Applied Psycholinguistics **21** (2000), 297–320
Printed in the United States of America

Cross-linguistic variations in L2 morphological awareness

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ABSTRACT
This study investigated the effects of L1 processing experience on L2 morphological awareness. Preliminary cross-linguistic comparisons indicated that morphological awareness in two typologically distinct languages, Chinese and English, differs in several major ways. Based on the comparisons, three specific hypotheses were formulated: compared with learners with a typologically similar L1 background, Chinese learners of English as an L2 would be less sensitive to intraword structural salience, less efficient in structural analysis, and more adept at integrating word-internal (morphological) and word-external (context) information. These hypotheses were tested empirically with two groups of adult L2 learners of English with contrasting L1 backgrounds (Chinese and Korean). The data demonstrated that virtually no difference existed between the two ESL groups in their intraword structural sensitivity, and that, although Chinese learners were notably slower than Korean learners in performing intraword structural analysis, they were far more efficient in integrating morphological and contextual information during sentence processing. Viewed collectively, these findings seem to suggest that L1 processing experience influences the development of L2 morphological awareness in specific and predictable ways.

In recent time, the role of metalinguistic awareness in literacy acquisition has attracted serious attention among psychologists and reading researchers. The emerging consensus is that learning to read is fundamentally metalinguistic, involving the recognition of functionally important units of spoken language and their relation to the writing system, as well as the skills with which to map between the two (e.g., Fowler & Liberman, 1995; Goswami & Bryant, 1992; Nagy & Anderson, 1998). Since such awareness evolves through progressive print processing experience (e.g., Bowey & Francis, 1991; Perfetti, Beck, Bell, & Hughes, 1987; Vellutino & Scanlon, 1987), its nature may well vary across languages – certainly to the extent that the way their lexical information is graphically represented differs. Moreover, inasmuch as linguistic knowledge and its corollary processing skills transfer from language to language (e.g., Hancin-Bhatt & Nagy, 1994; Koda, 1998; Muljani, Koda, & Moates, 1998; Sasaki, 1993), it is conceivable that L2 lexical processing is heavily constrained by L1 metalinguistic awareness, and that L2 awareness is an amalgamation of previous cross-linguistic processing experiences in L1 and L2. Should this be the case,

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https://doi.org/10.1017/S0142716400003015 Published online by Cambridge University Press

we can expect that the nature of L2 metalinguistic awareness differs fundamentally among learners with typologically diverse L1 backgrounds.

The primary goal of the study, therefore, was to obtain evidence of such cross-linguistic variations in L2 metalinguistic awareness among adult ESL learners. The sections that follow discuss the facilitative benefits of metalinguistic awareness during early literacy development and then compare morphological awareness, an aspect of metalinguistic awareness, in typologically different languages. Based on the comparisons, cross-linguistic variation in morphological awareness is hypothesized, and the logic of the investigative framework is described.

Metalinguistic awareness in early literacy development

The facilitative benefits of metalinguistic awareness in the development of reading competence can be explained in two ways. First, to ease the transition from oral to written communication, children must recognize that written symbols correspond to speech units and learn how functionally important elements in speech are graphically coded. Second, understanding the segmental nature of words promotes an analytical approach to word learning (i.e., a conceptualization of word segmentation bolsters the capacity to analyze a word's internal structure and enables the reader to distinguish its distinct segments). In the absence of such analytical competence, readers are seriously handicapped in extracting even partial information from an unfamiliar word, which, in turn, restricts lexical inference, retention, and, ultimately, reading effectiveness.

Because of the morphophonemic nature of English orthography, much of the current empirical research has concentrated on both phonological and morphological awareness. Some have argued that, to master an alphabetic script, children must not only perceive that words can be divided into sequences of phonemes (e.g., Liberman et al., 1977; Liberman, Shankweiler, Fischer, & Carter, 1974; Liberman, Shankweiler, & Liberman, 1989), but also become adept at dissecting the internal structure of words so as to identify their phonemic constituents (e.g., Blachman, 1991; Bradley, 1988). Developmental studies have shown that sensitivity to the segmental structure of spoken sounds is directly related to children's ability to read and spell English words (e.g., Stahl & Murray, 1994; Stanovich, Cunningham, & Cramer, 1984; Yopp, 1988); that phonological awareness is a powerful predictor of reading success in both early and middle grades (e.g., Bryant, MacLean, & Bradley, 1990; Juel, Griffith, & Gough, 1986); and that reading progress is significantly enhanced by phonemic awareness training (e.g., Bradley & Bryant, 1991).

The importance of morphological awareness also has been well-documented. Recent empirical findings have led to three insights. First, morphological awareness, independent of phonological awareness, makes a unique contribution to alphabetic literacy (e.g., Fowler & Liberman, 1995). Second, considerably more errors of omitting inflectional and derivational morphemes occur in the writing (e.g., Duques, 1989; Rubin, 1991) and speaking (e.g., Henderson & Shores, 1982) of less skilled readers. Third, the ability to use morphological information during sentence comprehension distinguishes skilled from less skilled high school readers (e.g., Tyler & Nagy, 1989, 1990).

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Importantly, phonological and morphological awareness both involve a number of capabilities, ranging from a general understanding of the segmental nature of words to the more sophisticated skills with which to extract and manipulate intraword segmental information. There is an increasing consensus that, although segmental understanding is a prerequisite to early word-reading development, extracting and manipulating skills develop through progressive print processing experience (e.g., Bowey & Francis, 1991; Perfetti et al., 1987; Vellutino & Scanlon, 1987). Metalinguistic awareness and literacy, thus, are developmentally interdependent (i.e., improvement in word-reading competence engenders corresponding gains in metalinguistic awareness, which, in turn, upgrades word reading and spelling capacities).

Two implications arise from this developmental interface and reciprocity: lexical information – both phonological and semantic – is accessed through orthographic knowledge, and, as a consequence, lexical processing procedures (e.g., phonological decoding, morphological analysis, semantic access) can be heavily constrained by the manner in which such information is represented in the visual word display. Cross-linguistic experiments have, in fact, repeatedly demonstrated systematic variations in the way individuals respond to various lexical processing tasks in typologically diverse orthographies (e.g., Frost, 1994; Frost, Katz, & Bentin, 1987; Hatta, 1992; Henderson, 1985; Nakagawa, 1994; Rusted, 1988; Turvey, Feldman, & Lukatela, 1984; Tzeng & Wang, 1983).

Defining morphological awareness

In its broadest sense, morphological awareness refers to a learner's grasp of morphological structure (i.e., the ways in which morphemes are conjoined in words) as well as his or her capability of using this knowledge during morphological processing in visual word recognition. As noted earlier, such awareness is a constellation of several abilities: recognizing that words can be segmented into smaller, functionally identifiable elements; mapping these elements on graphic symbols; and assembling and dissembling segmental intraword information. Presumably, efficient readers perceive the specific function assigned to each morphemic element and, in so doing, become aware of the structural and distributional constraints associated with its utilization. In this context, therefore, morphological awareness can be defined as the working conceptions competent readers form about intraword morphological elements and the ability to utilize the resulting operational clues in extracting and manipulating intraword morphological information.

It is this utilization aspect of awareness that was measured and compared in the present study. Because such awareness is an outcome of print processing experience, its capability components must vary across languages, at least to the extent that the structural and functional properties of their intraword morphemes, as well as the manner in which they are graphically represented, deviate. By examining the structural alliance between orthographic and morphological systems, we should be able to isolate related, but distinct, components of morphological awareness capability in any given language. Based on this conceptualiza-

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tion, we conducted systematic comparisons of orthographic and morphological systems to illuminate the metalinguistic competencies essential to morphological processing in typologically diverse languages.

