examine past-tense inflectional processing in Korean (Experiment 3) and English (Experiment 4).

Chapter 2: Literature Review

This chapter aims to provide a comprehensive analysis of past-tense inflection of Korean and English, which enables us to predict differences in how each of the two languages' past tense may be processed. This chapter also reviews several major theoretical accounts for morphological processing and relevant studies in past-tense processing – how the three major factors (regularity, frequency, and form similarity) of past-tense words influence lexical processing.

2.1. Characteristics of Past-Tense Inflection in English and Korean

Morphology is the study of word structure, and a morpheme, which is defined as the smallest, indivisible unit of meaning (Spencer & Zwicky, 1998), and the basic unit of morphology. There are three types of morphology: inflection, derivation, and compounding. Inflectional morphology operates to change number (e.g., *book – books*) or tense (e.g., *walk – walked*), and it is the most syntactically relevant type of morphology (Spencer & Zwicky, 1998). Derivational morphology, similar to inflectional morphology, works with affixation to stem (e.g., *attract – attractive*), but compounding morphology works with combining two or more free stems (e.g., *dead + line = deadline*). There are several criteria that distinguish inflection from derivation (Scalise, 1988; Stump, 1998). The three most critical criteria are regularity, semantic transparency, and productivity of affixes. With respect to these criteria, inflection is more regularly operating, more semantically transparent, and more productive in the usage of affixes than derivation.

2.1.1. English Past Tense

For English verbs, past-tense inflection operates to form the verb tense regularly by concatenation of a past tense suffix -*ed* to a stem (e.g., *work-worked*), or irregularly either by modifications of internal structure of a stem (e.g., *teach – taught*) or preservation of the same stem forms (e.g., *put-put*). English has approximately 160 irregular verbs, which is much smaller than the number of regular verbs (Bybee & Slobin, 1982). However, the usage of English irregular past forms is critical based on the observation of how frequently English speakers use irregular verbs (Slobin, 1971).

Pinker (1999) summarized the differences between regular forms and irregular forms as follows. Regular forms follow the rule with no change to their stems (i.e., *V* + *ed* for past tense), but irregular forms do not follow any specific rules and/or undergo stem change in the past tense. While the regular verb class is open to generate new words' inflected forms (e.g., *email-emailed*), irregular patterns do not generate new ones. In addition, regular forms are acquired relatively earlier than irregular forms by children (Pinker, 1999).

Irregular English verbs have been classified into several types. Pinker (1999) categorized the English irregular verbs into two groups (strong and weak) depending on the phonological similarities between their stems (present forms) and past-tense forms first, then further categorized them into 13 different types (see Table 1). In addition to these categorizations, the English irregular verbs categorized as weak irregular verbs, (categories 1 to 4 in Table 1) hold a final dental consonant /*t*/ or /*d*/ (e.g., *have* - *had*), and therefore they bear a resemblance to the regular form phonologically. In contrast, strong irregular verbs differ phonologically and orthographically from regular forms. For example, vowel change in the pair of *eat-ate* does not resemble the regular past-tense form. Therefore, differences in the processing of past-tense inflection between these irregular types are expected. Indeed, several studies (e.g., Marslen-Wilson, Hare, & Older, 1993; Stanners, Neiser, Hernon, & Hall, 1979) showed that the processing of weak irregular verbs, but not strong irregular verbs, is similar to that of regular verbs. The findings from these studies will be reviewed in a later chapter.

Yang (2002) accepted general phonology and distributed English past-tense forms across word classes (see Table 1). Thus, there is no clear distinction between regular and irregular forms. According to his categorization, regular verbs are considered as –d suffixation without change in stem. In addition, several –*d* suffixation irregular types undergoing vowel shortening (e.g., *say-said*) or ablaut (e.g., *sell-sold*) are included in this category.

Table 1. Categorization of Irregular Past Tense in English by Pinker (1999) and Yang (2002)

Irregular categories (by Pinker, 1999)	Examples	Past tense type categories (by Yang, 2002)		Examples
1. No change	beat, cut, hit	1. Suppletion		go, be
2. Drop their final consonant and retain the –d suffix	have, make	2. –t suffixation	No change	burn, learn, spell
3. Change their final consonant /d/ to /t/ or simply add /t/	burn, spell		Deletion	bend, send, spend, lend
4. Change the internal long vowel to a short	keep, feel		Vowel shortening	lose, deal, feel, kneel
5. Change a long /i/ to a long /o/	rise, find		Rime → a	buy, bring, catch, see
6. Change a short /e/ to a short /o/	get, forget, tread	3. -ø suffixation	No change	hit, slit, quit, spit, bid
7. Change a shot /o/ to a short /e/	fall, hold		Vowel shortening	bleed, breed, feed, lead,
8. Form their past-tense ending in -ew	blow, know	4. –d suffixation	Vowel shortening	flee, say
9. Take a long /a/	come, give, eat		Consonant	have, make
10. Following the –ing, -ang, -ung pattern	ring, sing, drink		Ablaut	sell, tell
11. Totally unrelated past-tense form	be, go		No change: *regular*	walk, work
12. Regular past-tense form and irregular past participle	swell, show			
13. A unique pattern for past-tense formation	choose			

2.1.2. Korean Past Tense

Korean is morphologically rich as an agglutinative language in which a morphologically complex word is generated by joining morphemes together and adding affixes to the stem of a word. Korean has over 600 affixes (both prefixes and suffixes); inflectional suffixes are exclusively from native Korean, while derivational prefixes and suffixes come from both native Korean and Sino-Korean (Chinese origin) sources. Among eight word classes in Korean, nouns, verbs, and adjectives are used with affixation most productively (Sohn, 1999). Inflectional morphology is critical for various grammatical functions and conjugations of verbs and adjectives in Korean (Sohn, 1999). For Korean past tense, regular forms are generated by adding a past-tense suffix[1] either 았(-*ass*)[2] or 었(-*ess*) to a verb stem in a way to maintain vowel harmony with the verb stem. Namely, a past-tense suffix, 았(-*ass*) is attached to the verb stems with vowels ㅏ(a) or ㅗ (o), and the allomorphic past-tense suffix, 었(-*ess*) is attached to the verb stems with any other vowels. For instance, the past tense for 잡다 (*cap-ta* means 'catch' in English) is 잡았다 (*cap-ass-ta* means 'caught' in English), and the past tense for 먹다 (*mek-ta* means 'eat' in English) is 먹었다 (*mek-ess-ta* means 'ate' in English).

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[1] The Korean past-tense marker should be regarded as a suffix, not as an infix because it is attached to, not inserted into, a stem. As an agglutinative language, Korean allows multiple suffixes to a stem, which may make a suffix between a stem and another suffix look more like an infix. However, it is more accurate to say that Korean past-tense marker is 'suffix' not 'infix'.

[2] All transliterations in this article follow the Yale Romanization System (Martin, 1992).

There are several categories of irregular past-tense forms in Korean (see Table 2). A few characteristics distinguish irregular past tense of Korean from that of English. First, there are no cases of '*no change'* in the past-tense form in Korean, in contrast to English (e.g., hit-hit). Second, a past-tense suffix (-았 *ass* or -었 *ess*) is always attached to a stem in the Korean irregular past-tense forms although it is merged with the stem orthographically and phonologically in some cases. Therefore, irregular form in Korean is still regarded as concatenative, in contrast to irregular form in English which is regarded as nonconcatenative. For example, a Korean irregular verb 끄다 (*kkuta* means 'turn off' in English), which consists of a stem 끄- (*kku*-) and terminal ending -다 (-*ta*), become 껐다 (*kkessta* means 'turned off' in English) for its past-tense form by omitting the vowel ('ㅡ') from the stem and merging with the past-tense suffix '었' ess (see Table 2).

In summary, Korean irregular past-tense forms maintain some resemblance to their regular forms; making Korean irregular past-tense forms more predictable than English irregular past-tense forms. Therefore, it is expected that Korean regular and irregular words in Korean are processed more similarly to each other, than those in English. The major characteristics of past-tense inflection in the two languages, English and Korean, can be summarized in Table 3.

Table 2. Categorization of Irregular Types in Korean Past Tense by Sohn (1999)

Irregular type	Example	Meaning
Consonant omission	'ㅅ' (s) → Ø 짓다 - 지었다 cis-ta → ci-ess-ta	build
Vowel to vowel change	'ㅜ' (wu) or 'ㅡ' (u) → 'ㅓ' (e) 끄다 – 껐다 kku-ta → kkess-ta	turn-off
Consonant to consonant change	'ㄷ' (t) → 'ㄹ' (l) 걷다 - 걸었다 ket-ta → kel-ess-ta	walk
Consonant to vowel change	'ㅂ' (p) → 'ㅜ' (wu) 굽다 -구웠다 kup-ta→ku-wess-ta	bake
Past suffix's vowel change	'ㅏ' (a) → 'ㅕ' (ey) 하다- 하였다 ha-ta→ ha-eyss-ta	do
Consonant added to suffix	'었' (ess) → '렀' (less) 이르다→이르렀다 iluta → ilulessta	arrive
Consonant added to stem & vowel change	'ㄹ' (l) → 'ㄹㄹ' (ll) 가르다 - 갈랐다 ka-lu-ta → kal-lass-ta	divide

Table 3. Characteristics of Past-Tense Inflection in English and Korean

	English	Korean
Regular	V-ed	Stem - ass/ess
	Concatenative	Concatenative
	Predictable	Predictable
Irregular	Unpredictable	Quasi-predictable
	Nonconcatenative	Concatenative
	Stem change	Stem change

2.2 Models of Morphological Processing in First Language (L1)

A variety of accounts have been proposed to explain how morphological structures are represented in the mental lexicon and how they are processed (Butterworth, 1983; Bybee, 1995; Caramazza, Laudanna, & Romani, 1988; McClelland & Patterson, 2002; Pinker, 1999; Pinker & Ullman, 2002; Stockall & Marantz, 2006; Taft, 1979; Westermann & Ruh, 2012; Yang, 2002). Those accounts can be classified into two categories: single-mechanism accounts and dual-mechanism accounts. Several influential models from both accounts are featured in this section.

2.2.1.Single-Mechanism Accounts

Decomposition Account vs. Full-Listing Account

There have long been two contrastive explanations within the single-mechanism account of morphological processing and representation: the Decomposition account and the Full-listing account. The Decomposition account posits that morphologically complex words are processed through their morpheme units (e.g., Stockall & Marantz, 2006; Taft, 1979; Taft & Forster, 1975). Taft and Forster (1975) proposed that all affixes of a morphologically complex word are always stripped off prior to lexical access. For example, *revive* would be accessed via *vive*, the bound stem (a stem that cannot stand alone as an independent word, but must be combined with another prefix or suffix) without *re,* the affix. In order to test this account, a lexical decision task was frequently used to compare reaction time responses to different target word's characteristics. The results showed that the participants took longer to judge that prefixed nonwords are not real words when they contain real stems (e.g., *joice* in *dejoice*) than when they contain unreal stems (e.g., *jouse* in *dejouse*). In addition, nonwords were rejected more slowly when they have bound stems (e.g., *vive* from *revive*) than when they have pseudo-stems (e.g., *lish* from *relish*). Based on these results, Taft and Forster (1975) concluded that affixed words are stored in their base form in the lexicon. Taft and Forster (1975) also provided additional evidence supporting their account. They found a robust effect of stem frequency in morphologically complex words (e.g., the frequency of *dark* influences the response when presented with *darkness*), regardless of whole-word frequency of a complex word.

However, Henderson (1985) argued that the data from Taft and Forster (1975) with nonwords may not reflect real word recognition, and the morphological decomposition of nonwords may occur only when whole-word based lexical access fails. In order to solve this problem, experiments using real words (e.g., *misplace* and *misery*) were conducted. If decomposition occurs as obligatory processing, then delayed recognition of the pseudo-prefixed form *misery* during a lexical decision task should be due to erroneous searching for the false stem *–ery* in the mental lexicon. Previously, Rubin, Becket, and Freeman (1979) found this pseudo-prefixation effect only when prefixed nonwords (e.g., *retext*) were used as their experimental stimuli, but not when non-prefixed nonwords were used. Thus, the authors suggested that decomposition is one possible strategy for processing morphologically complex words, not an obligatory process. In order to respond to these critiques, Taft (1994) revised the initial version of the decomposition account and proposed the Interactive Activation Model, which, similar to the dual-mechanism account, incorporates the possibility of whole word access as well as decomposition.

In contrast to the Decomposition account, the Full-Listing account proposed that the mental lexicon does not contain separately stored morphological structures, and lexical access always takes place through an independent lexical representation for each word (Butterworth, 1983). Advocates of the Full-listing account point out the idiosyncrasy of affixation. First, the meaning of an affixed word is often not predictable from the meaning of their constituents, especially for the derived words. As Butterworth (1983) demonstrated, there is little semantic regularity for suffixed forms (*induce* + -*ment*, -*ive*, -*ible*, -*tion*). Second, it is not easy to find regularity in the combinations of affixes and roots. For instance, the verb *induce* has the derived forms *induction* and *inducement*, whereas *produce* has *production*, but not *producement* (Butterworth, 1983). Based on the idiosyncrasy of affixation, he concluded that it is not likely that the mental lexicon contains morphological rules, and that the full-listing model is the only possible model.

Both the Decomposition and Full-listing accounts were rather extreme cases to explain morphology by a single route. Later, however, these accounts were modified and unified, and led to dual-mechanism accounts.

Connectionist Account

In Connectionist accounts, (Gonnerman, Seidenberg, & Andersen, 2007; Plaut & Gonnerman, 2000; Rueckl, Mikolinski, Raveh, Miner, & Mars, 1997; Seidenberg & Gonnerman, 2000), morphology is learned sensitivity to the mappings among three components of lexical processing. Instead of explicit morphological rules (e.g., regularity), the associative patterns of connections between the units based on the orthographic/phonological and semantic similarities extract quasi-regularities for morphological structures, and the connection weights among the processing units in the model are gradually updated as the learning period increases (Bybee, 1995; McClelland & Patterson, 2002; Plaut & Gonnerman, 2000; Rumelhart & McClelland, 1986; Seidenberg & Gonnerman, 2000). Figure 1 shows the three components of lexical processing (orthography, phonology, and semantics) connected to each other, and the morphological level as an emergent concept from the relationships among the three components (Plaut & Gonnerman, 2000). Thus, Connectionist accounts posit that regular forms and irregular forms are at opposite ends on the continuum, and there is no clear distinction between regular and irregular forms.

According to the Connectionist account, performance on a priming lexical decision task should elicit graded effects of both formal and semantic similarities. Indeed, Gonnerman and her colleagues (Gonnerman et al., 2000) showed that semantically highly-related primes and targets (e.g., *baker-bake*) elicited greater priming effects than semantically-moderately related (e.g., *dresser-dress*) or semantically-unrelated pairs (e.g., *corner-corn*). Also, when semantic transparency was controlled, the morphological priming effect was modulated by the degree of phonological similarity between prime and target (priming effect magnitudes: *deletion-delete* > *vanity-vain* > *introduction-introduce*).

In short, in the Connectionist account, regularity is not critical for morphological processing and representation, and the effects of morphology can be attributed to the combined effects of phonological, orthographical, and semantic similarity of words. As a result, this perspective raised the fundamental question of whether or not morphology has psychological reality (e.g., Gor, 2010).

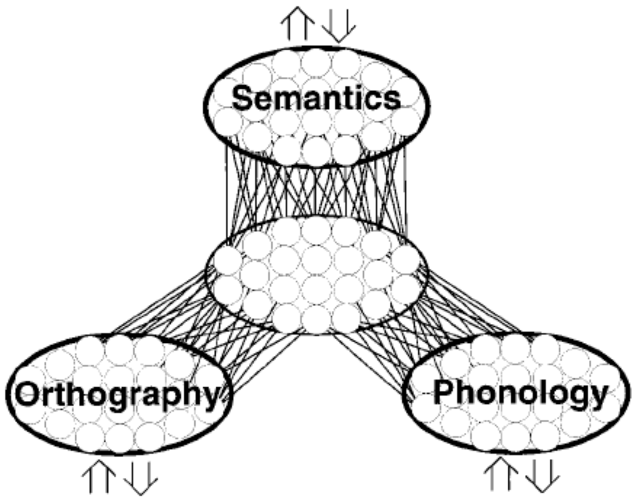


Figure 1. A connectionist framework for lexical processing (from Plaut & Gonnerman, 2000)

2.2.2. Dual-Mechanism Accounts

In general, dual-mechanism models suggest that morphologically complex word forms are processed either through a morphological parsing mechanism (i.e., decomposition) or through a direct access route to stored whole-word representations (Clahsen 2006; Gor 2010). Several models based on the dual-mechanism have been proposed to explain how two access routes interact with each other.

The Augmented Addressed Morphology Model

Caramazza and his colleagues proposed the Augmented Address Morphology (AAM) Model, a combined model of decomposition and full-listing accounts (Burani & Caramazza, 1987; Caramazza, Laudanna, & Romani, 1988; Chialant & Caramazza, 1995). According to this model, a morphologically complex word activates both the whole word and its constituent morphemes, and the lexical processing is achieved through whichever route is quicker. The degree of activation of a given word's representation is determined by the grapheme similarity between the input string and the stored representation; the input string activates all ‘similar’ access units, such as whole words, morphemes and orthographically similar words. For example, the input string *walked* activates the access units for the whole word, *walked*, the constituent morphemes, *walk* + *ed*, and orthographically similar forms such as *talked* and *balked*.

An important assumption of the AAM model is that whole-word access units are always activated first for known words, whereas morphemic access units are activated first for novel and unfamiliar morphologically regular words. Hence, frequency, transparency, and regularity all play a critical role in the activation of the access units.

The Interactive Activation Model

Taft (1994) revised his Decomposition account (Taft & Forster, 1975) and developed the Interactive Activation Model in order to incorporate McClelland (1987) and others’ connectionist approach. Based on the observation that pre-lexical morphological decomposition takes place prior to a search for the stem morpheme within the mental lexicon, Taft (1994) posited that prefixed words are represented in a decomposed form. Thus, prefixes are considered independent activation units, separate from their roots, and, therefore, prelexical prefix stripping is not necessary.

In this model, activation from units in the lower orthographic levels can spread to higher orthographic levels in the direction from grapheme level, body level, morpheme level, word level, and concept level, and the activation also can feed backward from the units in higher levels to the lower levels. A lexical decision response is based on the amount of activation of the word at the whole word level, and the response time is dependent upon the amount of competitive activations in the other units in the word level.

For example, in the case of a word INVENT, the units in the grapheme level (I and N for IN; V for VENT) and the unit in the body level (ENT for VENT) activate the units in the morpheme level, IN and VENT, and then the units in the morpheme level activate the units in the word level INVENT and VENT. Thus, INVENT in the word level is activated by both IN and VENT in the morpheme level, whereas VENT in the word level is activated only by VENT in the morpheme level. As a result, the activation of INVENT in the word level is higher than the other candidate and is selected as the response.

The Words-and-Rules Model

Another version of the dual-mechanism account, called the Words-and-Rules Model (Pinker, 1999; Pinker & Prince, 1994; Pinker & Ullman, 2002), posits that a combinatorial system and an associative memory system support the learning and processing of morphological structures of regular forms and irregular forms, respectively (see Figure 2). The regular past tense formation, the *verb* + *ed* formation, is predictable and can be applied to any stem forms. So, the combinatorial system is rule-based. In contrast, irregular past-tense formation (e.g., *teach-taught*) relies on stored forms (memory based access) rather than a rule-based system. This Words-and-Rules account has been supported by research on typologically different languages from English (e.g., Clahsen, 1999). In addition, the account is supported by the studies on child language acquisition (e.g., Marcus et al., 1992), adult language processing (Alegre & Gordon, 1999), and language disorder (e.g., Marslen-Wilson & Tyler, 1997; Ullman, Pancheva, Love, Yee, Swinney, & Hickok, 2005), as well as the studies with a language production task (Prasada & Pinker, 1993), and event-related potentials techniques (Münte, Say, Clahsen, & Kutas, 1999).

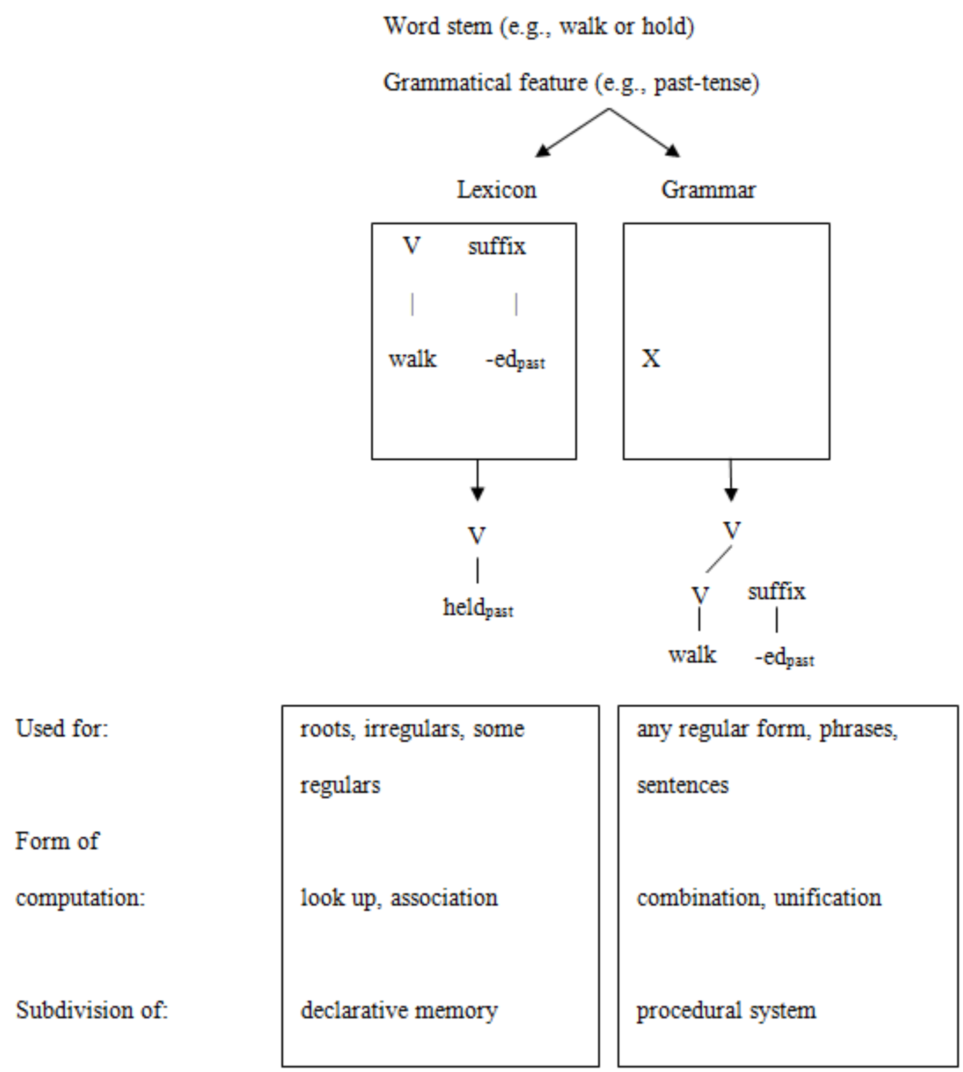


Figure 2. Words-and-Rules Account (from Pinker and Ullman, 2002)

2.3. Models of Inflectional Processing in Second Language (L2)

There have been several attempts to explain how L2 learners engage in inflectional processing. For example, Ullman (2001, 2004) elaborated the Words-and-

Rules Model with two memory systems, declarative memory and procedural memory. In his model, declarative memory (which generally supports the associative and contextual binding of information) and procedural memory (which generally supports learning and producing sequential skills) correspond to the underlying mechanisms *words* and *rules*, respectively. With respect to past-tense forms, declarative memory is involved in accessing irregular forms, and the procedural memory system may be particularly critical in learning and computation of sequential and hierarchical structures such as grammatical structure building.

Ullman (2004) attempted to use the Word-and-Rules account to explain how and why L2 learners' morphological processing is different from that of L1 speakers. L1 speakers are expected to show a whole-word frequency effect for irregular words, but not for regular words, because the processing of irregular words and regular words are expected to rely on the memory-based system and combinatorial rules, respectively.

In contrast, L2 learners' processing of regular morphology is expected to rely more on declarative memory (i.e., full-listing access) than on procedural memory (i.e., decomposition), and furthermore, late L2 learners' processing of inflectional morphology should be different from that of early L2 learners as well (Ullman, 2001) because early L2 learners are expected to utilize both declarative and procedural memory systems for regular inflectional morphology as L1 readers do.

Similar to Ullman's Declarative/Procedural memory model, the Shallow Structure Hypothesis (SSH) by Clahsen and Felser (2006a, 2006b) posited that L2 learners have asymmetric sensitivity to linguistic knowledge where they are less sensitive to syntactic information than lexical and semantic information. Thus, the weak reliance on syntactic information in L2 learners is linked to their morphological insensitivity, which ultimately results in memory-based processing for L2 morphological structures. In addition to the lack of grammatical knowledge, the authors also pointed out L1 influence, cognitive resource limitations, and maturational changes during adolescence as major factors for L1 and L2 differences.

2.4. Empirical Evidence of L1 Inflectional Processing: Words in Isolation

Morphological processing is affected by several factors, including regularity (e.g., regular vs. irregular), frequency (e.g., stem frequency and whole-word frequency), transparency (e.g., semantic transparency and phonological transparency), and headedness in compounds (e.g., *line* in *deadline*). As past-tense inflection is the main topic of the present dissertation research, previous studies on the major inflection-related factors (regularity, frequency, and form similarity) will be reviewed in the following section.

2.4.1. Effect of Regularity

The first factor to review is regularity. Several studies have shown consistent regularity effects in inflectional processing (e.g., Marslen-Wilson, Hare, and Older, 1993; Pinker, 1997; Sonnenstuhl, Eisenbeiss, & Clahsen, 1999; Stanners, Neiser, Hernon, & Hall, 1979; Tyler, et al., 2004). For example, an early study by Stanners et al. (1979) provided evidence of regularity effects using priming experiment paradigms. They found that when frequency was controlled, the regular past-tense verbs elicited a priming effect on the stems (e.g., *poured* - *pour*) with similar magnitude to identical priming effect (e.g., *pour* -

pour). Whereas, the irregular past-tense verbs elicited a reduced priming effect on the stem target (i.e., *hung* - *hang*) as compared to identical priming (i.e., *hang* - *hang*).

Marslen-Wilson, Hare, and Older (1993) also showed that regular and irregular verbs elicit different priming effects using a cross-modal priming task. The researchers further categorized irregular verbs into two types based on the degrees of phonological and morphological changes between their stems and irregular inflected forms. One is the semi-weak irregular category that operates with affixation to mark the past tense (e.g., *build-built*) and the other is vowel change verbs that have phonologically regular changes in stem vowels (e.g., *keep-kept*). For each of these three types of past-tense verbs (regular, semi-weak irregular, and vowel change irregular), three prime conditions were manipulated: identity (*agree-agree*), past tense (*agreed-agree*), and unrelated control (*occur-agree*). Results from the regular verbs showed that, when compared to the unrelated control condition, the past-tense prime condition elicited significantly faster reaction times to the targets; these reaction times matched those in the identical prime condition. However, the semi-weak irregular verbs did not elicit a priming effect to their stem, showing that the processing of regular verbs is different from that of irregular verbs even after the form similarity was taken into consideration, and the vowel change irregular verbs even showed an interference effect.

Distinct processing of regulars and irregulars was supported by neurological studies as well (e.g., Marslen-Wilson & Tyler, 1997; Tyler, et al., 2004; Ullman, et al., 2005). For instance, Marslen-Wilson and Tyler (1997) found a double dissociation between the processing of regular and irregular verbs in aphasic patients who completed a cross-modal priming task; a patient who had left hemisphere lesions exhibited a priming effect only for irregular pairs (e.g., gave-give), but not for regular pairs (e.g., showed-show), whereas, another aphasia patient with lesions in both hemispheres exhibited priming effects only for regular words.

2.4.2. Effect of Stem Frequency and Whole-Word Frequency

The second inflection-related factor is frequency, especially stem frequency and whole-word frequency. Note that stem and whole-word frequencies have many synonyms; stem frequency (the sum of the frequencies of all affixed forms that share the same stem) is also called stem-cluster frequency, base frequency, lemma frequency or cumulative frequency, while whole-word frequency (the frequency of the presented word form) is also called surface frequency or, simply, word frequency.

The recognition latency of morphologically complex words relies not only on their stem frequency but also on their whole-word frequency. First, for example, the stem frequency of *walked,* which is the sum of frequencies of *walk*, *walks*, *walking* and *walked,* has an influence on its priming effects, showing that the readers are sensitive to the stem within a complex word. Since a given stem word (e.g., walk) is shared by the entire family of the word, the sensitivity of the morphological parser has to be determined by summing the frequencies of the entire family of the word. Thus, the recognition times of morphologically complex words with the same whole-word frequency has been shown to vary as a function of their stem frequencies, as higher stem frequency generally leads to faster recognition (Andrews, 1986; Burani & Caramazza, 1987; Holmes & O'Reagan, 1992; Taft, 1979). Second, the whole-word frequency involves confirmation of the legal conjunction of a stem with affixes, as shown in the studies using lexical decision tasks

(Scheuder & Baayen, 1995). This verification of the entire orthographic parcel yields a conventional whole- word frequency effect.

Many studies have demonstrated interaction effects between stem frequency and whole-word frequency using inflected words (Alegre & Gordon, 1999; Burani, Salmaso, & Caramazza, 1984; Gordon & Alegre, 1999; Taft, 1979). Burani, Salmaso, and Caramazza (1984) attempted to more systematically control both their stem frequency and whole-word frequency by comparing three types of regular verbs with 1) high stem frequency and high whole-word frequency (e.g., walked), 2) high stem frequency and low whole-word frequency (e.g., kicked), and 3) low stem frequency and low whole-word frequency (e.g., tested). Note that there was no condition that included inflectional words with low stem frequency and high whole-word frequency, because it is nearly impossible to produce enough of those words in English (Gor, 2010). The researchers found that the stem frequency of a word is a major determinant of the reaction time in the lexical decision task, showing that the decision latencies for both word types 1) and 2) were reliably shorter than those for word type 3). In addition, whole-word frequency also contributed significantly to the lexical decision latencies, showing that the difference in reaction times between groups 1) and 2) was also significant. The results are compatible with the Augmented Addressed Morphology Model that proposed that lexical processing is achieved by access to morphologically decomposed lexical representations through whole-word access.

Kelliher and Henderson (1990) examined whether *the citation form frequency* (which refers to stem frequency only, e.g., high frequency citation form *buy* vs. low frequency citation form *shake*) affects the latency in lexical decision of the irregularly inflected verbs, when whole-word frequency (i.e., *bought* vs. *shook*) is held constant. Their results showed that lexical decisions for irregularly inflected verbs with high frequency citation form (e.g., *bought*) were faster than those with low frequency citation form (e.g., *shook*), suggesting that, for irregular verbs, the abstract level of morphological relationship may play a role in the processing of inflectional structures. However, this finding contrasted with the strong position of the Words-and-Rules Model, which assumes that stem frequency has no effect on recognition of irregular verbs, and provoked a debate over the role of frequencies of a stem and its morphological family on lexical decision of irregular verbs.

The strong position of the Words-and-Rules Model was also challenged by Alegre and Gordon (1999) who attempted to modify the model by considering the role of whole-word frequency in regularly inflected words. According to the Words-and-Rules Model (Pinker, 1999), the rule-based decomposition system can be applied to the processing of regular words so that a regular inflected word (e.g., *walked* from *walk*) can be retrieved as a function of its stem frequency, not whole-word frequency. Thus, high stem frequency regular words are recognized faster than low stem frequency words when whole-word frequency is controlled, while whole-word frequency does not affect the lexical decision latency of regular words when their stem frequency is controlled. The experiments of Allegre and Gordon (1999) tested the whole-word frequency effect for regularly inflected words, but with a much wider range of whole-word frequencies than the previous studies. The results showed that the whole-word frequency effect was not found from the regularly inflected forms within a whole-word frequency range lower than 6 per million, but found those with a whole-word frequency above 6 per million. This indicates that above the frequency threshold of about 6 per million, the whole-word frequency becomes a significant factor for regular forms. These data supported the weaker version of Pinker's Words-and-Rules Model. Namely, higher-frequency regularly inflected words could be processed as whole-word forms, and only lower-frequency regularly inflected words are decomposed into their stems and suffixes.

2.4.3. Effect of Form Similarity

In addition to regularity and frequency effects, whether form similarity plays a role in the recognition of morphologically-related words has been an issue in this field (Allen & Badecker, 2002; Basnight-Brown et al., 2007; Marslen-Wilson, Hare, & Older, 1993). Two types of form similarities can be considered: phonological similarity and orthographical form similarity. The effects of those similarity types on the latencies of the processing change depending on the task demands (i.e., cross-modal priming task or intra-modal priming task, e.g., visual-visual presentation).

