Lang. Teach. (2014), **47.1**, 1–37 © Cambridge University Press 2013
doi:10.1017/S0261444813000396

State-of-the-Art Article

The role and importance of lower-level processes in second language reading

Hossein Nassaji University of Victoria, Canada
nassaji@uvic.ca

This article examines current research on the role and importance of lower-level processes in second language (L2) reading. The focus is on word recognition and its subcomponent processes, including various phonological and orthographic processes. Issues related to syntactic and semantic processes and their relationship with word recognition are also discussed. When examining the role of these processes, an important focus is also on cross-linguistic variables and the various ways in which they facilitate or impede the development of L2 reading skills. The review concludes with a discussion of the implications of the issues addressed for L2 reading instruction and directions for future research.

1. Introduction

Reading is not a simple process, but a complex, multi-component skill that involves an intricate combination of many lower- and higher-level cognitive, linguistic, and non-linguistic skills and sub-skills. Because reading involves multiple skills and knowledge sources, an analysis of the contributions of these components is critical to understanding how second language (L2) reading acquisition and comprehension occurs. In addition, L2 reading is a cross-linguistic process, involving more than one language (Koda 2005). Therefore, a number of L2-specific factors are involved in L2 reading, such as first language (L1) transfer, learners' level of L2 proficiency, and previous literacy experience. These characteristics increase the complexity of L2 reading, so their investigation has profound implications for any theory of L2 reading comprehension and development. An examination of these issues is also essential because they help identify the specific problems that L2 readers experience, and can thus contribute to more effective L2 reading instruction.

However, although current conceptualizations see reading as a complex cognitive operation, consisting of an integration of both lower- and higher-level processes, studies of L2 reading have traditionally been influenced heavily by L1 top-down frameworks, such as the psycholinguistic models (Goodman 1967, 1988) and schema-theoretic views of reading comprehension (Rumelhart 1980; Anderson & Pearson 1984). These models emphasized the role of higher-level conceptual and background knowledge sources in reading, downplaying to a large degree the contributions of basic lower-level graphophonic processes. In recent

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

years, however, the pendulum has swung back to a more balanced position regarding the role of different component processes involved in L2 reading, so a growing body of research has begun to explore the nature and the contributions of lower-level sub-component processes in L2 reading, including word recognition and graphophonic processes. Although still limited in extent, this research has provided substantial information about how these processes work and what contributions they make to L2 reading comprehension skills. In addition, a number of cross-linguistic studies have examined differences in basic reading sub-skills across languages and orthographies. These studies have explored how readers from different L1 orthographic backgrounds process L2 written texts and have thus advanced our knowledge of the unique nature of L2 processes and the specific mechanisms involved in their acquisition. Recent studies have also begun to examine the effects of other variables such as general linguistic ability, the amount of prior L1 and L2 experience, and L2-specific processing strategies. This research has offered additional insights into the diversity of factors that can influence L2 lower-level processes, including phonological and orthographic processes.

This review article examines and discusses this emerging body of research on lower-level processes in L2 reading. Through a detailed synthesis of current theory and research, it examines the range and nature of the empirical evidence currently available on the role of these processes and the contributions they make to L2 reading comprehension and development. Due to the limited scope of the paper, the focus is on L2 word-recognition processes and their subcomponents, including phonological and orthographic processing skills. I begin by providing a brief overview of the past and current theoretical positions on reading and how they view the importance of lower-level processes, and then examine research that has addressed their role in L2 reading.

2. Different views of reading: Past and present

Three kinds of perspective have been dominant in most L1 and L2 reading research in the past few decades. These frameworks have been traditionally called bottom-up, top-down, and interactive views of reading. Most early theories took a stringently bottom-up approach, considering reading as consisting of a series of successive stages, starting with a visual analysis of letters and words, then combining them to construct phrases and sentences, and finally building a semantic representation of the text in a sequential fashion (Gough 1972; LaBerge & Samuels 1974). In this view, the major role was ascribed to decoding processes, with little attention paid to comprehension processes. Failure at decoding was thus considered to result in inevitable and irreversible failure in reading comprehension.

