Word recognition research in foreign language reading: A systematic review

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ABSTRACT

This article systematically reviews word recognition research in foreign language (FL) reading. Word recognition, one of the lower-level processes, is widely acknowledged as the most frequent cognitive activity involved in reading. Word recognition research in first language (L1) reading in various languages abounds. Compared with a considerable number of L1 word recognition studies, word recognition has only received minimal attention in FL reading research. The issues in word recognition research in FL reading are much more complicated than those in L1 reading, as FL reading involves more than one language. A number of factors have been taken into consideration for FL word recognition research, and these factors have produced four major foci: (1) learners' L1 orthographic backgrounds, (2) FL experience, (3) FL print input properties, and (4) the relationship between word recognition and reading outcomes (e.g., reading comprehension). The article first explains processes in word recognition and summarizes major findings in L1 word recognition research which lay the foundation for FL word recognition research, and then reviews existing studies with the above four foci in FL reading. The review reveals limitations in the extant research and points out directions for future research and offers some practical implications in relation to teaching.

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INTRODUCTION

Most of us read everyday, from academic texts to technical reports, from literature to popular magazines, and from newspapers to brochures. This seemingly common practice is in fact a complex cognitive activity (Block, 2004; Burns, Roe, & Smith, 2002; Pressley, 2002). Although there is still mystery in this complicated cognitive process await to be unveiled, one thing we already know is that the importance of word recognition in reading cannot be neglected. As readers, we are often called "extraordinary word recognizers". This is because "[W]hen we read, we actually focus visually on almost all (about 80%) of the content words that we read and about 50 percent of the small function words" (Grabe, 2009, p. 23). Word recognition, thus, is the most frequently "recurring cognitive activity" in reading (Perfetti, 2007, p. 357). Given the frequent occurrence of word recognition in both first language (L1) and foreign language (FL) reading, this article aims to provide a state-of-art review of word recognition research with a focus on FL reading. It begins by defining what word recognition is and providing the key findings of word recognition research in L1 reading. It then points out similarities and differences in the focus of word recognition research in L1 and FL reading. Three foci which are unique in FL reading and one focus which is common in both L1 and FL reading are critically reviewed. The review also points out a number of important avenues for FL word recognition research. The review concludes with some practical implications of word recognition in FL reading in relation to teaching practice.

DEFINITION OF WORD RECOGNITION

Researchers seem to agree upon the fact that it is not possible for fluent reading to take place without accurate and fast word recognition (Hulstijn, 2001; Just & Carpenter, 1980; Macalister, 2010; Stanovich, 2000). For skilled readers, recognizing a word occurs in less than 100 milliseconds (Ashby & Rayner, 2006). According to Wolf and Katzi-Cohen (2001), word recognition is a summation of accuracy and speed of meaning access through decoding of printed words. This definition tells us that word recognition involves two sub-

processes: (1) visual decoding of orthographic forms of words and activating links between graphic and phonological codes (known as word decoding or phonological decoding); and (2) retrieving relevant semantic resources through a word dictionary in the mind referred to as a mental lexicon (known as lexical access or semantic access) (Jeon, 2009; Perfetti & Hart, 2001).

As to how meaning is activated through word decoding, this remains debatable. There is disagreement on whether phonological information is mandatory in the meaning activation process, and on whether meaning activation is via holistic word recognition (Ehri, 1994, 1998; Kato, 2009). Two models have been proposed for meaning access. The first model maintains that activating phonological information is obligatory and central in meaning retrieval from a mental lexicon regardless of orthographies (e.g., McCutchen & Perfetti, 1982; Perfetti, 2003; Rayner & Pollatsek, 1989). In contrast, the second model postulates that lexical access may not require phonological information to be involved. Semantic information can either be retrieved via orthographic information or it can activate meaning through decoding phonological codes (e.g., Coltheart, Curtis, Atkins, & Haller, 1993; Jackson & Coltheart, 2002). The direct lexical route normally enables readers to process familiar words and words of high frequency, whereas the optional route tends to operate when unfamiliar and less frequent words are encountered (or pseudowords) (Castles, 2006; Roth, 2006). Research evidence has shown that as reading proficiency increases, readers are more likely to adopt a direct route using only orthographic (not phonological) information to access word meaning in reading (Bowey & Muller, 2005; Kato, 2009).

EMPIRICAL RESEARCH ON WORD RECOGNITION IN L1 READING

Word recognition research in L1 reading abounds, with a predominant focus on children's acquisition of word recognition skills. The literature indicates that children acquire word recognition skills in their native language gradually with increasing accuracy and speed (Verhoeven & Perfetti, 2003; Verhoeven & van Leeuwe, 2009). There is considerable variance in word recognition skills among

children, and such variance seems not to be explained by children's linguistic knowledge, as children's proficiency in oral language often fails to predict their word recognition ability (e.g., Perfetti, 1985, 1991; Stanovich, 1988, 1991). Previous longitudinal studies with elementary school children have consistently found that individual differences in word recognition ability are stable and are predictive of children's word recognition ability in later years (e.g., Juel, 1998; Wagner *et al.*, 1997).