In a study using a cross-modal priming task, Allen and Badecker (2002) attempted to distinguish irregular verbs based on their orthographic similarities: orthographically similar forms (e.g., *gave - give*) and dissimilar forms (e.g., *taught - teach*). They showed that, for orthographically similar forms, response times on targets (e.g., *give*) were longer when they were primed by auditory inflected primes (e.g., *gave*) than unrelated primes (e.g., *look*). In contrast, for orthographically dissimilar forms, the opposite data pattern was found – response times on targets (e.g., *teach*) were shorter when they were primed by auditory inflected primes (e.g., *taught*) than unrelated primes (e.g., *look*). The authors reasoned that the inhibitory effect from the orthographically similar past-tense primes was due to competitions at the lexeme level, and the facilitation effect from orthographically dissimilar past-tense primes resulted from the link between the past tense surface form and lemma level stem (see Figure 3). These results suggest that even irregular past-tense forms can elicit a significant morphological priming effect based purely on their morphological relatedness (i.e., link between the surface level and lemma level).

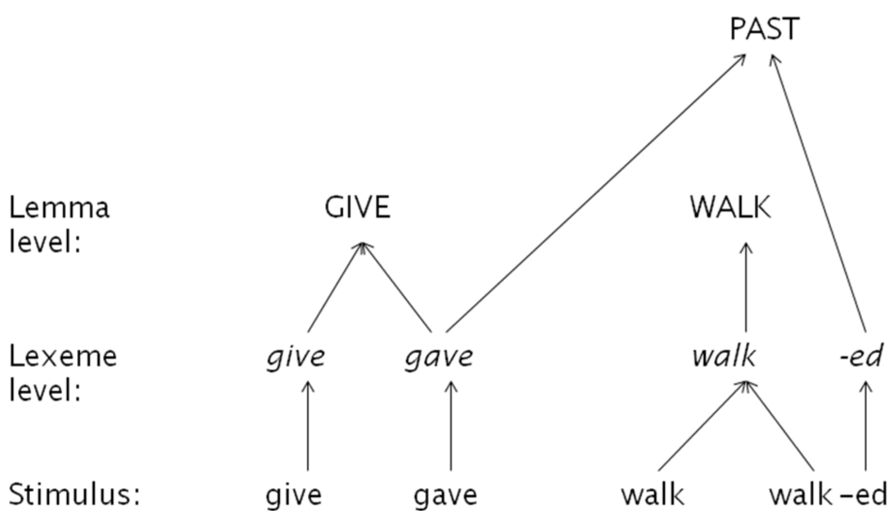


Figure 3. A two-level model of lexicon (from Allen & Badecker, 2002)

Morphological regularity and orthographic overlap are typically confounded in English. Regular past-tense forms (e.g., *worked*) and their stems (*work*) are not only morphologically related, but also overlap orthographically. Therefore, it is impossible to tease apart the effect of orthographic overlap from the effect of morphological relatedness in the processing of the regular forms in English. Pastizzo and Feldman (2002) addressed this issue by examining whether the degree of orthographic overlap influences and facilitates processing of irregularly inflected forms. This is a valid approach because the degrees of overlap in irregular forms are independent of their morphological relatedness. Pastizzo and Feldman (2002) constructed three conditions, regular (e.g., hatched-

HATCH), irregular with high overlap (e.g., fell-FALL), and irregular with low overlap (e.g., taught-TEACH) in the masked priming lexical decision task (prime duration = 48ms). The results showed that the regular forms and the irregular forms with high overlap, but not the irregular forms with low overlap, elicited morphological priming effects. The results suggest that form similarity (or orthographic overlap) may contribute to morphological priming in regular forms, and it is important to consider this factor when examining whether the processing of regular and irregular forms are affected by form similarity.

2.4.4. Cross-Language Comparisons in Inflectional Processing

Many languages have been investigated to determine whether inflectional processing in different languages can be explained by the same account: German (Clahsen, 1999; Smolka, Komlósi, & Rösler, 2009; Sonnenstuhl, Eisenbeiss & Clahsen, 1999), Hebrew (Frost, Deutsch, & Forster, 2000), Greek (Orfanidou, Davis, & Marslen-Wilson, 2011), French (Grainger, Cole, & Segui, 1991; Meunier & Marslen-Wilson, 2004), and Italian (Orsolini & Marslen-Wilson, 1997; Say & Clahsen, 2001). These studies provided inconsistent evidence even within same languages. For instance, Sonnenstuhl, Eisenbeiss and Clahsen (1999) tested German inflection using a cross-modal priming lexical decision task. They found that the priming effect for regular participles (e.g., *gekauft-kaufte, 'bought-buy'*) equaled the effect observed in the identical condition (i.e., *kaufe-kaufe,* 'buy-buy'). However, they failed to observe a priming effect for irregular participles (e.g., *geschlafe-schlafe,* 'slept-sleep'), where the priming effect was less than the identity condition. Sonnenstuhl, Eisenbeiss and Clahsen argued that the different priming effects with regular and irregular verbs support the dual-mechanism model in German. The regular participles are decomposed into individual morphemes (i.e., *ge-kauf-t*), which results in a priming effect on the recognition of the target. In contrast, the irregular participles are stored as wholes, and can only elicit a reduced priming effect. This finding contradicted results from other German inflection studies by Smolka and her colleagues (Smolka, Zwitserwood, & Rösler, 2007; Smolka, et al., 2009). For instance, Smolka et al. (2007) showed no differences between the priming effects in regular and irregular forms in German. The inconsistent patterns across different studies and research groups imply that no argument is conclusive at this point.

In addition, no support for dual-mechanism processing has been reported from Italian (Orsolini & Marslen-Wilson, 1997) and French (Meunier & Marslen-Wilson, 2004) studies. For instance, Orsolini and Marslen-Wilson (1997) argued that the dual-mechanism account cannot explain the processing of regular and irregular verbs in Italian. They administered a cross-modal repetition priming task where both the regular inflected pairs (e.g., *giocarono*-*giocare*) and the irregular inflected pairs (e.g., *scesero-scendere*) elicited priming effects, and the priming effects did not differ by regularity. Therefore, this study claimed that the dual-mechanism account based on English is not universal. Irregular inflection in Italian can be regarded as more predictable than English irregulars, thus, it is possibly processed more like regular verbs. The language specificity aspect of morphological processing suggests that more research should be done with less commonly studied languages. Therefore, a major focus of this research is to determine if Korean inflectional processing is consistent with an existing theoretical account despite its language-specific morphological characteristics.

In summary, there have been many studies dealing with three major issues in inflectional processing: regularity, frequency, and form similarity. It seems clear that both regularity and frequency play a significant role in the processing of past-tense forms with their interaction. In addition, form similarity might also be critical, but this issue has not been extensively investigated to this point. In order to suggest a better account for past-tense processing, it is necessary to investigate how processing is affected by these factors. In addition, there has been evidence suggesting that inflectional processing is not universal, but is instead a language-specific phenomenon. Therefore, it is possible that the morphological systems of different languages might elicit different patterns.

2.5. Empirical Evidence of L1 Inflectional Processing: Words in Sentence

A reader normally does not encounter words in isolation, but more frequently processes a series of words in a sentence or text. There have been several methods employed to examine how morphological processing occurs during sentence reading. The first is self-paced reading, which was originally introduced by Just, Carpenter and Wolley (1982). In this paradigm, participants press a button to control the duration of each word (or each chunk of words) within a sentence they read. The latency of pressing the button reflects cognitive processes based on the various properties in a given word. An infrequent word is expected to require more time to press the button as compared to a frequent word. In addition, reading times for a word after the target may also be affected by the difficulty caused by the target (i.e., spill-over effect).

A self-paced reading task is commonly conducted using the moving window paradigm. In this moving-window self-paced reading task, a sentence (or more than one sentence) is first displayed as a series of dashes on the computer screen. Each dash corresponds to a word in a sentence. As a participant presses the button, the very first dash is replaced by a word. When the participant presses the button again after she or he read the first word, the next dash is replaced by a second corresponding word and, at the same time, the previous word is replaced by the dash again.

Since the self-pace reading task imitates natural reading, it allows researchers to examine on-line processing of each word in the sentential context, not as isolated words. Several studies have used this paradigm to examine on-line processing of morphological structures (Jiang, 2004; Jou & Harris, 1991; Luke & Christianson, 2011). For instance, Luke and Christianson (2011) investigated the effects of stem and whole-word frequency in the processing of regular past-tense English verbs both in isolation and in sentential context. The four target conditions were: high stem frequency, high whole-word frequency (e.g., EXCITED); high stem frequency, low whole-word frequency (e.g., BORED); low stem frequency, high whole-word frequency (e.g., GREETED); and low stem frequency, low whole-word frequency (e.g., AMAZED). The past-tense words in the four target conditions were also tested as embedded in a sentence (e.g., The elderly retiree EXCITED/BORED/GREETED/AMAZED the neighborhood children by telling them about his military service).

While the researchers replicated a reliable effect of stem frequency using a lexical decision task, there was a main effect of whole-word frequency and an interaction between stem and whole-word frequency when the same inflected words were presented in a sentence. For lower stem frequency words, reading times for the high whole-word frequency words (e.g., GREETED) were facilitated as compared to the low whole-word frequency words (e.g., AMAZED), but for the high stem frequency words, reading times for the high whole-word frequency words (e.g., EXCITED) were slightly inhibited as compare to the low whole-word frequency words (e.g., BORED). However, the whole-word frequency of these same words did not interact with the stem frequency effect when the verbs were presented in isolation. Thus, no difference in reaction times between the high whole-word frequency words with high stem frequency (e.g., EXCITED) and low stem frequency (e.g., GREETED) existed in the lexical decision task. Luke and Christianson (2011) interpreted their results that a highly frequent subunit in a complex word may compete with the whole-word frequency, especially when the words are embedded in sentence context. The results further implied that specific task demands play a role in determining the competition between the effects of whole-word frequency and stem frequency. Note that this study only included regular past-tense forms, thus it is important to examine whether the effect of whole-word frequency affects recognition of irregular words during sentence reading. Previous studies (e.g., Alegre & Gordon, 1999; Kelliher & Henderson, 1990) showed a more complicated relationship between regularity and both types of frequencies, stem and whole-word frequency. Therefore, the question of whether the recognition of irregular verbs is affected by both frequencies remains unclear.

Another recent study examined whether the morphological priming effect found in tasks with words in isolation can be sustained in the tasks with words in a sentence context (Paterson, Alcock, & Liversedge, 2011). Paterson et al. (2011) examined the role of the semantic relationship between a prime as a derived word and a target as its stem in the processing of derivational structure during sentence reading. They used the same stimuli as Rastle, Davis, and New (2004) to replicate the results for words in isolation based on morpho-orthographic priming (e.g., *corner* primes *corn*) in the sentential context. In their eye-movement experiment, as in Rastle et al. (2004), a prime and a target were paired as one of three different relationships (semantically transparent morphological relationship, e.g., *marshy – marsh*; opaque morphological relationship, e.g., *secretary – secret*; morphologically unrelated, e.g., *extract – extra*). In Paterson et al. (2011), however, both the prime and target of each pair were shown in the same sentence (e.g., The forest had a *marshy* path leading to a *marsh* whether students studied wildlife.). The results of Paterson et al. revealed that the first fixation duration and the gaze duration were reliably shorter, but only when prime and target pairs have a semantically transparent morphological relationship (e.g., *marshy – marsh*) but not when they have an opaque morphological relationship (e.g., *secretary – secret)*. The pattern of results are dissimilar to the study with isolated words using masked priming lexical decision tasks by Rastle et al. (2004) which found a morpho-orthographic priming effect (a significant effect from the pair of pseudomorphologically related, (e.g., *secretary – secret*), but rather similar to unmasked priming task data (e.g., Feldman & Soltano, 1999).

Paterson et al. (2011) suggested that the findings of their study demonstrate the unique aspects of lexical processing during normal sentence reading. It is possibly because both the stem and the derived word in a semantically transparent complex word (e.g., *marsh-marshy*) are redundantly related to the meaning of the sentence (i.e., semantically redundant), but both the stem and the derived words in an opaque complex word (e.g., *secret-secretary*) *are not* semantically redundant.

Measuring eye-movement is a frequently used method to examine on-line processing of target words during sentence reading. Although the present study does not employ eye-movement measures, it is worth reviewing some of major findings in the eye-movement literature because of the similarities between tasks. One characteristic of eye-movement patterns, *parafoveal preview benefit* stems from information extracted from the parafoveal vision (i.e., information that is extracted before the eyes actually land on a target word). The parafoveal preview benefit was originally reported by Rayner (1975). Rayner developed a rapid change of a single word during the saccade in which the eyes move to fixate the word. The display change is triggered when the eyes cross an invisible boundary just prior to the target word. Thus, readers are virtually unaware of the display change and are unable to consciously identify the stimulus in the parafovea. In spite of this, the parafoveal information is integrated with the subsequent activation of the foveal word, thereby facilitating its identification.

Lima (1987) examined the effect of morphological structure on parafoveal processing, using prefixed words (e.g., *revive*) and pseudoprefixed words (e.g., *rescue*). Lima found that pseudoprefixed words elicited longer fixation durations and gaze durations than prefixed words, which supports the notion that stem morphemes are represented by stripping off the affixes. The more interesting results of this study were consistent with Inhoff (1989), which provided no evidence to indicate that a parafoveal preview of morphological information facilitated the processing of target words.

Another study by Niswander, Pollatsek, and Rayner (2000) investigated the role of both whole-word frequency and stem-frequency by measuring eye movements while people read sentences in which derived words and inflected words were embedded as targets. The results with derived words showed that stem frequency was reflected in the earlier measure of the word (i.e., the duration of the first fixation), whereas whole word frequency affected the later processing of it (i.e., the second fixation). However, for inflected regular words, whole-word and stem frequencies significantly affected its early processing (i.e., the first fixation) only for plural nouns, not for inflected verbs. Thus, this study suggests that both the whole word and the stem play a critical role in the reading of complex words.

In contrast to evidence from English studies, Deutsch, Frost, Pollatesk, and Rayner (2005) conducted parafoveal display change experiments using Hebrew, in which they found a significant morphological preview effect for words (i.e., first fixation duration & gaze duration) that did not share initial letters, suggesting that morphological units mediate word identification. It is possible that these effects are specific to highly inflected languages (e.g., Hebrew, Finnish, or Turkish), where morphological information is more informative. The contrasting results may reflect linguistic differences between Hebrew and English. Since Hebrew morphology is significantly richer than English morphology (Plaut & Gonnerman, 2000), it is possible that morphological processing can be more easily detected in a language such as Hebrew than in English. Thus, the different patterns of morphological processing (during sentence reading) in English and Hebrew suggest that it might be possible to observe similar differences in other cross-language comparison situations (e.g., English and Korean).

There have been some attempts to combine both sentence reading and masked (or fast) priming to investigate how word recognition can be affected by sentential contexts. Sereno and Rayner (1992) attempted to combine a natural reading task with the masked priming paradigm (i.e., fast priming). In their eye-tracking experiments, the participants were asked to read each sentence silently (e.g., *Margaret enjoyed her flute lessons a lot.*).

When the reader encountered a target word (*flute*) in a sentence, a prime word (a semantically related word, *piano* or a semantically unrelated word, *pupil*) was briefly (20-60ms) preceded by a target. Due to the masked priming paradigm, participants were unable to identify the primes. Their results showed that primes semantically related to the target elicited significant priming effects as compared to the unrelated primes. Thus, this task permits researchers to infer how automatic lexical processes occur during silent reading of sentences. This fast priming method was adapted to a self-paced reading task (Novick, Kim, & Trueswell, 2003); however, most studies employing it have focused on syntactic bias rather than lexical processing itself. In this study, a self-paced reading with masked priming paradigm was employed to examine how morphological structures are processed during silent sentence reading.

In summary, there have been several studies examining inflectional processing while people read a sentence, not just words in isolation. The findings from these ecologically more valid tasks have provided better understanding about how morphological structures are processed during sentence reading. As Bertram, Hyönä, and Laine (2011) suggested, evidence from words in isolation is limited when attempting to generalize morphological processing to normal reading situations. For example, sentential context is expected to reduce the ambiguity of homonymous constituents in a complex word (Bertram, Laine, Schreuder, Baayen, & Hyönä, 2000) and to reduce the process of 'checking' the legality of the stem and affix combination as compared to words in isolation (Baayen, Wurm, & Aycock, 2007). Thus, the present dissertation seeks to use the combined task of self-paced reading and masked priming to examine how automatic processes of past-tense inflection occur during silent reading of sentences.

2.6. Empirical Evidence of L2 Inflectional Processing: Words in Isolation

The amount of research on L2 morphological processing has been limited; furthermore, interpretations of the results are controversial. For instance, several studies found no differences between L1 and L2 in production latencies (Beck, 1997), priming effects of regularly inflected word forms (Basnight-Brown et al., 2007; Portin, Lehtonen, & Laine, 2007; Portin, et al., 2008) or derived word forms (e.g., Dipendaele, Dunabeitia, Morris, & Keuleers, 2011). These results generally suggest that L2 learners' processing of morphologically complex words, although slower and less automatized than L1 processing, is the same as L1 processing of morphologically complex words. Contrary to that position, other studies found differences between L1 and L2 processing of morphological information, and argued that L2 processing differs fundamentally from L1 processing (e.g., Clahsen & Neubauer, 2010; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008).

Portin, Lehtonen, and Laine (2007) examined whether Finnish learners of Swedish are sensitive to the frequency of Swedish inflected words to the same degree as Swedish L1 speakers, and found that effects of frequency and morphological type were significant High frequency words were processed more rapidly (and more accurately) than low frequency words, and monomorphemic words were processed more rapidly (and more accurately) than inflected words. In addition, low-frequency inflected words elicited significantly longer reaction times and greater error rates compared to monomorphemic words with low frequency. This is regarded as evidence that morphological decomposition occurs in low-frequency inflected words, which is consistent with English data (Alegre & Gordon, 1999). No difference in reaction times and error rates between monomorphemic words and inflected words in the medium and high-frequency lists implies that whole-word access was favored for these words by the Finnish learners of Swedish. These patterns are similar to those obtained with Swedish natives in the study by Lehtonen, Miska, Wande, Niemi, and Laine (2006), showing that in the Swedish L1 group, Swedish inflected words with low frequency induce longer reaction times and lower accuracy compared to corresponding monomorphemic words. In contrast, both medium and high-frequency inflected words and monomorphemic words showed no difference in reaction times and accuracy. This suggests that Swedish L1 speakers access low frequency complex words via decomposition. Taken together, the researchers suggested that even late exposure to another language can yield similar representations for morphological structures that are typical of L1 speakers.

Additional support was evident in a study done by Feldman et al. (2010) who investigated inflectional processing in Serbian learners of English and native speakers of English using both visual masked and cross-modal priming lexical decision tasks. When participants were presented both prime and target visually (i.e., visual masked priming), bilingual speakers did not show reliable priming effects, especially when using irregular past-tense words as primes and when the length of irregular was preserved (e.g., fell–FALL). However, this pattern did not hold for the highly proficient L2 learners. Namely, highly proficient L2 learners showed significant morphological priming effects on both regular verbs and irregular verbs regardless of their length preservation (e.g., fell-FALL or teach-TAUGHT). Native speakers of English showed significant facilitation from morphologically-related primes in all the conditions (regular, irregular length preserved, and irregular length changed). In addition to this morphological priming effect, orthographic priming effects were observed. Native speakers of English showed a reliable priming effect from orthographically related primes in regular forms (billion-BILL) or length-preserved irregular forms (fill-FALL). The results from high proficiency L2 learners were the same as those of the native group. Low proficiency L2 learners also showed a significant orthographic priming effect for regular verbs (billon-BILL). Summarizing these results, no reliable difference was found between native and non-native speakers during the visual masked priming experiment. Since significant priming effects were observed for orthographically related primes, it is hard to determine whether the significant priming effects from the morphologically related primes were due only to morphological priming. Therefore, a cross-modal priming experiment was conducted by the researchers, and the results provided evidence that morphological facilitation by regularly inflected words is reliable not only for native speakers of English but for L2 learners as well. Thus, the results of Feldman et al. failed to support the claim that L2 learners lack the grammar to decompose regular past-tense forms and, while native speakers showed cross-modal form inhibition in length preserved irregulars (longer latencies for fell-FALL), non-native speakers did not. Note that native speakers, not L2 learners, showed a reliable inhibitory priming effect from orthographic controls. The researchers suggested that dual-mechanism accounts (i.e., decomposition and memory based access) are not necessary for inflectional processing in both L1 and L2, based on reliable facilitation for regulars and attenuated priming effect in irregulars with a degree of form overlap in the different tasks (i.e., the visual masked priming task and the cross-modal priming task).

Basnight-Brown et al. (2007) tested past-tense form processing with native English speakers and two groups of English L2 learners to show the possibility of L2 processing mediated by L1 background: Serbian-English and Chinese-English. While Serbian is morphologically rich, Chinese inflection is minimal. In their experiments, morphologically simple, present tense English verbs served as target words and three different prime words for the targets were used: (1) a morphological related (i.e., past-tense form, billed- BILL); (2) an orthographically similar form (e.g., billion-BILL); and (3) a morphologically and orthographically unrelated control (e.g., careful-BILL). Basnight-Brown et al. controlled several factors such as written frequency of primes, letter-length or number of neighbor, and repeated letters (% repeated letters). For irregular words, length preservation was considered another factor to see whether the length-changed irregular verbs (e.g., taught – TEACH) are processed differently from the length-preserved verbs (e.g., fell-FALL). Feldman et al. found no reliable differences in facilitation across regular and irregular verb types for native and non-native speakers. The absence of reliable differences in facilitation across verb types fails to provide compelling evidence that decomposition and the activation of stems is the mechanism that underlies morphological facilitation for regularly inflected forms.

This pattern of results was replicated in cross-modal presentation of primes and targets (Feldman et al., 2010). While native speakers showed cross-modal form inhibition for orthographically related primes (i.e., longer reaction times for auditory prime *billion* and its visual target *bill* pair), non-native speakers did not. Results suggest that morphologically unrelated word primes similar in form to the target failed to generate either competition or facilitation in L2 speakers. L2 learners are also less sensitive to pairs that are only orthographically related.

Diependaele, et al. (2011) attempted to test Ullman's declarative/procedural model for L2 morphological priming. In the case of derivational morphology, the transparency issue was addressed in terms of whether L2 morphological processing is different from L1 processing. That is, L2 processing relies more on whole-word storage supported by the declarative memory system (Ullman, 2004). A stronger reliance on declarative memory in L2 should affect morpho-orthographic processing. In other words, L2 morphological processing is less dependent on a combinatorial treatment of inputs, which is related to morpheme based decomposition. Therefore, L2 learners are expected to show a reduced morphological priming effect for semantically opaque complex words (e.g., *corner-CORN*), as compared to semantically transparent derived words (e.g., *famer-FARM*). Diependaele et al. (2011) tested native English speakers and two groups of bilinguals (Spanish-English and Dutch-English) using three types of prime-target relations: semantically transparent morphologically related (e.g., *viewer-VIEW*), semantically opaque pseudo-morphological related (e.g., *corner-CORN*), and only orthographically related (e.g., *freeze-FREE*). Both bilingual and native English groups showed the largest priming effects in the transparent condition, the smallest priming effects in the form condition, and intermediate effects with the opaque condition. Based on a similar pattern of priming effects between the L2 groups and the native English group, the researchers concluded that even late bilinguals adopt a morphological processing strategy in their L2 that is similar to native speakers of that language. These results were not consistent with the declarative/procedural model. Rather, it showed there is no evidence for a qualitative difference in L1 and L2 morphological processing.

In contrast to this position, other studies have found differences between L1 and L2 processing of morphological information, and argued that L2 processing differs in more fundamental ways from L1 processing (e.g., Bowden, Gelfand, Sanz, & Ullman, 2010; Clahsen & Neubauer, 2010; Neubauer & Clahsen, 2009; Silva & Clahsen, 2008). For instance, Silva and Clahsen (2008) compared L1 speakers of English and Chinese and German L2 English learners on English regular past-tense forms using a lexical decision task. While the L1 group did not show a whole-word frequency effect, the L2 learners showed a significant whole-word frequency effect. The difference between the two groups' performance in terms of the whole-word frequency on inflectional morphology indicates that morphological structures are processed differently by English L1 and English L2 groups. Namely, L1 speakers are sensitive to the stem in regularly inflected verbs, so whole-word frequency did not affect the processing of the regular past-tense forms via decomposition. However, L2 learners rely more on the whole word form even when the words are regularly inflected ones. Thus, Silva and Clahsen (2008) provided a significant effect of whole-word frequency on the latency of the regular past-tense forms.

Additional support comes from Clahsen and Neubauer (2010) research examining whether L2 morphological processing differs from L1 morphological processing. In their experiments, adult German natives and adult Polish learners of German were shown derived German nouns with the nominalizing suffix *–ung* in a lexical decision task, and both groups responded more rapidly to the derived words with high whole-word frequency as compared to the derived words with low whole-word frequency when the stem frequencies were matched. In contrast, in a masked priming lexical decision task, the morphological priming effect was only significant for the German native group, not for the L2 group. Thus, the researchers concluded that the priming effect from *–ung* forms in the L1 group is due to the morphological structure embedded in the complex words. However, the L2 learners do not rely on the morphological structure.

If dual route processing is correct, then whole-word frequency should not affect processing of regular inflected words, as rule application takes place automatically and independently of the frequency of the stem. In contrast, the processing of irregular words should be affected by their whole-word frequency because irregular verbs are assumed to be accessed by memory trace. However, L2 learners would be affected by whole-word frequency both in regular and irregular words based on their reliance on declarative memory (Ullman, 2004) or lack of morphological sensitivity (Clashen & Felser, 2006a, 2006b; Jiang, 2004). Thus, it can be hypothesized that only the high L2 proficiency group respond more slowly to the regular words in lexical decision task than the irregular words if L2 proficiency is critical to acquire combinatorial rule in inflection. This would support the hypothesis that dual route processing in L2 morphological processing depends on the level of proficiency in the L2. However, the results from Kirkici (2005) did not demonstrate any difference between high vs. low proficiency groups across regular and irregular verbs in Turkish learners of English.

In summary, research on L2 inflectional processing at the word level has provided inconsistent results with respect to the issue of whether the pattern of L2 inflectional processing is similar to L1 inflectional processing. The previous studies considered several critical factors central to this question. For instance, characteristics in the L1 inflectional system can be similar to those in L2, which may affect L2 inflectional processing. As a common factor in L2 research, L2 proficiency could be important as well. This may be the case even if L1 and L2 morphological processing is thought to be fundamentally different (e.g., Ullman, 2004). Therefore, it is expected that the pattern of L2 morphological processing becomes more similar to the pattern of L1 morphological processing as L2 experience increases. In the present dissertation research, the L2 group (Korean learners of English) is expected to have intermediate to advanced levels of English proficiency. In order to ensure the participants' English proficiency, two objective measures (C-test and Boston Naming test) of participant L2 proficiency were used to identify the L2 proficiency of the participants. In addition, a self-report of the Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007) was used to record their language profiles.

2.7. Empirical Evidence of L2 Inflectional Processing: Words in Sentence

L2 studies on inflectional processing in sentence reading have normally focused on how sensitive L2 learners are to inflectional violation (Hahne, Mueller, & Clahsen, 2006; Jiang, 2004; Pliatsikas & Marinis, *in press*). Hahne, Mueller, and Clahsen (2006) examined the processing of L2 inflectional morphology in Russian learners of German using ERPs (Event Related Potentials) experiments. In their study, a group of proficient German L2 group was presented with a list of sentences embedding four different types of participles: regularly inflected, irregular inflected, overregularized (i.e., illegal combination of an irregular stem and a regular inflectional suffix), and irregularized (i.e., illegal combination of a regular stem and an irregular inflectional suffix). The sentences were presented word by word for a fixed duration. The ERPs results from this study suggest that there is no difference between L1 and L2 online processing of past-tense forms. Regularized participles of irregular verbs elicited a Left Anterior Negativity (LAN) between 300 – 800ms and a smaller P600 response when compared to correct irregular participles (Experiment 1B). In previous ERPs studies, the LAN response has been shown to be sensitive to violations of rule-based morphological processing, whereas the P600 response has been shown to relate to controlled processing and especially reanalysis. Thus, these two responses regarding overregularization suggest that L2 learners of German made use of the rules, realized its misapplication to a pseudoword, and conducted a reanalysis. In contrast, a N400 was elicited by irregularizations of regular verbs in L2 learners. N400 has been claimed to be related to lexical processing and its interpretation (Lau, Phillip, & Poeppel, 2008). Thus, a significant N400 could be caused by failure of whole word processing of an irregularized pseudoword. This has been reported as well in native speakers for pronounceable non-words that are created by irregularization, so it is likely related to lexical violation. Taken together, these two findings suggest that during sentence processing, L2 learners process regular and irregular verbs via two different mechanisms, which are similar to native speakers. This demonstrates that the dual-system model of processing can be applied to highly proficient L2 learners. This is in contrast to other L2 studies using the same language (German) with words in isolation experiments (Neubauer & Clahsen, 2009; Silva & Clahsen, 2008). Hahne et al.'s findings were based on ERPs which could not be directly compared to other behavioral data. Note that de Diego Balaguer, Sebastian-Galles, Diaz, and

Rodriguez-Fornells (2005) showed no differences between native vs. non-native groups in reaction time data, but they found a significant difference in ERP data.

The lack of L2 morphological priming can be explained by L2 morphological insensitivity. Concerning L2 morphological insensitivity, Jiang (2004) conducted a self-paced reading experiment recruiting Chinese learners of English. The participants in this experiment were asked to read a list of sentences which contained either correct or incorrect inflected word forms (e.g., number agreement). Chinese participants failed to detect the inflectional violation when they read the English sentences. This result suggests that L2 learners are not sensitive enough to morphological structure in L2. Jiang suggested that the L2 morphological insensitivity may be related to the L1 morphological characteristics of Chinese learners of English. Specifically, it should be noted that "grammatical number is seldom encoded in their L1, Chinese" (Jiang, 2004: p. 627). If this is the case, morphological insensitivity to L2 depends upon L1 characteristics. In order to test this possibility, English learners with different L1 backgrounds needed to be recruited.

A recent study by Pliatsikas and Marinis (in press) investigated how proficient Greek-English L2 learners' processing of regular and irregular English past-tense inflection at the sentence level compared to native English speakers. A self-paced reading task was used, and the sentences were divided into 6 segments (e.g., Regular verb target "helped": The head teacher/ gave a prize/ to the student because she/ *helped* / a poor guy/ last month.). There were four types of target verbs: Regular (e.g., *helped*), Irregular (e.g., *fought*), Regularized (illegally regularized irregular verb, e.g., *taked*), and Irregularized (illegally irregularized regular verbs, e.g., *arrove*). The whole-word frequency and orthographic neighborhood sizes were controlled. As in the example sentence, the target word was always presented as the fourth segment in a sentence. Thus, RTs for segment 4 were the critical, and segments 3 and 5 were analyzed for any potential spill-over effects. The results revealed that native speakers of English recognized regular inflected verbs more slowly than irregular verb. This can be interpreted as decompositional processing in regular inflected words requiring more time to process compared to irregular inflected words, both words in isolation and words in sentence contexts. Pliatsikas and Marinis recruited highly-proficient L2 learners of English using an objective English proficiency measure. Within their L2 learner group, L2 proficiency level and the methods of L2 exposure (naturalistic vs. classroom) did not affect the processing of regular and irregular verbs. Both pseudo-inflected words (i.e., regularized and irregularized pseudowords) were processed more slowly than real inflected words, but, importantly, there was no difference between real regular verbs and regularized forms. It may be the case that when a regularized pseudoword consists of morphological structures (e.g., *feeled*), it is still effectively decomposable. This morphological sensitivity regardless of lexicality has been observed in derived words (e.g., Kim, Wang, & Ko, 2011; Longtin & Meunier, 2005). The results of this study suggest that the processing of L2 regular past-tense verbs by highly proficient L2 learners is rule based (i.e., decomposition) and access to irregular past-tense forms is memory based (i.e., full-form access), as is the case with L1 speakers.

In summary, although there have been a limited number of studies examining L2 morphological processing during sentence reading, both behavioral and neurophysiological evidence suggest there is no qualitative difference between L1 and L2 morphological processing (e.g., Foucart & Frenck-Mestre, 2012). All evidence thus far supports the dual-mechanism account for the processing of L2 past-tense forms. All of studies investigating L2 morphological processing in sentence context used violations (either syntactic violations or lexical violations) to examine how sensitive L2 learners are to those violation types. As mentioned in the previous section, a task combining self-paced reading and the masked priming paradigm can open another window to observe L2 past-tense form processing. This combined technique can be a good measure for the early processing in visual word recognition within the context of a sentence.