MORPHOLOGICAL STRUCTURE IN VISUAL WORDS: CROSS-LINGUISTIC COMPARISONS

Inasmuch as morphemes provide a basis for word formation and orthography makes it visually accessible, a usable notion of "word" is critical in determining precisely how the properties of morphemes and their visual representation are analyzed and compared. Unfortunately, there is no universally applicable conception of what a word is. It is essential, therefore, that its definition be clarified at the outset. This is particularly important in Chinese because even native speakers/readers rarely agree on what constitutes a word (e.g., Packard, 2000; Perfetti & Tan, 1999; Taylor & Taylor, 1995). Packard (2000) described several linguistic criteria through which a word can be defined, such as orthographic, sociological, lexical, semantic, phonological, and syntactic. Although orthographic and syntactic definitions are both relatively easy to match across languages, the former was used in the present study for a particular reason. Whereas the orthographic definition refers to an entity circumscribed by writing conventions, the syntactic definition refers to an entity that can stand as a single occupant of a syntactic form class slot. Although both criteria converge in English (i.e., the written material occurring between the spaces usually fills a single syntactic slot), the two criteria represent distinct word pools in Chinese. Although the orthographic word corresponds to a single character, roughly two-thirds of the syntactic words are compounds consisting of two or more characters. Because each character in the compound generally makes a unique, independent contribution to the meaning and pronunciation of the whole word, the analysis of necessity involves the morphological elements within each character as well as the characters themselves as morphological components.

To reiterate, the constructs of central interest here are the working conceptions readers form, from their print processing experience, about intraword morphemes and their utilization. Since morphologically complex single-character, or orthographic, words permit direct examination of the structural relationship between orthography and morphology, they are more suitable than syntactic words for a cross-linguistic analysis of morphological awareness. For this reason, compound words in English were also excluded from the present examination. The following sections describe the morphological and orthographic characteristics of affixed words in English and multiple-unit characters in Chinese. Descriptions of Korean systems also are provided because Korean learners of English as an L2 were included in the study.

English

Orthography. The English orthography is morphophonemic: although bound by phonemic constraints, it tends to preserve morphological information in its

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graphic representation. Phonemic descriptions, therefore, provide only partial accounts for English orthographic conventions. For example, distinctive orthographic patterns often serve to differentiate two distinct morphemes sharing identical phonological representation, as in *threw* and *through*. Conversely, shared morphemes can be represented by identical spellings despite their different phonological status, as in *anxious/anxiety* and *electric/electricity*, or by the past tense marker *-ed* (e.g., *moved/talked/visited*). Many English spelling irregularities can thus be explained more readily by morphemic, rather than phonemic, construction.

This being the case, it seems logical to presume a symbiotic relationship, wherein orthographic processing is greatly facilitated by morphological knowledge and, at the same time, orthographic sophistication substantially enhances morphological processing. Since the distributional characteristics of letter sequences forming affixes vary widely, readers should benefit from recognizing how frequently, and reliably, each sequence functions as an affix. Recent studies, in fact, have demonstrated that, while awareness of morphological structure facilitates learning to read and spell (e.g., Carlisle, 1988, 1995; Fowler & Liberman, 1995; Leong, 1989), knowledge of spelling also aids morphological analysis and decomposition (e.g., Derwing, Smith, & Wiebe, 1995).

Morphology. The basic units of word formation and the principles governing their combination vary widely across languages. In concatenative languages such as English, morphological formation generally entails the addition of affixes (before or after base morphemes) in a reasonably systematic and linear fashion. Three types of morphemes are commonly used in English: (a) inflectional affixes, which signal grammatical relationships (e.g., past tense, progressive, and plurality marking); (b) class-changing derivational affixes, which form new words by altering the grammatical class (happy → happiness); and (c) class-maintaining derivational affixes, which form new words without changing the grammatical class (e.g., happy → unhappy).

Importantly, there is considerable variation in the systematicity through which intraword morphemes are concatenated. Morphological mapping is, for example, far more systematic in inflectional processes, wherein distinct grammatical functions (e.g., tense, plurality) are assigned to specific affixes, than in derivational formations, wherein multiple linguistic forms are available for a single conversion function. As an illustration, several suffixes (e.g., *tion*, *ment*, *al*) can be used to convert verbs into nouns (*inform* → *information*, *move* → *movement*, and *arrive* → *arrival*).

There are also issues surrounding regular/irregular formations, or morphological transparency. In regular formations, base morphemes retain their orthographic forms through affixation, and therefore their resulting forms are structurally transparent, whereas irregular formations, whose base morphemes undergo orthographic changes, are visually opaque. Presumably, such transparency may affect the way morphologically complex words are processed. Simple rule-based operations may be appropriate for morphologically transparent words but not for structurally opaque formations. However, empirical findings have demonstrated that skilled readers are sensitive to intraword morphological structure

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even when its components are not easily decomposed either orthographically or semantically (e.g., Stolz & Feldman, 1995), and that the recognition of low-frequency complex words are facilitated by their high-frequency morpheme components (e.g., Katz, Rexer, & Lukatela, 1991; Kelliher & Henderson, 1990). Experimental studies using a priming technique have shown that visual processing of unaffixed words is facilitated to a far greater extent by their morphologically complex relatives than by orthographically similar, but morphologically unrelated, words (e.g, Feldman & Bentin, 1994; Fowler, Napps, & Feldman, 1985). These findings thus affirm readers' consistent engagement in morphological decomposition during lexical processing, which, in turn, generally mandates that two basic processes are essential in morphological processing: (a) systematic intraword structural analysis to identify a word's morphological components, and (b) linear integration of segmental morphological information.

Tyler and Nagy (1989, 1990) contended that a full understanding of English derivational morphemes involves at least three distinct aspects of awareness: relational, syntactic, and distributional. According to the researchers, relational awareness refers to a broad understanding that words have complex internal structures, and that two or more words may share a common base morpheme. Syntactic awareness, in contrast, has to do with the tacit knowledge that affixation alters syntactic categorization. To wit, a competent user of English knows that *generalize* is a verb by virtue of being suffixed with *-ize* and *generalization* is a noun because it is suffixed with *-tion*. Distributional awareness concerns learners' sensitivity to the constraints on base–affix concatenation. They should know, for example, that *able* can be used with verbs but not nouns.

Chinese

Orthography. According to Taylor and Taylor (1995), Mandarin has approximately 7,000 different morphemes and 400 syllables with four distinct tones, making up 1,200 tone-syllables. In logographic scripts, such as Chinese, each graphic symbol (character) corresponds, in general, to a single morpheme. The majority of single morphemes are used as words. Therefore, there should be as many characters as there are words and morphemes, but in actuality roughly 6,000 characters are necessary for high-level scholarly literacy, and 3,500 are designated as modern Chinese characters for everyday use. During their six years of primary education, Chinese children are required to learn 2,834 characters through formal instruction.

Characters are formed with radicals (i.e., recurrent stoke patterns) (e.g., Chen, Allport, & Marshall, 1996; Shu & Anderson, 1997). Many radicals themselves are single-unit characters and are used both as independent words and as components in other characters. Some radicals, however, lack lexical status, serving only as character components. Although there are several character formation procedures, semantic–phonetic compounding is, by far, the most dominant method; it is used in the vast majority (roughly 80%–90%) of multiple-unit characters (Zhang, 1994). This method generally involves a non-linear integration of two radicals, which provide either phonetic or semantic information.

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Table 1. *Relationships among words, characters, and radicals*

Word type	Orthographic form	Morpheme components	Components' function	Meaning
single-unit/single-character word	糸	—	—	thread
multiple-unit/single-character word	結	(radicals)		to unite
		糸	semantic information	things made out of thread or actions involving thread
		吉	phonetic information	—
multiple-character compound word	結婚			marriage
		(characters)		
		結	semantic/phonetic information	to unite
		婚	semantic/phonetic information	wedding

There are approximately 700 phonetic radicals and about 140 semantic radicals currently in use.