Apart from longitudinal research on the development of word recognition skills among children, the most important question for researchers in L1 word recognition research is to investigate the relationship between word recognition skills and reading comprehension. Word recognition has been widely acknowledged as one of contributing processes to reading comprehension among children, as "word reading and reading comprehension are highly related; correlations fall within the range of 0.35 to 0.83" (Cain, 2006, p. 65). With an increase in children's reading experience, the role of word recognition in text comprehension tends to decrease (Bowey, 2005; Perfetti, 1998). The strength of association between word recognition and text comprehension also varies for good and poor readers. While for skilled readers, the relationship between word recognition and comprehension tends to diminish at the end of primary school (Bowey, 2005), this relationship may still persist among less skilled readers all the way to adulthood (Perfetti, 1999; Stanovich, 2000).

Among older L1 readers, word recognition has not been consistently observed to affect reading comprehension (e.g., Walczyk, 1995; Walczyk & Raska, 1992). Empirical evidence has shown that there is a dissociation between word decoding skill and reading comprehension, and even when readers have good word decoding ability, they still have comprehension problems (Nation, 2006; Perfetti, 2007; Perfetti, Landi, & Oakhill, 2005). For example, among 799 L1 adult populations, Landi (2005) used five measures, namely decoding, spelling, vocabulary, comprehension, and the Author Recognition Test. The results of factor analysis of the five tests showed a comprehension component and a lexical processing

component. Landi observed that 23.00% of students were below the median on the comprehension component measure, but their lexical processing component scores were above the median. This seems to suggest that lexical processing skill is a necessary but not sufficient requirement for good comprehension.

In proposing a Compensatory Encoding Model (CEM) in L1 reading, Walczyk and his associates attempted to explain the relationship between word recognition and reading comprehension[1] beyond children's initial stage of reading acquisition. The CEM proposes that the relationship between word recognition efficiency and reading comprehension tends to be weak or non-significant when reading occurs without time pressure as strategic readers are able to use strategies to compensate for inefficiency in word recognition. However, when there are severe time constraints, such as in a testing situation, the relationship between word recognition and the level of comprehension will become stronger (Walczyk, 1993, 1995, 2000; Walczyk, Marsiglia, Bryan, & Naquin, 2001, Walczyk, Marsiglia, & Johns, 2004; Walczyk, Wei, Griffith-Ross, Goubert, Cooper, & Zha, 2007; Walczyk & Taylor, 1996). A number of studies conducted by Walczyk and his associates with both young (but beyond the initial stage of reading acquisition) and mature readers (e.g., Walczyk *et al.*, 2001, 2004, 2007) have confirmed this postulation. For instance, for adult native English speakers, Walczyk (1995) compared correlations between word recognition and text comprehension in a reading situation with time pressure (known as timed hereafter) and a situation without time pressure (known as untimed hereafter). The results showed that in the timed reading condition, the measure of lexical access was correlated with comprehension. However, in the untimed condition, the correlation between lexical access and reading comprehension did not reach significance.

EMPIRICAL RESEARCH ON WORD RECOGNITION IN FL READING

Compared with a considerable number of word recognition studies in L1 reading, Koda (2005) contends that "word recognition, despite its significance, has received scant attention in L2 research" (p. 37). Past investigations in word recognition in FL reading have

demonstrated that FL readers' word recognition is much inferior to native speakers of that language (Koda, 1994; Haynes & Carr, 1990; Muljani, Koda, & Moates, 1998). Even among fluent or balanced bilingual readers whose L1 and L2 are typologically and linguistically similar languages (i.e., both alphabetic languages using Roman scripts), such as English and French and English and Irish (e.g., Favreau & Segalowitz, 1983; Mack, 1986), the word recognition in L2 is much slower compared to their word recognition in L1. With increased exposure to FL print and accumulated FL reading experience, not only do learners' word recognition error rates decrease (Segalowitz & Segalowitz, 1993), but also their word recognition speed increases (Favreau & Segalowitz, 1982; Haynes & Carr, 1990), and FL readers are able to achieve automaticity in FL word recognition (Segalowitz, Segalowitz, & Wood, 1998).