2.8. Limitations of Previous Research on Inflectional Processing

The previous research regarding the processing and representation of inflectional morphology has limitations. First, the generalizability of theoretical accounts of inflectional morphology could be questioned due to the lack of research on different languages. Most studies on inflectional morphology rely on English or Indo-European alphabetic languages. Regular past-tense inflection in Korean generally resembles that of English, because regular past-tense inflection in both Korean and English is very predictable in the way of concatenation. However, Korean irregulars are more predictable than English irregulars, which leads to a not-so-clear distinction between regular and irregular and may further result in a different pattern of irregular verb processing compared to English. Therefore, data from Korean could produce evidence to further develop cross-language comparisons to investigate whether a single account can explain morphological processing across different languages.

Another specific question addressed throughout this review was whether L2 morphological processing resembles L1 morphological processing. Regarding this question, two lines of investigation were highlighted. First, several studies provided evidence showing that regardless of L1 characteristics, L2 morphological processing may be different from L1 morphological processing (Clahsen, Felser, Neubauer, Sato, & Silva, 2010; Silva & Clahsen, 2008; Ullman, 2004). The declarative/procedural memory based model (Ullman, 2001, 2004) supports this view based on both behavioral and neural correlate data from L1 and L2 morphological processing. For instance, Silva and Clahsen (2008) argued that the trend and magnitude of L2 morphological priming is different from that in L1 based on their comparison of native English speakers and advanced L2 learners (e.g., German-English, Japanese-English and Chinese-English). Their masked priming experiments included three conditions of primes to the targets, identical prime (boil-BOIL), past-tense form (boiled-BOIL), and unrelated prime (jump-BOIL). Researchers tested whether primes as inflected forms elicit the same magnitude of priming effect as identical primes. In their results, only the native speaker group showed similar magnitudes of priming effects in both identical and past-tense forms, where recognition latencies were equally masked in the unrelated prime condition. However, L2 learners, regardless of their L1s, only showed priming effects in the identical prime condition. The past-tense forms did not elicit faster RTs for the target as compared to the unrelated primes. Silva and Clahsen interpreted this as L2 learners failing to decompose the past-tense forms into their constituents. It indicates that L2 learners' access to the irregular forms occurs via memory. However, their findings could not be generalized because of a small number of items and limited types of suffixes used. Ullman's (2004) argument is also limited to inflectional morphology.

In contrast to this view, Diependaele and his colleagues (2005, 2009, 2011) provided evidence showing that morphologically complex words are processed based on similar principles in L1 and L2. In their experiment, bilingual speakers showed a similar pattern of morphological priming effects regardless of the types of primes (whether semantically transparent or not) as compared to their native English-speaking counterparts. However, both bilingual groups' L1 languages (Spanish and Dutch) in their study were typologically similar to the L2 target language, English (Serva & Petroni, 2008). Thus, the general applicability of their findings is still limited. The present dissertation research seeks to examine Korean learners of English and English L1 speakers. Korean is a non Indo-European agglutinative language. Furthermore, as Diependaele et al. acknowledged, language proficiency was not taken into account carefully via objective tests such as C-tests or the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 2001). Both objective English proficiency tests will be employed in this study to control the participants' L2 proficiency.

Another limitation in the literature could be the lack of empirical research regarding online processing of morphological structure while reading sentences in both L1 and L2. Basically, more studies are needed to provide a better understanding of differences in how morphological structures are processed in word in isolation vs. word in sentence context. As opposed to words in isolation, words in sentence context may reduce the ambiguity of homonymous constituents in a complex word (Bertram et al., 2000), which may lead to emergence of a stem frequency effect. Indeed, many morpheme constituents in complex Korean words can be homographic morphemes (either as a stem or a bounded morpheme). Therefore, this ambiguity may be more salient in the situation of words in isolation as compared to words in sentence in Korean.

In addition, the recognition of a complex word in a sentence where the process of "checking" the legality of the stem and affix combination is not critical, which can be related to stem frequency effect when an ambiguous complex words are presented in sentential context (Baayen et al., 2007; Luke & Christianson, 2011). Taken together, as factors of interest in this dissertation, both stem and whole-word frequency effects are expected to be dependent on task differences.

In summary, the present dissertation sought to address three major issues: 1) Are Korean L1 speakers and English L1 speakers similarly sensitive to inflectional morphological structures? Although both Korean and English have regular and irregular past-tense inflection, the Korean irregular cases are different from English irregulars in terms of their consistency (i.e., Korean irregulars are much more predictable than English irregulars). 2) How do adult Korean learners of English process L2 morphological structures as compared to English L1 speakers? Similar to the first question, how regularity, stem and whole-word frequencies, and form similarity affect English L1 and L2 will be tested. 3) To what degree do task differences between words in isolation and words in sentences affect the processing of morphologically complex words?

In order to answer these questions, four experiments were conducted. Three language populations were examined with Korean L1, English L1 and English L2. The studies employed two different methodologies: the masked priming lexical decision task and self-paced reading with masked priming. The general design of the 4 experiments is summarized in Table 4.

Table 4. Summary of Experiments in the Present Study

Experiment	Language	Participant group	Task
Exp. 1	Korean	Korean L1	Masked priming LDT
Exp. 2	English	English L1 (2a) & KLE (2b)	Masked priming LDT
Exp. 3	Korean	Korean L1	Self-paced reading with masked priming
Exp. 4	English	English L1 (4a) & KLE (4b)	Self-paced reading with masked priming

Abbreviations: KLE: Korean learners of English, LDT: Lexical decision task

Chapter 3: Experiment 1

Korean Past Tense in Native Korean Speakers: Words in Isolation

3.1. Purpose

Experiment 1 examines the processing of past-tense inflectional morphology in Korean. Since the majority of the previous studies regarding past-tense inflection have been conducted with English or other Indo-European languages such as German (Sonnenstuhl, Eisenbeiss, & Clahsen, 1999) or French (Meunier & Marslen-Wilson, 2004), the present study using the Korean language provides an opportunity to better understand how morphological processing occurs across different languages.

In order to examine inflectional processing in Korean, four factors of interest are considered: regularity, stem frequency, whole-word frequency, and orthographic similarity between present- and past-tense forms. The research questions addressed by Experiment 1 are:

1) Do Korean L1 readers show morphological priming effects in the processing of past-tense words?
2) Does regularity play a role in performing masked priming lexical decision tasks with past tense words in Korean L1?
3) Which factors among regularity, stem and whole-word frequencies, and orthographic similarity affect morphological priming magnitude in Korean L1 and how?

4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense in Korean L1?

In order to answer the research questions above, a masked priming lexical decision paradigm (Forster & Davis, 1984) was employed. In this paradigm, prime and target pairs are constructed by manipulation of their relationships such as semantic (e.g., *fruit* - *apple*) or morphological (e.g., *breakable* - *break*) relationships. In Experiment 1 of the present study, regular and irregular words were used as targets, and they were paired with three types of primes: 1) corresponding past tense, 2) orthographically similar words, and 3) unrelated words. With the short prime duration in this paradigm (48ms in the present study), it is almost impossible for participants to identify the primes consciously; therefore, this task is regarded as a good tool for examining how participants process lexical information without conscious strategy.

3.2. Hypotheses

If the dual-route model (e.g., Clahsen, 2006; Pinker, 1999; Pinker & Ullman, 2002), which posits a clear distinction between regular and irregular forms, is applicable to Korean past-tense inflection, then there should be different patterns in response latencies for regular and irregular words. First, regular past-tense forms in Korean are generated by a rule-based combination of a stem and a suffix (either -았 /*ass*/ or –었 /*ess*/). Therefore, it is expected that, when a past-tense form (e.g., 보았다 /*poassta*/, meaning *saw* in English) is used as a prime for its stem target (e.g., 보다 /*pota*/, meaning *see* in English), the processing of the target is facilitated, as compared to when an unrelated prime (e.g., 운동장 /*wuntongcang*/, meaning *playground* in English) is used as a prime. The past-tense form of Korean irregular verbs is constructed differently than regulars (see

Table 2 in Chapter 2). The irregular past-tense construction includes consonant or vowel omissions or additions (e.g., 고르다 /*koluta*/ - 골랐다 /*kollassta*/, meaning *choose* - *chose* in English) in addition to adding a suffix (either -았 /*ass*/ or –었 /*ess*/). Therefore, according to the dual-route model, there should be no facilitation effect from the irregular form primes to the stem target. If this is the case, then the whole-word frequency effect will be greater for the irregular form than for the regular form. In other words, an interaction between regularity and whole-word frequency should be observed.

However, Korean irregular forms can be regarded as less irregular compared to those in other languages (e.g., English), because their forms still include a past-tense marker with stem changes. Thus, it is hypothesized that there should be less difference in the response latencies for regular versus irregular words in Korean, and a whole-word frequency effect should be evident in both regular and irregular forms. In addition, a form similarity effect is expected in Korean past-tense processing because a length-changed irregular past-tense form in Korean is not necessarily orthographically different from the corresponding present form. Rather, some length-preserved cases are different from their present forms regarding form similarity. Therefore, in the present study, degree of form similarity is treated as a continuous variable to capture its effects at a finer resolution.

3.3. Method

3.3.1. Participants

Thirty-nine Korean native readers (14 females and 25 males) were recruited from a university in Seoul, Korea (age $M = 24$, $SD = 2.8$). The majority of the participants were undergraduate students. All participants had normal or corrected-to-normal vision, and they received monetary compensation equaling approximately $8 for their participation.

3.3.2. Design and Materials

There were three conditions of prime type: past-tense form, orthographic control, and unrelated control. For the past-tense form condition, four factors were considered: regularity, stem frequency, whole-word frequency, and orthographic similarity. Among these variables, regularity was a categorical variable (regular vs. irregular); stem frequency, whole-word frequency, and orthographic similarity were treated as continuous variables. Both stem and whole-word frequencies were based on the Korean Word Database (2001). Orthographic similarities between morphologically-related primes and targets were calculated by orthographic similarity calculation (Van Orden, 1987, see the details of the calculation procedure in Appendix A). In addition, the length preservation within the irregular form was examined; irregular verbs differed in length between their present and past-tense forms. The characteristics and an example list of the stimuli are shown in the Table 5.

The total set of experimental stimuli included 156 present-form targets (78 regulars and 78 irregulars). The targets were paired with their corresponding past-tense primes, with orthographic control primes, and with unrelated control primes, forming 156 pairs for each of the three conditions. These pairs were assigned to three stimuli lists. All of the 156 target words appeared once in each of three stimuli lists in a way that each target was paired with the three different types of primes across the three lists. In each list, one third of the targets were preceded by a morphologically related (past-tense form condition) word prime, another one third of the targets were preceded by an orthographically related word prime (orthographic control condition), and the last one third of the targets were preceded by an unrelated control word prime (unrelated control condition).

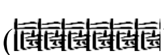
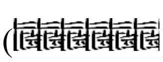
In order to reduce the influence of processing strategies and expectations (by matching numbers of correct yes- and no- responses), 260 filler pairs were added to each list: 52 filler pairs were unrelated words coupled with complex and monomorphemic words, and 208 filler pairs consisted of unrelated word/nonword pairs (monomorphemic, inflected pseudowords and nonwords). In total, there were 156 experimental pairs of real words, 52 filler pairs of real words, and 208 filler pairs of nonwords in each stimuli list. Therefore, the proportion of related prime-target pairs in the stimuli list was .25 (52 pairs in past-tense condition out of 156 pairs in three experimental conditions and 54 filler pairs of real words).

The thirty-nine participants were randomly assigned to one of the three stimuli lists. Each participant completed a practice session of 10 trials prior to the experimental procedure.

Table 5. Characteristics [Mean (SD)] and Examples of Primes and Targets in Experiment 1

	Prime type (N = 78)			Targets (N=78)
	Morphological (N = 26)	Orthographic (N = 26)	Unrelated (N = 26)	
Regular	긁었다	긁은점	백화점	긁다
Logged stem freq.				3.10 (.5)
Logged whole-word freq.	1.60 (.7)	1.46 (.6)	1.46 (.6)	1.98 (.7)
Number of letters	7 (1)	6 (1)	6 (1)	5 (1)
Repeated letters	5 (1)	4 (1)	1 (1)	N/A
% repeated letters	70 (7)	62 (11)	15 (30)	N/A
Orthographic similarity	.82 (.02)	.71 (.3)	.36 (.2)	N/A
	Prime type (N = 78)			Targets (N=78)
	Morphological (N = 26)	Orthographic (N = 26)	Unrelated (N = 26)	
Irregular	잠갔다	잠자리	수영장	잠그다
Logged stem freq.				3.99 (.8)
Logged whole-word freq.	1.54 (.8)	1.46 (.6)	1.46 (.6)	1.98 (.7)
Number of letters	7 (2)	7 (2)	7 (2)	6 (1)
Repeated letters	5 (1)	3.5 (1)	1 (1)	N/A
% repeated letters	69(16)	57 (10)	15 (15)	N/A
Orthographic similarity	.74 (.03)	.56 (.1)	.34 (.2)	N/A

3.3.3. Procedure

All of the stimuli were presented in the center of the screen. Each trial started with a fixation sign (+) presented for 500ms. Then, a forward mask, made with upside down Korean letters (), was presented for 500ms, and replaced with a prime for 48ms, and then with a post mask () for 75ms. Then, a target appeared for

2000ms or until the participant responded. Primes and targets were displayed in 16-point and 23-point of Hangul Gulim font, respectively. The experiment was run on a desktop computer, using E-Prime software 2.0 (Psychology Software Inc., Pittsburgh, PA) with a random trial presentation.

After signed informed consent was obtained, participants received written instructions on the screen stating that they would see a string of letters on the screen in each trial, and that they would have to indicate as quickly and as accurately as possible whether the letter string was a Korean word or not, by pressing one of two buttons on the keyboard ('1' key for the 'yes' response and '0' key for the 'no' response). Reaction times were recorded as the times between the onsets of the targets and the responses. The presence of a visual prime was not mentioned at this time. After completing 10 practice trials, the participants started the main experimental session.

3.4. Results

Accuracy rates were very high in all conditions (> 95%), and the analyses revealed no effect of any variables on error rates. Incorrect responses were removed for the reaction time (RT) analysis. Also, correct responses with RTs less than or greater than 2.5*SD* from the mean of each participant (2.6%) were excluded from the RT analysis. In addition, six items (3 regular words and 3 irregular words) were excluded due to low overall accuracy (< 80%). In order to increase normality and homoscedasticity, all RTs were logarithm-transformed. Mean RTs and error rates are summarized in Table 6.

For the RT analysis, two categorical variables (regularity and prime type) and four continuous variables (word length, stem frequency, whole-word frequency, and orthographic similarity) were included, and two types of analyses were conducted: an analysis of covariance (ANCOVA) and a hierarchical multiple regression analysis. First, a mixed design ANCOVA was conducted. Prime type was a within-subject variable, and regularity was a between-subject variable. Stem frequency, whole-word frequency, orthographic similarity, and word length (the number of syllables) were covariates. The main effect of prime type was statistically significant [F (2, 276) = 3.98, p = .020]. The main effect of regularity was not significant [$F < 1$], and the interaction between regularity and prime type was not significant [F (2, 276) = 1.167, p = .313]. The mean RTs in the past-tense form condition was 19ms faster than the mean RTs in the unrelated condition, and the difference was significant [F (1, 143) = 5.065, $p < .001$]. The mean RTs in the past-tense form condition was 23ms faster than the mean RTs in the orthographic condition, and the difference was significant [F (1, 143) = 5.978, $p < .001$]. However, there was no significant difference in RTs between the unrelated and the orthographic control conditions [F (1, 143) = .918, p = .36].

These results suggest that the morphological priming effect from past-tense form in Korean L1 is significant, regardless of regularity (regular vs. irregular) and orthographic overlap between the prime and the target.

Table 6. Reaction Times and Error Rates in Experiment 1

Regularity	Prime type	Reaction times Mean (SD) in msec	Error rates Mean (SD) in %
Regular	Past-tense	574 (39)	1.8 (.5)
	Orthographic control	602 (52)	2.9 (.5)
	Unrelated control	591 (42)	2.0 (.6)
Irregular	Past-tense	577 (50)	1.9 (.4)
	Orthographic control	595 (41)	1.7 (.4)
	Unrelated control	598 (45)	1.6 (.4)

Second, a hierarchical regression analysis was carried out in order to assess the extent to which both stem frequency and whole-word frequency account for the morphological priming effect after controlling for other variables including regularity, word length, and orthographic similarity. In addition, interactions between the two frequencies and regularity were tested. The regression analysis involved one independent categorical variable (regularity), four independent continuous variables (stem frequency, whole-word frequency, word length, and orthographic similarity) and one dependent variable (magnitude of morphological priming effect: $RT_{unrelated\ control} - RT_{past\text{-}tense}$). The order of variable entry for the analysis was: regularity, word length, orthographic similarity, stem frequency, whole-word frequency, interaction between regularity and stem frequency, and interaction between regularity and whole-word frequency. In order to test whether each variable's contribution to the magnitude of morphological priming effect is unique, entry orders within the two frequency variables and within their interaction terms with regularity were switched and tested. Together, the focus of these analyses was to examine the unique contributions of two frequency variables and their interactions with regularity after controlling for the other three variables (see Table 7).

Table 7. Hierarchical Regression Analysis in Experiment 1

		R	R^2	ΔR^2	*F* for ΔR2
Predicting morphological priming magnitude					
Step1: REG		.040	.002	.002	.223
Step 2: Length		.084	.007	.005	.759
Step 3: OS		.084	.007	.000	.017
Model 1	Step 4: SF	.427	.182	.175	29.713***
	Step 5: WF	.453	.205	.023	4.054*
Model 2	Step 4: WF	.423	.179	.171	29.007***
	Step 5: SF	.453	.205	.027	4.651*
Model 1	Step 6: REG × SF	.455	.207	.001	.232
	Step 7: REG × WF	.480	.231	.024	4.250*
Model 2	Step 6: REG × WF	.469	.220	.015	2.560
	Step 7: REG × SF	.480	.231	.011	1.910

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity *$p < .05$, *** $p < .001$; Models 1 and 2 represent the different entry orders of the pair of variables.

As shown in Table 7, regularity, word length, and orthographic similarity did not explain morphological priming. After controlling regularity, word length and orthographic similarity, however, the analysis revealed that both stem frequency and whole-word frequency explained a significant amount of variance in morphological priming effect (~17%, $p < .001$, ~2%, $p = .046$, respectively). The interaction effect between regularity and stem frequency on the priming magnitude was not reliable. The results of the regression analyses suggest that there is no clear distinction between regular and irregular forms in morphological priming in Korean. This was expected based on the characteristics of Korean past tense, in that irregular forms in Korean are "less irregular" compared to other language such as English. The robust and unique contribution of stem frequency to morphological priming regardless of regularity confirmed that abstract level of morphological relations between prime and target play a critical role in past-tense processing in Korean.

The analyses also revealed that, after all the other factors were taken into account, whole-word frequency significantly explained the morphological priming effect. The significant contributions from both stem frequency and whole-word frequency imply that rule-based decomposition and memory-based whole-word access may coexist for the processing of past-tense in Korean. Both absence of regularity effect and the strong effect of stem and whole-word frequencies in Korean past-tense processing are unlikely to be explained by dual-mechanism accounts such as the Words-and-Rules Model. This language-specificity shown in Korean past-tense processing suggests that more data from different languages are needed to generalize the language-dependent mechanism of morphological processing.

In sum, when a past-tense form and its corresponding stem were used as prime and target, a significant morphological priming effect was observed. This morphological priming effect was independent of regularity and orthographic overlap between the prime and target pair. Among the major inflection-related factors, only stem frequency and whole-word frequency uniquely contributed to the morphological priming.

Chapter 4: Experiment 2

English Past Tense in Native English Speakers and Korean Learners of English: Words in Isolation

4.1. Purpose

Experiment 2 examines the processing of past-tense form in English by English Native speakers (NES: English L1 in Experiment 2a) and Korean learners of English (KLE: English L2 in Experiment 2b). Except for the inclusion of English words in the masked priming lexical decision task in Experiment 2, the experimental paradigms in Experiments 1 and 2 were almost identical. The parallel designs of Experiment 1 and 2 allow us to compare not only inflectional processing in English between English L1 (Experiment 2a) and English L2 (Experiment 2b), but also inflectional processing between English L1 (Experiment 2a) and Korean L1 (Experiment 1). Furthermore, inflectional processing in English L1 (Experiment 2a) and Korean L1 (Experiment 1) can be compared and discussed in the perspective of language-dependent or language-universal processing.

The majority of previous studies on inflectional morphology have involved L1 readers (e.g., Alegre & Gordon, 1999; Andrews, 1986; Burani et al., 1984; Luke & Christianson, 2011; Pinker, 1991; Plaut & Gonnerman, 2000; Taft, 1979). Moreover, the small number of inflectional studies on L2 processing has also been limited to L2 learners with Indo-European L1 backgrounds (e.g., Hahne et al., 2006; Meunier & Marslen-Wilosn, 2004; Silva & Clahsen, 2008). Therefore, research with Korean learners of

English provides a unique opportunity to investigate L2 morphological processing since Korean and English are typologically different languages. . Korean is an agglutinative language, and its script differs completely from English, even though Korean and English are both alphabetic systems. The major research questions for Experiment 2 are:

1) Do English L1 and English L2 show morphological priming effects in the processing of past tense words?
2) Does regularity play a role in performing the masked priming lexical decision task using past tense words in English L1 and English L2?
3) Which factors among regularity, orthographic similarity, stem and whole-word frequencies affect morphological priming magnitude in English L1 and English L2, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense in English L1 and English L2?

4.2. Hypotheses

According to the dual-mechanism account, effects of whole-word frequency should be found in English L1 with larger magnitudes for irregular forms than regular, whereas effects of stem frequency can be found only for regular forms in English L1. However, when assuming insensitivity to syntactic information and heavier reliance on declarative memory of English L2, greater effects of whole word frequency, for both regular and irregular verbs, and lack of stem frequency effects are expected for English L2.

4.3. Design, Materials, and Procedure

As in Experiment 1, there were three prime conditions (past tense, orthographic control and unrelated control), and four factors (regularity, stem frequency, whole word frequency, and orthographic similarity) were considered for the past-tense form conditions. Both stem and whole word frequencies were based on the CELEX Database (Baayen, Piepenbrock, and Gulikers, 1995). Orthographic similarity calculations were identical to Experiment 1 (Van Orden, 1987). The characteristics and an example stimuli list are shown in Table 8.

Three lists of stimuli were constructed using the same method as in Experiment 1, but with 174 pairs of prime and targets (87 regulars and 87 irregulars), and 290 filler pairs. The task procedure was the same as in Experiment 1.

4.4. Method: Experiment 2a

4.4.1. Participants

Thirty-six native English speakers (NES) at a University in the United States participated in this experiment. They were mostly undergraduate students with a mean age of participants was 20.7 (*SD* = 1.8), and they received course credit for their participation. All participants have normal or corrected-to-normal vision.

Table 8. Characteristics [Mean (SD)] and Examples of Primes and Targets in Experiment 2

	Prime type (N = 87)			Targets (N = 87)
	Morphological (N = 29)	Orthographic (N = 29)	Unrelated (N = 29)	
Regular	liked	life	table	like
Logged stem freq.				5.79 (1.7)
Logged whole-word freq.	1.67 (.5)	1.49 (.7)	1.46 (.7)	1.75 (.5)
Letter-length	7 (1)	5 (1)	5 (1)	5 (1)
Neighbors	3 (3)	4 (5)	3 (4)	5 (4)
Repeated letters	5 (1)	4 (1)	1 (1)	N/A
% repeated letters	73 (7)	68 (11)	18 (60)	N/A
Orthographic similarity	.73 (.3)	.72 (.15)	.35 (.2)	N/A
Logged connectivity				1.56 (.55)
Logged Resonance strength				.09 (.1)

	Prime type (N = 87)			Targets (N = 87)
	Morphological (N = 29)	Orthographic (N = 29)	Unrelated (N = 29)	
Irregular	saw	sea	car	see
Logged stem freq.				8.14 (3.1)
Logged whole-word freq.	1.78 (.7)	1.46 (.6)	1.44 (.6)	1.91 (.6)
Letter-length	4.5 (1)	4.7 (1)	4.7 (1)	4 (1)
Neighbors	8 (5)	7 (6)	5 (5)	9 (5)
Repeated letters	3 (1)	3 (1)	1 (1)	N/A
% repeated letters	69(16)	70 (10)	19 (15)	N/A
Orthographic similarity	.63 (.2)	.71 (.2)	.36 (.2)	N/A
Logged connectivity				1.65 (.66)
Logged Resonance strength				.11 (.1)

4.5. Results: Experiment 2a

Accuracy rates were high in all conditions (> 98%), and the analyses revealed no effect of any variables on error rates. Incorrect responses were removed prior to the RT analyses. Also, correct responses with RTs less than or greater than 2.5*SD* from the mean of each participant were excluded from the RT analyses. All response times for target words greater than 2.5*SD* from the mean of each participant (1.6%) were excluded from data analysis. Incorrect responses were removed for the RT analysis (1.1%). Two auxiliary verbs (*have* and *keep*), 7 doublet verbs (e.g., *wake – woke* or *waked*) were excluded (Ullman, 1999) and 7 verbs that are predominantly used in roles other than verbs (e.g., *clean*, which is often an adjective, and *smell*, which is often a noun) were also excluded from data analysis (e.g., Niswander et al. 2000). Therefore, 156 items (78 items for each regularity condition) were included for analysis.

First, an ANCOVA revealed that the main effect of prime type was significant [(F (2, 296) = 3.419, p = .034]. However, the main effect of regularity was not significant (F < 1). The interaction between regularity and prime type was not significant [(F < 1]. The mean RT in the past-tense primes was significantly faster (27ms) than in the unrelated control [(F (1, 171) = 6.923, p < .001]. The mean RTs in the past-tense condition was significantly faster (12ms) than the unrelated control condition [(F (1, 171) = 3.175, p = .002]. In addition, the mean RTs in the orthographic control condition was significantly faster (15ms) than the unrelated control condition [(F (1, 171) = 3.706, p < .001].

These results suggest that the morphological priming effect from past-tense forms in English L1 is evidenced independently of orthographic overlap between the past-tense and present forms. Note that, however, the orthographic priming effect in English L1 was also significant as compared to the unrelated control, which is different from the findings in Korean L1 (Experiment 1). As in Korean L1 data, regularity did not influence on the latencies of target recognition in English L1.

Table 9. Reaction Times and Error rates in English L1 in Experiment 2a

Regularity	Prime type	Reaction times Mean (SD) in msec	Error rates Mean (SD) in %
Regular	Past-tense	545 (35)	1.5 (.5)
	Orthographic control	557 (44)	1.2 (.5)
	Unrelated control	574 (42)	1.7 (.6)
Irregular	Past-tense	546 (35)	1.9 (.4)
	Orthographic control	559 (37)	1.7 (.6)
	Unrelated control	570 (37)	1.1 (.4)

Second, a hierarchical regression analysis was conducted with the same rationale underlying the order of entering variables into the models as described in Experiment 1. In Table 10, stem frequency contributed to the morphological priming magnitude even after whole-word frequency was taken into consideration (2.0%, $p = .04$). The interaction term between regularity and whole-word frequency also explained a unique amount of variance in morphological priming magnitude (5.7%, $p = .003$). These results are mixed with respect to dual-mechanism accounts. The finding of a reliable contribution of stem frequency even for the irregular forms, as found with Korean L1 (Experiment 1), is inconsistent with the dual-mechanism account, implying an abstract morphological relationship between prime and target. However, the finding of unique contribution from the interaction between regularity and whole-word frequency, which was not found in Korean L1 (Experiment 1), suggests that English past-tense processing is better explained by a dual-mechanism account. Therefore, the mixed results suggest that rule-based stem access and memory-based whole word access coexist in processing of past-tense forms in English.

Table 10. Hierarchical Regression Analysis in Experiment 2a

	R	R^2	ΔR^2	*F* for ΔR2
Predicting morphological priming magnitude				
Step 1: REG	.036	.001	.001	.198
Step 2: Length	.037	.001	.000	.017
Step 3: OS	.038	.001	.000	.005
Model 1 Step 4: SF	.062	.004	.002	2.147*
Step 5: WF	.124	.036	.032	3.212*
Model 2 Step 4: WF	.062	.004	.002	.372
Step 5: SF	.190	.036	.004	5.007*
Model 1: Step 6: REG × SF	.313	.098	.005	6.411*
Step 7: REG × WF	.305	.093	.057	3.634*
Model 2: Step 6: REG × WF	.305	.093	.057	9.305**
Step 7: REG × SF	.313	.098	.005	.862

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity, *$p < .05$, ** $p < .01$

4.6. Method: Experiment 2b

4.6.1. Pre-experimental Task: Familiarity Rating Task

Since L2 learners may be exposed to a limited L2 corpus due to their educational settings, the word frequencies in an L1 corpus may not be relevant to L2 learners. Thus, it cannot be assumed that a given word with high frequency in L1 corpus is familiar to Korean learners of English. Therefore, a familiarity-rating task was administered to select English stimuli that are reliably familiar to Korean learners of English.

Twelve Korean learners of English, who lived in the USA at least for one year and at most for seven years, participated in the familiarity-rating task, and they did not participate in the subsequent experiment. The participants were given 182 English words and asked to rate their familiarity with each of the words on a scale ranging from 1 to 7 (1 = not familiar at all; 7 = very familiar). Based on the results, eight items were removed (mean score below 5 out of 7). The mean score of the selected items was M = 6.65 (SD = .28).

4.6.2. Participants

Thirty-six Korean learners of English readers at a Mid-Atlantic state university participated in this experiment. The mean age of participants was approximately 31.1 (*SD* = 4.2), and the majority of participants were graduate students. All participants had normal or corrected-to-normal vision. They were paid ($10 per hour) for their participation.

Prior to the experimental session, Korean participants were asked to fill out the Language Experience and Proficiency Questionnaire (Marian et al., 2007; see Appendix D for the results). The participants were also tested with two English proficiency tests: an English Cloze-test (Babaii & Moghaddam, 2006; see Appendix D for the results) and the Boston Picture naming test (Kaplan et al., 2001; see Appendix D for the results). The English Cloze-Test included five passages adapted from *Encyclopedia Britannica*, 60 *Practice and Progress*, *Readers Choice*, and *Developing Reading skills*, and the each passage contained twenty-five blanks where 2/3 or 1/2 of words were removed or whole words, except the first letters, were removed. The participants were asked to restore the missing letters. The Boston Naming Test contained 60 pictures, arranged in incremental levels of difficulty. The participants were asked to verbally name the English word that matched an object in each picture.

4.7. Results: Experiment 2b

Accuracy rates were high in all conditions (> 95%), and the analyses revealed no effect of any variables on error rates. Data trimming and analysis were identical to those in previous experiments. Incorrect responses were removed for the RT analysis (4%). The RTs for target words that were less than or more than 2.5*SD*'s from the mean of each participant (3%) were excluded from data analysis. An ANCOVA revealed that the main effect of prime type was only marginally significant [(F (2, 298) = 2.844, p = .074]. The main effect of regularity was not significant ($F < 1$), and the interaction between regularity and prime type was also not significant [(F (2, 298) = 2.193, p = .122]. A 12ms facilitation difference between the past-tense prime and the unrelated control in regular forms was significant [(F (1, 171) = 2.318, p = .028]. In addition, the 9ms facilitation difference between the past-tense prime and the orthographic control [(F (1, 171) = 2.087, p = .046] was also significant. Neither the 4ms facilitation difference between the past-tense prime and the unrelated control, nor the 6ms facilitation difference between the past-tense prime and the orthographic control in irregular forms was significant (Fs < 1).

Table 11. Reaction Times and Error rates in English L1 in Experiment 2b

Regularity	Prime type	Reaction times Mean (SD) in msec	Error rates Mean (SD) in %
Regular	Past-tense	610 (35)	3.5 (.5)
	Orthographic control	618 (37)	3.2 (.5)
	Unrelated control	621 (36)	4.7 (.6)
Irregular	Past-tense	607 (39)	3.9 (.4)
	Orthographic control	605 (37)	2.7 (.6)
	Unrelated control	611 (35)	3.1 (.4)

As shown in the results of a hierarchical regression analysis in Table 12, stem frequency explained a significant amount of variance in morphological priming effect (~2%, $p < .05$) regardless of its entry order, but whole-word frequency did not contribute to the morphological priming effect after contribution from regularity, orthographic similarity, and whole-word frequency were taken into account. None of interaction terms were significant.