Morphology. Semantic radicals are often considered as equivalent to single morphemes because of their primary function (i.e., providing a guide to character meanings) (e.g., Nagy & Anderson, 1998; Packard, 2000; Shu & Anderson, 1997). Given that characters holistically correspond with their meaning, they are also treated as equivalent to single morphemes (e.g., Taft & Zhu, 1995). Chinese morphemes are thus graphically coded in the form of lexical and nonlexical radicals and as single- and multiple-unit characters. Table 1 presents the relationships among words, characters, and radicals.

Because of the holistic and somewhat independent meaning–symbol association at each of the multiple representation levels (e.g., radical, character, and word), logic would suggest that morphological processing in Chinese requires parallel information retrievals for the lexical and sublexical elements. A recent study (Zhou & Marslen-Wilson, 1994) reported that lexical decision is facilitated, though to varying degrees, both by word frequency and by radical frequency, thus implying that lexical processing in Chinese necessitates simultaneous activation of the whole character and its semantic radical information.

Properties of semantic radicals. Since the present study focuses on morphologically complex, multiple-unit characters, semantic radicals are of primary interest. What follows is a brief description of their structural and functional properties. Semantic radicals provide a guide to characters' meanings by signaling, in most instances, the semantic category of the whole character. As an illustration,

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the meaning of characters containing the *water* radical generally relates to water in one way or another. For example, the characters for 湖 (lake), 池 (pond), 洋 (ocean), 洪 (flood), and 泳 (swim) all share the *water* radical.

Because of this category signaling function, semantic radicals also serve as a "category header" and are used to index literally thousands of dictionary entries. However, for this system to work properly, certain conditions are essential. For instance, each character must have one, and only one, semantic radical. The semantic radicals must appear at designated locations within the character in order to convey their function as category header. In all probability, competent logographic readers progressively become aware of these constraints and develop the capacity to utilize them in accelerating character recognition. It is not surprising, then, that ongoing experimental studies have affirmed that semantic radicals are processed somewhat differently from other radicals (e.g., Chen & Allport, 1995; Leck, Weekes, & Chen, 1995), and that the ability to exploit semantic category information during lexical processing is directly associated with reading competence among logographic readers (Shu & Anderson, 1997; Shu, Anderson, & Zhang, 1995).

It is important to underscore, however, that semantic radicals yield information only partially related to character meanings, and therefore it is unlikely that meanings of unknown characters can be elicited through semantic radical information alone. Moreover, given that other radicals supply no semantic clues whatsoever, it is equally improbable that whole character meanings can be inferred through the integration of diverse radical information. Hence, constructing meaning from isolated characters is virtually impossible. As a consequence, lexical inference in Chinese necessitates extracting clues from character-external sources, such as neighboring characters or contiguous sentences and paragraphs. Recent studies have suggested that, when encountering unknown characters in context, logographic readers tend to infer meanings by combining character-internal (semantic radical) and character-external (lexical and/or sentential context) information (e.g., Mori & Nagy, 1999; Shu et al., 1995).

Furthermore, the relationship between semantic radical information and whole character meaning is not always transparent. The *water* radical, as a case in point, appears in the character for *decide*, and the *female* radical is incorporated in the character for *son-in-law*. In both examples, the relationship between the radical and the whole character is not as clear as it would be if the information from the two morphological elements were semantically consistent. Hence, semantic radical information is useful, but insufficient, for character recognition.

For all these reasons, it seems logical to presume that competent character users are aware that one of the radicals provides partial information on the whole character meaning; that, in general, characters with shared semantic radicals are semantically related; that semantic radical information, in itself, is insufficient for character recognition; and that radical information is not always semantically consistent with whole character meanings.

Korean

Orthography. Korean employs a non-Roman alphabetic script, Hangul. Taylor and Taylor (1983) pointed out that Hangul is unique in that one or more conso-

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nants are always combined with a vowel to form a syllable, such as VC, CV, CVC, CVCC. Multiple Hangul symbols in a single syllable are packaged in a square-like block. Syllable blocks are ostensibly the basic unit of visual processing during the reading and spelling of Hangul words: blocks are visually more distinguishable than individual phonemic symbols, and syllables are perceptually more salient than phonemes. Although roughly 12,700 blocks can be generated simply by packaging various combinations of the 24 basic symbols, approximately 2,000 are in common use (Taylor & Olson, 1995).

Although Chinese characters (Hancha) are used in conjunction with Hangul in South Korea (where the study participants received their education), their use is relatively sparse because it is not taught in primary schools. Indeed, recent experiments have demonstrated that adult Korean readers process Hangul-only texts more efficiently than mixed Hangul–Hancha texts (Taylor & Park, 1995). A basic assumption of the present study, therefore, was that experience with alphabetic Hangul, rather than logographic Hancha, plays a major role in shaping L1 metalinguistic capabilities among Korean ESL learners. Another assumption was that Korean readers develop reasonably sophisticated intraword structural awareness through repeated practice in the syllable block formation necessitated in reading and spelling in the Hangul script.

Morphology. Korean inflectional morphology is concatenative. Verbs, for example, have seven distinct suffix positions: active/passive voice; subject honorific or subject–verb agreement; tense and aspect; modality; addressee honorific; retrospective mood (e.g., indicative, requestive); and clause type. Most suffixes are optional, with the exception of the clause type (Sohn, 1994). Like English, Korean inflectional suffixes are lexically free and not word formational.

Korean derivational morphology, however, is word formational and lexically restricted. Nouns, for example, can be derived from verbs with suffixes such as /-i/ (*pel* 'to earn' derives *pel-i* 'earning') or /-kay/ (*ssa* 'to wrap' derives *ssa-kay* 'wrapper'). Other lexically restricted suffixes deriving nouns from verbs include /-ki/, /-po/, and /-em/. Similarly, nouns can be derived from adjectives, and adjectives and adverbs often stem from nouns through appropriate (i.e., lexically combinable) suffixes.

Inasmuch as English and Korean morphological systems are structurally and functionally comparable, it was assumed that Korean morphological processing necessitates a set of metalinguistic competencies analogous to those required for English.

CROSS-LINGUISTIC VARIATIONS IN MORPHOLOGICAL AWARENESS

To reiterate, morphological awareness is defined as a body of working conceptions competent readers form about intraword morphological elements, together with the ability to utilize the resulting operational clues in extracting and manipulating intraword morphological information. Based on the functional and structural differences in intraword morphemes described, we can project three specific ways in which the utilization aspect of morphological awareness varies in English and Chinese.

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First, since individual morphological components collectively create the meaning of morphologically complex English words, efficiency in intraword analysis and morphological decomposition are critical capabilities. In Chinese, however, semantic radicals provide partial information of characters' meanings. Hence, identifying the semantic radical within a character and extracting its information are two key abilities. Second, since a major function of English intraword morphemes is to provide grammatical information, competence in form-to-function mappings plays a vital role in English morphological processing. In contrast, grammar plays a minor role in Chinese morphology. Its formation, therefore, is far less systematic, prohibiting similar mapping procedures. Third, each graphemic unit in English represents segmental phonological information and must, consequently, be assembled at lexical and sublexical levels to elicit morphological and lexical information. Intraword information integration is thus an essential ability in English. Chinese semantic information, on the other hand, is holistically represented by a single graphemic unit both at the character and radical levels. As a result, character recognition primarily depends on parallel information retrievals at multiple representational levels rather than intraword analysis and information integration. Hence, attending to both radical and character information simultaneously is a requisite in Chinese morphological processing. Finally, semantic radicals simply provide a guide to character meanings, yielding insufficient information for the meaning construction of unfamiliar characters in isolation. Two capacities are thus crucial in Chinese character inference: extracting clues from semantic radicals and integrating them with character-external, or contextual, information.