Research in reading in a FL needs to consider a number of additional aspects compared to research in L1 reading, including elements such as L1 orthographic background, FL print input properties, FL experience (e.g., FL proficiency and FL print experience), and an interplay of these elements (Koda, 2005, 2007). These factors have also been considered in FL word recognition research, which has produced three areas of concentration: (1) learners' L1 orthography, (2) FL experience, and (3) FL print input effect. In addition, similar to L1 word recognition research, a fourth research concentration in FL word recognition research is to investigate the relationship between word recognition and reading outcomes in FL reading (Koda, 2007; Yamashita, 2013). As studies with this fourth research focus have produced more contentious results compared to the other three foci, description and critique of studies in this area have been given more attention.

FL WORD RECOGNITION RESEARCH WITH A CONCENTRATION ON L1 ORTHOGRAPHY

L1 orthographical backgrounds of FL readers have long been a focus in FL word recognition research. The reasoning behind this line of research is rooted in differences between the writing systems of languages in terms of how speech sounds (phonology) correspond to basic linguistic units (orthography) (Hamada & Koda, 2010; Inutsuka,

2009; Koda, 2007; Yamashita, 2013). Three different kinds of basic linguistic units are distinguished in orthographies: namely phonemes, syllables, and morphemes (Cook & Bassetti, 2005). Phonemes are the basic units in alphabetic languages, such as English, French, and Dutch; syllables are the basic units in a syllabary system, such as Japanese kana; and morphemes are the smallest representational units in logographic languages, such as Chinese and Japanese Kanji (also known as morphosyllabic languages) (Cook & Basseti, 2005; Perfetti, 2003; Ziegler & Goswami, 2005, 2006).

Research has consistently found evidence that word recognition in reading different orthographies makes different demands on cognitive processes (Cook & Bassetti, 2005; Koda, 2005, 2007; Inutsuka, 2009; Shiotsu, 2009; Yamashita, 2013). Reading in alphabetic languages requires readers to segment phonemes and to conduct intra-word analysis; whereas reading in logographic languages places much fewer demands on intra-word segmentation abilities. Logographic readers rely less on phonological information and more on holistic visual information (Adams, 1990; Inutsuka, 2009; Koda, 2005, 2007).

The above discussion about orthographies has implications for FL reading because word recognition skills are able to be transferred from L1 to FL. As a result, learners' L1 orthographies have deep and profound effects on FL word recognition processes (Akamatsu, 2005; Hamada & Koda, 2008, 2010, 2011). Research on cross-linguistic studies examining FL word recognition skills have consistently demonstrated that the distance between the orthographical backgrounds of readers' L1 and FL results in "procedural divergence" and "qualitative differences" in FL readers' word identification behaviours (Koda, 1996, p. 454). Previous studies have collectively shown that similarity between L1 and FL orthographies accelerates acquisition of FL word recognition skills, but a large distance between L1 and FL orthographies (i.e., alphabetical languages vs. logographical languages) adversely affects transfer of word identification skills from L1 to FL (e.g., Akamatsu, 1999, 2003, 2005; Brown & Haynes, 1985; Chikamatsu, 1996, 2006; Fender, 2003; Green & Meara, 1987; Holm & Dodd, 1996; Koda, 1988, 1990, 1998; Muljani *et al.*, 1998; Ryan

& Meara, 1991; Sasaki, 2005; Wade-Woolley, 1999; Wang & Koda, 2005; Wang, Koda, & Perfetti, 2003). A handful of studies on the comparison of English word identification skills by learners from different L1 backgrounds have suggested that learners from a logographic language background (e.g., Chinese and Japanese) employ qualitatively different processing strategies to process English words from learners from an alphabetic language background (e.g., Arabic, Indonesian, Korean, Persian). Moreover, language background is associated with quantitative variations in terms of accuracy and speed in English word recognition (Akamatsu, 1999, 2003; Koda, 1988, 1989, 2000; Muljani *et al.*, 1998; Wang *et al.*, 2003; Wang & Koda, 2005).

These studies have repeatedly found that alphabetic background learners are faster and more accurate in English word recognition than logographic learners (e.g., Hamada & Koda, 2008; Koda, 2000; Muljani *et al.*, 1998; Wang & Koda, 2005); and logographic learners tend to be affected more in word recognition by visual shapes of words compared to alphabetic learners (e.g., Akamatsu, 1999, 2003). In two studies conducted by Akamatsu (1999, 2003), comparisons were made between Persian (alphabetic) and Chinese and Japanese (logographic) FL readers in terms of both oral word reading and oral passage reading of visually distorted English words (e.g., time vs. tImE). The results jointly demonstrated that Chinese and Japanese learners' word reading and passage reading were more adversely impacted by the distortion of visual shapes of words compared to their Persian counterparts.