Table 12. Hierarchical Regression Analysis in Experiment 2b

	R	R^2	ΔR^2	F for ΔR2
Predicting morphological priming magnitude				
Step 1: REG	.058	.003	.003	.514
Step 2: Length	.126	.016	.012	1.933
Step 3: OS	.126	.016	.000	.022
Model 1 Step 4: SF	.132	.028	.019	2.93*
Step 5: WF	.199	.032	.005	.821
Model 2 Step 4: WF	.128	.016	.000	.074
Step 5: SF	.199	.040	.023	3.63*
Model 1: Step 6: REG × SF	.210	.044	.004	.678
Step 7: REG × WF	.210	.044	.000	.010
Model 2: Step 6: REG × WF	.209	.044	.004	.662
Step 7: REG × SF	.210	.044	.000	.026

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity *$p < .05$,

4.8. Comparison between Experiments 2a and 2b

Additional ANCOVA was performed in order to test whether the two language groups showed a significant difference in the latencies of inflected word processing. Therefore, the data from the two language groups were entered in the ANCOVA, and one group variable (English L1 vs. English L2) was added (shown in Table 13). The results revealed that language group affects the target latencies, showing that the NES group processed targets significantly faster [$F(1, 150) = 6.047$, $p = .015$]. However, no other main effects or interaction effects were significant. This was not surprising because English was the target language in the task. There was no significant interaction between language group and prime condition, showing that the past-tense forms failed to facilitate the latencies for target recognition in one group more than the other. This was inconsistent with the findings of some previous studies (e.g., Silva & Clahsen, 2008). Silva and Clahsen (2008) demonstrated significant (or greater) morphological facilitation using regularly inflected words for an English L1 group but not for English L2 groups, and argued that L2 learners are not as sensitive to morphological structure as L1 readers. However, based on the current data, the question of whether L1 and L2 differences in morphological priming are due to differences in the two groups' fundamental competence still remains. The KLE group in the present study showed a similar pattern of latencies on the task across conditions to those in the NES group, and the interaction between group and primed condition was not significant when both groups' data were merged together. Therefore, no fundamental differences in the past tense processing of L1 and L2 were demonstrated conclusively.

Moreover, a unique contribution of stem frequency to the morphological priming magnitude found in the KLE and NES groups in the present study suggests that both groups are sensitive to the stem in the past-tense form, regardless of its regularity. However, no interaction between regularity and whole-word frequency was found with the KLE group, unlike the NES group, which suggests that the NES group is more sensitive to regularity than the KLE participants.

Table 13. ANCOVA on Merged Data from English L1 and English L2

Effects	*F*	*p*
Group	6.047	.015
Prime	.965	.382
Regularity	.000	.995
Group × Prime	1.239	.291
Group × Regularity	1.363	.245

CHAPTER 5. Experiment 3

Korean Past-Tense in Native Korean Speakers: Words in Sentence

5.1. Purpose

Experiment 3 examines on-line processing of past-tense forms in Korean using a self-paced reading task with masked priming. The research questions for Experiment 3 are:

1) Does Korean L1 show morphological a priming effect in processing of past-tense words in a sentence context?
2) Does regularity play a role in processing of past tense words in a sentence context in Korean L1?
3) Which factors among regularity, orthographic similarity, stem and whole-word frequencies affect morphological priming magnitude during a sentence reading task in Korean L1, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense during a sentence reading task in Korean L1?
5) Do the results of the self-paced reading task with masked priming differ from those of the masked priming lexical decision task in Korean L1?

5.2. Hypotheses

If masked priming during a self-paced reading task operates in the same manner as a typical lexical decision task, a morphological priming effect is expected with a similar magnitude to that found in Experiment 1.

In regard to the frequency effects, characteristics of Korean word structure should be considered; as described in Chapter 2, Korean syllabic boundaries are salient, and Korean has many homographs at the syllable level, so that each syllable in a complex word often matches with morpheme units as either free or bound morphemes. Therefore, a Korean morphologically complex word may require more time for checking whether the constituent morphemes are legally combined when the word is in isolation compared to words in sentence context. If this is the case, whole word frequency is expected to contribute to morphological processing less in sentence contexts than in isolation, and stem frequency is expected to demonstrate the opposite effect. Also, a unique contribution of orthographic similarity is expected to contribute to morphological processing less in words in sentences than words in isolation.

5.3. Methods

5.3.1. Participants

Forty-eight Korean native readers (16 females and 33 males) at a university in Seoul, Korea, participated in this experiment (age $M = 23.5$, $SD = 2.5$). The majority of the participants were undergraduate students. All participants had normal or corrected-to-normal vision, and they received compensation of approximately $8 for their participation.

5.3.2. Design and Materials

As in the previous experiments, there were three prime conditions: past-tense prime, orthographical control, and unrelated control conditions, and four factors (regularity, stem frequency, whole word frequency, and orthographic similarity) were considered for the past-tense form conditions.

A set of 180 sentences was generated using the set of target words used in Experiment 1. In order to avoid a wrap-up effect (e.g., Kuperman et al., 2010), each target word was placed in the middle of each sentence. In order to locate all target words in the middle of a sentence, the targets and their corresponding past tense primes in Korean in Experiment 3 were revised as connecting forms by adding a connecting marker '-고, –ko', which can be located in the middle of a sentence instead of the terminal ending marker '-다, –ta' (e.g.,먹었다 → 먹었고 /mekessko/ means 'ate and', 먹었고 → 먹고 /mekessko/ means 'eat and'), which was used in Experiment 1.

Predictability of the target words in the sentences was tested with a sentence fragment completion task; the task consisted of the 180 sentences with the target words and the latter parts of sentences being blank (see an example partial sentence a.). Twenty-six Korean native students were asked to complete the sentences with whatever words that first came to mind. The average response rate for target words was below 20%. Grammaticality and plausibility of the sentences were also confirmed by two other Korean native graduate students. Examples of stimuli sentences are shown below (see example sentences b and c).

a. 종수는 대뜸 봉투를 ________

Jongsu-nun tayttum pongtu-lul ________

Jongsu-*SUBJ*/ suddenly/ envelope-*OBJ*

b. Regular: 상태가 / 좋은 사과는/ 모두 / **팔고**/ 남아 /있는 것은/ 상태가/ 별로다.

Target: 팔고 *palko* "sell"

Past-tense prime: 팔았고 *palassko* "sold"

Orthographic control: 팔다리 *paltari* "arm and leg"

Unrelated *control*: 사용법 *sayongpep* "manual"

c. Irregular: 선생님은 / 여러가지 / 화초를 / **기르고**/ 가꾸는/ 것이 / 오래된/ 취미이다.

Target: 기르고 *kiluko* "grow"

Past-tense prime: 길렀고 *killessko* "grew"

Orthographic control: 기러기 *kileki* "seagull"

Unrelated: 나뭇잎 *namusip*"leaf"

5.3.3. Procedure

The initial display of each trial consisted of multiple masks, each of which was at the position corresponding to each word of a sentence. The participants were instructed to press the space bar to read each word at their natural speed to comprehend the task sentence. By pressing the space bar, the masks were replaced with words, one by one, for each position; the first space-bar press replaced the first mask with the first word in the sentence. From the second bar press, the previously shown word was again masked, and the next word was revealed from its mask. Thus, only one word was shown at a time, except for the initial presentations of each trial when no words were shown. The critical manipulation of this task was, when the button press was made for the target word, one of three primes was presented for 48ms immediately before the target presentation. A true/false comprehension question was presented at the end of every one to four trials (determined randomly) to encourage on-line comprehension of the sentence and to avoid "mechanical" pushing of the button to move forward through the sentence. The participants were asked to answer these questions by pressing either '1' for 'true' or '0' for 'false.' Each participant had five practice trials to become familiar with the procedure before starting the experimental session.

5.4. Results

Accuracy for the comprehension questions was high (97%), confirming that the participants did not simply press the button mechanically. For the reading time analyses, trials with reading times of the target words (region 4) greater or less than 2.5*SD*'s from the mean from each participant were excluded (4%). Then, sixteen target items (8 each for regular and irregular) with high trial exclusion rates (> 40%) were excluded. Therefore, 140 items (70 items for each regularity condition) remained for analysis.

In addition to target words, reading times of the words immediately following the targets (region 5) were analyzed to check for spillover effects, showing that there were no differences across conditions [all *p*s >.4].

First, an ANCOVA revealed that effects of prime type [$F(2, 270) = 1.741$, $p = .21$] and regularity [$F < 1$] and their interaction [$F < 1$] were not significant. However, there was a trend in the past-tense condition that reading times for regular forms were slower than irregular forms (Table 8), which is compatible with the assumption that the parsing route typically operates more slowly than the whole-word route (Allen, Badecker, & Osterhout, 2003).

Table 14. Reaction Times in Experiment 3

Regularity	Prime type	RT Mean (SD)
Regular	Past-tense	341 (48)
	Orthographic control	338 (45)
	Unrelated control	348 (51)
Irregular	Past-tense	326 (47)
	Orthographic control	339 (49)
	Unrelated control	339 (46)

Second, the results of a hierarchical regression analysis with four variables (Table 14) showed that stem frequency reliably contributed to the morphological priming effect, even after whole-word frequency was taken into account. However, none of other variables remained significant in the full model.

Table 15. Hierarchical Regression Analysis in Experiment 3

	R	R^2	ΔR^2	*F* for ΔR2
Predicting morphological priming magnitude				
Step 1: REG	.059	.004	.004	.487
Step 2: Length	.091	.008	.005	.649
Step 3: OS	.183	.033	.025	3.553*
Model 1 Step 4: SF	.284	.081	.047	6.913**
Step 5: WF	.288	.083	.002	.395
Model 2 Step 4: WF	.269	.073	.039	5.700*
Step 5: SF	.288	.083	.020	1.494*
Model 1: Step 6: REG × SF	.288	.083	.000	.028
Step 7: REG × WF	.289	.083	.000	.059
Model 2: Step 6: REG × WF	.288	.083	.000	.000
Step 7: REG × SF	.289	.083	.001	.087

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity, **p* < .05, ** *p* < .01

In summary, the morphological priming effect was not significant despite the noticeable trend that reading time of the target was shorter in the past-tense condition compared to the unrelated control, and the difference was larger in irregulars than regulars. Also, after controlling whole-word frequency, a unique contribution to magnitude of the reading time difference was found only for stem frequency.

The pattern of results from Experiment 3 is different from Experiment 1. This is likely due to the task differences between a lexical decision task and a self-paced reading with masked priming. The null effect of regularity on the past-tense form processing suggests that regularity does not play a critical role in Korean past-tense forms during sentence reading. In the regression analysis, the overall patterns of roles for stem and whole-word frequencies were reconfirmed. In addition, the stem frequency effect was more reliable when Korean L1 readers process the past-tense during sentence reading.

This finding relates to a previous study using a self-paced reading paradigm with a focus of regular past-tense verbs (Luke & Christianson, 2012). Luke and Christianson demonstrated that stem- and whole-word frequency interact during a self-paced reading task, but not in a lexical decision task. Ecological validity and task differences in the self-paced reading task will be discussed further in General Discussion.

5.5. Comparisons between Words in Isolation and Words in Sentence for Korean L1

In order to examine the differences between the processing of past tense words in isolation and in sentence context for Korean, the data from Experiments 1 and 3 were merged and analyzed with task type as a between-subject variable. As shown in Table 16, the main effect of task type (MLDT: masked priming lexical decision task in Experiment 1 vs. SPRM: self-paced reading task with masked priming in Experiment 3) was significant [$F(1, 123) = 5.292$, $p = .023$], and the interaction between task type and prime condition was significant [$F(1, 246) = 2.905$, $p = .048$], which indicates that facilitation effects from past-tense primes were greater for present-tense targets in isolation than in sentence context.

The difference between Korean words in isolation and in sentence context may result from differences in processes underlying checking the legality of constituent morphemes in the complex words. The processing of a complex word involves several stages, such as morphemic segmentation, checking the legality of the stem-affix combination, and composition. Among the stages, checking the legality of the stem and affix is assumed to be required more when a complex word is presented in isolation as compared to in sentence context (Baayen et al., 2007; Luke and Christianson 2011). For instance, Bertram and his colleagues (Bertram et al., 2000) used inflected words formed with affixal homonyms in Finnish, and found stem frequency effects only for words in sentences, and whole word frequency effects only for words in isolation. The authors reasoned that the different patterns of frequency effects for words in isolation and for words in sentences were due to affix homonymy of morphologically complex words, which produced more ambiguity when the words were in isolation than in sentences (Bertram et al., 2000). Likewise, many Korean syllables have homographs that can be used as stems or bound morphemes; this leads to ambiguity in lexical access, possibly more for words in isolation than in sentences. Therefore, the results of the present study that showed only stem frequency, but not whole word frequency, contributed to morphological priming magnitude in sentence reading task can also be regarded as an outcome of less ambiguity of Korean morphologically complex words in sentence contexts.

Table 16. ANCOVA on Merged Data from Word in Isolation and Words in Sentence in Korean L1

Effects	*F*	*p*
Task (MLDT vs. SPRM)	5.292	.023
Prime	.350	.705
Regularity	.011	.916
Task × Prime	2.905	.048
Task × Regularity	3.137	.079

Note. MLDT: masked priming lexical decision task; SPRM: self-paced reading task with masked priming

CHAPTER 6. Experiments 4a and 4b:

English Past-Tense in Native English Speakers and Korean Learners of English: Words in Sentence

6.1. Purpose

Experiments 4a and 4b examine the on-line processing of past-tense forms in English L1 readers and Korean learners of English. The research questions for Experiment 4 are:

1) Do English L1 and English L2 readers show morphological priming effects in processing of past-tense words in a sentence context?
2) Does regularity play a role in processing of past tense words in a sentence context in English L1 and English L2?
3) Which factors among regularity, orthographic similarity, stem and whole-word frequencies affect morphological priming magnitude during a sentence reading task in English L1 and English L2, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense during a sentence reading task in English L1 and English L2?
5) Do the results of a self-paced reading task with masked priming differ from those of masked priming lexical decision task?

6.2. Hypotheses

As masked priming operates in a typical lexical decision task as shown in Experiment 2a, morphological priming effects are expected in the sentence reading task in Experiment 4a for English L1. In addition, both stem frequency and whole-word frequency are expected to contribute to the morphological priming effect. However, significant morphological priming effects may not be found for English L2 readers in Experiment 4a, because they are not as sensitive to English morphological structure and they rely more on syntactic information in comprehending sentences.

6.3. Design, Materials, and Procedure

Design, materials, and procedure of Experiment 4 are identical to Experiment 2 in every aspect, except that 174 pairs of prime and target words were embedded in the sentence stimuli in Experiment 4. In addition, 20 filler sentences were included in an attempt to block participants' sensitivity to the similar structures of target sentences as described in Experiment 3.

Predictability of the English target words in the sentences was tested in the same manner as the Korean target words in Experiment 3. Ten English L1 and ten Korean readers of English participated in the predictability task (see example sentence d, below) and were asked to fill in the blanks with the first response that came to mind. The average response rate for responses that included target words was below 5%. Examples of stimuli sentences are shown below (see example sentences e and f).

d. Predictability task example: My little brothers _____

e. Regular: The/ drug /companies/ **claim/** that/ their/ new drugs/ are better than /those of any other company.

Target: *claim*

Past-tense prime: *claimed*

Orthographic control: *clam*

Unrelated: *mute*

f. Irregular: His/ parents/ always/ **send** /a letter/ for/ his birthday /after/ he went to college.

Target: *send*

Past-tense prime: *sent*

Orthographic control: *sense*

Unrelated: *today*

6.4. Experiment 4a

6.4.1. Participants

Thirty-six English native speakers were recruited from a United States university to participate in Experiment 4a. The English L1 readers were mostly undergraduate students with a mean age of 21 (*SD* = 1.6), and they received course credit for their participation. The participants had normal or corrected-to-normal vision.

6.4.2. Results

Accuracy for the comprehension questions was high (> 95%), confirming that participants actively read the target sentences. For reading time analyses, trials with reading times of target words (region 4) greater or less than 2.5*SD*'s from the mean of each participant were excluded from the data analysis (5% of data removed). In order to check for spillover effects, reading times of the words immediately following the targets (region 5) were also analyzed, and there were no differences across conditions [all *p*s >.5].

The reading times for target words were analyzed using the same techniques as in Experiment 3. First, an ANCOVA revealed a significant effect of prime type on reading times of target words [(F (2, 298) = 4.287, p = .015], but no significant effect of regularity [F < 1]. In addition, the interaction between regularity and prime type was marginally significant [F (2, 298) = 2.959, p = .055]. Based on the marginally significant interaction between regularity and prime type, separate ANCOVAs for regular and irregular forms were performed. For regular forms, the main effect of prime type on RTs was significant (F (2, 144) = 5.699, p = .005); the 13ms facilitation from the past-tense prime in comparison to the unrelated control was significant [F (1, 171) = 2.97, p < .01], and the 17ms facilitation from the orthographic control in comparison to the unrelated control was also significant [(F (1, 171) = 3.706, p < .001]. More importantly, there was no difference between the past-tense prime condition and the orthographic control [F < 1]. Thus, the main effect of prime type for regular forms may not be a result of independent morphological priming, but a combined effect of orthographic and morphological priming. For the irregular condition, there were no significant main effects or interaction effects [*F*s < 1]. These results failed to show that English L1 readers were sensitive to morphological structure during sentence reading.

Second, hierarchical regression results showed that only orthographic similarity uniquely contributed to the morphological priming effect [F value for ΔR2 = 2.851, p = .041]. This result suggests that it is the orthographic overlap, but not the morphological relatedness between the prime and target that contributed to priming effect. It also indicates that the orthographic overlap between the past-tense prime and the stem target may elicit an inhibition effect (e.g., Allen & Badecker, 2002) under the natural reading task situation.

Table 17. Reaction Times in Experiment 4a

Regularity	Prime type	Reaction times Mean (SD) in msec
Regular	Past-tense	368 (54)
	Orthographic control	364 (61)
	Unrelated control	381 (72)
Irregular	Past-tense	365 (60)
	Orthographic control	375 (66)
	Unrelated control	366 (63)

Table 18. Hierarchical Regression Analysis in Experiment 4a

	R	R^2	ΔR^2	F for ΔR2
Predicting morphological priming magnitude				
Step 1: REG	.071	.005	.005	.785
Step 2: Length	.073	.005	.000	.035
Step 3: OS	.154	.024	.018	2.852*
Model 1 Step 4: SF	.155	.024	.000	.076
Step 5: WF	.156	.024	.000	.050
Model 2 Step 4: WF	.154	.024	.000	.026
Step 5: SF	.156	.024	.001	.100
Model 1: Step 6: REG × SF	.182	.033	.009	1.322
Step 7: REG × WF	.185	.034	.001	.210
Model 2: Step 6: REG × WF	.173	.030	.006	.855
Step 7: REG × SF	.185	.034	.004	.672

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity. *p < .05, ** p < .01

6.5. Comparisons between Words in Isolation and Words in Sentence in English L1

In order to examine the effect of task type in the processing of past-tense words in English L1, the data from Experiments 2a and 4a were merged and analyzed. The results revealed that both task difference [(F (1, 150) = 8.293, $p < .001$] and prime condition [(F (2, 300) = 4.149, $p = .017$] were significant, showing that the latencies in target recognition were affected both by task type and the prime condition in English L1. Note the interaction between prime condition and task type was significant in Korean L1 data (Experiments 1 and 3). This inconsistency between English L1 and Korean L1 could be due to differences in morphological characteristics between those languages (language-specificity).

Table 19. ANCOVA on Merged Data from Words in Isolation and Words in Sentence in English L1

Effects	*F*	*p*
Task (MLDT vs. SPRM)	8.293	< .001
Prime	4.149	.017
Regularity	.053	.818
Task × Prime	.184	.832
Task × Regularity	1.968	.163

6.6. Experiment 4b

6.6.1. Participants

Thirty-three Korean learners of English attending a US university participated in Experiment 4b. The Korean learners of English were mostly graduate students with a mean age of 29.5 (*SD* = 5.3), and they received $10 in monetary compensation for their participation. The participants had normal or corrected-to-normal vision. The results of

LEAP-Q and other English proficiency tests (Boston Naming and C-test) are available in Appendix D.

6.6.2. Results

Accuracy for the comprehension questions was high (> 90%), confirming the participants actively read the target sentences. All reading times at the target word (region 4) greater or less than 2.5*SD*'s from the mean of each participant were excluded from data analysis (4% of data removed). There were no differences in reading times for region 5 (all *p*s > .5) across conditions, suggesting no spillover effect.

For the RT analysis, two types of analyses were conducted: an analysis of covariance (ANCOVA) and a hierarchical multiple regression analysis (Tables 20 & 21). First, an ANCOVA revealed that main effects of prime type, regularity, and their interaction were not significant [*Fs* < 1, see Table 20]. Second, the results from hierarchical regression analyses (Table 21) showed that the contribution of stem frequency to morphological priming magnitude was marginally significant [2%, $p < .05$].

Table 20. Reaction Times in English L1 in Experiment 4b

Regularity	Prime type	Reaction times Mean (SD) in msec
Regular	Past-tense	544 (67)
	Orthographic control	541 (73)
	Unrelated control	558 (61)
Irregular	Past-tense	526 (76)
	Orthographic control	541 (83)
	Unrelated control	551 (64)

Table 21. Hierarchical Regression Analysis in Experiment 4b

	R	R^2	ΔR^2	F for ΔR2
Predicting morphological priming magnitude				
Step 1: REG	.030	.001	.001	.150
Step 2: Length	.119	.014	.013	2.054
Step 3: OS	.119	.014	.000	.009
Model 1 Step 4: SF	.172	.030	.015	2.405*
Step 5: WF	.194	.038	.008	1.272
Model 2 Step 4: WF	.142	.020	.006	.908
Step 5: SF	.194	.038	.018	2.763*
Model 1: Step 6: REG × SF	.223	.050	.012	1.887
Step 7: REG × WF	.225	.051	.001	.174
Model 2: Step 6: REG × WF	.215	.046	.008	1.326
Step 7: REG × SF	.226	.051	.005	.737

Note. REG: regularity; SF: stem frequency; WF: word frequency; OS: orthographic similarity, *$p < .05$

6.7. Comparisons between Words in Isolation and Words in Sentence in English L2

In order to test an effect of task type in the processing of past-tense words in English L2, another ANCOVA was performed. The English L2 data from Experiment 2b and 4b were merged and reanalyzed. The results revealed only the task difference was significant [(F (1, 150) = 6.297, $p < .013$]. The lack of other significant effects suggests that there may be no particular difference in L2 inflectional processing across the two different tasks.

Based on the series of comparative analyses of the results from the two tasks (words in isolation vs. words in sentence context) in L2 data, task demand appears to impact L1 processing more than L2 processing. According to Clahsen and Felser (2006a; 2006b), L2 learners are more sensitive to lexical and semantic information than syntactic and morphological information. Therefore, when L2 learners read a sentence, they may be less sensitive to morphological structure; this is primed rapidly, and may result in no morphological priming.

Table 22. ANCOVA on Merged Data from Word in Isolation and Word in Sentence in English L2

Effects	*F*	*p*
Task (MLDT vs. SPRM)	6.297	.013
Prime	.287	.751
Regularity	.450	.818
Task × Prime	.499	.607
Task × Regularity	.042	.839

These results of Experiment 4a and 4b suggest differences between the two language groups (English L1 and L2) in the processing of past-tense verbs under different conditions of word recognition, words isolation and words in sentence. The English L2 group showed a certain level of sensitivity to stem frequency in English past tense, as did the English L1 group in Experiment 4a.

6.8. Comparison of Words in Sentence between English L1 and English L2

Finally, L1 and L2 comparisons can be drawn based on data from the self-paced reading task with masked priming. An ANCOVA was performed with the merged data from Experiments 4a and 4b. The results revealed that language group significantly affects the target latencies [$F(1, 150) = 38.705$, $p < .001$]. None of the independent variables interacted significantly with the language group variable, as shown in Table 23.

Table 23. ANCOVA on Merged Data from English L1 and English L2

Effects	*F*	*p*
Group	38.705	< .001
Prime	1.993	.138
Regularity	.569	.452
Group × Prime	1.784	.170
Group × Regularity	1.463	.228

CHAPTER 7. General Discussion

One of the most fundamental questions in language science is how humans process complex words. In order to answer this question, three major issues related to past tense inflection were addressed in this dissertation research: 1) How past tense processing is achieved by different L1s, 2) How past tense processing in L1 and L2 is different, 3) Whether past tense processing in L1 and L2 is dependent upon the task with either words in isolation or in sentence. These three major issues were investigated with more detailed research questions in four experiments with Korean L1, English L1, and English L2. Two different tasks – a masked priming lexical decision task and a self-paced reading task with masked priming – were both used to examine how the factors of particular interest (i.e., regularity, stem frequency, whole-word frequency, and orthographic similarity) affect past tense forms' processing in Korean L1, English L1, and English L2.

7.1. Inflectional Processing in L1

The first issue in this dissertation, namely, how past tense processing is achieved by different L1s, was studied by investigating the following questions in Experiments 1 and 2a:

1) Do Korean L1 and English L1 show morphological priming effects in the processing of past-tense words?
2) Does regularity play a role in performing masked priming lexical decision tasks with past tense words in Korean L1 and English L1?

3) Which factors among regularity, stem and whole-word frequencies, and orthographic similarity affect morphological priming magnitude in Korean L1 and English L1, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense in Korean L1 and English L1?

First, both Korean L1 and English L1 showed a significant morphological priming effect. The past tense forms primed the corresponding stems and led to faster RTs compared to the orthographic controls or unrelated controls. These findings suggest that both L1 groups are sensitive to morphological structures while they process past-tense inflection by accessing the stem rapidly.

Second, regularity itself did not affect the target latencies in the masked priming lexical decision task in either Korean L1 or English L1, in contrast to some previous findings (e.g., Burani & Caramazza, 1987; Cole, Beauvillain, & Segui, 1989). However, only for English, the interaction between regularity and whole-word frequency in contributing to morphological priming magnitude was found. This apparently inconsistent result could be because the role of regularity in morphological processing can vary depending on languages, supporting my expectation that irregular forms are expected be similarly processed to regular forms in Korean due to the less irregular property with Korean irregular than other languages such as English.

The dual-mechanism account, for example, hypothesizes that there are two distinct processes, one for regular forms in English and one for irregular forms. Previous studies have provided evidence supporting the dissociation between processing of regular and irregular forms (i.e., regularity effect) using various tasks such as a production task (Beck, 1995), a visual priming study (e.g., Patizzo & Feldman, 2002a; Stanners et al., 1979), cross-modal priming (e.g., Marslen-Wilson, et al., 1993; Patizzo & Feldman, 2002b), and neuroimaging studies (e.g., Marslen-Wilson & Tyler, 1997; Ullman et al., 2005). Since there is no rule for generating irregular forms, dual-mechanism accounts postulate rule-based access for regular and memory-based access for irregular forms (e.g., Clahsen, 1999; Marcus, Brinkmann, Clahsen, Wiese, & Pinker, 1995; Pinker, 1991; Ullman, 2001).

More specifically, dual-mechanism accounts have been supported by double dissociation between stem frequency and whole-word frequency. For instance, previous studies showed a significant stem frequency effect for regular forms during lexical access (e.g., Burani, Salmaso, & Caramazza, 1984; Gordon & Alegre, 1999). In addition, a whole-word frequency effect was found for irregular forms, but not for regular forms; this finding was used as key supporting evidence for the Words-and-Rules Model by Pinker (1991). The strong version of the Words-and-Rules Model was challenged by the finding that the inflected forms within lower whole-word frequency range (i.e., 0-6 per million) did not show whole-word frequency effects (Alegre & Gordon, 1999). This led to a revision of the Words-and-Rules Model in which only less frequent regular forms (< 6 instance per million) are accessed by rule-base; otherwise lexical access to regular forms is also affected by whole-word frequency.

Third, the Korean L1 results showed that both stem and whole-word frequency effects were significant in explaining morphological priming magnitude, but none of the other factors contribute to morphological priming. Also, regularity has no significant interaction with the two frequency factors. These results may be due to lack of dissociation between regular and irregular forms in Korean. Indeed, some previous studies found no effect of regularity in French (Meunier & Marslen-Wilson, 2004), Italian (Orsolini & Marslen-Wilson, 1997), German (Smolka et al., 2007), and English (Westermann, Kovic, & Ruh, 2008). This evidence was used to support another approach to inflectional system, that is, the connectionist approach. According to the connectionist approach (e.g., McClelland & Patterson, 2002; Seidenberg & Gonnerman, 2000), there is no qualitative, clear distinction between regular and irregular forms, but instead a graded continuum of differences based on the combined effects of phonological, orthographical, and semantic similarity. This approach may be more applicable to one language than the other. As described in Chapter 2, Korean irregular forms are "less irregular" than English irregular forms. They involve stem changes as English irregulars do. However, Korean inflected forms have an allomorphic past-tense marker -았 /*-ass*/ or -었 /*-ess*/ attached to a stem in a concatenative manner, which is not the case for English irregulars forms as a traditional perspective. Therefore, if regularity can be regarded as a continuum rather than a binary category, the regularity effect should be smaller on the processing of past tense in Korean in comparison to other languages that have a more distinct boundary between regular and irregular forms (e.g., English). Note that some of recent approaches with single-mechanism succeeded in explaining morphological acquisition and processing using English past tense (e.g., Stockhall & Marantz, 2006; Yang 2002). Similar examples can be found other languages such as German (Smolka et al., 2007) or Italian (Say & Clahsen, 2001). For example, German has an unclear boundary between regular and irregular words. German mixed verbs consisting of an irregular stem and a regular ending *–t* are considered as irregular, not regular, even though it is the default verb form in German. Therefore, no regularity effect in some languages including Korean suggests that language-specificity should be taken into account for understanding morphological processing and representation.

The arguments in the previous paragraph are well-supported by the present data. Like Korean L1, English L1 results demonstrated both stem and whole-word frequency effects in morphological priming magnitude. In contrast, the English L1 showed a significant interaction between regularity and whole-frequency with regard to morphological priming effect. This interaction originates from a whole-word frequency effect for irregular words but not for regular words; the magnitude of the morphological priming effect for irregular words increases as whole-word frequency increases. This is consistent with dual-mechanism accounts. Note that the stem frequency effect was significant, but it did not interact with regularity in English. The main effect of stem frequency regardless of regularity is novel given that few previous studies examined the role of stem frequency across regular and irregular forms. This may imply that the sum of frequencies from all of the morphologically-related forms has an influence on the morphological priming effect for both regular and irregular forms. A previous study (Kelliher & Henderson, 1990) showed a similar pattern of results demonstrating a significant effect of the stem frequency in irregular forms. When two irregular past tense verbs, e.g., *bought* and *shook* have the same whole-word frequency, lexical decision for *bought* was faster than *shook* because *buy* is a high frequency stem and *shake* is a low frequency stem. This result indicates that the abstract level of morphological relationship, even in irregular forms, plays a role in the processing of inflectional words.

In order to provide a coherent explanation for the inconsistent findings in the present study and the previous literature, more fine-grained categories, beyond the simplistic binary category in inflection system (regular vs. irregular), need to be explored.

For example, in English, several different categorizations regarding irregular forms have been suggested (Bybee & Slobin, 1982, Pinker, 1999, Yang, 2002). If there is an effect of irregular types on the processing of past tense words, it will enhance our understanding about underlying mechanism of inflectional morphology. For example, Yang (2002) sought to modify the Words-and-Rules Model by proposing the Words and Competition model (RC model). Although this model was initially proposed to explain children's English acquisition data from Marcus et al. (1995), this model is likely to also explain the processing data in L1 and L2.

In the RC model (Yang, 2002), past tense forms in English are not strictly dissociated by regularity, but distributed across several word classes (see Table 1 in Chapter 2). The model accepts generative phonology to represent both regular and irregular verbs, and postulates a single-mechanism regarding morphological processing and representation. And this model successfully explained the error patterns from the English children corpus (Marcus et al., 1995) using different weights on each class. For example, in the Marcus et al.'s corpus, children's error rates for the past tense forms *hurt* and *cut* were much lower (19.6%) than those for *draw* and *blow* (64.8%), although each pair of words has similarly low frequencies. The words *hurt* and *cut* fall into the word class [-ø suffixation & no change] and the words *draw* and *blow* fall into the word class [-ø suffixation & rime change →"u"]. The former word class has much higher weights than the latter word class because the rule for the [-ø suffixation & no change] more frequently occurs in the input (over 3000 occurrences) than the rule for [-ø suffixation & rime change → "u"] which has 125 occurrences in the input data. Therefore, it would be valuable to reanalyze the data of the present study if all the weights for each word class based on word corpus for adults are available.