Later perspectives held an opposing top-down position, conceptualizing reading as primarily a reader-driven activity. It was assumed that text comprehension was mainly based on what readers brought to the task, such as their conceptual and world knowledge. Notable among top-down views were the psycholinguistic models of Goodman and Smith, which saw reading as a game of guessing, sampling, predicting, and verifying top-down hypotheses (Goodman 1967, 1988; Smith 1994). The psycholinguistic models emphasized higher-level syntactic and semantic skills, minimizing the contributions of basic lower-level phonological and orthographic processes. Individual differences in reading were instead understood mainly

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

in terms of differences in higher-level knowledge sources, including the ability to use syntactic and semantic cues, rather than lower-level graphophonic information. In particular, the phonological interface between the graphic representation of words and their meaning was completely ignored. Smith (1994) argued that reading is only incidentally visual and the role that graphophonic processes play in recognizing written words is negligible.

The field of L2 reading was heavily influenced by such top-down views. Several L2 researchers developed models very similar to the psycholinguistic models of Goodman and Smith for L2 reading (Coady 1979; Rizzardi 1980). Coady, for example, presented an L2 reading model consisting of three main components: a) conceptual abilities, b) background knowledge, and c) process strategies. Coady argued that the problems L2 readers have are primarily conceptual. Although they might begin by paying attention to stimulus-driven processes, efficient reading involves a move away from using visual data-driven components to more abstract conceptual information.

Influenced by these ideas, much of the earlier L2 reading research, particularly that of the 1970s and 1980s, focused primarily on expectation-driven processes such as schemata and meta-cognitive knowledge sources, with little attention devoted to lower-level processes. About two thirds of the references in research articles during this period were to such top-down models (Bernhardt 2010). One reason for the great influence of these models on L2 reading was the assumption that reading processes are universal across languages. That is, no matter what kind of language the readers were reading in, there was only one way of reading, and that was the use of selecting, sampling, and predicting information based on minimal graphic cues. The other reason was that, in L2 research, no clear distinction was made between general L2 proficiency and lower-level processing abilities (Koda 2005). It was assumed that lower-level processing skills were simply by-products of language proficiency, and that as learners' overall language competence increased, their ability to process textual information automatically improved as well.

At present neither the strict bottom-up nor the top-down psycholinguistic models are popular in the field of L1 or L2 reading, as many of their premises have not been borne out by current research. Contemporary perspectives are all interactive in the sense that reading is considered to entail the combination and integration of various sources of information, including both lower-level text-based and higher-level reader-based knowledge sources. At least three interrelated sets of processes are considered essential in reading: first, decoding processes, concerned with recognizing and extracting meaning from the printed word; second, syntactic and semantic processes, concerned with combining the information extracted from the words into larger linguistic units used for understanding the meaning of the text; and, third, text-integration processes, concerned with the integration of text-based information and the reader's global knowledge for the purpose of general interpretation and mental representation of the text.

A feature of most current views is the importance attributed to the role of lower-level processes. In particular, taking an information-processing perspective, many reading researchers now consider reading as a complex information-processing task, in which rapid and efficient lower-level processes are critical to the operation of higher-level comprehension processes (Stanovich 1980, 1996, 2000; Perfetti & Roth 1981; Perfetti 1985, 2007; Rayner & Pollatsek 1989; Bell & Perfetti 1994; Perfetti & Hart 2001; Breznitz 2006).

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

'Lower-level processes' here are primarily the processes involved in recognizing words, including the visual recognition of features, letters, and the use of phonological and orthographic information (Bell & Perfetti 1994). They are distinguished from higher-level comprehension processes concerned with linking and combining the text together and arriving at a collective understanding of the whole.

In an information-processing view, although information from lower- and higher-level processing interacts to bring about comprehension, the two processing levels are not used reciprocally. Lower-level processes can be carried out reasonably well without top-down processes. However, the reverse is not possible (Perfetti & Roth 1981). In other words, although comprehension is an outcome of information provided from various levels of process, lower-level processing is not driven by higher-level processes. Rather, it 'seeks to synthesize the stimulus based on its own analysis and the constraints imposed by both higher and lower-level processes' (Stanovich 1980: 35). The idea of reading as a guessing game is strongly rejected here. Instead of being imprecise guessers, skilled readers are seen as efficient processors who sample the whole visual array of textual input. If any guessing occurs during reading, it is only as a last resort, to compensate for the poorly developed stimulus-driven processes. In short, regardless of how skillful readers are at higher-level processes, efficient reading comprehension is not possible unless they are highly competent at lower-level processes.