MORPHOLOGICAL AWARENESS AMONG L2 READERS: HYPOTHESES

In view of these differences, significant issues in L2 research revolve around the extent and manner in which L1 lexical processing experience constrains the formation of L2 morphological awareness when L1 and L2 differ typologically. Using the structural and functional variations described, three hypotheses were formulated regarding L2 morphological awareness among Chinese learners of English. First, because of their limited experience with intraword structural analysis and information integration, Chinese learners would be less sensitive to intraword structural salience than learners whose L1 is structurally more similar to English. Second, lacking such sensitivity, they would be less efficient in analyzing intraword morphological structure. Third, because of their extensive experience in using radical and contextual information during unfamiliar character processing, they would be more adept at integrating word-internal (morphological) and word-external (contextual) information.

These hypotheses were tested empirically using dual on-line tasks. The study objectives were two-fold: to compare the three L2 morphological awareness capabilities (i.e., intraword structural sensitivity, analysis efficiency, and morphological and contextual information integration capability) and then to determine the extent to which each of these impacts on L2 vocabulary knowledge.

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METHODS

Participants

Two groups of adult ESL learners participated: native speakers of Chinese ($N = 22$) and native speakers of Korean ($N = 20$). Koreans were used as a control group because their L1 orthographic and morphological systems, while typologically similar, are unrelated to their English counterparts.

Participants were students at two American universities. To assure adequate L1 literacy competence, at least a high school education in their native countries and less than two years of residency in the United States were required. To ensure that the groups were similar in written English proficiency, two subsections of TOEFL (vocabulary and reading comprehension) were administered. Vocabulary scores for the Chinese participants ranged from 7 to 25 ($M = 19.52$, $SD = 3.82$), and their reading scores ranged from 8 to 28 ($M = 21.96$, $SD = 4.79$). Vocabulary scores for the Korean participants ranged from 15 to 26 ($M = 20.47$, $SD = 3.41$), and their reading ranged from 7 to 28 ($M = 21.47$, $SD = 3.41$). Subsequent t tests indicated that neither set of subtest scores differed significantly between the groups (vocabulary, $t = .76$, $p > .05$; reading comprehension, $t = 1.22$, $p > .05$).

Test batteries

Intraword structural sensitivity and analysis efficiency. A separability judgment task – to determine whether a word could be divided into smaller meaningful units – was used to measure intraword structural sensitivity and analysis efficiency. Groups' performance was assessed under three stimulus conditions, varying in structural salience. The first condition, high salience, contained 20 morphologically complex words, each consisting of a prefix and a lexical base (e.g., re + solve and in + visible). The second condition, low salience, comprised 20 morphologically complex words, each containing a prefix and a sublexical (or Latinate) base (e.g., re + volve and in + clude). The third condition, orthographically similar but monomorphemic, was based on 20 monomorphemic words that shared the same initial orthographic sequence as the prefixes used in the other conditions (e.g., *re*gime and *in*fant). Four prefixes (*con*, *de*, *in*, and *re*) were utilized because of their flexibility in concatenation (i.e., they could be attached either to lexical or sublexical bases), thus altering structural salience while sustaining the same orthographic sequence. Stimulus words in all three conditions were matched on word length and frequency, using the Kucera and Francis (1967) lists. The mean length (number of letters per word) was 7.1 in the structurally high-salience stimuli, 7.2 in the low-salience stimuli, and 7.4 in the monomorphemic stimuli. Mean frequency count (occurrences per million words) was 20.5 for the high-salience words, 19.4 for the low-salience words, and 19.2 for the monomorphemic words.

Since separability decisions could be based on lexical memory, bypassing structural analysis, it was essential to compare performance in situations where lexical knowledge could not be used. Thus, three corresponding pseudoword

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stimulus sets were devised using the same prefixes. High-salience pseudoword stimuli were created by combining the same prefixes with familiar English words (e.g., re + stand, in + assign); low-salience pseudoword stimuli were created by adding the prefixes to the same Latinate bases used in the real word low-salience condition (e.g., re + clude, in + tach); orthographically similar monomorphemic pseudowords were constructed by replacing one syllable in each word used in the real word monomorphemic condition (e.g., regime → refume, infant → inpent). Again, pseudoword and real word items were matched in regard to word length.

The 120 stimulus items (20 in each condition) were randomized across participants and projected individually on a computer screen. In the experiment, written instructions were first presented and then two practice sessions followed. The task sequence began with an asterisk at the center of the screen. Participants were instructed to focus on the asterisk and, when ready, to click the space bar. The task was simply to decide whether the word presented could be separated into two or more meaning-bearing components; the participants responded by clicking either the "Yes" or "No" key. Once a response was entered, the screen cleared, and the asterisk indicating the next sequence appeared. After the first practice session, participants were encouraged to ask questions about the experimental procedures. A second set of practice materials was given, and then the actual experimental items were presented. Reaction times between the onset and offset of each stimulus item were measured and, together with the judgement responses, recorded.

It was hypothesized that, compared with L2 learners of English with structurally similar L1, Chinese ESL learners would be less sensitive to intraword structural salience and less efficient in analyzing the internal structure of words. It was predicted that Chinese participants would be slower in reaching separability decisions, and that intraword structural salience would differentially influence separability judgment performance among Chinese and Korean participants. In other words, responses by the Chinese participants would be less affected by structural salience than those by the Korean participants.

Morphological and contextual information integration. The second task – semantic inconsistency detection – was used to measure the ESL participants' ability to integrate morphological and contextual information. In this experiment, participants were given an incomplete sentence lacking its last word. The missing (target) word then appeared on the next screen. Participants were asked to determine whether the target word was semantically consistent with the rest of the sentence. Three types of sentences were presented: experimental, related distracter, and unrelated distracter. The experimental sentences involved 12 pairs of semantically inconsistent sentences, each containing either a morphologically complex (e.g., dishonest) or simple (e.g., honest) target word. An example of a morphologically complex sentence would be "People who always tell the truth are *dishonest*"; its morphologically simple counterpart would be "People who never tell the truth are *honest*." To prevent participants from entering their responses without reading the stimulus sentences and target words, 12 corresponding pairs of semantically consistent sentences (related distracters) were devised

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by switching the target words of the semantically inconsistent sentences within each pair. A related morphologically complex distracter sentence would be "People who never tell the truth are *dishonest*"; its morphologically simple counterpart would be "People who always tell the truth are *honest*." A total of 48 sentences were divided into four blocks with the two sentence types (semantically consistent and inconsistent) and the two target word types (morphologically complex and simple) equally distributed. Finally, 12 unrelated sentences (unrelated distracters) were added to each block. A total of 24 sentences in each block were randomly sequenced, and the presentation order of the four blocks was counterbalanced across participants within each group.

Once again, written instructions were presented on a screen, followed by two practice sessions. As in the previous separability task, the experimental sequence opened with an asterisk on the screen. Participants were given a sentence with its last word omitted and were asked to read it at a speed comfortable for comprehension. After the offset of the sentence, its last word appeared, and participants were asked to indicate whether the word was semantically consistent with the sentence through one of the two designated keys. Reaction times were measured in milliseconds between the target word onset and offset and recorded together with the judgment responses. Once a response key was pressed, the screen cleared, and an asterisk signaled the beginning of the next sequence. To reduce random performance, a yes–no comprehension question was interspersed every five to eight trials.

Based on the cross-linguistic comparisons, it was hypothesized that Chinese ESL learners would be more adept at integrating word-internal (morphological) and word-external (contextual) information. It was predicted that morphological complexity would facilitate semantic inconsistency detection among Chinese learners to a greater extent than it would among Korean learners. Contrasting response patterns were therefore expected from the two ESL groups when detecting semantic inconsistency in the morphologically complex target word condition.