Table 24. Results Summary of Experiments 1 and 2a

	Korean L1 (Exp. 1)	English L1 (Exp. 2a)
ANCOVA results		
MP	*	*
REG	–	–
MP × REG	–	–
Regression results		
SF	*	*
WF	*	*
SF × REG	–	* (weak)
WF × REG	* (weak)	* (strong)

Note. MP: morphological priming effect, REG: regularity, SF: stem frequency, WF: whole-word frequency, *significant, – no significant

In summary, the findings from the two language groups, Korean L1 and English L1, were very similar except that the interaction between regularity and whole-word frequency only occurred in English. While the morphological priming effect was significant, no regularity was found for Korean L1 and English L1. In addition, both stem and whole-word frequencies contribute to the morphological priming effect in Korean L1 and English L1. Based on the fact that regularity is less salient in Korean than in English, both language groups make use of morphological structure when they process inflected words; however, English L1 readers may be more sensitive to regularity than their Korean L1 counterparts.

7.2. Inflectional Processing in L2

The second issue of this dissertation, how past tense processing in L1 and L2 is different, was investigated by the following questions in Experiments 2a and 2b:

1) Do Korean learners of English show morphological priming effects in the processing of past tense words?
2) Does regularity play a role in performing the masked priming lexical decision task using past tense words in Korean learners of English?
3) Which factors among regularity, orthographic similarity, stem and whole-word frequencies affect morphological priming magnitude in Korean learners of English, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense in Korean learners of English?

First, Experiment 2b with Korean learners of English (KLE) showed only a marginally significant morphological priming effect. Second, there was no regularity effect on the latencies of target recognition. These results are consistent with the pattern of the results of the NES group from Experiment 2a (See Table 25 for summary of the results). It seems that the KLE group makes use of morphological structures when they process an inflected word in L2, similar to what English L1 readers do.

Third, stem frequency, but no other factors, significantly contributed to morphological priming magnitude, which was also found in English L1 (Experiment 2a). Fourth, no interaction effect between regularity and stem or whole-word frequency factors was observed for KLE, which is different from the English L1 data (Experiment

2a). This could be explained by the limited duration of L2 learning (i.e., short period of exposure to L2 input) of the KLE group in this study. An artificial language training study done by Ellis and Schmidt (1998) suggested that regularity and whole-word frequency interaction is a result of learning and development of knowledge about the inflectional system. Their results showed that language learners tend to show a strong whole-word frequency effect for both regular and irregular words at their early stage of learning, but this whole-word frequency effect significantly decreased as the learning time increased only for regular words, but not for irregular words. The interaction between regularity and whole-word frequency that emerged as learning time increases can be explained by the connectionist approach (MacWhinney & Leinback, 1991; Rumelhart & McClelland, 1986). As a single-mechanism account, the connectionist model (e.g., Rumelhart & McClelland, 1986) interpreted this regularity and whole-word frequency interaction as a product of sufficient learning experience, rather than as an outcome of rule-based decomposition of an inflected word into its constituent morphemes.

The results of English L1 (Experiment 2a) and English L2 (Experiment 2b), together suggested that the two language groups might process the inflected words in different ways in the masked priming task. As shown in Table 25, although the morphological priming effect was significant in the English L1 group, it was only marginally significant in the English L2 group. Also, when the two groups' data were merged to test for the main effect of language group on morphological priming magnitude, the L1 group showed a significantly stronger priming effect than the L2 group. These different levels of significance in the effects between the two language groups may be due to the different time courses for processing regular and irregular words between the two groups. According to Allen et al. (2003), the time courses for processing regular and irregular forms should be different. For the regular forms, but not for the irregular forms, inflected words should elicit decompositional processing, which requires more time to access the stem and to utilize syntactic features from affixes (Pliatsikas & Marinis, *in press*). Also, if the decompositional processing for regularly-inflected forms occurs more slowly in L2 than in L1, the prime duration (48ms) in the present study may not be sufficient to fully process a regularly inflected prime by the L2 group.

In addition, stem frequency significantly contributed to morphological priming magnitude for both groups, which suggests that the L2 group is as sensitive to morphological structures in a prime as the English L1 group. However, whole-word frequency was significant only for the English L1 group, and an interaction between regularity and whole-word frequency was significant only for the English L1 group. These results suggest that the English L1 group might gain additional benefit from higher whole-word frequency for irregulars because of their L1 familiarity. In contrast, the L2 group, who had relatively little exposure to L2 input, might fail to gain additional benefits from whole-word frequency of a prime regardless of its regularity.

The results of Experiments 2a and 2b suggest that English L1 and English L2 might engage the same strategy to process inflected forms (i.e., decomposition), but they are differentially affected by frequency factors. The rapid presentation of prime (48ms) and/or insufficient learning experiences in L2 may also contribute to the quantitative difference between L1 and L2 groups in the lexical decision latencies with masked priming.

Table 25. Results Summary of Experiments 2a and 2b

	NES (Exp 2a)	KLE (Exp 2b)
ANCOVA results		
MP	*	√
REG	–	–
MP x REG	–	–
Regression results		
SF	*	*
WF	*	–
SF x REG	* (weak)	–
WF x REG	* (strong)	–

Note. NES: native English speakers, KLE: Korean learners of English; MP: morphological priming effect, REG: regularity, SF: stem frequency, WF: whole-word frequency, *significant; √ marginally significant; – no significant

In summary, there were different patterns in past tense processing between English L1 and L2 groups. While English L1 (NES) showed a stronger morphological priming effect, and the interaction between regularity and whole-word frequency were significant, English L2 (KLE) showed a marginal morphological effect and no interaction between word frequency and regularity. Therefore, L2 learners appear to be less sensitive to morphological structure in L2 inflected forms as compared to L1 readers, and are not sensitive to regularity in L2 when undergoing the rapid visual processing of inflected words.

7.3. Inflectional Processing During Sentence Reading

The third issue investigated in dissertation research was whether task differences (i.e., word in isolation vs. word in a sentence context) affect the processing of past-tense verbs in Korean L1, English L1, and English L2 in addition to the three factors of regularity, stem-and whole-word frequencies, and form similarity. The research questions were specified as follows:

1) Do Korean L1, English L1, and English L2 show morphological priming effect in processing of past-tense words in a sentence context?
2) Does regularity play a role in processing of past tense words in a sentence context?
3) Which factors among regularity, orthographic similarity, stem and whole-word frequencies affect morphological priming magnitude during a sentence reading task, and how?
4) To what extent does regularity interact with the two frequency variables (stem frequency and whole-word frequency) in processing of past tense during a sentence reading task?
5) Do the results of the self-paced reading task with masked priming differ from those of the masked priming lexical decision task?

Several previous studies examined the recognition of morphologically complex words during sentence reading (Allen, Badecker, & Osterhout, 2003; Bertram, Hyona, & Laine, 2000; Deutsch et al., 2000, 2003; Luke & Christianson, 2011; Niswander, Pollatsek, & Rayner, 2003; Sereno & Rayner, 1992). As Bertram et al. (2011) suggested, conclusions drawn from an isolated word recognition study are not guaranteed to be sufficient in explaining the findings from studies employing words in a sentence context. The use of a self-paced reading with masked priming in Experiments 3 and 4a/b was motivated by the concern of ecological validity of established theoretical frameworks on morphological processing. Therefore, data from Experiments 3 and 4 were compared to those from Experiments 1 and 2 to assess task differences in past tense processing.

Several previous studies in inflectional morphology using a sentence reading task have focused on one of the two categories (regular or irregular). For instance, Niswander, Pollatesk, and Rayner (2000, Exp 2) revealed whole-word frequency effects on early processing measures in eye-movement for regularly inflected forms embedded in a sentence. The lack of stem frequency effect for regular forms in Niswander et al. contradicts the dual-mechanism account. However, this study only employed regular forms, so it is important to include irregular forms to understand a complete picture of past tense processing across different tasks.

The results from the self-paced reading tasks from the present study are summarized and discussed as follows. First, as summarized in Table 26, the morphological priming effect was significant only for English L1, although the same trend was observed for Korean L1. Since there was relatively large variability in reading times for target words, it is not certain whether the differing patterns between the languages are reliable. In terms of cross-language comparisons, Plaut and Gonnerman (2000) hypothesized that morphological priming can be easily observed in Hebrew as compared to English because Hebrew is a morphologically rich language. However, the present study showed no morphological priming effect in Korean which is morphologically much more productive than English. This could be due to the influences of language-specificity and the task characteristics.

Korean target words and their past tense primes in Experiment 3 (words in a sentence task) were different forms than those used in Experiment 1 (words in isolation task). As described in the earlier section, both stems (e.g., 먹다 /mekta/ 'eat') and past tense forms (e.g., 먹었다 /mekessta/ 'ate') in Experiment 1 are a sentence-ending verb form. Therefore, if these stimuli (with the terminal ending marker '–ta') are used in Experiment 3, all the targets should be located at the end of a sentence. However, the target word at the end of a sentence is not a sound experimental design in a sentence reading task due to the sentence wrap-up effect (Kuperman et al., 2010), so all target words should be located in the middle of a sentence (i.e., region 4). To resolve this concern, the targets and their corresponding past tense primes in Korean in Experiments were revised as connecting verb forms by adding a connecting marker '-고, –ko', which can be located in the middle of a sentence instead of the terminal ending marker '-다, –ta' (e.g.,먹었다 → 먹었고 /mekessko/ means 'ate and', 먹었고 → 먹고 /mekko/ means 'eat and').

For the two different markers (-다 and –고) in Korean, it is possible that the ending marker "-ta" does not need to be fully (or consciously) processed for a lexical decision task. In addition, the participants are likely to become insensitive (or habituated) to this marker because all target words in Experiment 1 ended with "-ta". In contrast, the connecting marker "-ko" should be processed fully in a sentence context because this morpheme is a more salient syntactic cue than "-ta". Thus, this connecting form, 먹었고/mekessko/ may require more time to be decomposed into its three constituents, mek(eat) – ess (past-tense suffix) – ko (connecting marker), which may consequently elicit a weak morphological priming to the target word 먹고 /mekko/ (eat and).[3] Therefore, the forms used in Experiments 1 and 3 might well be expected to cause a nonsignificant morphological priming effect when the task is a sentence reading task with masked priming.

Second, there was no regularity effect on response latencies to targets in the two language groups. Third, both frequency factors contributed to the magnitude of morphological priming in Korean L1 and in English L1. Orthographic similarity contributed to morphological priming magnitude for both language groups, which was not observed in the previous experiments employing the task with words in isolation. It could be that somewhat holistic processing is engaged in natural reading of a sentence. So, it might lead to the reduced effect of frequency factors. Fourth, there was no interaction between regularity and the two frequency variables in both L1 and L2 groups.

Fifth, the results from Experiments 2 and 4a are compared. Again, the interaction was significant in isolated word recognition using the same list of target words (Experiment 2). In contrast, when a self-paced reading task with masked priming was used for English L1, the regularity by whole-word frequency interaction effect was not significant (Experiment 4a), but orthographic similarity contributed significantly to the morphological priming. This result is expected because the natural reading situation restricted decompositional processing of primes.

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[3] The relationship between 먹었고 (three morphemes, *mek* + *ess* + *ko*) and 먹고 (two morphemes, *mek* + *ko*) in Korean is analogous to that of *attractively* (three morphemes, *attract* + *ive* + *ly*) and *attractive* (two morphemes, *attract* + *ive*) in English. However, in the case of 먹었다 (mek + ess + ta) – 먹다 (mek + ta), the terminal ending marker '-ta' can be regarded as morphologically less informative than a connective marker '-ko'.

Table 26. Results Summary of Experiments 3, 4a, and 4b

	NKS (Exp 3)	NES (Exp 4a)	KLE (Exp 4b)
ANCOVA results			
MP	–	–	–
REG	–	–	–
MP x REG	–	–	–
Regression results			
OS	*	*	–
SF	*	–	*
WF	*	–	–
SF x REG	–	–	–
WF x REG	–	–	–

Note. NKS: native Korean speakers, NES: native English speakers, KLE: Korean learners of English, MP: morphological priming effect, REG: regularity, SF: stem frequency, WF: whole-word frequency, *significant.

7.4. Contributions of the Present Study

This dissertation research provides three unique and valuable contributions to the area of morphological research. First, as interest in cross-linguistic comparisons in morphological processing increases, the present study on past tense processing in Korean L1 and English L1 improves our understanding of inflectional processing across typologically different languages. Furthermore, the present study provided novel evidence for a less commonly studied language (Korean) in this field in comparison to Indo-European languages (e.g., English or German). There have been only a few studies examining how morphological structures are processed in Korean (e.g., Yi, 2009), while many recent studies have examined whether morphological processing is language specific or language universal by employing languages other than English. Given that Korean is an agglutinative language, its past tense words are created mostly through concatenation (i.e., adding morphemes to a stem verb), while English past tense words are created not only by concatenation, but also often by ablaut (i.e., stem vowel changes, *keep*-*kept*). Thus, this leads to the conclusion that Korean irregular forms are likely "less irregular" as compared to English irregulars.

The second contribution of this dissertation study originates from its research design, which employed both regular and irregular past tense forms, and manipulated stem and whole-word frequency factors as continuous variables. Most of the previous studies have focused on either regular or irregular forms with either stem or whole-word frequency factors, but not the combination. For example, Alegre and Gordon (1999b) found the effect of whole-word frequency, but only in the processing of regular forms, Therefore, it is difficult to draw overall understanding about the past tense processing. Especially when considering that the abstract morphological relationship between irregular past tense and its stem could affect the processing of irregular words (Kelliher & Henderson, 1999), irregular forms also need to be examined to fully understand the role of stem frequency in inflectional morphology.

Furthermore, considering the two frequency factors as continuous variables in the present study was advantageous in examining the effect of fine-grained stem and whole-word frequencies in processing of past-tense words. Previous studies that employed the frequency variables as dichotomous variables may have missed possible frequency effects. This is why hierarchical multiple regression analyses were performed as well as ANCOVAs.

The third contribution of this dissertation study is that ecological validity of the past-tense processing was improved by examining not only words in isolation using masked priming lexical decision task, but also words in a sentence context using a self-paced reading task with masked priming. The masked priming lexical decision task has been regarded as a tool to examine rapid visual processing of word recognition while minimizing development of participants' task strategy. Thus, the masked priming paradigm allows the examination of strategy-free/automatic processing of morphologically-related primes, which fits the goal of the present research. Many previous studies used auditory/production tasks, especially for examining L2 morphological processing, to test whether readers/speakers are sensitive to morphological structure or are making use of morphological structure during the task. Therefore, it is possible that the participants developed task strategies during the task and the results could therefore be confounded. Indeed, one set of studies (Experiments 4a and 4b) revealed that orthographic similarity likely plays a more significant role in self-paced reading than in lexical decision tasks.

In sum, the use of two different languages, Korean and English, in the present study significantly increases the generalizability of the results for understanding the past tense processing mechanism. In addition, treating the frequency variables as continuous variables helped to more completely assess the role of these factors in the processing of the past tense. Finally, the use of two distinct tasks (words in isolation vs. words in a sentence context) in the present study increased the ecological validity of the findings.

7.5. Limitation & Future Research Directions

There are a few limitations in the present study. First, the self-paced reading with masked priming did not consider the time that participants' eyes moved from the region of target-1 to the region of the target. Because a reader needs time (~10ms) to move their eyes to read the next word (i.e., saccade), the pre-mask should have remained on the target region during this time to ensure that participants oriented their eyes on the target location by the prime onset. This could be more problematic for L2 readers, because L2 learners' eye-movement is generally slower than L1 readers (Frenck-Mestre & Pynte, 1997). Therefore, efforts should be taken to block the potential methodological flaw that prime is presented before a reader's eyes arrive at the target location (i.e., shorter prime duration than the actual prime duration). Indeed, in a recent attempt to develop a new experimental paradigm called SPaM (Self-paced reading task with masked priming), the time for saccade was considered by adding a 10ms pause before the prime was presented (Luke and Christianson, 2012, see Figure 4). Future studies need to consider this time duration of saccade.

1. I ### ####. (until button press)
2. _ ### ####. (10ms)
3. _ buy ####. (50ms prime)
4. _ **eat** ####. (until button press)
5. _ ___ ####. (10ms)
6. _ ___ spam. (50ms prime)
7. _ ___ **spam**. (until button press)

Figure 4. The SPaM procedure from Luke and Christianson (2012)

Second, the sentence stimuli could be improved to reflect more distinct properties of natural sentence reading. For example, sentential context (i.e., strong context vs. weak context) would affect the processing of a word embedded in the sentence. If so, one would expect to observe interactions between sentential level factors (e.g., contextual strength) and word level factors (e.g., regularity or word frequency) in word recognition during a sentence reading task. In the present study, however, emphasis was placed on controlling the predictability of targets in order to focus on the different situations of word recognition: words in isolation and words in sentence. As a result the present study did not examine how the past tense processing would be affected by predictability of sentential context. Therefore, for a future study, if the stimuli sentences can be generated with two or more levels of predictability (high predictability vs. low predictability), then it would allow us to better understand inflectional processing in more natural situations.

Third, the present study only focused on past tense. However, different patterns of inflectional processing in Korean are possible if a study employs other types of inflectional structures such as number or gerund (e.g., 먹음 /mek-um/, eating in English). In Korean, there is a plural marker –tul attached to any nouns, but it is often dropped in natural sentences as the example (7a).

(7a) 식탁에 사과가 많다.

Siktake sakwa-ka manh-ta.

On the table apple-$_{\text{subject marker}}$ many are

Meaning: There are many apples on the table.

In this example (7a), 사과 (apple) is singular form and it is not only acceptable, but also natural in Korean. Therefore, Korean speakers' sensitivity to the plural marker may be weaker than to the past tense marker. Moreover, L1 morphological characteristics may affect L2 morphological processing. For example, Chinese learners of English showed an asymmetric pattern between past tense and number in English (Jiang, 2004). The author reasoned that it is because inflectional structure regarding number in Chinese is almost absent, while the past tense morpheme is used in Chinese more frequently. Likewise, similar asymmetric usage between inflectional structures in Korean would also lead to asymmetric sensitivity between the structures and consequently results in different latencies and accuracy on English L2 inflected words.

7.6. Conclusion

The findings of the present dissertation suggest that the role of regularity should be reconsidered with respect to both language-specific characteristics and task differences. Although both Korean L1 and English L1 showed sensitivity to morphological structures, no clear distinction between regular and irregular forms in Korean may contribute to the differential past-tense processing from English, which cannot be easily explained by a dual-mechanism account. In contrast, the mixed evidence of no regularity effect, but the regularity by frequency interaction from English past-tense processing can be explained by either dual-mechanism or single-mechanism accounts. Therefore, more evidence is needed to better explain how English past-tense inflection is processed.

No morphological priming effect regardless of the tasks in English L2 supports a perspective of morphological insensitivity in L2. However, the pattern of morphological priming in English L2, despite its lack of statistical significance, and the contribution of stem frequency to past-tense priming in both tasks in English L2 still raise the questions of whether morphological processing in L1 and L2 is fundamentally different.

Finally, differential evidence from the two tasks between Korean L1 and English L1 suggests that taking ecological validity into account is critical to understanding how morphological information is processed in a natural setting.

Appendix A. Index of orthographic similarity calculation

Van Orden (1987)'s orthographic similarity (modifying from Weber, 1970)

Graphical Similarity (GS) by Weber (1970)

$GS = 10([(50F + 30V + 10C)/A] + 5T +27B + 18E$

F = number of pairs of adjacent letters in the same order shared by word pairs
V = number of pairs of adjacent letters in reverse order shared by word pairs
C = number of single letters shared by word pairs
A = average number of letters in the two words
T = ratio of number of letters in the shorter word to the number in the longer
B = 1 if the first letter in the two words is the same; otherwise, B = 0
E = 1 if the last letter in the two words is the same; otherwise, E = 0

Orthographic Similarity (OS) by Van Orden (1987)

OS = (GS of target foil and category exemplar) / (GS of category exemplar and itself)
For example, in a case of *catch – caught,*
GS of target foil and category exemplar = catch : caught
$F = 1, V = 0, C = 4, T = 5/6, A = 5.5, B = 1, E = 0$
GS of category exemplar and itself = catch:catch
$F= 4, V = 0, C = 5, T = 5/5=1, A = 5, B = 1, E = 1$
Therefore, OS between catch-caught is .475.

Appendix B. Familiarity Check Example

Please rate your familiarity to the following words. If you have never seen this word before, please mark on "1" for "very unfamiliar"; if you know a word very well, please mark on "7" for "very familiar". You do not need to think too much about each item, just use your intuition (not a dictionary). Thank you for your help!

	Item	1 Very Unfamiliar	2 Somewhat unfamiliar	3 A little unfamiliar	4 Neither familiar nor unfamiliar	5 A little familiar	6 Somewhat familiar	7 Very familiar
1	produce	( )	( )	( )	( )	( )	( )	( )
2	like	( )	( )	( )	( )	( )	( )	( )
3	carry	( )	( )	( )	( )	( )	( )	( )
4	need	( )	( )	( )	( )	( )	( )	( )
5	call	( )	( )	( )	( )	( )	( )	( )
6	share	( )	( )	( )	( )	( )	( )	( )
7	claim	( )	( )	( )	( )	( )	( )	( )
8	learn	( )	( )	( )	( )	( )	( )	( )
9	follow	( )	( )	( )	( )	( )	( )	( )
10	fix	( )	( )	( )	( )	( )	( )	( )
11	pick	( )	( )	( )	( )	( )	( )	( )
12	touch	( )	( )	( )	( )	( )	( )	( )
13	hate	( )	( )	( )	( )	( )	( )	( )
14	cite	( )	( )	( )	( )	( )	( )	( )
15	adjust	( )	( )	( )	( )	( )	( )	( )
16	owe	( )	( )	( )	( )	( )	( )	( )
17	beg	( )	( )	( )	( )	( )	( )	( )
18	chop	( )	( )	( )	( )	( )	( )	( )
19	clean	( )	( )	( )	( )	( )	( )	( )
20	smell	( )	( )	( )	( )	( )	( )	( )
21	dance	( )	( )	( )	( )	( )	( )	( )
22	respond	( )	( )	( )	( )	( )	( )	( )
23	shape	( )	( )	( )	( )	( )	( )	( )
24	judge	( )	( )	( )	( )	( )	( )	( )
25	shift	( )	( )	( )	( )	( )	( )	( )
26	count	( )	( )	( )	( )	( )	( )	( )
27	scream	( )	( )	( )	( )	( )	( )	( )

Appendix C1. Proficiency test 1: English Cloze-Test

Participant #: _____________
English Proficiency Test
Directions
The following tests have been developed by removing the second half of every second word in a text. You are supposed to reconstruct the texts.

Example: My name is Tom. I'm t__ oldest ch__ in m__ family. I ha__ a sister a__ two brot___.
Answer: My name is Tom. I'm the oldest child in my family. I have a sister and two brothers.

Text 1
The representation of thought was achieved by means of oral signs, mutually understood by the group who recognized the same system of representation. This or___ manifestation w___ later o___ preserved i___ the fo___ of draw___ and writ___, so th___ each comm____ left beh___ a record o___ its cul___. But wri___ is n___only a w___ to pres___ memory; i___ is al___ the sym___ of a cul___. This c___ be cle___ observed i___ the sys___ of wri____, which were historically developed. Writing was later developed into artistic and aesthetic forms of knowledge and communication and whether it developed so do calligraphy.

Text 2
Postcards always spoil my holidays. Last sum___, I we___ to It___. I vis___ museums, a___ sat i___ public gar___. A frie___ waiter tau___ me a f___ words o___ Italian. H___ lent m___ a bo___. I re___ a f___ lines, b___ I d___ not under___ a wo___. Every d___ I tho___ about post___. My holi___ passed qui___, but I did not send any cards to my friends. On the last day I made a big decision. I got up early and bought thirty-seven cards. I spend the whole day in my room, but I did not write a single card!

Text 3
Some people believe that cigarette smoking is dangerous and should be considered a health hazard. They wa___ their gover___ to cre___ antismoking prog___. People dif___as t___ how st___ these antis___ campaigns sho___ be. So___ of the stro___ campaigns wo___ try t___ completely elim___cigarette smo___. Supporters o___ these prog___ would t___ to b___ cigarette smo___completely i___ public pla___. Others wo___ try on___ to rest___ the number of places where people could smoke. Such restrictions would not try to eliminate public smoking completely, but only to curb 133 smoking by reducing cigarette consumption.

Text 4
Recent studies indicate that grandparents and grandchildren are better off when they spend large amounts of time together. Grandparents gi__ children lo___ of affe___ with

n__ strings atta___, and t__ children ma___ the grandp___ feel lo___ and nee___ at a ti___ when t__ society m___ be tel___ ol___ people th___ they a___ a bur___ Grandparents a___ a sou___ of stre___ and wis___ and he___ ease t___ pressure bet___ children and their parents.

Text 5

Is astrology a science? It cert___ claims t___ be o___ . We kn___ that astro___ commit thems___ to predi___ based o___ an all___ connection bet___ the posi___ of t___ stars a___ human li___ . People bo___ under a cer___ sign o___ the zod___ are supp___ to b___ of a cer___ temperament. Wh___ one pla___ is ne___ ano___ this is supposed to mean that the time is favourable for love, or war, or business deals. But does astrology make good its claims to predict the future with reasonably consistent success?

Appendix C2. Target answers of the Boston Naming Test

item #	Target word	item #	Target word
1	bed	31	rhinoceros
2	tree	32	acorn
3	pencil	33	igloo
4	house	34	stilts
5	whistle	35	dominoes
6	scissors	36	cactus
7	comb	37	escalator
8	flower	38	harp
9	saw	39	hammock
10	toothbrush	40	knocker
11	helicopter	41	pelican
12	broom	42	stethoscope
13	octopus	43	pyramid
14	mushroom	44	muzzle
15	hanger	45	unicorn
16	wheelchair	46	funnel
17	camel	47	accordion
18	mask	48	noose
19	pretzel	49	asparagus
20	bench	50	compass
21	racquet	51	latch
22	snail	52	tripod
23	volcano	53	scroll
24	seahorse	54	tongs
25	dart	55	sphinx
26	canoe	56	yoke
27	globe	57	trellis
28	wreath	58	palette
29	beaver	59	protractor
30	harmonica	60	abacus

Appendix C3. Language Experience and Proficiency Questionnaire (LEAP-Q)

Northwestern Bilingualism & Psycholinguistics Research Laboratory
Please cite Marian, Blumenfeld, & Kaushanskaya (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech Language and Hearing Research, 50* (4), 940-967.

Language Experience and Proficiency Questionnaire (LEAP-Q)

Last Name		First Name		Today's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know **in order of dominance**:

1	**2**	**3**	**4**	**5**

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1	**2**	**3**	**4**	**5**

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:					
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc):

List cultures here					
	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)

(7) How many years of formal education do you have? ______ ________________________________
Please check your highest education level (or the approximate US equivalent to a degree obtained in another country):

☐ Less than High School ☐ Some College ☐ Masters
☐ High School ☐ College ☐ Ph.D./M.D./J.D.
☐ Professional Training ☐ Some Graduate School ☐ Other:

(8) Date of immigration to the USA, if applicable ___ ____
If you have ever immigrated to another country, please provide name of country and date of immigration here. __________________ ____

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐ ? (Check all applicable). If yes, please explain (including any corrections):
____________________________________ ____

Language:

This is my (please select from pull-down menu) language.

All questions below refer to your knowledge of .

(1) Age when you…:

began acquiring :	*became fluent* in :	*began reading* in :	*became fluent reading* in :

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where is spoken		
A family where is spoken		
A school and/or working environment where is spoken		

(3) On a scale from zero to ten, please select your *level of **proficiency*** in speaking, understanding, and reading from the scroll-down menus:

Speaking	(click here for scale)	Understanding spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning :

Interacting with friends	(click here for pull-down scale)	Language tapes/self instruction	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Watching TV	(click here for pull-down scale)
Reading	(click here for pull-down scale)	Listening to the radio	(click here for pull-down scale)

(5) Please rate to what extent you are currently exposed to in the following contexts:

Interacting with friends	(click here for pull-down scale)	Listening to radio/music	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Reading	(click here for pull-down scale)
Watching TV	(click here for pull-down scale)	Language-lab/self-instruction	(click here for pull-down scale)

(6) In your perception, how much of a foreign accent do you have in ?

(click here for pull-down scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in :

(click here for pull-down scale)

Language: English

This is my (please select from pull-down menu) language.

All questions below refer to your knowledge of English.

(1) Age when you…:

began acquiring English :	*became fluent* in English :	*began reading* in English:	*became fluent reading* in English :

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where English is spoken		
A family where English is spoken		
A school and/or working environment where English is spoken		

(3) On a scale from zero to ten please select your *level of* ***proficiency*** in speaking, understanding, and reading English from the scroll-down menus:

Speaking	(click here for scale)	Understanding spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning English:

Interacting with friends	(click here for pull-down scale)	Language tapes/self instruction	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Watching TV	(click here for pull-down scale)
Reading	(click here for pull-down scale)	Listening to the radio	(click here for pull-down scale)

(5) Please rate to what extent you are currently exposed to English in the following contexts:

Interacting with friends	(click here for pull-down scale)	Listening to radio/music	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Reading	(click here for pull-down scale)
Watching TV	(click here for pull-down scale)	Language-lab/self-instruction	(click here for pull-down scale)

(6) In your perception, how much of a foreign accent do you have in English ?

(click here for pull-down scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in English:

(click here for pull-down scale)

Appendix D. The LEAP-Q and English Proficiency tests' results from Korean learners of English

Experiment 2b

The average length of formal education of the participants was 20.2 years (*SD* = 3.1). For all the participants, Korean was their native and dominant language, and English was their second language. The average age at which they began learning English was 11.1 (*SD* = 1.8). Three component skills (speaking, listening, and reading) were rated as being significantly better in Korean than English [speaking, $t(35) = 10.94$, $p < .001$; listening, $t(35) = 9.62$, $p < .001$; reading, $t(35) = 8.75$, $p < .001$]. The average scores for the English Boston Naming Test and Cloze-Test were .72 (SD = .12) and .68 (SD = .09).

Experiment 4b

The average length of formal education of the participants was 21.8 years (*SD* = 2.5). For all the participants, Korean was their native and dominant language, and English was the second language. The average age at which they began learning English was 11.2 (*SD* = 3.1). Three component skills were rated as being significantly better in Korean than English [speaking, $t(35) = 9.20$, $p < .001$; listening, $t(35) = 7.221$, $p < .001$; reading, $t(35) = 3.96$, $p = .001$]. The average scores for the English Boston Naming Test and Cloze-Test were .62 (SD = .18) and .60 (SD = .13).

Table. Means and standard deviations of self-rated proficiency and language profiles of participants in Experiment 2b and 4b.