Moreover, there is dissociation between visual decoding and phonological decoding abilities among logographic learners (e.g., Brown & Haynes, 1985; Sasaki, 2005; Wang *et al.*, 2003). For instance, Wang *et al.* (2003) found that logographic learners were much more influenced by an orthographic similarity effect (words with similar spelling but not similar pronunciation) compared to alphabetic learners, who were much more affected by a phonological similarity effect (words with similar pronunciation but not similar spelling) in English word processing. In another study, Brown and Haynes (1985) compared English word recognition among Arabic,

Japanese, and Spanish EFL learners. They used two tasks for measuring word recognition: (1) visual discrimination of English words and pseudowords, and (2) oral pronunciation of English words and pseudowords. The results showed that while Japanese learners performed best in both accuracy and latency for visual word discrimination, they performed worst in an oral pronunciation task. The divergent results have provided some evidence for the dissociation of visual and oral phonological decoding abilities of English words among logographic learners. These studies indicate that when comparing FL word recognition skills with learners whose L1 involves logographical languages (e.g., Chinese and Japanese), both visual and oral phonological decoding measures should be used in order to guard against the biased oral decoding measures towards learners with a logographical language as a L1.

FL WORD RECOGNITION RESEARCH WITH A CONCENTRATION ON FL EXPERIENCE

In the research on foreign language learning in general, the most frequent index for FL experience is language proficiency. Language proficiency has been examined to find out its effect on FL word recognition. Similar to the results on the influence of language proficiency in other language skills, language proficiency also affects FL word recognition skills. With the increased level of language proficiency of FL learners, not only does FL word recognition speed increase (Favrean & Segalowitz, 1982; Haynes & Carr, 1990), but error rate decreases (Bernhardt, 1991). With increased proficiency level, the length of eye fixation in recognizing words is also significantly reduced, although the number of eye fixations of low-proficiency FL readers is the same as those of high-proficiency FL readers (e.g., Bernhardt, 1984; Saito, 1989).

Research has shown a specific interest in exploring whether the interplay between proficiency and L1 orthographic backgrounds jointly affects FL word recognition performance (Koda, 2007; Inutsuka, 2009; Yamashita, 2013). However, these investigations have not produced consistent results. Some studies have shown that the earlier and longer the exposure to FL print, the better performance is on FL word recognition, irrespective of L1

orthographic effects (e.g., Jackson, Chen, Goldsberry, Kim, & Vanwerf, 1999; Wade-Woolley & Geva, 1999).

On the other hand, other studies have indicated that, regardless of FL reading experience, L1 orthographic effect has a lasting impact on FL word recognition) (see Akamatsu, 1999, 2005; Chikamatsu, 2006; Koda, 1996, 2005, 2007; Yamashita, 2013). For instance, Akamatsu (1999) contends that through L1 reading experience, readers have modularized the optimal cognitive processing strategies for a particular orthography, which may be hard to modify in word recognition when they read in an FL. Empirical studies of both Akamatsu (2005) and Chikamatsu (2006) appear to support such a view. Akamatsu (2005) compared the performance of the naming accuracy and latency of reading normal English words and visually distorted English words (e.g., time vs. tImE) between proficient and poor Japanese EFL learners. The results showed that proficient readers were slower and less accurate in pronouncing the visually distorted English words than the normally displayed English words. The researcher interpreted this finding as that "the nature of L1 orthography affects L2 word recognition processes so deeply that L2 reading proficiency could not influence L1 orthographic effects on the efficiency of processing the constituent letters in an English word" (Akamatsu, 2005, p. 253).

Similarly, in another study on word recognition other than in English, Chikamatsu (2006) compared native English speakers learning Japanese at higher and lower proficiency. The higher proficiency group showed decreasing reliance on L1 word recognition strategies in reading katakana and hiragana only in the single word recognition task, but not in the contextual word recognition task. These studies jointly tell us that even at a more advanced level, FL readers' word recognition may be still affected by their L1 word processing strategies, and that FL proficiency may not be able to offset the profound influence of L1 word recognition skills on FL word recognition skills.

FL WORD RECOGNITION RESEARCH WITH A CONCENTRATION ON FL PRINT INPUT

As has been stated, the third focus in FL word recognition is the effect of FL print input on FL word recognition. Different from the research on the influence of L1 orthographical backgrounds on FL word recognition, this area of research does not aim to investigate the effect of a specific language, rather it aims to reveal the commonalities of FL word recognition irrespective of learners' L1 backgrounds. Two aspects of FL print input characteristics, namely orthographic regularity (i.e., the degree of regularity with which the phonology of a word is mapped onto its orthography) and word frequency (i.e., whether the word is a high-frequency word or a low-frequency word) have been examined (Koda, 2007; Inutsuka, 2009; Yamashita, 2013). Research in this area has generally demonstrated that regardless of FL readers' L1 backgrounds, they perform better on regular words compared to irregularly spelled words, and they are better on high frequency than on low frequency words (e.g., Akamatsu, 2002; Brown & Haynes, 1985; Chikamatsu, 2006; Hamada & Koda, 2008; Muljani *et al.*, 1998; Wang & Koda, 2005). For example, using a lexical decision task, Muljani *et al.* (1998) found that Indonesian learners of English (alphabetic background) and Chinese learners of English (i.e., logographical background) responded to high frequency English lexical items faster than to low frequency English lexical items. Similarly, Akamatsu (2002) used a naming task to examine whether regularity features affect word recognition performance among three groups of learners with advanced level of proficiency (i.e., Chinese, Japanese, and Persian). The stimuli he used were 40 high- and 40 low-frequency monosyllabic English words. For each frequency type, there were 20 regular and 20 exception words. The results revealed that irrespective of learners' backgrounds, they tended to recognize high-frequency irregular words as quickly as high-frequency regular words, but they tended to take more time to process low-frequency irregular words than low-frequency regular words.