RESULTS AND DISCUSSION

Separability judgment

Intraword structural sensitivity and analysis efficiency were estimated by comparing response speed and accuracy across the six stimulus conditions. Data from two Chinese participants were excluded because preliminary analysis indicated that their responses were identical across conditions, and that their reaction times (RTs) were considerably shorter than those of other participants, suggesting that perhaps they may have simply pressed the response keys without actual processing. Data from the remaining 40 participants (20 Chinese and 20 Korean) were used in subsequent analyses. Each participant's RT distribution was normalized within a single stimuli condition by replacing the RTs which were either three standard deviations above or below the cell mean with the individuals' mean RT. The total number of replaced RTs was less than 3% of the total responses. Adjusted RT means and standard deviations appear in Table 2.

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Table 2. *Separability judgment performance (RT in milliseconds)*

		Chinese		Korean	
Prefix conditions	Example	*M*	*SD*	*M*	*SD*
Real words					
High-salience prefix	resolve	2,301.94	1,096.92	1,976.14	536.87
Low-salience prefix	revolve	2,856.0	1,268.47	2,369.47	693.94
Monomorphemic	regime	2,932.42	1,242.36	2,357.71	796.42
Pseudowords					
High-salience prefix	relook	2,060.68	769.88	1,931.21	617.55
Low-salience prefix	revest	2,643.53	764.44	2,276.29	669.06
Monomorphemic	refume	2,931.47	1,040.93	2,967.71	1,107.05

The data demonstrated that the Korean participants were notably faster than the Chinese participants across all conditions when dealing with real word stimuli (Figure 1); that there was little difference between the groups' RT means in the pseudoword conditions (Figure 2); that the shortest RT mean occurred in the structurally high-salience condition, and the longest RT mean occurred in the monomorphemic condition across word status; and that the groups' RT change patterns were similar across structural conditions as well as word status.

A three-way repeated measures ANOVA was performed on the RTs with language group (Chinese vs. Korean) as the between-subjects variable and structural condition (structurally high-salience vs. low-salience vs. monomorphemic) and word status (real vs. pseudo) as the within-subjects variables. The analysis indicated that the main effect of group, $F(1, 38) = 9.33$, $p < .005$, and condition, $F(2, 38) = 13.51$, $p < .0001$, were significant, but that of status was not. None of the interactions was significant. Interestingly, Chinese RTs for real word stimuli were consistently longer across conditions by roughly 550 ms. Post-hoc pairwise comparisons, in fact, revealed statistically significant RT differences between the groups in the structurally low-salience ($t = 2.16$, $p < .05$) and monomorphemic ($t = 2.17$, $p < .05$) conditions.

These outcomes would seem to suggest that ESL learners, regardless of their L1 backgrounds, benefit from intraword structural salience when analyzing morphologically complex words; that Korean learners are considerably more efficient in analyzing structurally less salient real English words; and that Chinese and Korean learners are virtually equal in intraword analysis efficiency with pseudowords. Given that the groups did not vary in vocabulary test scores or pseudoword RTs, it seems reasonable to interpret the disparity in real word judgment speed as indicative of efficiency differences in intraword structural analysis. This, in turn, can perhaps be attributed to a procedural variation in morphological processing in their respective L1s (i.e., differential degrees of intraword structural analysis and information integration required for morphological processing).

Table 3 presents the means and standard deviations of "separable" responses (i.e., total number of responses wherein participants judged that the stimulus

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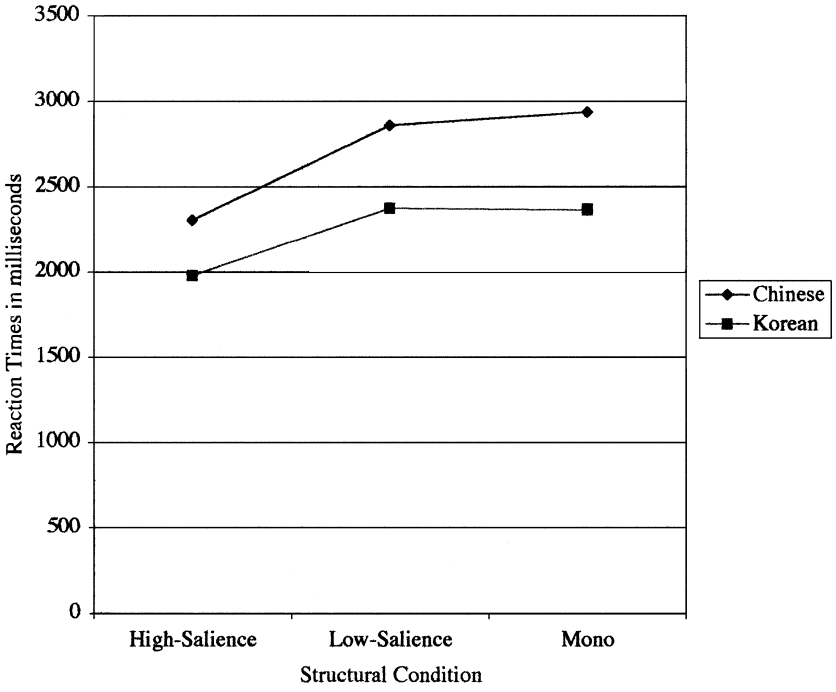


Figure 1. RT differences between the groups in separability judgment in the real word conditions.

word was separable). Unlike the RT results, the response data showed virtually no difference between the groups in any of the structural conditions across word status. A subsequent three-way repeated measures ANOVA conducted with the same set of variables showed that, although the two within-subjects variables were significant (condition, $F(2, 38) = 85.28$, $p < .0001$; status, $F(1, 38) = 9.41$, $p < .005$), the main effect of group was not. None of the interactions was significant. These results would seem to imply that the groups were similar in their intraword structural sensitivity, suggesting that such sensitivity is largely unaffected by differences in L1 processing experience.

The significant main effect of word status, moreover, clearly indicates that real word and pseudoword stimuli may have been processed differently. The larger number of "separable" responses in the pseudoword conditions suggests that ESL learners, irrespective of their L1 backgrounds, relied on morphological decomposition when dealing with unfamiliar English words. Finally, the absence of group mean differences across structural conditions leads to the supposition that L2 intraword structural sensitivity evolves primarily through cumulative experience with the lexical peculiarities of the target language. Its development, therefore, may well be affected to a far greater extent by L2 print processing experience than by L1 experience.

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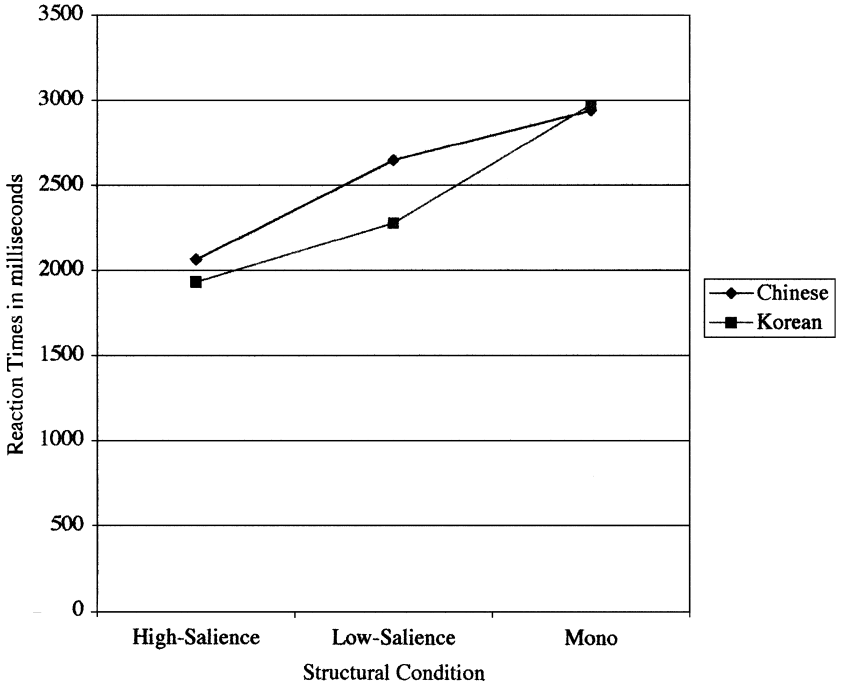


Figure 2. RT differences between the groups in separability judgment in the pseudoword conditions.