	Exp. 2b Korean	English	Exp. 4b Korean	English
Age of acquisition (yrs.)	0.4 (0.7)	11.1 (1.8)	0.8 (0.4)	11.0 (3.2)
Age of reading acquisition (yrs.)	5.8 (1.2)	11.8 (1.1)	6.1 (1.6)	11.3 (2.6)
Age of reading fluency (yrs.)	7.6 (1.6)	20.8 (4.5)	9.3 (2.0)	20.3 (7.4)
Length of residence - country (yrs.)	26.4 (7.5)	3.5 (2.2)	25.7 (5.2)	4.1 (2.4)
Length of residence: family (yrs.)	28.4 (3.7)	0.1 (0.3)	27.1 (6.6)	0.5 (0.5)
Length of residence: school/work (yrs.)	18.3 (4.5)	3.6 (2.5)	19.7 (6.7)	3.7 (1.9)
Speaking rating (0-10)	9.8 (0.4)	5.5 (1.7)	9.8 (0.4)	5.2 (2.1)
Listening rating (0-10)	9.8 (0.4)	5.9 (1.6)	9.9 (0.3)	6.3 (1.8)
Reading rating (0-10)	9.7 (0.3)	6.8 (1.2)	9.8 (0.5)	6.6 (1.6)
Percentage of current exposition (%)	59 (17)	41 (17)	62 (20)	38 (20)

Appendix E. List of Korean Stimuli in Experiment 1

Regular

Target	Translation	SF	Log SF	#Type	Past-tense	WF	Log WF	OS
겪다	experience	3305	3.52	244	겪었다	180	2.26	0.81
굳다	harden	863	2.94	72	굳었다	13	1.11	0.81
끊다	quit	1808	3.26	366	끊었다	174	2.24	0.81
끌다	haul	4095	3.61	371	끌었다	288	2.46	0.81
끓다	boil	473	2.67	366	끓었다	14	1.15	0.81
넣다	insert	6915	3.84	1001	넣었다	333	2.52	0.81
늙다	be old	1764	3.25	252	늙었다	10	1.00	0.81
닮다	resemble	1092	3.04	225	닮았다	53	1.72	0.81
덮다	cover	1321	3.12	216	덮었다	86	1.93	0.81
맺다	make	1921	3.28	248	맺었다	98	1.99	0.81
묶다	tie	1296	3.11	209	묶었다	54	1.73	0.81
믿다	trust	6644	3.82	650	믿었다	310	2.49	0.81
밟다	step on	1435	3.16	233	밟았다	64	1.81	0.81
벗다	undress	1974	3.30	282	벗었다	58	1.76	0.81
볶다	roast	383	2.58	78	볶았다	5	0.70	0.81
붙다	adhere	3472	3.54	456	붙었다	113	2.05	0.81
빚다	make	1083	3.03	133	빚었다	62	1.79	0.81
뻗다	stretch	1080	3.03	159	뻗었다	26	1.41	0.81
뽑다	pluck	2158	3.33	420	뽑았다	81	1.91	0.81
섞다	mix	920	2.96	99	섞었다	10	1.00	0.81
신다	wear	1079	3.03	179	신었다	43	1.63	0.81
쌓다	stack	1885	3.28	277	쌓았다	76	1.88	0.81
썩다	rot	963	2.98	162	썩었다	5	0.70	0.81
썰다	cut	340	2.53	72	썰었다	1	0.00	0.81
쏘다	fire	815	2.91	284	쏘았다	31	1.49	0.85
쏟다	pour	1336	3.13	282	쏟았다	48	1.68	0.81
쓸다	sweep	558	2.75	167	쓸었다	20	1.30	0.85
씌다	be blinded	569	2.76	108	씌었다	1	0.00	0.85
씹다	chew	743	2.87	144	씹었다	35	1.54	0.81
씻다	wash	1561	3.19	278	씻었다	54	1.73	0.81
안다	hold	2373	3.38	266	안았다	130	2.11	0.81
앉다	sit	10291	4.01	570	앉았다	795	2.90	0.81
알다	know	35692	4.55	2320	알았다	811	2.91	0.81
앓다	be sick	1101	3.10	139	앓았다	42	1.62	0.81
얹다	put on	726	2.86	117	얹었다	38	1.58	0.81
얻다	earn	7849	3.89	583	얻었다	258	2.41	0.81
얼다	freeze	445	2.65	116	얼었다	8	0.90	0.81

업다	piggyback	497	2.70	96	업었다	10	1.00	0.81
엎다	turn over	171	2.23	72	엎었다	6	0.78	0.81
엮다	weave	576	2.76	142	엮었다	17	1.23	0.81
열다	open	6932	3.84	595	열었다	900	2.95	0.81
외다	memorize	173	2.24	74	외었다	3	0.48	0.85
울다	cry	3736	3.57	546	울었다	344	2.54	0.81
웃다	laugh	6263	3.80	428	웃었다	1336	3.13	0.81
읊다	recite	296	2.47	83	읊었다	23	1.36	0.81
읽다	read	8474	3.93	939	읽었다	260	2.41	0.81
잃다	lose	3810	3.58	276	잃었다	174	2.24	0.81
입다	wear	6450	3.81	518	입었다	225	2.35	0.81
잊다	forget	3046	3.48	288	잊었다	37	1.57	0.81
잡다	grab	9299	3.97	1141	잡았다	508	2.71	0.81
적다	write	1488	3.17	247	적었다	65	1.81	0.81
절다	limp	196	2.29	41	절었다	2	0.30	0.81
접다	fold	632	2.80	120	접었다	38	1.58	0.81
젖다	be wet	1664	3.22	152	젖었다	47	1.67	0.81
졸다	drowse	322	2.51	72	졸았다	8	0.90	0.81
죽다	die	10176	4.01	1460	죽었다	225	2.35	0.81
줄다	decrease	1105	3.10	193	줄었다	105	2.02	0.81
쥐다	hold	1625	3.21	255	쥐었다	91	1.96	0.81
짚다	point	729	2.86	141	짚었다	26	1.41	0.81
쪼다	peck	165	2.22	62	쪼았다	2	0.30	0.85
쫓다	chase	681	2.83	147	쫓았다	23	1.36	0.81
쬐다	expose to	130	2.11	50	쬐었다	3	0.48	0.85
찍다	shoot	2776	3.44	490	찍었다	107	2.03	0.81
찢다	tear	587	2.77	139	찢었다	37	1.57	0.81
찧다	pound	227	2.36	60	찧었다	12	1.08	0.81
찾다	find	12465	4.10	1135	찾았다	441	2.64	0.81
추다	dance	1023	3.01	225	추었다	46	1.66	0.85
캐다	excavate	449	2.65	142	캐었다	1	0.00	0.85
털다	brush	1094	3.04	203	털었다	41	1.61	0.81
튀다	spark	668	2.82	166	튀었다	34	1.53	0.85
틀다	turn on	864	2.94	188	틀었다	80	1.90	0.81
팔다	sell	4352	3.64	580	팔았다	81	1.91	0.81
풀다	solve	3639	3.56	547	풀었다	149	2.17	0.81
품다	incubate	1089	3.04	119	품었다	20	1.30	0.81
핥다	lick	279	2.45	91	핥았다	41	1.61	0.81
헐다	unbuild	246	2.39	70	헐었다	1	0.00	0.81
훑다	scan	281	2.45	87	훑었다	25	1.40	0.81
휘다	bend	206	2.31	54	휘었다	1	0.00	0.85

Irregular Target	Translation	SF	Log SF	Type Freq	Past-tense	WF Freq	Log WF	OS
가깝다	be near	4041	3.61	368	가까웠다	66	1.82	0.72
가르다	separate	688	2.84	146	갈랐다	20	1.30	0.76
가볍다	be light	2042	3.31	175	가벼웠다	29	1.46	0.72
가쁘다	breath	416	2.62	77	가빴다	15	1.18	0.83
거르다	fliter	238	2.38	46	걸렀다	3	0.48	0.76
걷다	walk	4009	3.60	486	걸었다	398	2.60	0.70
고르다	choose	1535	3.19	189	골랐다	33	1.52	0.76
고프다	be hungry	451	2.65	135	고팠다	17	1.23	0.79
괴롭다	suffer	747	2.87	167	괴로웠다	22	1.34	0.72
구르다	roll	403	2.61	100	굴렀다	18	1.26	0.76
굽다	grill	647	2.81	118	구웠다	8	0.90	0.72
그립다	miss	737	2.87	176	그리웠다	33	1.52	0.72
긋다	draw	466	2.67	115	그었다	23	1.36	0.72
기르다	grow	1923	3.28	330	길렀다	24	1.38	0.76
기쁘다	be pleased	1147	3.06	186	기뻤다	94	1.97	0.79
긷다	draw	108	2.03	46	길었다	2	0.30	0.70
깁다	sew	76	1.88	32	기웠다	2	0.30	0.72
깨닫다	realize	2567	3.41	232	깨달았다	461	2.66	0.71
끄다	turn off	604	2.78	172	껐다	66	1.82	0.68
나르다	move	536	2.73	139	날랐다	30	1.48	0.83
나쁘다	be bad	2516	3.40	304	나빴다	26	1.41	0.83
낫다	get well	1152	3.06	191	나았다	22	1.34	0.72
눕다	lie down	2547	3.41	205	누웠다	151	2.18	0.72
담그다	soak	690	2.84	144	담갔다	18	1.26	0.75
더럽다	be dirty	759	2.88	113	더러웠다	8	0.90	0.72
덥다	be hot	858	2.93	162	더웠다	28	1.45	0.72
돕다	help	2185	3.34	303	도왔다	49	1.69	0.72
듣다	hear	13889	4.14	1192	들었다	679	2.83	0.70
따르다	follow	262	2.42	69	따랐다	158	2.20	0.76
뜨다	float	498	2.70	114	떴다	36	1.56	0.68
맵다	be spicy	256	2.41	78	매웠다	2	0.30	0.72
모르다	don't know	24424	4.39	1741	몰랐다	883	2.95	0.76
무겁다	be heavy	1803	3.26	202	무거웠다	56	1.75	0.73
무르다	be weak	80	1.90	12	물렀다	1	0.00	0.76
묻다	bury	8936	3.95	591	물었다	2971	3.47	0.70
미덥다	be reliable	78	1.89	34	미더웠다	2	0.30	0.73
밉다	be hateful	559	2.75	177	미웠다	38	1.58	0.72
바르다	apply	957	2.98	169	발랐다	23	1.36	0.76

바쁘다	be busy	2059	3.31	328	바빴다	106	2.03	0.79
벼르다	wait	177	2.25	42	별렀다	6	0.78	0.76
뵙다	meet	252	2.40	87	뵈었다	4	0.60	0.72
부르다	call	9929	4.00	1013	불렀다	854	2.93	0.76
붓다	swell	781	2.89	195	부었다	36	1.56	0.72
비우다	empty	911	2.96	201	비웠다	79	1.90	0.83
사납다	be fierce	402	2.60	75	사나웠다	9	0.95	0.73
서럽다	be sad	305	2.48	70	서러웠다	6	0.78	0.73
속이다	cheat	655	2.82	169	속였다	11	1.04	0.73
숨기다	hide	1222	3.09	189	숨겼다	42	1.62	0.73
쉽다	be easy	7832	3.89	315	쉬웠다	33	1.52	0.72
스치다	brush	996	3.00	111	스쳤다	94	1.97	0.73
슬프다	be sad	1331	3.12	187	슬펐다	25	1.40	0.80
싣다	load	1646	3.22	240	실었다	114	2.06	0.70
쓰다	use	25391	4.40	1111	썼다	332	2.52	0.68
어둡다	be dark	2155	3.33	233	어두웠다	56	1.75	0.73
어르다	coax	41	1.61	14	얼렀다	1	0.00	0.76
예쁘다	be pretty	1807	3.26	287	예뻤다	32	1.51	0.79
오다	come	30819	4.49	3323	왔다	1140	3.06	0.68
오르다	climb	5802	3.76	672	올랐다	601	2.78	0.76
이르다	reach	5669	3.75	225	이르렀다	492	2.69	0.75
일컫다	call	553	2.74	82	일컬었다	1	0.00	0.73
잇다	succeed	37	1.57	288	이었다	250	2.40	0.72
자르다	cut	1394	3.14	233	잘랐다	35	1.54	0.76
잠그다	lock	230	2.36	59	잠갔다	16	1.20	0.82
젓다	shake	764	2.88	114	저었다	280	2.45	0.72
조르다	nag	390	2.59	78	졸랐다	33	1.52	0.76
줍다	pick up	692	2.84	171	주웠다	23	1.36	0.72
지르다	yell	1851	3.27	225	질렀다	20	1.30	0.76
지우다	erase	1733	3.24	168	지웠다	16	1.20	0.83
짓다	build	8105	3.91	1263	지었다	494	2.69	0.72
채우다	fill	1866	3.27	25	채웠다	4	0.60	0.83
춥다	be cold	1295	3.11	257	추웠다	36	1.56	0.72
치르다	pay	2184	3.34	301	치렀다	81	1.91	0.83
크다	be big	102	2.01	35	컸다	252	2.40	0.68
트다	open	286	2.46	87	텄다	4	0.60	0.68
파다	dig	886	2.95	206	팠다	21	1.32	0.68
푸다	scoop	237	2.37	93	펐다	6	0.78	0.68
푸르다	be blue	1750	3.24	164	푸르렀다	7	0.85	0.75
흐르다	flow	4044	3.61	331	흘렀다	900	2.95	0.76

Appendix F. List of English Stimuli in Experiment 2

Regular Target	SF (log freq)	WF (log freq)	# Letter	Neighbor size	Connectivity	Resonant Strength
accept	6.06	1.98	6	1	1.94	0.026
adjust	6.92	1.1	6	0	NA	NA
admit	3.08	1.73	5	0	1.89	0.021
agree	5.62	1.91	5	0	0.43	0.106
allow	6.82	1.95	5	3	1.73	0.196
apply	5.7	1.69	5	3	1.15	0.003
attach	3.94	0.93	6	1	1.71	0.014
beg	3.47	1.1	3	12	1.44	0.125
borrow	3.61	1.19	6	4	2.25	0.243
bury	3.49	1.06	4	8	2.57	0.015
call	8.43	2.38	4	12	1.2	0.139
carry	7.26	2	5	5	1.5	0.034
cheat	2.53	0.74	5	4	2.18	0.023
check	5.67	1.82	5	3	1	0.02
cite	2.06	0.54	4	9	NA	NA
claim	6.15	1.87	5	0	0.81	0.004
clean	4.71	1.96	5	3	1.83	0.217
collect	5.5	1.44	7	0	1.19	0.096
cook	5.5	1.7	4	11	1.6	0.055
count	5.33	1.9	5	3	0.86	0.005
cover	6.69	2.02	5	10	0.82	0.062
create	6.15	1.78	6	1	1.42	0.061
dance	5.38	1.67	5	1	1.47	0.055
decorate	5.08	0.61	8	0	1.95	0.005
develop	4.37	1.87	7	0	1.5	0.001
die	6.81	1.94	3	13	2.79	0.153
enjoy	5.09	1.84	5	1	2.79	0.021
enter	5.69	1.68	5	2	1.62	0.221
exist	6.53	1.81	5	0	2.35	0.009
fade	3.68	0.91	4	10	1.95	0.002
finish	5.93	1.55	6	0	1.25	0.24
fix	5.15	1.29	3	8	1.5	0.186
follow	4.42	1.95	6	3	0.64	0.174
hate	7.77	1.76	4	14	1	0.243
help	7.6	2.58	4	7	1.14	0.052

ignore	4.72	1.42	6	0	2.15	0.023
import	4.9	1.12	6	1	0.76	0.026
improve	6.71	1.63	7	0	NA	NA
join	5.59	1.82	4	3	1.61	0.014
judge	5.28	1.75	5	3	1.18	0.13
kill	6.39	1.89	4	13	2.06	0.2
learn	6.85	2.09	5	1	3	0.114
like	7.88	3.3	4	11	2.07	0.08
match	10.03	1.76	5	7	0.89	0.011
move	4.45	2.27	4	10	2.54	0.019
need	8.12	2.67	4	7	0.71	0.175
offer	7.05	2.02	5	0	NA	NA
paint	5.71	1.62	5	6	1.62	0.029
pass	7.22	2	4	12	1	0.055
pick	6.18	1.84	4	14	0.5	0.141
predict	3.25	1.05	7	0	0.82	0
press	5.78	2.14	5	4	1.06	0.009
print	4.91	1.43	5	2	2.08	0.09
produce	5.64	2.01	7	1	2	0.002
prompt	6.3	0.73	6	0	NA	NA
prove	5.64	1.8	5	5	2.04	0.007
pull	6.28	1.83	4	13	0.67	0.318
punish	5.8	0.97	6	0	1.96	0.029
reach	6.85	1.97	5	7	1.67	0.009
remind	2.99	1.32	6	2	1.7	0.005
respond	4.3	1.4	7	0	1.6	0
return	6.85	2.19	6	0	1.75	0.006
save	5.45	1.83	4	13	1.15	0.003
scream	4.65	1.17	6	1	2.27	0.345
serve	6.25	1.83	5	3	NA	NA
shape	5.06	1.83	5	6	1.69	0.046
share	6.42	1.96	5	14	1.84	0.008
shift	5.05	1.56	5	3	1.1	0.028
show	7.97	2.37	4	9	1.52	0.046
skip	2.15	0.76	4	7	0.9	0.059
smell	4.91	1.79	5	5	1.54	0.284
solve	4.07	1.39	5	1	1.65	0.062
start	7.86	2.33	5	4	1.9	0.159
stop	7	2.25	4	5	1.75	0.435
talk	8.17	2.42	4	8	1.79	0.209
touch	6.11	1.99	5	5	1.6	0.265

trade	8.17	2.22	5	2	1.9	0.054
treat	5.14	1.59	5	2	1.94	0.036
visit	6.46	2	5	0	1.27	0
walk	7.51	2.09	4	4	1	0.237
wash	5.18	1.61	4	12	1.43	0.006
watch	4.07	2.04	5	7	1.79	0.109
wave	5.78	1.67	4	14	1.8	0.022
wish	6.34	2.11	4	6	0.62	0.026
wonder	6.53	1.96	6	4	1.36	0.037
work	9.49	2.92	4	8	1.63	0.091
worry	5.78	1.89	5	3	1.65	0.017

Past-tense prime	WF (log freq)	# Letter	Neighbor size	Repeated letter	% Repeated letter	Orthographic similarity
accepted	1.96	8	1	6	0.75	0.73
adjusted	1.03	8	0	6	0.75	0.67
admitted	1.57	8	0	5	0.63	0.74
agreed	2	6	1	5	0.83	0.77
allowed	2.13	7	0	5	0.71	0.73
applied	1.66	7	1	5	0.71	0.59
attached	1.59	8	2	6	0.75	0.74
begged	1.06	6	5	3	0.50	0.78
borrowed	1.14	8	2	6	0.75	0.68
buried	1.56	6	3	4	0.67	0.70
called	2.62	6	7	4	0.67	0.78
carried	2.11	7	6	5	0.71	0.58
cheated	0.79	7	1	5	0.71	0.71
checked	1.49	7	1	5	0.71	0.75
cited	0.84	5	2	4	0.80	0.67
claimed	1.59	7	1	5	0.71	0.77
cleaned	1.14	7	4	5	0.71	0.78
collected	1.46	9	0	7	0.78	0.72
cooked	1.43	6	9	4	0.67	0.72
counted	1.25	7	3	5	0.71	0.76
covered	1.94	7	3	5	0.71	0.66
created	1.81	7	7	6	0.86	0.75
danced	1.2	6	2	5	0.83	0.71
decorated	1.18	9	0	8	0.89	0.72
developed	2.03	9	1	7	0.78	0.71
died	2.1	4	8	3	0.75	0.72
enjoyed	1.71	7	0	5	0.71	0.77

entered	1.74	7	0	5	0.71	0.78
existed	1.53	7	0	5	0.71	0.77
faded	1.31	5	8	4	0.80	0.73
finished	1.97	8	1	6	0.75	0.77
fixed	1.76	5	5	3	0.60	0.72
followed	2.12	8	1	6	0.75	0.82
hated	1.58	5	8	4	0.80	0.70
helped	1.9	6	2	4	0.67	0.74
ignored	1.5	7	1	6	0.86	0.67
imported	1.16	8	2	6	0.75	0.74
improved	1.5	8	1	7	0.88	0.78
joined	1.78	6	2	4	0.67	0.72
judged	1.23	6	3	5	0.83	0.82
killed	1.99	6	6	4	0.67	0.75
learned	1.97	7	2	5	0.71	0.70
liked	2	5	4	4	0.80	0.78
matched	1.09	7	6	5	0.71	0.70
moved	2.25	5	5	4	0.80	0.77
needed	2.19	6	3	4	0.67	0.71
offered	1.97	7	0	5	0.71	0.71
painted	1.65	7	6	5	0.71	0.72
passed	2.15	6	6	4	0.67	0.72
picked	1.96	6	9	4	0.67	0.75
predicted	1.18	9	0	7	0.78	0.65
pressed	1.59	7	2	5	0.71	0.67
printed	1.44	7	3	5	0.71	0.75
produced	1.99	8	2	7	0.88	0.77
prompted	0.98	8	2	6	0.75	0.75
proved	1.82	6	3	5	0.83	0.73
pulled	1.95	6	9	4	0.67	0.73
punished	1.07	8	1	6	0.75	0.72
reached	2.15	7	4	5	0.71	0.71
reminded	1.44	8	2	6	0.75	0.70
responded	1.21	9	0	7	0.78	0.70
returned	2.05	8	0	6	0.75	0.73
saved	1.58	5	7	4	0.80	0.72
screamed	1.27	8	1	6	0.75	0.77
served	1.74	6	3	5	0.83	0.71
shaped	1.22	6	6	5	0.83	0.70
shared	1.69	6	12	5	0.83	0.72
shifted	1.24	7	0	5	0.71	0.78
showed	2.02	6	7	4	0.67	0.63
skipped	0.58	7	5	4	0.57	0.75

smelled	1.14	7	4	5	0.71	0.75
solved	1.31	6	1	5	0.83	0.74
started	2.31	7	4	5	0.71	0.65
stopped	2.17	7	6	4	0.57	0.74
talked	1.98	6	4	4	0.67	0.77
touched	1.68	7	3	5	0.71	0.77
traded	0.69	6	4	5	0.83	0.77
treated	1.73	7	1	5	0.71	0.72
visited	1.58	7	0	5	0.71	0.70
walked	2.19	6	4	4	0.67	0.66
washed	1.49	6	11	4	0.67	0.78
watched	1.97	7	6	5	0.71	0.77
waved	1.4	5	10	4	0.80	0.77
wished	1.7	6	4	4	0.67	0.72
wondered	1.85	8	2	6	0.75	0.72
worked	2.17	6	5	4	0.67	0.66
worried	1.78	7	1	5	0.71	0.70

Ortho Con prime	WF (log freq)	# Letter	Neighbor size	Repeated Letter	% Repeated Letter	Orthographic similarity
accent	1.42	6	2	4	0.67	0.90
adult	1.95	5	0	4	0.67	0.38
admire	1.24	6	0	4	0.67	0.68
agent	1.64	5	0	3	0.60	0.35
alloy	0.37	5	4	4	0.80	0.77
apple	1.27	5	2	4	0.80	0.77
attack	2.05	6	1	5	0.83	0.75
bag	1.8	3	22	2	0.67	0.24
border	1.57	6	1	3	0.50	0.37
busy	1.77	4	4	3	0.75	0.48
calm	1.6	4	4	3	0.75	0.60
carrot	0.55	6	1	4	0.67	0.78
cheap	1.66	5	1	4	0.80	0.78
cheek	1.41	5	3	4	0.80	0.60
city	2.34	4	2	3	0.75	0.68
clam	0.4	4	7	4	0.80	0.65
clerk	1.39	5	0	3	0.60	0.56
colleague	1.1	9	0	5	0.56	0.61
cookie	0.43	6	3	4	0.67	0.78
country	2.57	7	0	5	0.71	0.81
covert	0.63	6	1	5	0.83	0.88
cream	1.53	5	3	4	0.67	0.66
danger	1.87	6	5	4	0.67	0.52

decision	2	8	1	3	0.38	0.35
device	1.49	6	1	4	0.57	0.43
diet	1.75	4	5	3	0.75	0.83
enjoin	0	6	0	4	0.67	0.68
entail	0.63	6	0	3	0.50	0.49
exit	1.08	4	2	4	0.80	0.65
face	2.65	4	11	3	0.75	0.48
finite	0.72	6	0	4	0.67	0.57
fin	0.67	3	18	2	0.67	0.55
folio	0.29	5	1	4	0.67	0.43
hat	1.73	3	22	3	0.75	0.77
hell	1.98	4	16	3	0.75	0.68
ignite	0.25	6	0	4	0.67	0.59
important	2.57	9	0	6	0.67	0.81
impromptu	0.43	9	0	5	0.56	0.59
joint	1.6	5	2	4	0.80	0.86
juice	1.33	5	1	3	0.60	0.38
kilometer	0	9	0	3	0.33	0.38
lean	1.32	4	11	4	0.80	0.65
lines	1.94	5	17	3	0.60	0.43
matter	2.46	6	7	3	0.50	0.59
movie	1.49	5	0	4	0.80	0.69
needle	1.06	6	0	4	0.67	0.78
offend	0.78	6	0	4	0.67	0.71
pain	1.88	4	10	4	0.80	0.82
passion	1.54	7	0	4	0.57	0.72
pickle	0.54	6	3	4	0.67	0.78
president	2.12	9	0	6	0.67	0.41
present	2.39	7	1	4	0.57	0.65
prince	1.53	6	1	4	0.67	0.72
problem	2.43	7	0	4	0.57	0.40
promote	1.25	7	0	5	0.71	0.68
provoke	0.91	7	0	5	0.71	0.79
pulp	0.71	4	3	3	0.75	0.60
punch	1.08	5	5	4	0.67	0.50
react	1.16	5	1	4	0.80	0.75
reminisces	0	10	1	5	0.50	0.64
respect	1.87	7	0	4	0.57	0.60
retire	1.08	6	0	4	0.67	0.47
safe	1.91	4	7	3	0.75	0.48
screen	1.47	6	1	4	0.67	0.62
series	1.97	6	1	4	0.67	0.62
shop	1.93	4	9	3	0.60	0.38

sharp	1.79	5	2	4	0.80	0.75
shirt	1.67	5	4	4	0.80	0.60
shoe	1.19	4	6	3	0.75	0.68
skin	1.96	4	7	3	0.75	0.68
small	2.72	5	3	4	0.80	0.80
sole	1.27	4	11	4	0.80	0.65
star	1.73	4	7	4	0.80	0.82
stock	1.8	5	6	3	0.60	0.61
tale	1.27	4	16	3	0.75	0.82
tough	1.57	5	5	4	0.80	0.60
tradition	1.76	9	0	3	0.33	0.63
tread	0.82	5	5	4	0.80	0.75
vision	1.67	6	0	4	0.67	0.62
wall	2.14	4	12	3	0.75	0.68
waste	1.81	5	5	3	0.60	0.61
water	2.64	5	7	3	0.60	0.53
wage	1.41	4	11	3	0.75	0.48
wise	1.56	4	9	3	0.75	0.68
won	1.85	3	14	3	0.50	0.56
word	2.35	4	10	3	0.75	0.68
world	2.87	5	1	3	0.60	0.48

Unrelated prime	WF (log freq)	# Letter	Neighbor size	Repeated Letter	% Repeated Letter	Orthographic similarity
turkey	1.16	6	0	1	0.17	0.07
widow	1.18	5	0	1	0.17	0.04
topics	1.03	6	1	1	0.17	0.07
drama	1.38	5	0	2	0.40	0.08
leash	0.25	5	3	1	0.20	0.07
dense	1.15	5	2	0	0.00	0.01
season	1.74	6	1	1	0.17	0.03
fun	1.67	3	13	0	0.00	0.01
vacuum	1.21	6	0	0	0.00	0.01
gold	1.95	4	9	0	0.00	0.01
knee	1.48	4	1	0	0.00	0.01
parcel	0.96	6	0	3	0.50	0.27
giant	1.56	5	1	2	0.40	0.11
ninth	0.81	5	0	0	0.00	0.01
next	2.66	4	4	2	0.50	0.10
mute	0.63	4	8	1	0.20	0.05
ocean	1.4	5	0	3	0.60	0.55
hierarchy	1.19	9	0	1	0.11	0.05
rivals	0.99	6	0	0	0.00	0.01

several	2.38	7	0	0	0.00	0.01
shrimp	0.37	6	0	1	0.17	0.04
tooth	1.15	5	1	0	0.00	0.04
factor	1.66	6	0	2	0.33	0.04
religion	1.72	8	0	1	0.13	0.05
unique	1.51	6	0	1	0.14	0.03
rent	1.64	4	12	1	0.25	0.07
farmer	1.51	6	4	1	0.17	0.04
corral	0.21	6	0	1	0.17	0.04
bulb	0.87	4	2	0	0.00	0.01
side	2.6	4	11	2	0.50	0.38
script	1.16	6	0	1	0.17	0.04
sow	0.97	3	19	0	0.00	0.01
debit	0.55	5	1	0	0.00	0.01
sky	1.89	3	6	0	0.00	0.01
poet	1.26	4	4	2	0.50	0.10
celery	0.57	6	0	2	0.33	0.16
community	2.1	9	0	3	0.33	0.10
congruent	0	9	0	2	0.22	0.05
guest	1.4	5	2	0	0.00	0.01
cliff	1.24	5	0	0	0.00	0.01
accompany	0.95	9	0	0	0.00	0.00
slim	1.09	4	7	1	0.20	0.09
table	2.31	5	4	2	0.40	0.13
family	2.52	6	0	1	0.17	0.17
cloud	1.51	5	2	1	0.20	0.05
ticket	1.35	6	4	1	0.17	0.04
global	1.23	6	0	1	0.17	0.04
lady	2.06	4	3	1	0.20	0.05
journey	1.72	7	0	0	0.00	0.00
raisin	0.26	6	0	1	0.17	0.04
something	2.85	9	0	1	0.11	0.05
general	2.49	7	0	2	0.29	0.14
twist	1.16	5	0	2	0.40	0.11
certain	2.47	7	2	3	0.43	0.21
harmony	1.16	7	0	3	0.43	0.09
monitor	0.81	7	0	2	0.29	0.07
limb	0.94	4	3	1	0.25	0.05
scoop	0.8	5	4	1	0.17	0.04
onion	1.02	5	1	0	0.00	0.01
scrambling	0.59	10	1	2	0.20	0.08
average	1.99	7	0	2	0.29	0.06
picket	0.66	6	5	2	0.33	0.21

roof	1.68	4	7	0	0.00	0.01
liquid	1.47	6	0	0	0.00	0.01
direct	1.99	6	0	2	0.33	0.17
baby	2.27	4	1	1	0.20	0.05
legal	1.81	5	1	2	0.40	0.08
eager	1.39	5	3	0	0.00	0.01
odor	0	4	0	1	0.25	0.06
deny	1.4	4	4	0	0.00	0.01
place	2.74	5	4	2	0.40	0.07
tray	1.32	4	7	0	0.00	0.01
issue	1.97	5	0	1	0.20	0.05
labor	1.18	5	1	1	0.20	0.05
neat	1.47	4	11	2	0.50	0.25
error	1.33	5	0	1	0.20	0.05
yesterday	1.82	9	0	3	0.33	0.21
olive	1.09	5	1	1	0.20	0.05
double	1.74	6	1	0	0.00	0.01
cent	2.45	4	11	0	0.00	0.01
fruit	1.77	5	0	0	0.00	0.01
until	2.66	5	1	1	0.20	0.05
soil	1.65	4	6	0	0.00	0.01
crew	1.37	4	5	1	0.25	0.06
dry	1.96	3	6	0	0.00	0.08
half	2.52	4	5	0	0.00	0.01
house	2.75	5	5	1	0.20	0.04

Irregular Target	SF (log freq.)	WF (log freq.)	Letter	Neighbor size	Connectivity	Resonant Strength
bear	10.19	1.85	4	18	2.08	0.116
begin	13.6	2.08	5	2	2.2	0.274
bend	5.26	1.35	4	10	1.2	0.027
bind	4	0.76	4	11	1	0.002
bite	8.71	1.25	4	9	1.28	0.014
bleed	3.01	0.67	5	3	NA	NA
blow	8.71	1.62	4	8	0.74	0.041
break	11.56	2.03	5	6	1.6	0.089
breed	2.2	1.09	5	5	1.44	0
bring	8.1	2.26	5	5	1.3	0.003
build	7.57	1.88	5	2	2	0.096
buy	7.53	2.1	3	9	2.38	0.284
catch	6.87	1.85	5	6	1.82	0.044

choose	10.18	1.82	6	1	1.15	0.185
come	11.52	2.94	4	14	2.08	0.081
deal	7.87	2.25	4	16	0.93	0.005
dig	4.84	1.27	3	14	2.12	0.071
draw	10.48	1.8	4	5	1.53	0.107
drink	11.59	2.08	5	3	2.58	0.117
drive	11.15	1.96	5	1	1.69	0.063
eat	10.73	2.13	3	13	1.2	0.181
fall	11.62	2.05	4	12	1.41	0.117
feed	7.47	1.73	4	13	2.57	0
feel	9.85	2.57	4	9	1.71	0.264
fight	7.72	1.98	5	8	2.05	0.106
find	9.53	2.72	4	11	0.7	0.178
fly	9.78	1.72	3	6	1.42	0.097
forbid	4.44	0.74	6	1	2.89	0.013
forget	8.78	1.9	6	3	0.9	0.276
forgive	6.51	1.35	7	1	0.12	0.011
freeze	6.51	0.98	6	2	2.79	0.023
get	11.52	3.07	3	18	2.59	0.099
go	13.45	3.02	2	9	2.64	0.425
grind	4.51	0.81	5	2	0.63	0.002
grow	11.68	1.98	4	6	1.73	0.013
hang	6.88	1.55	4	11	1.56	0.022
have	10.43	3.68	4	14	1.93	0.05
hear	8.36	2.27	4	15	2.82	0.244
hide	9.39	1.52	4	10	0.44	0.039
hold	7.97	2.2	4	10	1.69	0.094
keep	8.8	2.55	4	9	1.56	0.058
know	16.05	3.13	4	4	1.62	0.032
lead	8.29	2.1	4	13	NA	NA
leave	10.16	2.39	5	3	2.12	0.045
lend	4.03	1.12	4	10	1.57	0.23
lose	7.34	1.91	4	12	0.9	0.294
make	11.65	2.95	4	17	1.5	0.063
mean	9.7	2.63	4	9	1.53	0.126
meet	8.17	2.14	4	5	0.94	0.043
pay	8.06	2.28	3	22	2.62	0.008
ride	7.51	1.55	4	14	1.5	0.113
ring	9.4	1.83	4	11	1.15	0.144
rise	10.36	1.93	4	9	1.4	0.005
run	9.19	2.36	3	14	1	0.353
say	11.83	2.94	3	23	1.33	0.016
see	15.79	3.07	3	15	2.36	0.299
seek	6.79	1.65	4	10	1	0.079
sell	6.89	1.74	4	11	2.36	0.194

send	7.84	1.93	4	8	2.67	0.019
shake	8.97	1.4	5	10	1.16	0.031
shoot	5.96	1.4	5	4	2.17	0.108
sink	7.29	1.43	4	13	1.94	0.05
sit	8.34	2.08	3	18	1.17	0.23
sleep	6.99	2.09	5	5	1.5	0.253
slide	4.68	1.24	5	4	1.18	0.021
speak	11.42	2.11	5	4	2.12	0.136
spend	7.57	1.95	5	2	1.14	0.077
spin	2.71	0.96	4	5	0.92	0.015
spring	9.22	1.85	6	5	1.71	0.08
stand	8.6	2.16	5	2	0.6	0.187
steal	7.02	1.13	5	4	2.56	0.131
stick	7.37	1.75	5	5	1.24	0.056
strike	6.83	1.91	6	5	1.2	0.004
swear	5.7	1.19	5	4	1.85	0.125
sweep	4.92	1.19	5	4	2.56	0.0209
swim	6.66	1.4	4	5	1.94	0.076
swing	5.61	1.5	5	6	1.82	0.033
take	14.37	2.89	4	12	2.55	0.25
teach	7.65	1.71	5	5	2.57	0.118
tear	6.89	1.28	4	16	0.44	0.223
tell	9.31	2.65	4	12	2.33	0.029
think	11.06	3.09	5	6	2.85	0.107
throw	10.02	1.69	5	2	1.54	0.185
wake	7.85	1.51	4	15	1.71	0.003
wear	10.61	1.84	4	14	1.11	0.044
win	6.42	1.8	3	15	0.5	0.193
write	13.17	2.11	5	4	2.25	0.191