The impact of input properties has also been examined in learning other languages as a FL. Among novice English learners of Chinese,

Wang, Perfetti, and Liu (2004) selected frequency of Chinese characters based on textbooks, and found that the participants' performance in lexical decision tasks on detecting violations of Chinese character structures were faster and more accurate when detecting higher-frequency characters than with lower-frequency characters.

Collectively, these studies have demonstrated the universal role of regularity and frequency of lexical items on FL word recognition performance, which is similar to the findings in L1 word recognition research. What may differ from L1 research is that the frequency effect may not necessarily be the true frequency of a word for FL readers. In particular, when a FL learning primarily occurs in a situation of a formal language classroom rather than in naturalist setting, frequency of words based on curricula and textbooks may be a more accurate indicator of word recognition performance.

FL WORD RECOGNITION RESEARCH ON THE RELATIONSHIP BETWEEN FL WORD RECOGNITION AND FL READING COMPREHENSION

Compared with the considerable number of studies in L1 reading on the role of word recognition in text comprehension, there are far fewer studies in FL reading. The relationship between FL word recognition and FL reading has not generated conclusive results (e.g., Haynes & Carr, 1990; Koda, 1992; Nassaji & Geva, 1999; Stevenson, 2005; van Gelderen *et al.*, 2004). A few reasons may explain the conflicting results: firstly, differences in measurements may have contribute to the inconsistent results; secondly, there may be differences in the populations examined (e.g., children vs. adults, alphabetic L1 learners vs. non-alphabetic learners); and thirdly, similar to L1 studies, the relationship between FL word recognition and FL reading comprehension may also be affected by the reading time allocated to readers. The review below will be arranged in the order of the three reasons stated above.

In FL word recognition research, most studies have employed measurements of word recognition similar to those used in L1 studies. Such measurements only measure word decoding or phonological

decoding without measuring whether or not meaning is accessed. Commonly used tasks are naming tasks, which require readers to read both real words and pseudowords aloud, and lexical decision tasks, which ask readers to make a judgment as to whether letter strings are real words or not.

In L1 reading, there is still a debate on whether word decoding leads to lexical access. On the one hand, some researchers believe that successful word decoding automatically leads to lexical access even among young children (Ehri, 1992). However, other researchers maintain that in order for meaning to be automatically activated from word decoding, the meaning of a word must be adequately established in memory (Bowers & Wolf, 1993; Nation & Snowling, 1997, 1998; Stanovich, 2000). Among FL learners, word decoding does not necessitate activating a connection to meaning, or may only lead to a weak connection to meaning (Grabe, 2009; Shaw & McMillion, 2008). As Nation (2013) points out, FL learners may know the form of a word but not have a concept of its meaning. "It is also possible to be familiar with the form, to have the appropriate concept but not to connect the two" (p. 64). He further maintains: "t[T]he strength of the connection between the form and its meaning will determine how readily the learner can retrieve the meaning when seeing or hearing the word form, retrieve the word form when wishing to express the meaning" (p. 64). Therefore, it cannot be assumed that recognizing the orthographic form or pronouncing the phonological codes of a word guarantees successful access to the semantic meaning of that word in FL readers' mental lexicons (Grabe, 2009; Jeon, 2009; Lems, 2003; Shiotsu, 2009). It is sometimes the case that FL readers can distinguish real words from pseudowords, they can sound a word out, or they can realize that a word has been encountered before; but they do not know the meaning of the word, or the meaning is vague and the connection between the word form-meaning mapping is not well established (Grabe, 2009; Nation, 2013; Shaw & McMillion, 2008).