Table 3. *Separability judgment performance (number of separable responses)*

		Chinese		Korean	
Prefix conditions	Example	*M*	*SD*	*M*	*SD*
Real words					
High-salience prefix	resolve	15.76	3.75	14.14	3.94
Low-salience prefix	revolve	9.41	4.37	8.21	5.07
Monomorphemic	regime	5.71	2.36	3.93	3.65
Pseudowords					
High-salience prefix	restand	16.88	5.07	16.64	3.13
Low-salience prefix	reclude	9.94	5.07	9.43	5.88
Monomorphemic	refume	8.24	3.99	7.14	4.62

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Table 4. *Semantic inconsistency detection*

	Chinese		Korean	
Prefix conditions	*M*	*SD*	*M*	*SD*
Reaction times (in milliseconds)				
Morphologically complex	2055.15	568.76	2670.25	705.18
Morphologically simple	2436.9	806.68	2585.95	529.24
Response accuracy (no. correct)				
Morphologically complex	8.72	1.81	7.65	3.49
Morphologically simple	9.0	1.44	8.41	2.52

Viewed as a whole, the separability judgment data suggest that commonality in L1 and L2 processing experiences accounts, at least in part, for individual differences in morphological analysis efficiency. It is important to note, however, that similar benefits from L1–L2 processing congruity do not extend to the formation of intraword structural sensitivity.

Semantic inconsistency detection

The second task, semantic inconsistency detection, was used to assess efficiency in integrating morphological and contextual information. In a preliminary analysis, each participant's RT distribution was adjusted within a single stimulus condition by replacing all RTs that were either three standard deviations above or below the cell mean with the participant's mean RT in the same condition. The total number of replaced RTs was less than 2% of all responses. Means and standard deviations of the adjusted RTs, as well as numbers of correct responses, are presented in Table 4. The data revealed that semantic inconsistency detection performance varied considerably between the groups as well as between the two target word conditions (morphologically complex and simple) within each language group. As shown in Figure 3, the RT difference between the groups was far greater in the morphologically complex condition than in the simple condition. While the Chinese mean RT was considerably shorter during semantic inconsistency detection in the morphologically complex condition, the Korean RTs increased slightly. As evident in the response data, Chinese participants scored higher than the Korean participants across target word conditions, but the group mean difference in response accuracy was considerably less pronounced than in the RT data (Figure 4).

To assess the impact of L1 processing experience, two-way repeated measures ANOVAs were used with group (Chinese vs. Korean) as the between-subjects variable and target word condition (morphologically simple vs. complex) as the within-subjects variable. The RT data revealed that the main effect of group, $F(1, 38) = 23.23$, $p < .0001$, and the Group × Condition interaction, $F(1, 38) = 8.64$, $p < .005$, were significant, whereas the main effect of condition was not. Post-hoc pairwise comparisons showed that the RT difference between the two target word conditions was significant in the Chinese data ($t = 3.405$, $p < .0001$)

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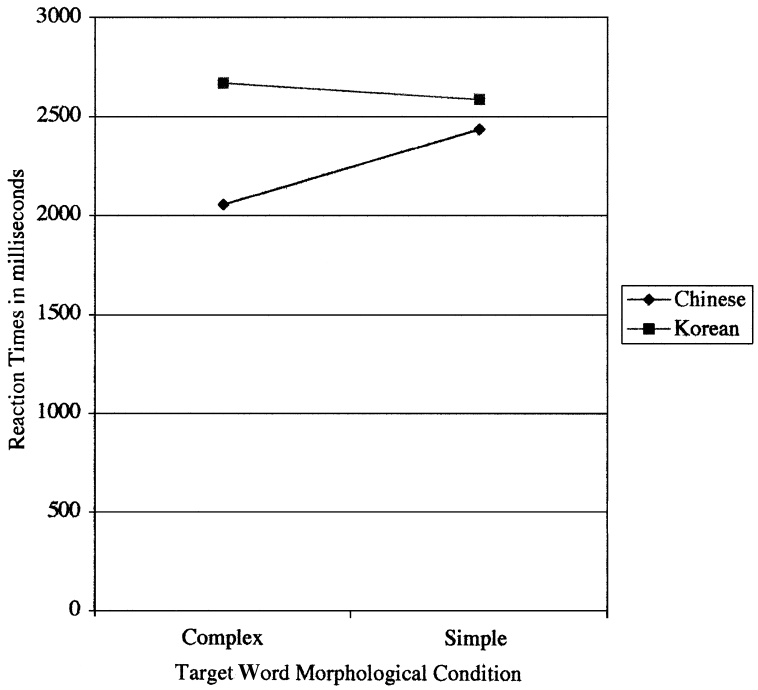


Figure 3. RT differences between the groups in semantic inconsistency detection.

but not in the Korean data, and that the group mean difference was significant in the morphologically complex target word condition ($t = 5.49$, $p < .0001$) but not in the simple condition. These results obviously indicate that the significant main and interaction effects can be attributed to the group mean difference in the morphologically complex condition. It seems reasonable to conclude that morphological complexity differentially affected semantic inconsistency detection among the Chinese and Korean ESL learners.

Subsequent analysis of the response data showed that group was the only significant variable, $F(1, 38) = 6.51$, $p < .0001$. The post-hoc pairwise comparisons showed that the groups' response accuracy differed significantly in the morphologically complex target word condition ($t = 2.3$, $p < .0250$) but not in the simple condition, and that there was no significant difference between the two target word conditions in either group. These results again reinforce the conclusion that morphological complexity had a differential impact on the inconsistency judgment accuracy of the two ESL groups.

Interestingly, the aggregate data from the semantic inconsistency detection task demonstrated that the groups were similar in their ability to integrate contextual and morphologically simple lexical information, but they varied perceptively in the ways they incorporated morphological (prefix) and word-external (contextual) information. The findings can be taken as a further indication that

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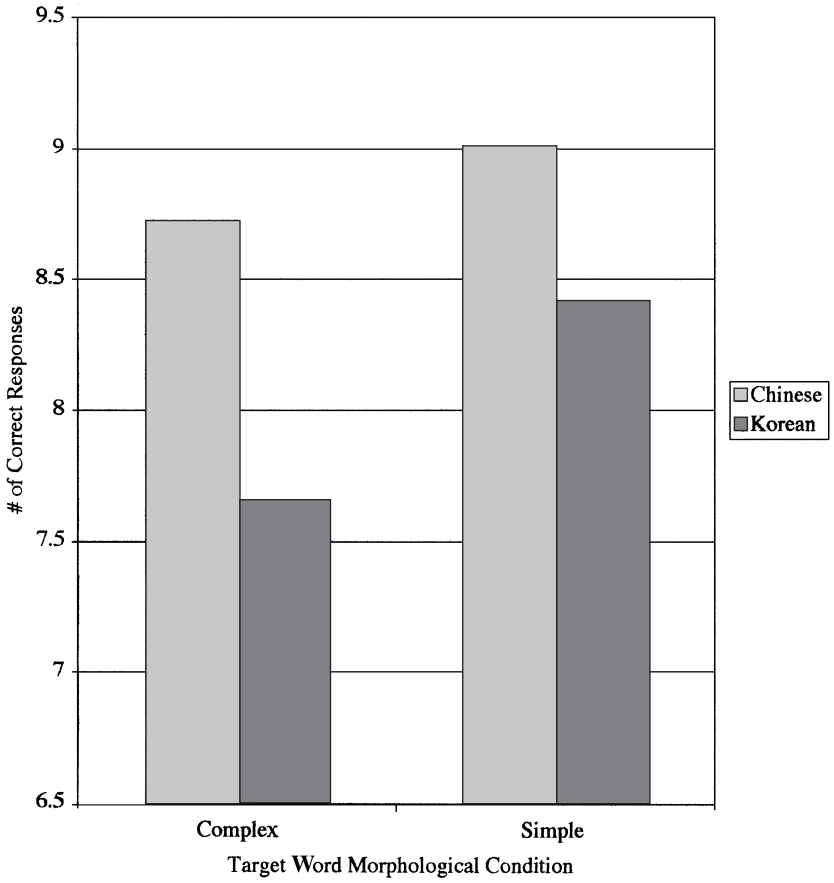