Past-tense prime	WF (log freq)	# Letter	Neighbor size	Repeated Letter	% Repeated Letter	Orthographic similarity
bore	1.45	4	15	3	0.75	0.77
began	2.55	5	3	4	0.80	0.77
bent	1.62	4	14	3	0.75	0.39
bound	1.75	5	7	3	0.60	0.78
bit	2.38	3	17	3	0.75	0.65
bled	0.7	4	5	4	0.80	0.68
blew	1.35	4	5	3	0.75	0.70
broke	1.83	5	2	4	0.80	0.86
bred	0.98	4	3	4	0.80	0.71
brought	2.4	7	2	3	0.43	0.49
built	2.11	5	3	4	0.80	0.43
bought	1.95	6	4	2	0.33	0.80

caught	2.05	6	2	4	0.67	0.33
chose	1.54	5	6	5	0.83	0.47
came	2.84	4	17	3	0.75	0.93
dealt	1.37	5	1	4	0.80	0.77
dug	1.22	3	15	2	0.67	0.52
drew	1.78	4	4	3	0.75	0.69
drank	1.55	5	5	4	0.80	0.76
drove	1.81	5	4	4	0.80	0.59
ate	1.62	3	8	3	1.00	0.39
fell	2.06	4	13	3	0.75	0.76
fed	1.63	3	12	3	0.75	0.77
felt	2.61	4	7	3	0.75	0.77
fought	1.58	6	3	4	0.67	0.65
found	2.68	5	8	3	0.60	0.63
flew	1.37	4	8	2	0.50	0.73
forbade	0.62	7	0	5	0.71	0.83
forgot	1.38	6	1	5	0.83	0.65
forgave	0.53	7	1	6	0.86	0.74
froze	0.78	5	0	4	0.67	0.68
got	2.94	3	15	2	0.67	0.65
went	2.84	4	15	0	0.00	0.77
ground	2.28	6	1	4	0.67	0.53
grew	1.85	4	5	3	0.75	0.61
hung	1.75	4	8	3	0.75	0.81
had	3.8	3	18	2	0.50	0.75
heard	2.45	5	4	4	0.80	0.59
hid	1.11	3	12	3	0.75	0.71
held	2.33	4	9	3	0.75	0.32
kept	2.32	4	2	3	0.75	0.74
knew	2.66	4	3	3	0.75	0.71
led	2.14	3	13	3	0.75	0.71
left	2.74	4	6	2	0.40	0.51
lent	1	4	14	3	0.75	0.76
lost	2.33	4	14	3	0.75	0.70
made	3	4	12	3	0.75	0.71
meant	2.16	5	2	4	0.80	0.65
met	2.17	3	13	3	0.75	0.69
paid	2.11	4	8	2	0.50	0.71
rode	1.22	4	13	3	0.75	0.53
rang	1.57	4	14	3	0.75	0.56
rose	2.01	4	14	3	0.75	0.45
ran	2.05	3	16	2	0.67	0.65
said	3.44	4	8	2	0.50	0.34

saw	2.59	3	15	1	0.33	0.69
sought	1.58	6	3	1	0.17	0.65
sold	1.76	4	8	2	0.50	0.71
sent	2.19	4	13	3	0.75	0.76
shook	1.84	5	3	3	0.60	0.82
shot	1.95	4	12	4	0.80	0.53
sank	1.17	4	14	3	0.75	0.71
sat	2.36	3	20	2	0.67	0.71
slept	1.54	5	2	4	0.80	0.71
slid	1.24	4	6	4	0.80	0.59
spoke	2.06	5	5	4	0.80	0.53
spent	2.15	5	3	4	0.80	0.31
spun	0.95	4	5	3	0.75	0.29
sprang	1.13	6	2	5	0.83	0.33
stood	2.33	5	3	3	0.60	0.65
stole	1.07	5	7	4	0.80	0.46
stuck	1.66	5	3	4	0.80	0.77
stroke	1.31	6	3	5	0.83	0.86
swore	0.9	5	7	4	0.80	0.81
swept	1.49	5	3	4	0.80	0.71
swam	0.91	4	11	3	0.75	0.71
swung	1.35	5	3	4	0.80	0.59
took	2.68	4	8	2	0.50	0.56
taught	1.83	6	2	3	0.50	0.74
tore	1.2	4	18	3	0.75	0.77
told	2.69	4	8	2	0.50	0.49
thought	2.86	7	0	2	0.29	0.69
threw	1.68	5	3	4	0.80	0.71
woke	1.4	4	7	3	0.75	0.81
wore	1.79	4	19	3	0.75	0.64
won	1.85	3	14	2	0.67	0.49
wrote	2.11	5	1	4	0.80	0.77

Ortho Con prime	WF (log freq)	# Letter	Neighbor size	Repeated Letter	% Repeated Letter	Orthographic similarity
beard	1.37	5	3	4	0.80	0.86328
beget	0.25	5	3	3	0.60	0.64
bench	1.31	5	5	3	0.60	0.60931
binary	0.64	6	0	3	0.50	0.55302
bitter	1.57	6	8	4	0.67	0.78159
bless	1.06	5	1	3	0.60	0.57705
block	1.6	5	4	3	0.60	0.60931
bread	1.88	5	6	4	0.80	0.74909

breeze	1.07	6	2	4	0.67	0.61741
bridge	1.79	6	2	4	0.67	0.51948
bullet	1.14	6	4	3	0.50	0.32113
bus	1.82	3	7	2	0.67	0.54897
cat	1.63	3	22	3	0.60	0.64545
choke	0.63	5	2	4	0.67	0.49251
comb	0.83	4	5	3	0.75	0.68
dear	2.09	4	15	3	0.75	0.68
dim	1.22	3	10	2	0.67	0.54897
drag	1.29	4	7	3	0.75	0.68
drift	1.39	5	1	3	0.60	0.53091
drizzle	0.59	7	0	4	0.57	0.51255
east	2.13	4	10	3	0.75	0.57377
false	1.68	5	0	3	0.60	0.53315
feet	2.36	4	8	3	0.75	0.72
fee	1.15	3	15	3	0.75	0.81315
figure	2.1	6	0	3	0.50	0.48642
fine	2.16	4	16	3	0.75	0.71429
flat	2.05	4	9	2	0.50	0.47741
forward	2.16	7	0	4	0.57	0.46707
forces	2.04	6	1	4	0.67	0.46824
foreign	2.04	7	0	6	0.86	0.52444
freedom	2.01	7	0	4	0.57	0.47485
gear	1.37	4	10	2	0.50	0.47741
goal	1.49	4	4	2	0.50	0.65708
grin	1.14	4	6	4	0.80	0.82404
growl	0.43	5	3	4	0.80	0.86328
hand	2.66	4	9	3	0.75	0.68
harvest	1.25	7	1	4	0.57	0.36856
heart	2.16	5	2	4	0.80	0.86328
hike	0.55	4	8	3	0.75	0.71429
hole	1.76	4	14	3	0.75	0.68
keen	1.44	4	5	3	0.75	0.82286
knot	0.95	4	4	3	0.75	0.68
leaf	1.22	4	7	3	0.75	0.68
league	1.5	6	0	4	0.67	0.5522
lens	0.87	4	13	3	0.75	0.68
lobe	0.52	4	7	3	0.75	0.47619
male	1.94	4	21	3	0.75	0.61905
meal	1.73	4	12	3	0.75	0.68
meat	1.86	4	13	3	0.75	0.41667
pan	1.48	3	19	2	0.67	0.54897
rice	1.45	4	13	3	0.75	0.47619
rink	0.33	4	11	3	0.75	0.68
risk	1.84	4	5	3	0.75	0.68

rub	1.14	3	13	2	0.67	0.54897
sad	1.67	3	17	2	0.67	0.54897
seed	1.46	4	18	3	0.75	0.83639
seem	2.35	4	9	3	0.75	0.72
self	1.6	4	2	3	0.75	0.595
sense	2.46	5	2	3	0.60	0.60931
shark	1.17	5	6	4	0.80	0.74909
short	2.29	5	7	4	0.80	0.59091
sin	1.42	3	19	3	0.75	0.76605
site	1.73	4	10	3	0.75	0.83209
sleeve	1.02	6	0	4	0.67	0.70683
slice	1.09	5	4	4	0.80	0.6
spear	0.97	5	4	4	0.80	0.74909
speed	1.88	5	3	4	0.80	0.6
spinach	0.71	7	0	4	0.57	0.71488
spirit	1.86	6	0	4	0.67	0.63394
standard	1.88	8	0	5	0.63	0.7868
steel	1.69	5	4	4	0.80	0.6
stink	0.63	5	5	4	0.80	0.6
stripe	0.44	6	5	5	0.83	0.67647
sweat	1.48	5	3	4	0.80	0.74909
sweet	1.68	5	5	4	0.80	0.77377
swan	0.81	4	8	2	0.50	0.39429
swipe	0.25	5	2	3	0.60	0.53091
tale	1.27	4	16	3	0.75	0.47619
teacup	0.34	6	0	4	0.67	0.68477
team	1.93	4	9	3	0.75	0.68
tall	1.82	4	15	3	0.75	0.61905
thing	2.74	5	5	4	0.80	0.85818
throat	1.64	6	1	4	0.67	0.74758
waive	0.19	5	1	3	0.60	0.43196
weak	1.68	4	8	3	0.75	0.68
wind	2.05	4	12	3	0.75	0.83209
wrist	1.32	5	4	4	0.80	0.56727

Unrelated prime	WF (log freq)	# Letter	Neighbor size	Repeated Letter	% Repeated Letter	Orthographic similarity
storm	1.46	5	3	1	0.20	0.05
maxim	0.57	5	0	1	0.20	0.05
hurry	1.47	5	3	0	0.00	0.01
defuse	0.37	6	1	0	0.00	0.04
yellow	1.81	6	3	1	0.17	0.04
demon	0.87	5	2	2	0.40	0.17
score	1.35	5	9	1	0.20	0.01

mayor	1.2	5	2	1	0.20	0.08
remedy	0.97	6	0	3	0.50	0.42
energy	2.3	6	0	1	0.17	0.07
mirror	1.62	6	0	1	0.17	0.04
pot	1.41	3	17	0	0.00	0.01
fog	1.02	3	14	0	0.00	0.01
apple	1.27	5	2	1	0.17	0.07
keel	0.51	4	6	1	0.25	0.06
item	1.35	4	1	1	0.25	0.06
tie	1.56	3	12	1	0.33	0.08
clue	1.13	4	4	0	0.00	0.01
realm	1.04	5	1	1	0.20	0.05
hammock	0.26	7	1	0	0.00	0.01
dark	2.27	4	10	1	0.25	0.07
movie	1.49	5	0	0	0.00	0.01
name	2.42	4	9	1	0.25	0.05
jar	1.08	3	14	0	0.00	0.01
policy	2.23	6	2	1	0.17	0.04
cold	2.26	4	10	1	0.25	0.09
rule	1.84	4	5	1	0.25	0.07
serious	2.14	7	0	3	0.43	0.09
modern	2.23	6	0	3	0.50	0.10
similar	2.07	7	0	1	0.14	0.06
evening	2.27	7	0	2	0.29	0.06
card	1.67	4	12	0	0.00	0.01
task	1.83	4	7	0	0.00	0.01
rely	1.38	4	0	1	0.20	0.05
fairy	1.08	5	4	1	0.20	0.05
away	2.83	4	2	1	0.25	0.06
episode	1.17	7	0	1	0.14	0.07
stage	2.15	5	6	2	0.40	0.09
foul	1.04	4	6	0	0.00	0.01
safe	1.91	4	7	0	0.00	0.01
pump	1.2	4	9	1	0.25	0.09
glue	0.61	4	6	0	0.00	0.01
boil	1.31	4	7	1	0.25	0.06
animal	2.06	6	0	2	0.33	0.07
silk	1.41	4	7	0	0.00	0.06
peel	1.06	4	8	2	0.50	0.10
foam	0.89	4	4	2	0.50	0.25
belt	1.35	4	10	1	0.25	0.06
soul	1.62	4	4	0	0.00	0.01
bet	1.56	3	18	0	0.00	0.01

bone	1.45	4	15	1	0.25	0.09
flea	0.43	4	5	0	0.00	0.01
huge	2.04	4	1	1	0.25	0.09
ion	0.48	3	7	1	0.33	0.12
bus	1.82	3	7	1	0.33	0.08
wire	1.56	4	17	1	0.25	0.09
cost	2.15	4	10	1	0.25	0.05
coat	1.73	4	9	0	0.00	0.01
today	2.36	5	0	1	0.20	0.09
tumor	0	5	1	0	0.00	0.01
music	2.13	5	0	1	0.20	0.04
bag	1.8	3	22	0	0.00	0.01
cell	1.57	4	10	0	0.00	0.01
rabbit	1.07	6	1	0	0.00	0.01
tower	1.68	5	7	1	0.20	0.05
tiger	0.99	5	1	1	0.20	0.05
broad	1.64	5	2	1	0.20	0.08
lineage	0.44	7	1	2	0.29	0.25
market	2.13	6	2	1	0.17	0.04
hospital	2.03	8	0	2	0.25	0.09
angry	1.82	5	0	1	0.20	0.05
yacht	0.75	5	0	2	0.40	0.08
poster	0.84	6	6	3	0.50	0.27
panic	1.46	5	1	1	0.20	0.05
title	1.55	5	1	1	0.20	0.04
ache	0.76	4	3	0	0.00	0.01
mourn	0.5	5	0	1	0.20	0.05
loop	0.84	4	7	0	0.00	0.01
queen	1.7	5	1	1	0.20	0.05
edge	1.89	4	1	1	0.25	0.06
wild	1.94	4	7	1	0.25	0.01
light	2.46	5	8	2	0.40	0.23
cousin	1.37	6	0	1	0.17	0.04
beige	0.59	5	0	1	0.20	0.08
beef	1.24	4	6	1	0.25	0.06
cell	1.57	4	10	0	0.00	0.01
theft	0.93	5	0	2	0.40	0.08

Appendix G. List of Korean Stimuli in Experiment 3

Target words are in Italics

Regular Items:

쓰레기 /치우는/것이/*더럽고*/사무실에서/일하는 /것은 /깨끗한 /것이 /아니다/

trash/cleaning/*being dirty*/at office/working/clean/being/not/

늑대라는/동물이/워낙에/*사납고*/빠르기 /때문에/잡을/엄두를/내지/못했다/

wolf/animal/originally/*being wild*/fast/due to/catch/attempt/did/not/

그는/틈만 나면/주인을/*속이고*/게으름을/피워서/결국/쫓겨났다/

he/whenever /boss/*deceive*/laziness/take/finally/be fired/

그는/금방/숨이/*가빠지고*/맥박이/빨라질만큼/긴장이/되었다/

he/suddenly/breath/*fast*/pulse/rapid/rigid/became/

자기/전에/문을/*잠그고*/불도/끄는/습관을/갖는 /것이 /좋다/

sleep/before/door/*close*/light/turn off/habit/keeping/good/

웬일인지/아침부터/배가/*고프고*/머리도/어지러운 게/컨디션이/정상은 /아니다/

somehow/in the morning/stomach/*hungry*/head/dizzy/condition/normal/not/

아이가/정신없이/발을/*구르고*/뛰어다니니까/결국/경비실에서/연락이/왔다/

kid/struggle/foot/*stamp*/running/finally/security/contact/reached/

콩을/불리고/메주를/*담그고*/하는 /일이/쉽지만은/않다/

bean/steep/soybean lump/*make*/do/work /easy/not/

뭔가 짜릿한/느낌이/정수리를/*가르고*/지나가듯/소름이/쫙/끼쳤다/

thrilling/feeling/head/*cut through*/pass/goose bumps/widely/get/

산에서 /큰 돌/밑을/*파고*/찾아보면/어렵지 /않게/좋은/거름을/얻을 수 /있다/

mountain/big rock/under/*dig*/look for/difficult/not/good/manure/get/can/

이제는 /추억이지만/그때는/*괴롭고*/부끄러운 /하루하루가//길게만/느껴졌다/

now/memory/then/*hard*/shame/days//long/feel/

종이/위에/선을/*긋고*/점을/찍어서/퍼즐을/만들었다/

paper/on/line/*draw*/dot/mark/puzzle/make/

거리의 매연 /때문에/눈이/*아프고*/목도/따가워/밖에/나가고 /싶지/않다/

pollution/because/eyes/*hurts*/throat/burn/outside/go/want/not/

이삿짐이/온/집안을/*채우고*/집안에/쓰레기도/많아/발 /디딜/틈이 /없다/

moving boxes/whole/house/*fill*/house/trash/lots/feet/step/space/not/

고향/산천은/온통/*푸르고*/싱그러운/모습/그대로였다/

hometown/nature/wholly /*green*/fresh/look/as before/

작가는 /썼던/습작들을/*지우고*/새로운/마음으로/다시/도입부를/써나가기/시작했다/

writer/write/practice pieces/*delete*/new/mind/again/intro/write/begin/

아이들이/이유없이/소리를/*지르고*/울지/않는지/관찰해야/한다/

kids/no reason/noise/*utter*/cry/not/observe/must/

세수를 하고나니/어지러운/것이/*낫고*/취기도/좀/가시는 것/같았지만/여전히/속이/안좋았다/

after washing/dizzy/being/*recover*/tipsiness/a little/disappear/feel/still/stomach/not good/

상처에/약을//*바르고*/붕대를/대었더니/한결/낫다/

wound/medicine//*apply/*bandage/put/lots/better/

선생님은/여러가지/화초를/*기르고*/모으는/것이/오래된/취미다/

teacher/various/flower/*grow*/collect/ing/long/habit/

아저씨는/이해할 수 /없을 만큼/*슬프고*/격한/감정이/올라와/너무/힘들었다/

/understand/cannot/*sad/*strong/emotion/surge/too/hard/

속으로 요새/젊은이들이/습관이/*나쁘고*/세월이/고약한/것을/탓했다/

inwardly/youth/habit/*bad/*time/hard/being/blame/

그는/행동/하나하나가/*가볍고*/민첩한데/똑똑하기/까지/했다/

he/behavior/every each/*light/*quick/smart/even/be/

옆집/아이가/참/*예쁘고*/깜직해서/과자라도/사주고/싶더라/

next door/kid/really/*pretty/*cute/cookie/buy/wanted/

가쁘게/몰아쉬던/숨을/*고르고*/하려던/말을/계속 /했다/

heavily/pant/breath/*catch/*wanted/speak/continue/did/

목재는/불에/타기/*쉽고*/썩기도/쉬워서/안쓰는/것이/낫겠다/

wood/fire/burn/*easily*/decay/easily/not using/better/

더우니까/집에/가서/*눕고/*싶었지만/그것도/쉽진/않았다/

hot/home/go/*lie*/wanted/it/easy/not/

열심히/연습한대로/정성껏/*쓰고*/마무리/한것으로/만족하기로/했다/

hard/practice/sincerely/*write*/wrap up/decide to/satisfy/

배달원은 /아침부터/하루 종일/*걷고*/배달물을/옮기느라/땀으로/범벅이 /되었다/

delivery man/morning/all day/*walk*/packages/deliver/sweat/cover/become/

오늘에서야/가을이/왔음을/*깨닫고*/가족 /여행을/가기로/했다/

today/autumn/come/*realize*/family/trip/go/decide/

친구가/잘못한 /일을/*이르고*/선생님께/벌을/받게/만들었다/

friend/wrong/doing/*snitch/*teacher/punishment/receive/make/

이/마을에/휴게소를/*짓고*/사람들이/이용할/수/있게하면/좋겠다/

this/village/rest area/*build*/people/use/can/let/good/

생각도 못했는데/이제보니/금값은/*오르고*/조카의/돌은/다가왔다/

unexpectedly/now/gold price/*increase*/nephew/birthday/come near/

한 시민이/흘러 나오는/노래를/*듣고*/감동을/받아/눈물을/훔쳤다/

a person/played/song/*hear*/moved//tear/wipe/

아까부터/누군가가/멀리서/*부르고*/달려오는/것 /같아/뒤를/보았다/

since a while ago/someone/far/*call*/run//like/back/look/

나는/그런/사정을/*모르고*/짐작만/하고 /있었다니/부끄럽다/

I/that/behind story/*do not know*/only guess/did/embarrassed/

저녁 무렵에/강물은/한가로이/*흐르고*/뒷편에/산자락은/자리를/지키고 /있었다/

at the evening/river/peacefully/*flow*/backside/mountain/its place/keep/

그렇게 밤이/새도록/비가/*오고*/천둥소리가/요란해서/쉽게/잠을/잘 수 /없었다/

All night/over/rain/*comes*/thunder/sounding/easily/sleep/fall/couldn't/

그것은/내가/진작부터/*묻고*/싶었던/것이어서/더욱/반가웠다/

That/I /already/*ask*/intended/thing/more/be gladded/

경비원이 피를/흘리는/아이를/*업고*/응급실로/뛰어/들어갔다/

security, blood/bleeding/kid/*carry on his back*/to emergency/run/entered/

모든/재료를/잘/*섞고*/알맞게/양념을 /해야 /감칠맛이/난다/

every/materials/well/*mixed*/appropriately/sources/put/taste/better/

동네 청년들이/모여서/곡식을/*찧고*/나무장작을/쪼개는/일을/했다/

people in the town/together/grains/*pound*/firewood/split/work/did/

등에 담이/와서/근육이/*굳고*/감각이/없어져/불편하다/

back pain/happens/muscle/*harden*/sense/weak/uncomfortable/

뚜껑을 닫으면/음식이/빨리/*끓고*/가스비도/적게/나온다/

closing the cover/cook/rapidly/*boil*/gas/less/needed/

정성스럽게/바구니를/철사로/*엮고*/구멍을 /메웠다/

with care/basket/wire/*weave*/hall/filled in/

딸아이의/치마자락이/방바닥을/*쓸고*/다닐 /지경이라/맘에 /들지 /않았다/

daughter's/skirts/floor/*sweep*/hang around/at that degree/do/not/like/

선생님은/높은/이상을/*품고*/치열하게/도전하라고/학생들에게/조언을/하셨다/

teacher/high/dream/*bear*/intensely/challenging/to students/advice/did/

그 시절/양반들은/시를/*읊고*/거문고/소리를/들으며/풍류를/즐겼다/

at that time/people/poet/*recite*/a instrument/music/listen/enjoyed/

적당량의/카페인은/졸음을/*쫓고*/집중력을/높여주는/효과가/있다/

certain amount/caffeine /sleepy/*take away*/concentration/increasing/effect/be

해마다/여름철엔/태풍이/*훑고*/지나간/자리에/군인들이 /복구를 /위해/애쓴다/

every year/during summer/typhoon/*wipe*/pass/place/soliders/recover/for/tried/

환자는/양손에/목발을/*짚고*/힘들게/앞으로/나아갔다/

patient/two hands/crutches/*stick*/strenuous/forward/walked/

먹기전에/꼭 /뚜껑을/*닫고*/충분히/끓여야/맛이/더욱/좋아진다/

before eating/certainly/*cover*/close/enough/boil/taste/much/better/

밤에도/더우니까/선풍기를/*틀고*/잠을/자는/사람들이/늘어났다/

At night/hot/fan/*turn on*/sleep/do/people/increased/

노교수는/마지막/강연에서/*늙고*/쇠약하지만/여전한/열정을/보여주어서/사람들을/감동시켰다/

old professor/last/lecture/*old*/weak/still/enthusiasm/showing/people/moving/

그는 /어느새/담배를/*잊고*/지냈다는/것을/깨닫고/마음이/뿌듯해졌다/

He/already/smoking/*forget*/living/thing/realize/feel/great/

그는 지난 /주말에/집에서/*앓고*/눈이 /푹 /꺼졌다/

He, last/weekend/at home/*be sick*/eye/fully/hollow/

밤에는/식은 땀에/이불이/*젖고*/기침이/더 /늘어났다/

At night/sweat/comforter/*wet*/coughing/more/increased/

오늘아침에는/큰 /비를/*쏟고*/난/하늘이/맑게 /개었다/

This morning/hard/raining/*pour*/after/sky/clearly/became/

보기 싫은/전선들은/가지런히/*묶고*/테이프로/붙여/놓으면/정리가 /된다/

dislike to see/cables/neatly/*tie/*tape/attached/become t/to be/clean/

그는/속세와의/인연을/*씻고*/다시/산으로/들어갔다/

he/the world/connection/*wash/*again/to mountain/entered/

날씨가 /더우니/신발을/*벗고*/앉아서/쉬는 /것이/좋겠다/

weather/hot/shoes*/take-off/*sitting/break/better/

그는/계단을/천천히/*밟고*/내려가/유유히/제길을/떠났다/

He/stairs/slowly/*step*/down/naturally/his way/left/

우리는 책을 /읽으며/교양을/*쌓고*/삶의/지혜를/얻기도 /한다/

we, book/read/knowledge/*cumulate*/life's/wisdom/earn/do/

도박판에서/혼자서/본전을/*뽑고*/왔다는/사람을/아직/본 적이/없다/

in gamble/alone/money/*return*/come back/any person/still/see/did not/

그렇게/쉽게/시들어/*죽고*/또/어딘가에서/다시 /태어난다/

so/easily/wither/*die/*again/anywhere/again/born/

하루/만에/식량을/*얻고*/마음 /편히/쉬게 /되었다/

a day/after/food/*earn*/peaceful//take a break/

현명한 사람은/상대방의/마음을/*읽고*/원하는 /것을 /먼저 /해준다/

wise person/the opposite/mind/*read/*want/thing/beforehand/do/

강아지는/다친/다리를/*끌고*/3 일만에/집을/찾아/돌아왔다/

dog/hurts/leg*/limp*/after 3 days/home/search/came back/

철없는/자식이어도/그 하나를/*믿고/*살아가는/어머니의/모습이/안쓰럽다/

merely/a child/only one*/trust*/living/mother's/life/pathetic/

국에는 /고기와/야채를/*넣고*/부침에는/굴을/이용했다/

in soup/meat/vegetable/*add*/fried/oyster/used/

영숙이는 /몇시간째/그저/*울고*/있는/친구를 /위로할 수 /밖에 없었다/

Young-sook/for hours/only/*cry*/being/friends/console/nothing but/

그 나라 국민들의/바람은/나라를/*찾고*/평화로운/체제를/유지하는 /것이었다/

people in the country/wish/national /*tack back*/peaceful/system/keep/was/

그는 흥분한/나머지/친구를/*잡고*/뛰기 /시작했다/

He, excited/so much/friend/*catch*/run/began/

내가 /친구와/앞자리에/*앉고*/영식이는/뒤에 /혼자 /앉았다/

I/with friend/in front/*sit*/Young-sik/behind/alone/sat/

형사는/그 사건의/내막을/*알고*/주변을/샅샅이/조사하기/시작했다/

The detective/the case's/behind story/*discover*/surrounding/carefully/investigate/began/

아침에/눈을 뜨면/창을/*열고*/바깥/날씨를/확인한다/

In the morning/open eyes/window/*open*/outside/weather/check/

이유가 뭐든/그는/늘/*웃고/*다니면서/사람들에게/인사를/건넨다/

whatever the reasons/he/always*/smiles*/hangout/to others/say/hello/

Irregular Items:

아이의 고집이/ 쎄서 /아무리 /*어르고*/ 구슬려도 /소용이 / 없었다 /

a child's stubborn/ strong /no matter how /*coax*/ amuse /useless/
겉보기와/ 달리 /그 나무는 /*무르고*/ 상태가 /좋지 / 않다고 /평가되었다./

what you see/ different from /the tree /*be weak*/ the condition /not good/ /was evaluated/
그는 스스로/ 거리의 /시인이라 /*일컫고*/ 실제로도 /일년에/ 반은 /거리에서/ 지낸다/

He himself/ Poet of the streets / *call*/ actually /spend half a year/ /on the street/
비가 많이/ 왔지만 /땅은 /*마르고*/ 농작물이 /충분히/ 자라기엔 /부족했다/

It rained hard/ but /the earth /*dry*/ for the crop /fully/ grow /not enough/
할아버지는 / 새벽녘에 /물을 /*긷고*/ 마당을 /청소하시며/ 하루를 /시작하셨었다/

Grandfather/ early morning /water /*draw*/ yard /cleaned/ the day /started/
나이도 / 어린 /조카가 /*맵고*/ 뜨거운 /육개장을/ 잘도 /먹는다/

age/ young /niece /spicy/ *hot* /chicken soup/ well /eats/
지난 / 주부터 /아침식사를 /*거르고*/ 출근했더니 /웬지/ 몸이 /가벼워진 것 같다/

since last week/ /breakfast /*skip*/ went to work /somehow/ body /feels light/
아버지는/ 출장길에 /할머니를 /*뵙고*/ 동네 /친구들도 / 만나고 /돌아오셨다/

Father/ on his way to business trip /grandmother /*meet*/ neighborhood /friends/ meet /returned/
요즘은 / 동갑이어도 /말을 /*트고*/ 지내기가 /여간/ 쉽지 /않다/

These days/ although you're at the same age /*open* /very/ easy /not /
김씨는/ 지난번 /일 때문에 /*벼르고*/ 있었는데 /알고보니/ 그것은 /오해에서/ 비롯된 것이었다/
Mr. Kim/ last time /because of what happened /*wait for a chance*/ /in fact/ it /misunderstanding/ resulted from/

점원은/ 아침부터 /쌀을 /*푸고*/ 거기에 /다시/ 다른 /잡곡을/ 섞었다/

The salesperson/ from morning /rice /*scoop*/ there /again/ different /grains/ mixed/
친구는 자신의/ 처지를 /생각하니 /*서럽고*/ 분해서 /잠이/ 오지 /않는다고 했다/

Friend / his situations /thinking /*be sad*/ angry /sleep/ /could not/ said/
아저씨가/ 야외에서 /통닭을 /*굽고*/ 아주머니는 /분주하게/ 손님을 /맞고 / 있었다/

The man/ outside /chicken /*grill*/ the lady /busily / guests /greeting/ were/
학생들이/ 노란색 /은행잎을 /*줍고*/ 책갈피로 /쓰던/ 낭만이 /있었다/

Students/ yellow /ginkgo leaves /*pick*/ as bookmarks /using/ romance /there was/
이 건물이/ 오래돼서 /항상 /*덥고*/ 비가 /오면/ 물이 /새는/ 일이/

This building / is old /always /*be hot* / when it rains // water /leaks/
아저씨들이/ 연탄을 /수레로 /*나르고*/ 아줌마들은 /뒷정리를/ 하느라 /분주했다/

Men/ briquette /with handcarts /*move*/ ladies /wrapping up/ /were busy/
아이는/ 아침부터 /엄마를 /*조르고*/ 엄마 /뒤만/ 졸졸 /따랐다/

The kid/ from morning /mom /*nag*/ mom /behind/ always /followed/
세월을/ 돌이켜 /보면 /*그립고*/ 아쉬운 /일들이/ 너무나 /많다/

time/ turn round /see /*miss/* sorry /things/ too /many/
졸린/ 눈을 /부시시 /*뜨고*/ 찬찬히 /바라보니/ 어느새 /열시/ 였다/

sleepy/ eyes /slowly /*open*/ carefully /watch/ already /10 0'clock/
누룽지에/ 적당히 /물을 /*붓고*/ 끓이면 /구수한/ 숭늉이 /만들어진다/

in dried steamed rice/ moderately /water /*pour*/ boil /savory/ scorched-rice water /is made/
이유는 / 모르겠지만 /그 선배가 /*밉고*/ 정이 /가지 / 않는다/