Indeed, psycholinguistic research has consistently reported that correspondences between word forms and concepts appear to be weaker and less direct than in L1 (Jiang, 2000; Kroll & Tokowicz,

2001). FL reading studies have also reported that lexical decision tasks, which require access to meaning, are much slower than phonological decoding tasks, which do not involve meaning access (e.g., Shiotsu, 2009). For instance, Shiotsu (2009) found that a lexical access task required an additional 90.00% of processing time compared with a word decoding task among Japanese EFL learners at university level. Shiotsu (2009) examined differences in three components of word recognition as measured via visual word decoding, visual pseudoword decoding, and lexical access between proficient and less proficient Japanese EFL readers. The results demonstrated that there were significant differences in pseudoword decoding and lexical access, but not in real word decoding. He concluded that skilled and less skilled readers did not necessarily differ from each other "at processing the visual forms of real words, but they were much slower at accessing the meanings of such words" (p. 37). This may also suggest that word decoding and lexical access are different constructs.

In terms of different populations, research has found a moderate relationship between word recognition and comprehension among FL children (e.g., Crosson & Lesaux, 2010; Droop & Verhoeven, 2003; Yaghoub Zadeh, Farnia, & Geva, 2012). The strength of association between word recognition and comprehension appears to be similar to that of L1 children. As the children are at the beginning of their reading acquisition, word recognition appears to be a significant predictor of comprehension compared to adolescent and/or adult populations.

For adolescent and/or adult populations, the relationship between word recognition and text comprehension appears to be inconsistent. On the one hand, word recognition has been shown to positively correlate with FL reading comprehension among learners of English with an alphabetic language background (e.g., Jeon, 2009; Nassaji, 2003; Nassaji & Geva, 1999) or non-alphabetic background (e.g., Inutsuka, 2009; Tsai, 2008), as well as in languages other than English as a FL (e.g., Koda, 1992), suggesting that the more efficiently a FL reader recognizes a word, the better he/she can perform in text comprehension. For instance, Nassaji and Geva

(1999) used a standardized test – the word reading section of the Wide Range Achievement to measure accuracy of word recognition of English learners speaking Farsi as L1. They found that word recognition was significantly and moderately associated with reading comprehension (r=.53). The word recognition in this study, however, did not involve a semantic access component. Besides, word recognition measured by oral reading may not accurately reflect how English words are processed in normal silent reading for comprehension.

With adolescent Korean EFL learners, Jeon (2009) found that naming efficiency of both words and pseudowords (a combination of accuracy and speed) positively correlated with reading comprehension. She found that word recognition was a significant contributor (path coefficient is .54) to the comprehension factor in Structural Equation Modeling, which has an advantage over correlation and regression in that it is robust enough to deal with measurement error variance (Byrne, 2009). It should be pointed out that the comprehension factor in this study is not a pure reading comprehension measure, as the comprehension factor is a summation of reading comprehension, metacognitive reading awareness of strategy use, and listening comprehension. Hence, the results cannot be compared to other studies that used pure reading comprehension scores.

In another study with advanced Japanese EFL learners, Inutsuka (2009) also found that word recognition as measured by accuracy and speed of reading English words out loud was a significant contributor to text comprehension when no sub-lexical processing variables (phonological and orthographic processing) were added to the model. However, as the word recognition variable was significantly related to the sub-lexical variables, when phonological and orthographic processing were included in the model, it was no longer a significant contributor to reading comprehension. The researcher interpreted the results as an indication of the importance of sub-lexical processing in explaining FL reading performance at both word and text levels.

Tsai (2008) also investigated the interrelationships between sub-lexical processing (phonological and orthographical), word recognition, and reading comprehension in English reading with a different population - Chinese EFL learners. Different from the above oral tasks, this study used a lexical decision task, which required judgment on whether letter strings were real- or pseudo- words to measure word recognition (a visual task). He found that word recognition is positively and significantly related to reading comprehension. However, the strength of the relationship between word recognition and reading comprehension (r=.17) is much weaker than in Nassaji and Geva (1999) (r=.53). This may suggest that word recognition may have different associations with reading comprehension among learners speaking an alphabetic language and learners with a non-alphabetic language as their L1. A serious measurement problem in Tsai's study is that word recognition test incorporates neither a meaning nor a speed component. This kind of measurement of word recognition is likely to only test the participants' vocabulary knowledge.

In a non-English reading context, Koda (1992) tested the word recognition efficiency of American learners of Japanese with two indicators: lexical access of both Kanji and Hiragana. She found that Kanji recognition could explain 36.00% of variance in paragraph comprehension in the fall semester, and Kanji and Hiragana recognition together could explain 53.00% of variance in paragraph comprehension in the winter semester. One problem with Koda's (1992) word recognition measure was that she timed the handwriting of the Kanji and Hiragana meanings within 3 minutes. This measure may be confounded by the handwriting speed of the participants. Similarly, in a recent study, Shen and Jiang (2013) also reported that both Chinese character-naming accuracy and Chinese character-naming speed significantly contributed to reading comprehension in Chinese for beginning learners.