The centrality of lower-level processes in the information-processing views of reading results from a number of psychological principles considered central to reading. One of these is the notion of 'limited attentional resources' (Perfetti & Lesgold 1977; Shiffrin & Schneider 1977). According to this principle, people's attentional capacity is limited, so in order to carry out a complex cognitive task such as reading, they need to make optimal use of this cognitive system. If readers use a lot of their attentional resources to process lower-level information in the text, they will have less capacity left for higher-level comprehension processes. Thus, to have enough resources for comprehension processes, the reader must be highly competent and efficient at lower-level processing operations. This notion highlights the importance of efficiency and automaticity of lower-level processes as important aspects of skilled reading. The top-down psycholinguistic models reviewed earlier also assume that readers have limited attentional resources. However, they consider that readers should bypass the visual and word-level processes and instead rely on higher-level contextual redundancies for comprehension. Within an information-processing perspective, the limitation imposed by short-term memory indicates that the language-processing mechanism should include an efficient cognitive component that can process the incoming data within attentional limits.

Another central idea is that of the hierarchical structure of skills and sub-skills in reading. According to this notion, reading can be best conceptualized as a hierarchical structure consisting of various lower-order and higher-order sub-components. Although higher-level processes may constrain lower-level processes, the successful operation of a higher-level process in the hierarchy of skills depends on the efficient and accurate execution of those at the lower-level.

A third idea which has also been applied in a number of more recent cognitive models of reading is the principle known as connectionism (Hinton, McClelland & Rumelhart 1986; McClelland 1988; P. McLeod, Plaut & Shallice 2001). Connectionism proposes that the architecture of human cognition consists of a dynamic network of operations involving

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

simpler units or components that are activated and assembled in parallel, and act in parallel. In this view, the information-processing system is a multi-level one, and mental representations of texts are made at many different levels, ranging from letter-features, through words and syntax, to thematic and discourse levels. However, information-processing does not occur through, nor is it controlled by, higher-order concept-driven processes. It is, rather, mainly text-based and occurs through the processing of visual input, building up information in a network of associations activated textually and enhanced through reciprocal interactions occurring within and between levels (McClelland 1988; Plaut, McClelland & Seidenberg 1995; Seidenberg 2005). In other words, to comprehend a text, textual information must be successfully generated and updated by incoming information. Otherwise, there will be no data for higher-level comprehension processes, and the information processing system will fail.

Although many of the current conceptualizations have stressed the significance of lower-level processes, the roles played by these processes are not the same in L1 and L2 reading. Indeed, the processes involved in L2 reading may be quite different from those involved in L1 reading. L1 theory and research is based on the assumption that readers begin to read after they have developed an adequate level of oral language proficiency. Therefore, for L1 learners, the task of learning to read is mainly one of learning how to convert a graphic input into meaning that is encoded by a linguistic system already mastered to a high degree. This is not necessarily true of many L2 readers, who are far more limited in terms of their L2 proficiency and consequently have limited knowledge of basic L2 vocabulary and grammar. Indeed, for many L2 learners, the initial stages of learning to read may be less about acquiring information from the text than about developing basic language skills (Nassaji 2011). Furthermore, L1 readers often begin learning to read in childhood. Many L2 readers, however, are adults who are proficient in various aspects of their L1. They may also be learning an L2 in different instructional and social contexts and thus may have different degrees of L2 as well as socio-cultural knowledge. Such L1- and context-related knowledge and experiences and their associated skills can have important consequences for the development of L2 reading skills, including lower-level processing skills. Given these differences, it is crucial to understand how L2 readers process L2 texts, what strategies they use to do so, and how the similarities and differences between L1 and L2 affect L2 reading processes.