The reason/ don't know /the man (superior) /*is hateful*/ affection /goes/ don't /
형섭이는/ 불을 /일부러 /*끄고*/ 라디오를 /켜둔 / 체 /잠을 / 청했다/

Hyoung-sub/ light /intentionally /*turn off*/ the radio /on / while /went to bed/
강아지가/ 꼬리를 /흔들며 /*따르고*/ 할아버지는 /뒷짐을/ 지신 /체/ 앞서

A dog/ tail /shake /*follow*/ grandfather /folded his hands behind his back / go ahead/
그 청년은/ 3 대째 /가업을 /*잇고*/ 있지만 /자신의/ 꿈을 /포기해야/ 했다/

The young man/ for three generations /family business /*succeed*/ /his / dream /had to give up/
이 제품은/ 특별히 /신축성이 /*크고*/ 질기다는 /장점/ 때문에 /대박이/ 예상된다/

This product/ particularly /elasticity /*be big*/ tough /strength/ because /huge success/ is expected/
남자는/ 대꾸도 없이 /고개를 /*젓고*/ 한숨을 /이따금/ 내쉴 /뿐이었다/

The man/ without response /his head /*shake*/ sigh /sometimes/
계획대로/ 공구로 /나무를 /*자르고*/ 깍아내어 /멋진/ 탁자를 /만들었다/

as planned/ with tool /the tree /*cut*/ shave /nice/ table /made/
올해 출장은/ 가을인데도 /유난히 /*춥고*/ 교통이 /좋지 / 않아서 /불편했다./
business trip this year/ although it's fall /especially /*be cold*/ transportation /not good/ /inconvenient/
헤어지기 전/ 마침내 /그녀는 /*숨기고*/ 있던 /선물을/ 수줍게 /건넸다/

before saying good bye/ finally /she /*hide*/ /present/ shyly /handed/
경찰이/ 죄수의 /탈옥을 /*돕고*/ 댓가를 /받아/ 물의를 /빚었다/

The police officer/ prisoners /escape /*help*/ return /received/ evoke much criticism/
위층으로/ 올라가는 /계단은 /*어둡고*/ 침침해서 /조심해야/ 한다/

to upstairs/ climb /stairs /*dark/* dim /should be careful/
그는 오늘 / 유난히 /몸이 /*무겁고*/ 두통도 /심해져서/ 쉬기로 /했다/

he today/ especially /body /*be heavy*/ headache /got severe/ decided to rest/
기대했던/ 올 여름 /휴가는 /*가깝고*/ 한적한 /곳으로/ 가서 /편안한/ 시간을

expected/ this summer /vacation /*be near*/ quiet /place/ go /peaceful/ time
친구들은 각자/ 맥주 /다섯병씩 /*비우고*/ 새벽이 /다/ 되어서야 /헤어졌다/

each friend/ beer /5 bottles /*empty*/ dawn /almost/ reached /say good bye/
선배는 늘/ 계산을 /먼저 /*치르고*/ 집으로 /가버려서/ 인사도 /할 수 / 없었다/

The man (superior) always/ paid first / /*pay*/ home /went/ greeting /could not do/
몇해 전/ 여행 /기억이 /*스치고*/ 잠시 /하던/ 일을 /잊고/ 추억에/

a few years ago/ trip /memory /*brush* / for a moment /doing/ job /forget/ memory/
반가운/ 소식을 /접하니 /*기쁘고*/ 흥분되어 /일이/ 손에 /잡히지 / 않았다/

glad/ news /meet /pleased/ *amuse* /job/ couldn't start/
이사한 후에/ 할 일이 /쌓여서 /*바쁘고*/ 정신이 /없다보니/ 편지 할 /겨를이/ 없었다/

after moving/ things to do /piled /*be busy* / in a daze // write letter /had no leisure/
그는 / 짐들을 /차에 /*싣고*/ 먼 /길을/ 떠났다/

He/ luggage /in the car /*carry*/ far away   left /
그 선수는/ 부상으로 /다리가 /*휘고*/ 허리까지 /다쳐서/ 매우 /고생하였다/
The player/ from injury /leg /*bend*/ back /hurt/ very much /suffered/
작년에/ 학교에서 /담장을 /*헐고*/ 그 /자리에 / 나무를 /심었다/
Last year/ in the school /wall /*unbuild*/ in the place // trees /planted/
깨끗이 / 씻은 /양파를 /*썰고* / 감자를 /볶아서/ 카레를 /만들었다/
cleanly/ washed /onions /*cut*/ potatoes /stir-fried/ curry /made/
두 시간 / 가량 /감자를 /*캐고*/ 점심을 /먹으러/ 집으로 /향했다/
two hours/ about /potatoes /*excavated*/ lunch /to eat/ home /headed/
누군가를/ 좋아하면 /콩깍지가 /*씌고*/ 모든 /것이 / 좋아 /보인다/
somebody/ if you love / /*is blinded* / everything // look good/
집에 돌아오는 / 길에 /모이를 /*쪼고*/ 있는 /새들을/ 보았다/
coming back home/ on the way /*feeds* /peck/ /birds/ saw/
그는 사고의/ 휴유증으로 /다리를 /*절고*/ 무릎을 /굽히지/ 못했다/
He, of the accident/ due to aftereffects /leg /*limp*/ knees /couldn't fold/
낮에는 충분히/ 따뜻한 /햇볕을 /*쬐고*/ 밤에는 /조명을/ 어둡게 /유지한다/
During the day/ warm /sunlight /*be exposed*/ at night /lights/ dark /keep/
선주는 늘/ 자기 결심을 /나즈막히 /*외고*/ 꼭 /지키기로/ 다짐했다/
Sunju always/ her resolutions /in low voice /*recite*/to keep/ make sure/
이 커피는/ 내가 /직접 /*볶고*/ 추출해 /만든/ 것이다/
this coffee/ I /myself /*roasted*/ extract /make/
사탕을 많이/ 먹으면 /치아가 /*썩고*/ 병에 /걸리기/ 마련이다/
too many candies/ eat /tooth /*rot*/ disease /catch/
밤에는 잠을/ 못자고 /낮에는 /*졸고*/ 피곤해 /하는/ 악순환이 /계속된다/
at night / can't sleep /during the day /*drowse*/ tired / vicious circle /continue/
이어지는 강추위/ 속에 /강물이 /*얼고*/ 그 /위에/ 눈이 /내렸다/
continuous bitter cold/river /*freeze*/ on the top /snowed /
두/ 팔을 /하늘로 /*뻗고*/ 기지개를 /피면서 / 하품을 /했다/
two   / arms /to the sky /*stretched*/ himself / yawn /
축제를/ 알리는 /폭죽을 /*쏘고*/ 가족이나 /친구끼리/ 모인 /많은 / 사람들이/
festival/ advertise /fireworks /*fire*/ family /friends/ gather /many/ people/
지하철에서/ 갑자기 /불꽃이 /*튀고*/ 연기가 /나는 / 바람에 /승객들이/ 당황했다/
on the subway/ suddenly /flame /*spark*/ smoke /the passengers/ were embarrassed/
제발 입을/ 다물고 /음식을 /*씹고*/ 팔꿈치는 /식탁에/ 올려놓지 /말아라/
please, the mouth/ close /food /*chew*/ elbow /on the table/ don't put /
종수는/ 대뜸 /봉투를 /*찢고*/ 서둘러 /편지를/ 읽어 /내려갔다/
Jong-soo/ ready /envelope /*tear*/ hurriedly /the letter/ read /
나는 친구가/ 하자는대로 /낚시대를 /*접고*/ 슬슬 /돌아갈/ 채비를 /꾸렸다/
I, as the friend said/ /the rod /*fold/* gently /return/ get ready /
아이들이/ 오른손을 /가슴에 /*얹고*/ 국가를 /조용히/ 따라 /불렀다/
Children/ right hand /on the chest /*put on*/ the national anthem /quietly/ sing along /

고양이는/ 자기 /다리를 /*핥고*/ 누워서 /잠이 / 들었다 /

the cat/ its /legs /*lick*/ lay down /fell asleep/

담요는/ 우선 /먼지를 /*털고*/ 햇볕에 /바짝/ 말려야 /한다/

the blanket/ first /the dust /*brush*/ sunlight / should dry /

오늘은 비가/ 오니 /장화를 /신고/ 학교에 /가는/ 것이 /좋겠다/

Today it rains/ /rain boots /*wear*/ to school /go / better /

그 사람은/ 늘 /춤을 /*추고*/ 노래 /부르는 / 것을 /즐겼다/

The person/ always / *dance*/ sing /enjoy/

세희는 엄마의/ 목소리를 /많이 /*닮고*/ 말투도 /비슷해서/ 전화만 /받으면/ 오해를/ 받는다.

Se-hee, mother's/ voice /a lot /*resemble*/ way of talking /similar/ receive calls / was misunderstood

남편은/ 흙으로 /그릇을 /*빚고*/ 아내는 /다양한/ 옷을 /만들었다/

The husband/ with earth /plate /*made*/ the wife /various/ clothing /made/

겉보기에 좋은 / 사과는 /모두 /*팔고*/ 남아 /있는 것은/ 상태가 /별로다/

good on the surface/ apples /all /*sell*/ left // condition /not good/

그는/ 추워서/ 이불을 / /덮고/ 누워서 /잠을/ 청해 /보았다/

He/ was cold/ the comforter / /*cover*/ lay down /sleep/ tried to /

그녀는 편지를 / 손에 /꼭 /*쥐고*/ 서울로 /떠나는/ 기차에 /올랐다/

She, the letter/ in hands / /*holding*/ to Seoul /leaving/ on the train /boarded/

그 물건들은/ 어서 /가계약을 /*맺고*/ 내일 /정식 / 계약을 /하는 것이/ 좋겠다

The objects/ quickly /temporary *contract* /make/ tomorrow /official/ contract /make/ good idea

올 / 가을에는 /어획량이 /*줄고*/ 중국선의 /횡포로/ 이중고를 /겪고있다/

this/ fall /amount of catch /*decrease*/ Chinese ships /arrogation/ double suffering /experience/

그 여배우는/ 한편의 /광고를 /*찍고*/ 억대의 /광고료를/ 받았다 /

The actress/ one /commercial /*shoot*/ six-figure /guarantee/ receive /

바닷가에 / 바람이 /순하게 /*불고*/ 물결도 /잔잔하다/

on the beach/ wind /mildly /*blow/* wave /calm/

아기는 / 자기 /인형을 /*안고*/ 다시 /놀이터로/ 나갔다 /

The kid/ his/her /doll /*hold* / again /to the playground/ went out /

지영이는/ 그 어려운 /문제를 /*풀고*/ 친구와 /비교해 / 보면서 /공부했다/

Ji-young/ the hard /problem /*solve*/ with friend /comparing/ /studied/

이제부터/ 밤에 먹는 /라면을 /*끊고*/ 운동을 /규칙적으로/ 하기로 /결심했다/

from now on/ at night /ramen /*quit* / exercise /regularly/ do /decided/

그 배우는 / 엄청난 /인기를 /*잃고*/ 시련을 /겪는 것이/ 믿기지 /않았다/

The actor/ tremendous /fame /*lose*/ hardship /experience/ can't believe /

친구는/ 어려움을 /함께 /*겪고*/ 부딪혀 /보아야/ 가치를 /알 수 있다./

Friend / hardship /together /*experience*/ face / value /know/

겨울에도/ 옷 /한벌 /*입고*/ 밖을 /쏘다녔던/ 20 대였다. /

in winter/ clothing /one piece /*wear*/ outside /wander around/ 20's

Filler sentences

1. 기업이/ 성공하기/ 위해서는/ *무엇보다* /소비자의/ 욕구를/ 파악해야/ 한다./
company/ succeed/ for/ *more than anything*/ consumers'/ need/ identify
2. 아침에/ 일어나보니/ 간밤에/ *함박눈이*/ 내린 것을/ 알 수 있었다./
In the morning/wake up/last night/ *large snowflake*/ falls/ realized/
3. 먼 조상이/ 만들었다는/ *그/ 도자기가* /집안의/ 가보로/ 전해져/ 내려온다./
distant ancestors/ made/ that/ *ceramic*/ family's/ treasure/ hand down/
4. 언제나/ 그런 것은 아니지만/ *뜬소문이*/ 사실일 수도 있다./
always/ not like that/ but/ *the rumor*/ could be/ true/ is/
5. 꾸준히/ 노력하면/ 언젠가/ *나에게도*/ 빛이/ 보이는/ 날이/ 있을 것이다. /
enthusiastic/ trying/ someday/ *for me*/ light/ shown/ a day/ will be/
6. 옛날에는/ 마을에/ 급한/ *일이*/생기면/ 종을/ 울려서/ 사람들에게/ 알리기도/ 했다. /
long time ago/in village/emergent/*happening*/occurs/bell/rings/to people/informed/
7. 산에/ 갔다가/ 날아든/ *벌에* /깜짝/ 놀랐다./
in mountain/ hiked/flying/*bees*/suddenly/surprised/
8. 긴/ 여정을/ 마친/ *여객선이* /닻을/ 내리고/ 항구에/ 정박했다./
long/ trip/ ending/ ferry/ anchor/ take down/ at harbor/off
9. 하루종일/ 전시회만/ 돌아다녔는데/ *어떤* /작품도/ 기억에/ 남질 않았다./
all day long/ exhibitions/look around/any/ work/in memory/ doesn't remain/
10. 소풍은/ 날씨가/ 나빠졌기/ *때문에*/ 결국/ 취소가/ 되고/ 말았다./
Picnic/ weather/ became bad/ *because*/ finally/ canceled
11. 현준은/ 어느새/ 머리가/ *희긋한* /중년이 /되어 있었다.
Hyunjoon/before one knows/hair/*grey*/middle age/became/
12. 군것질을/ 좋아하는/ 수빈이는/ *영화를*/ 볼때 /주로 /과자를 /먹는다./
junk food/ like/ Soobin/ *movie*/ watching/often/snack/eat/
13. 집에/ 와보니/ 우체통에 /*친구가* /보낸 /선물 /상자가 /들어/ 있었다./
at home/arrive/mailbox/*a friend*/sending/gift/box/left in/
14. 많은/ 사람들이/ 인구/ *과밀의* /서울을/ 벗어나/ 교외로/ 이사를/ 가는 /추세이다./
Many/people/ population/ densed /Seoul/out of/ suburb/moving/go/trend/
15. 시간이/ 늦어져서/ 간신히/ *막차를*/ 타고/ 집에/ 돌아왔다./
hours/ late/ barely/*the last bus*/ ride/ home/ came/
16. 앉는/ 자세가/ 나쁘면/ *흔히* /허리에/ 문제가/ 생기기/ 쉽상이다./
seating/ posture/ if bad/ often/ in back/ problem/ occur/ easily/
17. 한달에 한번 정도는 *친구들과* 모임을 갖고 있다. /
monthly/ once/ about/ *friends/* meeting/ having/
18. 지난/ 일요일/ 오후에/ *세차를* /했는데, /이번주에/ 내내/ 비가 내린다./
Last /Sunday/ afternoon/ *carwash/* did/ this week/ while/ raining/
19. 나는/ 아침/ 대신에/ *우유*/ 한잔을/ 마시는데/ 역시나/ 점심/ 시간/ 전에/ 배가/ 고파진다./
I/ morning/ instead of/ milk/ a glass/ drink/ obviously/ lunch hour/ before/ starving/ become/
20. 산에서/ 취사하는/ 것은/ *산불*/ 방지를/ 위해 /법으로 /금지하고/ 있다.
at mountain/ cooking/ thing/ fire/ preventing/ for/ by law/ prohibiting

Appendix H. List of English Stimuli in Experiment 4

Target words are in *italics*

Regular Items

The actor cannot *accept* why he isn't a famous movie star yet.
Q) The actor is now famous (T /F)
The flowers and lights *produce* cheerful ambiance in the girls' bedroom.
He stopped to *adjust* his vision to the faint starlight.
Q) He stopped to tie his shoestrings. (T /F)
When my parents travel, they *like* to visit a bookstore in order to find souvenirs for their friends back home.
Only some students *admit* that they cheated on the math exam.
Q) No one admitted to cheating. (T /F)
My little brothers *carry* their books, pencils, and calculators to school in big backpacks.
Their official statements *agree* with the facts as stated by the policeman.
Q) The facts in their official statements are verified by the policeman. (T /F)
The judges eventually *need* to decide which science project won first prize.
The referee had to *call* a foul on the players, whose teammates yelled and jumped around.
Q) The referee did not need to call a foul on the players. (T /F)
My camping buddy and I *share* a love of the great outdoors and hiking.
The drug companies *claim* that their new drugs are better than those of any other company.
Q) The drug companies developed their new drugs. (T /F)
The young boys in the town *learn* to be mechanics from Mr. Jones, who starts by telling them about engines.
All my relatives are doctors, so I will *follow* this trend instead of being an artist.
Q) All my relatives are artists. (T /F)
He said he could *fix* my car's engine, but it turns out he was not a mechanic at all.
The government did nothing to *solve* the problem of high unemployment.
Q) The government solved the high unemployment problem. . (T /F)
Today, I have to *cook* dinner because my wife is out of town.
Q) I don’t have to cook tonight. (T /F)
He started to *print* his own posters to present his project at the conference.
It took a long time to *wash* the mud out of his hair because of the wind.
You have to *check* the expiration date on your passport before you make a trip.
Q) You do not need to check the passport’s expiration date for a trip. (T /F)
Some people usually *ignore* the weather report because they don't trust it.
Some people do not trust the weather report. (T /F)
The soldiers helped to *bury* the dead in large communal graves.
The national health system will *save* hundreds of people from becoming crippled.

She learned how to *paint* only recently, but it has become her favorite thing to do.
Q) She has been painting for many years. (T /F)

She will continue to *apply* for jobs after she graduates this year.
She will try to get a job. (T /F)
The customer relations office will *treat* all complaints seriously, and all information received will remain confidential.
Someone is using a key to *enter* the computer room once a week.
Research opportunities often *exist* in a wide range of areas of entomology.
If necessary, the patient can *visit* his doctor for further advice.
Q) The patient can ask his doctor for more advice. (T /F)
All people can *pass* the front door only when they have an ID card from security.
Q) To enter the front door, people have to have their ID card (T /F)
Every night, he cannot *stop* thinking about his family because he lives far away from home.
Q) He lives far away from home. (T /F)
It is recommended to *walk* more than an hour per day when people are pregnant.
Q) Walking is good for pregnancy. (T /F)
When I saw the accident, I couldn't *move* at all for several minutes due to shock.
Q) I heard about the accident from my friend. (T /F)
Every morning, I *start* by having a cup of coffee and reading a newspaper.
Q) I regularly drink coffee in the morning. (T /F)
They are planning to *match* students with professional scientists, who become the students' mentors.
It is important not to *skip* meals, especially for children.
Q) Regular meals are important for children. (T /F)
Students may be tempted to *cheat* in order to get into top schools.
The results of the research *prove* that regulation of the salmon farming industry is inadequate.
Q) The research results did not tell us anything. (T /F)
Mr. Gould almost cannot *finish* his talk because the audience is clapping and cheering so loudly.
His children gently *wave* their hands at the window when their grandparents visit them.
Q) His children wave when their grandparents visit. (T /F)
During the weekend, I *work* at home, and I usually don't take phone calls.
Q) I do not work during the weekend. (T /F)
We love to *watch* the clowns at the circus every summer.
Q) We go to the circus every summer. (T /F)
College students have to *return* their books to the library before they leave for vacation.
Q) College student can return their books to the library after new semester begins. (T /F)
The boys at the beach *pick* up the shells that are on the shore.
In soccer, you cannot *touch* the ball with your hands, but you can hit it with your head.
Q) You can hit the ball with your head when you play soccer. (T /F)
My cats are odd because they *hate* tuna, while most cats like the favor.
Q) My cats love tuna. (T /F)
In class, all of the students *cite* their favorite poem to express what they think about life.

Q) All of the students read poems. (T /F)
There are thousands of people who *beg* on the streets in the twenty first century.
Q) There are still many people begging on the streets. (T /F)
It took half an hour to *clean* the rust stains in the bathtub.

We could definitely *smell* the gas as soon as we opened the front door because it was leaking in the kitchen.
Polly had never learned to *dance*, but she now loves to dance with her boyfriend.
Q)Polly knew how to dance since she was a child. (T /F).
They are likely to *respond* positively to the President's request for aid because there is no reason to refuse it.
Like it or not, our families *shape* our lives and make us who we are.
It is important to *judge* the weight of your laundry load correctly.
Q) The weight of your laundry does not matter. (T /F)
While driving, if you *shift* gears in a car, then you put the car into a different gear.
After the store closes, I *count* the money, and it usually totals more than five hundred dollars.
On mountains, hikers commonly *scream* loudly at the top of the mountain after their long climb.
All colors suddenly *fade*, especially under the impact of direct sunlight.
Q) All colors fade. (T /F)
If necessary, in order to *press* a button for the fire alarm, you have to break this glass first.
If you really *wish* to go away for the weekend, our office will make hotel reservations for you.
All the restaurants in town *serve* meat and potatoes for dinner.
Q) Most restaurants serve meat and potatoes. (T /F)
Some major companies *create* local jobs through the government stimulus.
Q) Some major companies created local jobs. (T /F)
You can of course *help* by giving them a donation directly.
Q) You can help by donating. (T /F)
The trees in my garden *cover* the ground with apples and leaves.
He knew he should *pull* the trigger, but he was suddenly paralyzed by fear.
Q) He pulled the trigger. (T /F)
A new student will *join* the research team after this semester.
Q) A new student will be added to the research team. (T /F)
In these days, many companies *offer* jobs to people not based on their education level, but based on their skills.
Tonight, she will *talk* on the issues she cares passionately about, including education and nursery care.
He had attempted to *kill* himself on several occasions, but then he finally gave up.
Q) He tried to commit suicide. (T /F)
These recent figures *show* an increase of over one million unemployed workers over the last five years.
The musician would *die* a very happy person if he could stay in music his whole life.
The compromise will *allow* him to continue his free market reforms.

Q) The compromise will not allow his work on free market reforms. (T /F)
During weekdays, in order to *reach* Cambridge before 3 o'clock, it would be better to take the next train.
The helpful teachers *prompt* the tongue tied student in the school play.
Sarah really wanted to *enjoy* the party tonight and forget her work for a while.
Q) Sarah skipped the party because she wanted to work. (T /F)

The group will *decorate* the shopping mall for the Christmas season.
Only several corporations *import* many gallons of oil from abroad every year.
The boy didn't *remind* his mother to pick him up after school.
Q) The boy told his mother to pick him up after school. (T /F)
Unfortunately, his brother cannot *improve* the poor conditions at the hospital.
Q) His brother is a patient in the hospital. (T /F)
It is difficult to *predict* how a jury will react to this case.
Mike had to *borrow* a lot of money to buy his new house.
Q) Mike didn't need to borrow money for his new house. (T /F)
It is important to *develop* a relationship of trust between students and teachers.
Q) A trust based relationship between teachers and students is important.
I understand that you may *wonder* how the machine works, but it's not that complicated.
The astronauts will *attach* a motor to boost the satellite into its proper orbit.
My goal was to *collect* various types of stamps to give to my kids.
Q) I collect stamps for myself. (T /F)
According to survey results, many people *worry* that extremists might gain control after this election.
Q) Survey results showed that people are concerned about the election results. (T /F)
They may refuse to *trade*, even when offered prices that are very attractive.
The authorities can only *punish* smugglers with small fines based on current law.

Irregular Items

The car salesmen in that dealership *say* this is a brand new car, but I can see where they painted over scratches.
Q) The car salesman is completely honest. (T /F)
Thirty of my brother's friends will *come* to his birthday party, and they will prepare a big gift box.
Q) It's my sister's birthday. (T /F)
All of the workers at the pool *think* John should win the best lifeguard award, but the boss's daughter wins it every year.
Q) The boss's daughter has never won the award. (T /F)
Many mansion owners *hang* a sign of no trespassing along the boundary of their properties.
Many recent studies *find* links between smoking and lung cancer because tobacco contains dangerous materials.
Q) Research supports that tobacco is harmful for health. (T /F)

She knew it was wrong to *steal* from her older brother's wallet, but she really wanted more video games.
Q) She loves playing video games. (T /F)
My family's yard sale will *begin* this week, so I went around my neighborhood posting flyers.
In Greece, tourists always *go* to the ruins of ancient cities and climb around old buildings.
Q) Many tourists visit historical sites in Greece. (T /F)
The security guard didn't *see* anyone enter the building during the night.
Q) The security guard saw someone entering the building. (T /F)
His parents always *send* a card and letter for his birthday since he is far away from home.
Q) His parents send a card for his birthday. (T /F)
All of his teammates *eat* dinner together after their games.
John asked me to *lend* him my car this weekend because his car is in the shop.
Q) John doesn't have a car. (T /F)
Not surprisingly, most cowboys *know* how to ride horse, and some even compete in rodeos.
In the desert, people normally *ride* camels to get around.
Q) People ride camels in the desert.
The policeman was ordered to *shoot* the suspect only if it was unavoidable.
Q) The policeman was ordered to not shoot the suspect. (T /F)
They have to *win* the last four games to get into a playoff spot.
Q) They have already secured a playoff spot. (T /F)
They came here to *seek* shelter from the biting winter winds.
Q) They need shelter for winter. (T /F)
If you intentionally *strike* your brother, then you will be punished by your parents.
He jumped to *catch* a ball and fell to the ground.
Q) He fell after throwing the ball. (T /F)
It's not a very good time to *sell* at the moment.
Q) It is a good time to sell the items at the moment.
When you want to *sleep,* you rest with your eyes closed and your body is inactive.
I will probably *lose* my job when the company moves to another city
He tried to *stick* his fork into the sausage, but it was not easy.
Q) He easily stuck his fork into the sausage. (T /F)
The small country could hardly *feed* its citizens due to its limited agriculture.
When my parents *buy* cheese, they always check out the expiration date.
The city council plans to *build* a bridge across the river.
Many businessmen in this country *spend* enormous amounts of money advertising their products.
The trainers have a program to *teach* the students vocational skills.
I prefer to *break* the chocolate into pieces.
Q) I do not break the chocolate into pieces. (T /F)
It is better to *drink* after you have a meal.
We watched the buildings *fall* on top of the trees and cars.
My hair began to *grow* again, and I felt terrific.
If you would like one, simply *write* your name and address on a postcard and send it to

us.
Q) You must include your name and address on the postcard. (T /F)
He was unable to *sit* still for longer than a few minutes because of his hip injury.
You can *hear* commentary on the match in about half an hour.
Q) Commentary on the match will be available in less than10 minutes.
They told me to *stand* still and not turn around until they are ready to proceed.
Q) I was asked to stand for a while. (T /F)
The soccer player did not *bite* or kick during the match, but he was ruled out.
Q) The soccer player was ruled out because he did not bite or kick other players. (T /F)
The best way to *keep* babies away from unhealthy sugar is to go back to eating lots of fresh fruit.
I returned to *tell* him how spectacular the stuff looked in the morning.
All of the signals *mean* something unique, even though they look the same to us.
Q) Each signal has its own meaning. (T /F)
I will always *feel* grateful to the friends who supported me through that difficult time.
Q) My friends helped me out when I was in a difficult time. (T /F)
They are expected to *sweep* the floor before every meal.
The sail of the little boat can *swing* chaotically in rough weather.
He would even *swear* in front of his mother because his language was so offensive.
Q) His language is very rude. (T /F)
Most fresh herbs will *freeze* successfully, so you can use some now and save the rest for later.
Q) You can use frozen herbs later. (T /F)
She learned to *swim* when she was really young.
Q) She has never learned how to swim (T /F).
All students are instructed to *tear* the edges off their paper.
The boat was about to *sink* and people tried to jump overboard.
Q) The boat arrived safely at its destination. (T /F).
Even after a few years, when I *wake* up in the morning my first thought is my family back home.
Q) My first thought of the day is what I want for breakfast. (T /F)
The government had been unable to *deal* with the economic crisis and finally lost the support of the people.
Q) People kept supporting their government. (T /F)
The magician intended to *bind* his assistant with a silk scarf.
Q) The assistant binds the magician with a silk scarf. (T /F)
The waiters are trained to *grind* some black pepper over the salad.
They want me to *bend* the rules for them, but I won't do it.
Our government should *fight* for an end to food subsidies.
It is good to *shake* the rugs well before placing them back on the floor.
Q) Shaking the rugs before placing them back on the floor is good. (T /F)
While they regularly *run* the last few yards, they had to walk this time.
If your kids spring out of bed so early, you would be tired too.
Julie's first instinct was to *hide* under the blankets, but she changed her mind.
When I got back to the hotel, I would *ring* the bell and then somebody would assist me.

Q) I stayed at the hotel. (T /F)
The bird can *fly* far longer distances than we expected.
Q) We knew exactly how far the bird can fly. (T /F)
I swear that I will *throw* a brick through their window if they don't stop making so much noise.
If I have to, I will *choose* what I want to do, not what my parents want me to do.
Q) I will follow what my parents want me to do. (T /F)
No one likes to *bear* the responsibility for such decisions.
The river level will *rise* to the flood stage if it keeps raining like this.
Q) The river level is not affected by rain. (T /F)
I have asked her to *draw* me because I know she is a very good artist.
Q) She is a terrible artist. (T /F)
Last night, she did not *wear* her coat despite the freezing temperature outside.
Q) It was not that cold last night. (T /F)
While you *drive* your car, please do not send text messages.
Q) Sending text messages while driving is discouraged. (T /F)
They wish to *speak* privately with you because they want to hear your opinion.
Q) They want to talk to you in private. (T / F)
He asked me if I *have* an extra bagel that he could eat for breakfast.
Q) He wanted to eat breakfast. (T /F)
Tomorrow morning I will *get* a taxi to go to the airport.
Q) I will go to the airport tomorrow. (T /F)
The cut is probably going to *bleed* for hours unless she gets stitches.
When a cold wind *began* to blow, I was in a hurry to return home.
Come to our party and *bring* any friends you would like to invite.
Q) You and your friends are invited to the party. (T /F)
Elderly people sometimes *forget* where they park their car and it takes hours to find it.
Q) Some people have difficulty remembering things as they get old. (T /F)
She would not *forgive* him because his conduct was not acceptable.
Q) She decided to forgive him. (T /F)
The volunteers will *lead* the tourists to a safe location because they were trained for that purpose.
My brother will *meet* with his new tennis coach today.
Q) My brother plays tennis (T /F)
One of my roommates *must* pay a little more money for rent because he is using a bigger room.
Q) All the roommates pay equally (T /F)
The latest computer disks *spin* very rapidly, almost twice as fast as older disks.
Parents are usually willing to *take* a risk in any situation for their children.
Passengers are told to *hold* the safety handles when the bus is moving.
Q) Passengers are told to remain seated at all times when the bus is moving. (T /F)
Some countries in Europe *forbid* the military use of nuclear energy.
If you want to *slide* the door open, just push the button on the side.
After the accident, rescue workers *dig* through the rubble in search of other victims.

Filler sentences

1. The audience threw piles and piles of flowers at the feet of the lead dancer in tribute to her marvelous performance.
2. James can buy many more TVs and gaming consoles than his parents could, because he has much more money. .
3. The office is having a huge meeting about budget cuts and everybody wants to talk, so the agenda for the meeting is two pages long.
4. McDonald's restaurants are painted red and yellow, which makes for a cheery ambiance that encourages people to eat faster.
5. The new park, with its tennis courts, restaurant, and duck pond, has far nicer ambiance than the old park.
6. As much as I try to like my grouchy neighbor, she keeps being mean and my frustration with her keeps growing.
7. He has been using oil paints for only a few months, but you can see from his amazing drawings that he has talent for art.
8. She knew it was wrong to steal from her older brother's wallet, but she really wanted more videogames, so she did it anyway.
9. The lady at the pet store told me a bunch of lies, including that puppies don't like to play, which they clearly do.
10. I wanted to buy a shell necklace and some delicious snacks, so I went to my favorite vendor a few streets over.
11. The Post Office was falling apart, so it's being rebuilt, and the cost of the new one was donated by rich businessmen in the town.
12. I had to cover my ears as I walked past the construction site because of the noise produced by the heavy equipment.
13. Be careful while using strong cleaning products, because they may contain chemicals which can make you very sick.
14. She didn't bake and decorate that huge flowery cake by herself like she claims.
15. I was angry at the child who tried to steal my wallet, but I decided to give him a second chance.
16. Sixteen people work in my office, but three of them spend so much time together that they've become a clique, and they won't really talk with the rest of us.
17. Joseph has tasted thousands of pizza toppings, so he's become quite the pizza connoisseur and now he wants to try Ancient Greek pizza recipes.
18. The friends made a pact to meet in the same location every year no matter how far apart they lived or what else was going on in their lives.
19. Because going to space is so dangerous, astronauts have to satisfy strict requirements about the health of both their bodies and minds.
20. After the festival, there was lack of fireworks in the area, because they'd all been used up.

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