On the other hand, word recognition has been found not to influence comprehension significantly for both learners from an alphabetic background, such as Dutch (e.g., Fukkink, Hulstijn, & Simis, 2005; Stevenson, 2005; van Gelderen *et al.*, 2003, 2004, van

Gelderen, Schoonen, Stoel, de Glopper, & Hulstijn, 2007), and learners from a non-alphabetic background, such as Chinese and Japanese (e.g., Haynes & Carr, 1990; Yamashita, 2013). In two large scale studies with adolescent Dutch EFL learners, van Gelderen *et al.* (2003, 2004) adopted Structural Equation Modeling to examine predictions about learners' metacognitive knowledge, English vocabulary and grammar knowledge, English word recognition speed, and sentence reading speed, in relation to English reading comprehension. The English word recognition speed was measured by a lexical decision task which asked the participants to judge as quickly as possible whether the letter strings are real or pseudo English words. The results showed that although speed of English word recognition significantly related to FL reading comprehension as reflected in correlation analysis, it was not a significant contributor to English reading comprehension in the full structural model. In another related study with a longitudinal design, van Gelderen *et al.* (2007) used similar measurements and found that word recognition speed had a significant effect on FL reading only among grade 8 students, but such effect disappeared in grades 9 and 10. This may suggest that similar to L1 children, word recognition may play a significant role in the initial stage of learning reading in a FL.

The non-significant relationship between word recognition and reading comprehension in FL reading was further supported by an intervention study with Dutch EFL learners. Fukkink *et al.* (2005) employed computer programs to train English word recognition. Although such training significantly improved students' word recognition speed, the improvement did not bring about better reading comprehension.

With non-alphabetic background learners, some non-significant results for the predictive power of word recognition to text comprehension have also been observed. A study conducted by Haynes and Carr (1990) found that Chinese EFL learners' word recognition, which was tested with word decoding and lexical access measures, only positively correlated with English reading speed, but did not correlate with text comprehension. In a recent study, Yamashita (2013) examined three aspects of word recognition as

measured by real- and pseudo-word decoding, and lexical access, in relation to English reading rate and text comprehension among Japanese university students. The results displayed both similarities and differences from the findings in Haynes and Carr (1990). The study indicated that both real- and pseudo-word decoding were only associated with reading rate rather than levels of text comprehension. However, lexical access was significantly related to, and was a significant contributor to, both reading rate and comprehension. The results were interpreted as providing support for differential contributions by the three aspects of word recognition to FL reading. Yamashita (2013) further maintained that decoding might only make an indirect contribution to comprehension via reading rate. Despite the contribution that the above two studies make to the fine-tuned examination of three aspects of word recognition to FL reading, both suffer from the major measurement problem of a paper-and-pencil format in the word recognition tests. Presumably, these are far less accurate compared with computerized tests. This defect may have impacted on the reliability of the results of the two studies.

In terms of the influence of reading time on the relationship between FL word recognition and reading comprehension, two studies that were carried out to test the utility of the CEM proposed in L1 (Walczyk, 1993, 1995, 2000; Walczyk *et al.*, 2001, 2007; Walczyk & Taylor, 1996) may shed some light on this issue. The first study was undertaken with English learners speaking an alphabetic language – Dutch. With 22 Dutch adolescent EFL readers, Stevenson (2005) measured (1) word recognition speed by a computerized lexical decision task, which required the participants to decide as quickly as possible whether letter strings were real English words or not; and (2) reading comprehension. The results suggested that word recognition speed did not correlate with reading comprehension. As readers thought aloud while reading the texts and thinking-aloud gives readers sufficient time to process a text, which may simulate untimed reading as proposed in the CEM, this study provides empirical evidence that in untimed reading, word recognition is not related to text comprehension in FL reading.

In another recent study with English learners of a non-alphabetic language as L1 (Chinese), Han (2014) compared the relationship between word recognition and reading comprehension of FL readers who were university students in two reading conditions (timed vs. untimed). To maximize accuracy, Han used a computerized lexical access measure that involved learners accessing the meaning of English words through decoding. Her results showed that the FL readers whose lexical access efficiency of English words significantly related to their FL reading comprehension only in timed reading (r=-.22), whereas the relationship between lexical access efficiency and reading comprehension was not significant in the untimed reading condition. These results seem to suggest that the strength of the relationship between word recognition and reading comprehension may depend on reading varying time, as proposed by the CEM for L1 reading. One problem with Han's study is that she did not include a measure of word decoding. This makes it difficult to see whether word decoding and lexical access measure the same constructs or whether they affect reading comprehension in a similar way. This issue can be addressed in the future directions in FL word recognition research discussed below.