3. Lower-level processes

In the following sections, I examine research into the role of lower-level processes in L2 reading. Much of what we know about basic lower-level component processes is rooted in L1 theory and research. Therefore, in each section, I begin by looking briefly at what L1 research has discovered about these processes and then proceed to an examination of their role and relationships in L2 reading. In examining L2 research, I draw upon research in both children and adults to clarify the nature of these relationships. I first review research that has investigated the contributions of lower-level processes. Then, I examine cross-linguistic research that has investigated similarities and differences between L1 and L2 reading in

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

these areas, including cross-orthographic variations and their effects on L2 lower-level processes.

3.1. Word recognition

Among the lower-level processes in reading, one of the most critical is word recognition: the skill with which readers process the visual symbol in the print in order to recognize and access its meaning in the mental lexicon (another term used in the literature to refer to the same processes is 'word identification'). Word recognition is a complex skill, involving many sub-component processes, including visual analysis of the printed symbols, the identification of letters, knowledge about grapheme–phoneme correspondence, the generation and utilization of phonological codes from the print and, finally, the association of a word with its semantic representation (Segalowitz, Watson & Segalowitz 1995). Skilled reading involves all these processes, which through practice become fluent and even automatic.

The importance of word recognition has been amply documented in the L1 reading literature. It is supported by an extensive body of research, including detailed studies of eye movements and of reading comprehension and development. Studies of eye movements during reading, for example, have demonstrated that fluent reading involves a detailed processing of visual features on the page. The typical pattern has been shown to be more or less word-by-word (Rayner & Pollatsek 1989; Rayner 1998; Reichle, Rayner & Pollatsek 2003). Research in this area has also indicated that most content words and a great number of function words are directly fixated during reading (Just & Carpenter 1987; Rayner & Pollatsek 1989, 2006; Reichle et al. 1998). There is also evidence that words are processed visually even if they are highly predictable in the context (see Schotter & Rayner 2012 for a recent review).

Both comprehension and developmental studies have also shown that word recognition is one of the most robust predictors of reading comprehension among not only beginning readers but also adult native readers (Cunningham, Stanovich & Wilson 1990; Stanovich, West & Cunningham 1991; Bell & Perfetti 1994; Shankweiler et al. 1996; Holmes 2009). The contribution of word recognition to reading comprehension has been found to be independent of that of other skills such as listening, speaking, or even vocabulary proficiency (Perfetti & Hart 2001; Jackson 2005; Cutting & Scarborough 2006; Kendeou et al. 2009; Harlaar et al. 2010). These findings not only highlight the importance of word recognition but also suggest that general comprehension and word recognition are two distinct abilities (Gough & Tunmer 1986; W. A. Hoover & Gough 1990). Both are essential for successful reading comprehension, but reading comprehension is not possible without adequate written word-recognition skills, even if learners have substantial linguistic and oral language proficiency.

Since many studies have documented the importance of word recognition in L1 reading, L2 researchers have often used their findings as a starting-point, so fewer L2 studies have directly examined the contribution of word recognition to L2 reading. Instead, L2 research has been more concerned with the specific nature of L2 word recognition, focusing on determining how these processes differ in L1 and L2 reading or between L2 readers with different L1 backgrounds, experiences, or proficiency. These studies, which will be reviewed

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

in the section on cross-linguistic studies, have shown that while there are differences between L1 and L2 word-recognition processes and strategies, there are also many commonalities. For example, studies that have examined the contribution of word recognition to L2 reading have consistently shown that it is fundamental, and that this is true for readers from all language backgrounds. In particular, studies of younger learners have repeatedly shown that word recognition is one of the major predictors of reading comprehension among these L2 readers (Gholamain & Geva 1999; Geva & Wang 2001; Gottardo et al. 2001; Chiappe, Siegel & Wade-Woolley 2002; Gottardo 2002; Gottardo et al. 2008; Verhoeven & van Leeuwe 2009; Grant, Gottardo & Geva 2011). These studies, like L1 reading research, have shown that word recognition also makes a unique contribution to L2 reading comprehension when the contributions of other relevant variables are controlled.