Figure 4. Response accuracy in semantic inconsistency detection.

L1 processing experience has lasting effects on the formation of L2 morphological awareness, thus accounting in part for performance variations in L2 lexical processing among ESL learners from typologically diverse L1 backgrounds.

Morphological awareness and L2 vocabulary knowledge

Since it is generally accepted that morphological awareness facilitates lexical processing and acquisition, its relation to L2 vocabulary knowledge was explored through correlational analysis. Four variables were entered: (a) L2 vocabulary knowledge (TOEFL vocabulary subsection scores); (b) morphological analysis efficiency (total reaction times for correct responses in the three real word stimulus conditions in the separability judgment task); (c) information integration efficiency (total reaction times in the semantic inconsistency detec-

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Table 5. *Correlations between L2 proficiency and intraword awareness components*

	L2 vocabulary knowledge	
Morphological awareness components	Chinese	Korean
Analysis efficiency (separability judgment RTs)	−.51**	−.24
Information integration efficiency (semantic inconsistency judgment RTs)	−.26	−.50*
Information integration accuracy (semantic inconsistency judgment responses)	.35	.29

*$p < .05$; **$p < 001$.

tion task); and (d) information integration accuracy (total number of correct responses in the inconsistency detection task). Correlation coefficients are listed in Table 5.

The groups' L2 vocabulary knowledge correlated somewhat differently with morphological awareness indices. Notable between-group variations emerged in the two efficiency variables. As shown in Table 5, intraword analysis efficiency correlated more highly with L2 vocabulary among Chinese than Korean participants. In contrast, the L2 vocabulary and information integration efficiency correlation was considerably higher in the Korean data. Considering that the groups were similar in L2 proficiency, that the Korean participants were more efficient in intraword analysis, and that the Chinese participants were faster in semantic inconsistency detection under the morphologically complex target word condition, the discrepant correlational patterns seem to support the likelihood that certain capability components of L2 morphological awareness, particularly those uniquely associated with L2 structural properties, improve only through increased L2 processing experience. It follows, then, that L2 processing experience may be far more influential than L1 in the acquisition of L2-specific properties. However, the acquisition of those components which are more compatible with L1 seems less affected by L2 experience. Hence, the results give rise to an interesting theoretical possibility: that is, similarity between L1 and L2 processing experiences may determine, to some degree, the extent to which L2 intraword awareness development is shaped by L2 processing experience.

SUMMARY AND CONCLUSIONS

This study investigated the specific ways in which L1 processing experience influences L2 morphological awareness. Based on cross-linguistic comparisons, three hypotheses were formulated. We hypothesized that Chinese ESL learners, compared with those from a structurally similar L1, would be less sensitive to intraword structural salience, less efficient in morphological analysis, and more

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adept at integrating morphological and contextual information during sentence processing.

To test these hypotheses, three aspects of morphological awareness (intraword analysis efficiency, intraword structural sensitivity, and morphological and contextual information integration ability) were compared among Chinese and Korean ESL learners. The results demonstrated that the groups were similar in intraword structural sensitivity; that Korean learners were more efficient in performing intraword structural analysis; that Chinese learners were faster and more accurate in detecting semantic inconsistency with morphologically complex target words; and that the groups were relatively equal in their inconsistency detection efficiency when the target words were morphologically simple.

The range of findings in the present study suggests that L1 processing experience influences L2 morphological awareness in specific and predictable ways; that variations in L1 processing experience can predict performance differences in some, but not all, aspects of L2 morphological awareness; and that L1 processing experience may determine, at least in part, both the extent and nature whereby L2 processing experience contributes to the formulation of L2 morphological awareness. Hence, we can conclude that both L1 and L2 processing experiences, in their own unique ways, materially enhance the development of L2 lexical processing competence.

ACKNOWLEDGMENTS

This research was supported by Carnegie Mellon University Faculty Development Funds. The author gratefully acknowledges the assistance of Etsuko Takahashi and Michael Fender in the construction of experimental materials and data collection. She is also indebted to the anonymous reviewers for their valuable and insightful comments, as well as to Catherine Snow for her skillful editorial guidance.

REFERENCES

Blachman, B. A. (1991). Phonological awareness: Implications for prereading and early reading instruction. In S. A. Brady & D. P. Shankweiler (Eds.), *Phonological processing in literacy* (pp. 9–36). Hillsdale, NJ: Erlbaum.

Bowey, J. A., & Francis, J. (1991). Phonological analysis as a function of age and exposure to reading instruction. *Applied Psycholinguistics, 12,* 91–121.

Bradley, L. (1988). Rhyme recognition and reading and spelling in young children. In R. L. Masland & M. W. Masland (Eds.), *Pre-school prevention of reading failure* (pp. 143–152). Parkton, MD: York Press.

Bradley, L., & Bryant, P. (1991). Phonological skills before and after learning to read. In S. A. Brady & D. P. Shankweiler (Eds.), *Phonological processing in literacy* (pp. 37–45). Hillsdale, NJ: Erlbaum.

Bryant, P., MacLean, M., & Bradley, L. (1990). Rhyme, language, and children's reading. *Applied Psycholinguistics, 11,* 237–252.

Carlisle, J. F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth grades. *Applied Psycholinguistics, 9,* 247–266.

(1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, NJ: Erlbaum.

Chen, Y. P., & Allport, A. (1995). Attention and lexical decomposition in Chinese word recognition: Conjunctions of from and position guide selective attention. *Visual Cognition, 2,* 235–268.

Chen, Y. P., Allport, D. A., & Marshall, J. C. (1996). What are the functional orthographic units in

https://doi.org/10.1017/S0142716400003015 Published online by Cambridge University Press

Chinese word recognition: The stroke or the stroke pattern? *The Quarterly Journal of Experimental Psychology, 49*(A), 1024–1043.

Derwing, B. L., Smith, M. L., & Wiebe, G. E. (1995). On the role of spelling in morpheme recognition: Experimental studies with children and adults. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 2–27). Hillsdale, NJ: Erlbaum.

Duques, S. (1989). Grammatical deficiency in writing: An investigation of learning disabled college students. *Reading and Writing, 2,* 1–17.

Feldman, L. B., & Bentin, S. (1994). Morphological analysis in disrupted morphemes: Evidence from Hebrew. *Quarterly Journal of Experimental Psychology, 47,* 407–435.

Fowler, A. E., & Liberman, I. Y. (1995). The role of phonology and orthography in morphological awareness. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 157–188). Hillsdale, NJ: Erlbaum.

Fowler, A., Napps, S., & Feldman, L. B. (1985). Relations among regular and irregular morphologically related words in the lexicon as revealed by repetition priming. *Memory and Cognition, 13,* 241–255.