FUTURE DIRECTIONS IN FL WORD RECOGNITION RESEARCH

Measurement issues in FL word recognition research

This critical literature review of previous studies in word recognition research in FL reading has revealed a number of issues that warrant further investigation. First and foremost, one serious problem in FL word recognition research is inconsistency and lack of validity in the measures. Most researchers adopt word decoding – the popular measurement for word recognition in L1 reading – in FL reading, and assume word decoding naturally entails access to meaning of words. Whether word decoding and lexical access measure the same constructs needs to be empirically tested. To date, only scant research has been carried out to comparer word decoding and lexical access for FL readers, and this research has only been conducted with learners with an alphabetical language background (Saiz, 2007).

Saiz found that although word decoding and lexical access are related, they represent two separate constructs for FL readers among L1 learners speaking an alphabetic language. Future studies may also look into whether word decoding and lexical access measure the same constructs for learners of logographic languages, such as Chinese and Japanese.

Word recognition and vocabulary acquisition

Although word recognition has been traditionally associated with reading only, recent developments show that word recognition may also affect both intentional and incidental vocabulary acquisition in a FL. However, research on the role played by word recognition efficiency in FL vocabulary acquisition has just started and no conclusions can be made based on the results of just a few studies. For intentional vocabulary learning, a learner's ability to extract phonological information from print (known as phonological decoding) is "a vital component in learning and remembering new words" (Hamada & Koda, 2008). This is because a quick and efficacious capacity for converting graphic symbols into corresponding sounds may facilitate newly obtained information (e.g., sounds and/or spelling of a new word) being integrated into working memory (Hamada & Koda, 2008). Hamada and Koda (2008) found that decoding efficiency affected learning of new English words through pictures among English learners with an alphabetic background but not with a non-alphabetic background. As for incidental vocabulary learning, fast and effort-free recognition of existing words may enable readers' working memory to be freed up, so that it can be used in processes involved in successful incidental vocabulary learning, including noticing, inferring, and integrating to be learnt words into the existing mental lexicon (Hamda & Koda, 2010; Pulido, 2004, 2009). Hamada and Koda (2010) did not find word decoding efficiency influenced incidental vocabulary learning during reading among non-alphabetic L1 learners of English. However, Han (2014) reported that lexical access inefficiency could inhibit incidental vocabulary learning among Chinese learners of English. The conflicting results from the limited number of studies suggest that

more research needs to be carried out to examine the relationship between word recognition and vocabulary learning.

Sub-lexical processing and word recognition

In recent years, a growing number of studies have been carried out on the role of sub-lexical processing in word recognition and reading comprehension among young L1 readers and young bilingual readers who acquire two languages and literacy skills simultaneously (e.g., *phonological:* Gholamain & Geva, 1999; Wade-Woolley & Geva, 2000; *morphological:* Nagy, Berninger, & Abbot, 2006; Wang, Ko, & Choi, 2009; *orthographical:* Tong & McBride-Chang, 2010; Wang *et al.*, 2005; Wang, Park, & Lee, 2006). However, there is a lack of investigation of the relationship between sub-lexical processing and word recognition, and reading comprehension among adult FL readers, who have well-established L1 linguistic and literacy skills before acquiring another language. To investigate this issue properly, researchers should make a clear distinction between sub-lexical knowledge and sub-lexical processing, as the former does not involve speed measures. However, having knowledge does not always guarantee that one can use such knowledge efficiently during online processing in reading (Eskey & Grabe, 1988; Fender, 2001; Nassaji, 2007). Secondly, future studies may also consider adopting a Structural Equation Modelling (SEM) approach to include sub-lexical processing, word recognition, and text comprehension simultaneously in a single model. As SEM has the advantage of being able to incorporate measurement error variance in a way that does not affect parameter estimates in model testing (Byrne, 2009), such studies can examine whether sub-lexical processing makes a unique and direct contribution to comprehension, or whether sub-lexical processing contributes to text comprehension indirectly through mediation of word recognition.

CONCLUSION

This article first defined word recognition and briefly overviewed L1 word recognition research, which laid the foundations for FL word recognition research. From the review, it can be seen that, although FL word recognition research shares common interests with L1 word

recognition in terms of exploration of the influence of print input properties to word recognition skills, and the role of word recognition in reading comprehension, due to the unique characteristics of FL reading, which has a dual involvement of two languages, FL word recognition research has established its own routes of pursuit: namely L1 orthographic background and FL experience of learners.

This synthesis of FL word recognition research can also provide some useful information for FL language instructors. In particular, teachers should be aware of the L1 background of FL learners at the beginning of learners' acquisition of reading skills. They may, for example, provide special support and adopt some activities to enhance non-alphabetic language learners' intraword analysis skills when they start to learn to read in an alphabetic language. Teachers may wish to use word decoding tasks and lexical access tasks to test word recognition efficiency of their students, and for those students who are inefficient word recognizers, some training programmes can be designed to increase their word recognition efficiency.

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