The contribution of word recognition to beginner-level reading comprehension is understandable because beginners are still at the stage of developing their reading skills. It may be assumed that as readers gain proficiency, other skills, including general language proficiency or comprehension strategies, become more important for comprehension and word-recognition skills less. Indeed, there is research that has shown that as reading comprehension abilities increase, the correlation between the accuracy of word decoding and reading comprehension decreases (Gough, Hoover & Peterson 1996; Jackson 2005; Braze et al. 2007; Landi 2010). Such findings may be taken to suggest that the significance of word recognition for text comprehension reduces over time. In other words, they may be taken as evidence that word recognition skills are not very important for skilled reading. However, such findings do not indicate that word recognition is not critical to skilled reading. Rather, they may indicate that advanced level readers have reached a level of reading proficiency where they are able to read and identify words quickly and efficiently while devoting little attention to those processes.

Not many studies have examined the role of word recognition among skilled adult L2 readers. However, those that have, have indeed provided evidence that efficiency of word recognition is critical even when L2 readers are highly proficient (Favreau & Segalowitz 1983; Koda 1992; Nassaji & Geva 1999; Akamatsu 2003; Nassaji 2003a; Shiotsu 2009). One piece of such evidence comes from a study by Favreau & Segalowitz (1983), which examined the reading performance of two groups of advanced bilinguals: one group who were able to read in the L1 and L2 at the same speed and level of understanding and another who were advanced but read the text more slowly to reach the same level of understanding. The study found that the group who took longer to comprehend the text was also less efficient in processing L2 written words. Nassaji & Geva (1999) examined the role of lower-level processes among adult advanced ESL (English as a Second Language) readers (university graduate students). They found that measures of efficiency of word-recognition skills contributed significantly to reading comprehension by these readers. Nassaji (2003a) further found that these skills can, to a significant extent, distinguish skilled from less skilled readers within the same population. In a more recent study, Shiotsu (2009) examined the role of L2 word recognition in groups of Japanese EFL university students; this research also found that the success of advanced L2 readers in L2 reading comprehension was strongly related to efficiency and the speed with which they recognized written words.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

The above findings are important for two reasons. First, they highlight the importance of both precision and automaticity for skilled L2 reading. Second, they challenge the idea that visual word-recognition skills in an L2 are developed primarily as a result of general language proficiency. Since L2 reading comprehension has been shown to be strongly related to L2 proficiency, it has sometimes been assumed that L2 word-recognition skills are a by-product of L2 proficiency. For this reason, the finding that advanced L2 readers are slower than L1 readers has been interpreted as evidence of L2 readers' weakness in using higher-level language-oriented strategies, rather than any deficiency in word-recognition skills. It has also been contended that these readers may lack the necessary comprehension strategies, or that if they do possess them, they cannot make use of them (Carrell & Eisterhold 1983; Carrell 1988). However, there is evidence that challenges these speculations. Comparing L2 readers' text recall with that of L1 readers, Horiba, van den Broek & Fletcher (1993) found that L2 readers were capable of using higher-level information about the causal structure of the text and made even more extensive use of it than L1 readers. In another study, McLeod & McLaughlin (1986) found that L2 readers who, on the basis of their semantic and syntactic knowledge, should have been able to use higher-level prediction strategies, were still processing the text in a slow word-by-word fashion. According to McLeod & McLaughlin (1986), the readers in their study did not approach the reading task as a prediction task, even though evidence from their cloze test indicated that they were capable of guessing and making predictions on the basis of their general language knowledge. Given these findings, along with the fact that adult L2 readers bring to the reading task an array of higher-level processing skills that they have already developed in their L1 reading, it is very hard to accept that, if they are slower in reading, it is because of their lack of ability in using higher-level comprehension strategies (Nassaji 2002). It is quite possible that they have not yet developed enough efficiency and automaticity of word-recognition processes to enable them to make use of their higher-level knowledge sources as fast as is required in fluent reading. For fluent reading, Segalowitz & Segalowitz (1993) made a distinction between general speed of processing and automaticity, which they defined as a qualitative change in the efficiency of cognitive processing. They then found that high L2 proficiency readers were not only significantly faster in their word-recognition performance than low L2 proficiency readers but also showed increased cognitive efficiency or automaticity.