Frost, R. (1994). Prelexical and postlexical strategies in reading: Evidence from a deep and a shallow orthography. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 116–129.

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographic depth: A multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 104–115.

Goswami, U., & Bryant, P. (1992). Rhyme, analogy, and children's reading. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), *Reading acquisition*. Hillsdale, NJ: Erlbaum.

Hancin-Bhatt, B., & Nagy, W. E. (1994). Lexical transfer and second language morphological development. *Applied Psycholinguistics, 15,* 289–310.

Hatta, T. (1992). The effects of Kanji attributes on visual field differences: Examination with lexical decision, naming and semantic classification tasks. *Neuropsychologia, 30,* 361–371.

Henderson, A. J., & Shores, R. E. (1982). How learning disabled students' failure to attend to suffixes affects their oral reading performance. *Journal of Learning Disabilities, 15,* 178–182.

Henderson, L. (1985). Issues in the modeling of pronunciation assembly in normal reading. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface dyslexia* (pp. 459–508). Hillsdale, NJ: Erlbaum.

Juel, C., Griffith, P. L., & Gough, P. B. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. *Journal of Educational Psychology, 78,* 243–255.

Katz, L., Rexer, K., & Lukatela, G. (1991). The processing of inflected words. *Psychological Research, 53,* 25–32.

Kelliher, S., & Henderson, L. (1990). Morphologically based frequency effects in the recognition of irregularly inflected verbs. *British Journal of Psychology, 73,* 441–454.

Koda, K. (1998). The role of phonemic awareness in L2 reading. *Second Language Research, 14,* 194–215.

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

Leck, K. J., Weekes, B. S., & Chen, M. J. (1995). Visual and phonological pathways to the lexicon: Evidence from Chinese readers. *Memory and Cognition, 23,* 468–476.

Leong, C. K. (1989). Productive knowledge of derivational rules in poor readers. *Annals of Dyslexia, 39,* 94–115.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicitly syllable and phone segmentation in the young child. *Journal of Experimental Child Psychology, 18,* 201–212.

Liberman, I. Y., Shankweiler, D., & Liberman, A. M. (1989). The alphabetic principle and learning to read. In D. Shankweiler & I. Y. Liberman (Eds.), *Phonology and reading disability: Solving the reading puzzle* (pp. 1–33). Ann Arbor: University of Michigan Press.

Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fischer, F. W., & Fowler, C. (1977). Phonetic segmentation and recoding in the beginning reader. In A. S. Reber & D. Scarborough (Eds.), *Toward a psychology of reading* (pp. 207–225). Hillsdale, NJ: Erlbaum.

Mori, Y., & Nagy, W. (1999). Integration of information from context and word elements in interpreting novel Kanji compounds. *Reading Research Quarterly, 34,* 80–101.

https://doi.org/10.1017/S0142716400003015 Published online by Cambridge University Press

Muljani, M., Koda, K., & Moates, D. (1998). Development of L2 word recognition: A connectionist approach. *Applied Psycholinguistics, 19,* 99–114.

Nagy, W. E., & Anderson, R. C. (1998). Metalinguistic awareness and literacy acquisition in different languages. In D. Wagner, R. Venezky, & B. Street (Eds.), *Literacy: An international handbook*. New York: Garland.

Nakagawa, A. (1994). Visual and semantic processing in reading Kanji. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 864–875.

Packard, J. L. (2000). *The morphology of Chinese: A linguistic and cognitive approach.* Cambridge: Cambridge University Press.

Perfetti, C. A., Beck, I., Bell, L. C., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. *Merrill-Palmer Quarterly, 33,* 283–319.

Perfetti, C. A., & Tan, L. H. (1999). The constituency model of Chinese word identification. In J. Wang, A. W. Inhoff, & H. C. Chen (Eds.), *Reading Chinese script: A cognitive analysis* (pp. 115–134). Mahwah, NJ: Erlbaum.

Rubin, H. (1991). Morphological knowledge and writing ability. In R. M. Joshi (Ed.), *Written language disorders* (pp. 43–69). Boston: Kluwer Academic.

Rusted, J. (1988). Orthographic effects for Chinese–English bilinguals in a picture–word interference task. *Current Psychology: Research Reviews, 7,* 207–220.

Sasaki, Y. (1993). Paths of processing strategy transfer in learning Japanese and English as foreign languages: A competition model approach. *Studies in Second Language Acquisition, 16,* 43–72.

Shu, H., & Anderson, R. C. (1997). Role of radical awareness in the character and word acquisition of Chinese children. *Reading Research Quarterly, 32,* 78–89.

Shu, H., Anderson, R. C., & Zhang, H. (1995). Incidental learning of word meanings while reading: A Chinese and American cross-cultural study. *Reading Research Quarterly, 30,* 76–95.

Sohn, H. (1994). *Korean*. New York: Routledge.

Stahl, S. A., & Murray, B. A., (1994). Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology, 86,* 221–234.

Stanovich, K. E., Cunningham, A. E., & Cramer, B. B. (1984). Assessing phonological awareness of kindergarten children: Issues of task comparability. *Journal of Experimental Psychology, 38,* 175–190.

Stolz, J. A., & Feldman, L. B. (1995). The role of orthographic and semantic transparency of the base morpheme in morphological processing. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 109–129). Hillsdale, NJ: Erlbaum.

Taft, M., & Zhu, X. P. (1995). The representation of bound morphemes in the lexicon: A Chinese study. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 109–129). Hillsdale, NJ: Erlbaum.

Taylor, I., & Olson, D. R. (1995). An introduction to reading the world's scripts. In I. Taylor & D. R. Olson (Eds.), *Scripts and literacy* (pp. 1–15). Dordrecht: Kluwer Academic.

Taylor, I., & Park, K. (1995). Differential processing of content words and function words: Chinese characters vs. phonetic scripts. In I. Taylor & D. R. Olson (Eds.), *Scripts and literacy* (pp. 1–15). Dordrecht: Kluwer Academic.

Taylor, I., & Taylor, M. M. (1983). *The psychology of reading*. New York: Academic.

(1995). *Writing and literacy in Chinese, Korean, and Japanese*. Philadelphia: John Benjamins.

Turvey, M. T., Feldman, L. B., & Lukatela, G. (1984). The Serbo-Croatian orthography constrains the reader to a phonologically analytic strategy. In L. Henderson (Ed.), *Orthographies and reading: Perspectives from cognitive psychology, neuropsychology, and linguistics* (pp. 81–90). Hillsdale, NJ: Erlbaum.

Tyler, A., & Nagy, W. (1989). The acquisition of English derivational morphology. *Journal of Memory and Language, 28,* 649–667.

(1990). Use of derivational morphology during reading. *Cognition, 36,* 17–34.

Tzeng, O. J. L., & Wang, W. S.-Y. (1983). The first two R's: The way different languages reduce speech to script affects how visual information is processed in the brain. *American Scientist, 71,* 283–243.

Vellutino, F. R., & Scanlon, D. M. (1987). Phonological coding, phonological awareness, and read-

https://doi.org/10.1017/S0142716400003015 Published online by Cambridge University Press

ing ability: Evidence from a longitudinal and experimental study. *Merrill-Palmer Quarterly, 33,* 321–363.

Yopp, H. K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly, 23,* 159–177.

Zhang, H. C. (1994). Some studies on the recognition of Chinese characters. In Q. Jing, H. Zhang, & D. Peng (Eds.), *Information processing of Chinese language* (pp. 1–11). Beijing: Beijing Normal University.

Zhou, X., & Marslen-Wilson, W. (1994). Words, morphemes, and syllables in the Chinese mental lexicon. *Language and Cognitive Processes, 9,* 393–422.

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