3.2. Graphophonic processes

Our mental lexicon contains at least three kinds of knowledge about words: knowledge about their visual form (their orthography), their pronunciation (their phonology), and their meaning (Coltheart 2006). Word recognition, whether in L1 or L2 reading, occurs when the reader encounters a visual orthographic symbol (or sequence of letters) pertaining to a word on the page and uses that information to pronounce the word and obtain the lexical meaning represented by that word in the mental lexicon. Therefore, two major subcomponent processes underlying word recognition are phonological and orthographic processes. It is the development of these two processes and their interactions that have been considered key in the development of accurate and efficient word recognition and consequently the acquisition

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

of reading skills (Perfetti 1985; Bell & Perfetti 1994; Berninger 1994; Berninger et al. 2000; Stanovich 2000; Perfetti & Hart 2001; Coltheart 2006).

3.2.1. Phonological processing

Phonological processing is the ability to use phonological information, that is, knowledge about the sound structure of one's language, when processing written words (Wagner & Barker 1994; Van Orden & Kloos 2005). The exact nature of this knowledge and how readers make use of it has been the focus of considerable debate. However, many researchers believe that the development of this lower-level processing skill is critical to normal reading (Adams 1990; Goswami & Bryant 1990; Wagner, Torgesen & Rashotte 1994; Goswami 2000; Hulme et al. 2005; Halderman, Asby & Perfetti 2012). According to Adams (1990: 157), without phonological skill, 'even skilled readers would find themselves faltering for fluency and comprehension with all but the very easiest of texts' (see Halderman et al. 2012 for a recent review).

Phonological processing involves a number of interrelated abilities, including phonological awareness (the ability to recognize and manipulate the sound constituents of oral language), phonological decoding (the ability to convert the visual print into its corresponding spoken form), phonological recoding (locating the word meaning in the mental lexicon through the use of phonological information), and phonological memory (the use of sound codes for temporary memory storage) (Wagner & Torgesen 1987; Wagner et al. 1994). Although there are still many outstanding questions about the details of these inter-relationships, an extensive body of L1 research has shown that these processing abilities play a very important role in the development of reading skills. For example, research has consistently shown a significant relationship between phonological decoding (measured, for example, in terms of learners' ability to read pseudowords) and reading, particularly at the early stages (Siegel & Ryan 1988; Stanovich & Siegel 1994; Share 1995; Share & Stanovich 1995; Shankweiler et al. 1996). Since reading builds on oral language, research has also shown a strong relationship between learners' ability to analyze spoken words into their constituent parts and reading development (phonological awareness). This skill has been found to play a crucial role in reading, not only with alphabetic languages, where individual sounds are represented by particular alphabetic letters or letter combinations, but also with non-alphabetic languages (Bryant et al. 1990; Hoien et al. 1995; Denton et al. 2000; Deacon & Kirby 2004; McBride-Chang 2004; Kim, Kim & Lee 2007).

As for phonological recoding (the use of phonological information in the identification and retrieval of the word meaning from the lexicon), there are currently different views about its role in reading. According to one popular model, the dual route model (Paap, Noel & Johansen 1992; Coltheart 2005, 2006), there are two routes to lexical access: a direct visual route whereby the lexicon is accessed as a whole unit through the visual properties of the words, and a phonological route whereby the lexicon is accessed through phonological information. The proponents of the dual route model believe that phonological and orthographic processes both contribute to word recognition but occur as independent processes during word recognition (Coltheart et al. 2001; Coltheart 2012), Another account, a single route connectionist

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

perspective, suggests a coordinate interplay between phonological, orthographic, and semantic processes, being activated by visual input and contributing interactively to identification processes (Jared & Seidenberg 1991; Harm & Seidenberg 2004; Plaut 2005).

Over the years, different versions of both dual route and connectionist models have been developed and used to account for various types of reading tasks and data (see Plaut 2005 and Coltheart 2012 for a more detailed review of these models). However, despite these different theoretical perspectives, most researchers agree that phonological processing is a key component of word recognition and reading (Perfetti & Zhang 1991; Castles & Coltheart 2004; Van Orden & Kloos 2005; Halderman et al. 2012). Such processes are considered to be relevant to reading, whatever the orthography of the language (Perfetti & Zhang 1991). Furthermore, although access via the phonological route was traditionally considered to be slower than access via the orthographic route, there is now increasing research evidence that phonological codes are also activated rapidly and automatically during lexical access (Alario, De Cara & Ziegler 2007; Halderman et al. 2012).

In the context of L2 reading, two major issues about phonological processing have been central. First, whether the various phonological processing skills shown to be essential in L1 reading are equally essential in L2 reading and, second, whether there is any relationship between L1 and L2 phonological processing skills. The latter line of research has been motivated by questions about whether there are any similarities or differences between the two and what factors can explain the possible differences. As far as the contribution of phonological processing is concerned, much attention in L2 reading research has been paid to the role of two aspects of this skill: phonological decoding and phonological awareness. Research that has examined the role of L2 phonological awareness has frequently found that – as with L1 reading – this skill is also a strong predictor of word-recognition ability among L2 readers, especially at early stages of reading development (Gottardo, Stanovich & Siegel 1996; Muter & Diethelm 2001; Chiappe et al. 2002; Lesaux & Siegel 2003; Geva & Yaghoub Zadeh 2006; Schiff & Calif 2007; Verhoeven 2007; Verhoeven & van Leeuwe 2008; Netten, Droop & Verhoeven 2011; Russak & Saiegh-Haddad 2011). This skill has been found to make a contribution even when learners come from different L1 backgrounds, and it is also independent of general oral language proficiency. For example, in a large-scale study of ESL grade 2 children from various L1 backgrounds (e.g., Chinese, Korean, Spanish, Persian, Polish, and Farsi), Lesaux & Siegel (2003) found that phonological awareness, measured in terms of rhyme detection, was a significant predictor of L2 word recognition and reading comprehension when the contribution of oral English proficiency measured through oral cloze tasks was controlled. Muter & Diethelm (2001) found that phonological awareness (measured by English phoneme completion and deletion tasks) was a significant predictor of reading performance among English learners from multilingual language backgrounds (e.g., English, French, Spanish, Japanese, Turkish, and Russian). Geva, Yaghoub-Zadeh & Schuster (2000) also found that English phonological awareness (measured by segmentation-deletion tasks) contributed unique variance to both English as an L1 and L2 word recognition after the contribution of vocabulary knowledge (a measure of language proficiency) and nonverbal intelligence were controlled.

L2 readers usually begin to read when their oral language proficiency is at a much lower level than L1 readers. It is therefore predicted that they will have greater difficulty in mastering

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

the ability to differentiate between target sounds in the L2 (Verhoeven 2011). Learners' limited oral ability can also affect their phonological decoding ability and consequently the development of their word-recognition processing skills. Studies that have compared L1 and L2 beginning readers have indeed shown significant differences in their phonological and word-decoding skills, and also the rate at which they develop these skills over time. For example, comparing the reading ability of students learning English as L1 and L2 in the third grade, Grant et al. (2011) found that English L1 readers significantly outperformed ESL students on measures of word decoding and phonological awareness. Differences were also found within ESL groups, which the researchers attributed to L2 readers' L2 literacy experiences and educational background. In a comparison of L1 and ESL readers in the first grade on measures of phonological awareness and word-recognition skills, Chiappe & Siegel (1999) found no difference between ESL and L1 readers on phonological awareness and word decoding strategies. However, they found that these measures significantly discriminated between average and poor readers in the two reader groups, a result which supports the idea that reading difficulties in both L1 and L2 relate significantly to difficulties in phonological processing.

Although many studies have examined the role of phonological awareness and decoding skills in L2 reading, far fewer have investigated the role of phonological recoding (the use of phonological information for lexical access). Little is therefore known about whether and to what extent phonological recoding is implicated in L2 lexical access. Despite the scarcity of research in this area, there is some evidence to suggest that phonological recoding is also involved in L2 reading. One such piece of evidence comes from Segalowitz & Hébert (1990), who examined the role of phonological recoding among advanced French and English bilinguals. Half of the bilinguals read at the same rate and half read at different rates in the two languages. The research used lexical decision tasks (involving phonologically ambiguous and unambiguous words and nonwords) and sentence verification tasks (involving meaningful sentences with and without homophones and meaningless sentences with congruent and incongruent homophones). The results of the lexical decision task showed no effects of phonological recoding in both groups of bilinguals, suggesting that the slower rate of reading in the L2 could not have arisen from a greater reliance on phonological codes during lexical access. The results of the sentence verification task, however, showed that while participants made more errors in both their L1 and their L2 in the congruent than in the incongruent conditions, in the meaningful homophone condition, the unequal-rate readers made more errors in their L2 than the equal-rate readers. These findings were taken to suggest that the lower skill level of the unequal bilinguals in processing the phonological code affected their judgment of L2 sentences. In other words, skills at processing the L2 phonological code facilitated semantic processing of L2 words during sentence comprehension. Another piece of evidence comes from Everson (1998), who investigated the relationship between phonological recoding (operationalized as learners' ability to pronounce words and knowing the meanings of those words) among English learners of L2 Chinese. The results of this study indicated a significant relationship between knowing the words' pronunciation and their meaning. Chinese orthography is different from English in that, in the former, characters represent words and meaning rather than alphabetic letters. Thus, the findings about the correlation between the ability

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

to pronounce the characters and comprehend their meaning could be interpreted to suggest that skillful use of phonological codes within the characters facilitated L2 lexical access.

3.2.2. Orthographic processing

Another aspect of word recognition is orthographic processing: the use of visual information when processing written words (Wagner & Barker 1994). There are two types of visual information contained in a word. One is the information related to the letters, letter shapes and positions as well as the combination of letters that comprises a specific word. This information, sometimes referred to as word-specific information (Barron 1986; Berninger 1995), distinguishes one word from another. The other is general information, which is derived from the combination of letters and letter patterns that a word shares with other words. In English, two types of such general orthographic information can be distinguished: statistical redundancy and rule-governed regularity. Statistical redundancy has to do with indices that are derived from the probability of occurrence of certain letters or letter combinations in words. Rule-governed regularity refers to the orthographic conventions that are generalized from an evaluation of orthographic patterns that govern the combination of letters in certain positions in words. It is these orthographic conventions that make some combinations of letters likely and some unlikely (Massaro & Sanocki 1993). The acquisition of this knowledge results from extended exposure to writing symbols and their configurations (Wagner & Barker 1994; Berninger 1995).

There is no consensus on how these knowledge sources are used during word recognition and, as a result, there are different accounts of how orthographic information affects reading. One view explains the contribution of orthographic knowledge within a direct access model to word recognition. According to this view, it is possible that orthographic information, with spelling pattern as its central unit, facilitates the holistic processing of words (Seidenberg 1992; Corcos & Willows 1993). Another view interprets the contribution of orthographic knowledge within the Fuzzy Logical Model of Perception (FLMP) (Massaro & Sanocki 1993). The FLMP conceptualizes visual processing in reading as a pattern-recognition process, within which identification processes consist of three operations: feature evaluation, feature integration, and decision. Consequently, word recognition is viewed as a continuous process of evaluating, integrating, and matching the visual features of the word with the relevant prototype descriptions in memory. Other accounts of orthographic processing have attempted to explain its influence on word recognition through other mechanisms such as orthographic priming or orthographic neighborhood effects (the effects of similarly spelled words surrounding the target word) (Ferrand & Grainger 1994; Grainger & Jacobs 1996; Grainger, Kiyonaga & Holcomb 2006).

As far as research is concerned, the role of orthographic processing has received much less attention than that of phonological processing. However, a number of L1-based studies have produced evidence that orthographic processing skills contribute significantly to the reading process (Stanovich & West 1989; Cunningham & Stanovich 1990; Barker, Torgesen & Wagner 1992; Cunningham, Perry & Stanovich 2001). For example, using a number of

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

measures of orthographic knowledge (letter string choice tasks, orthographic choice tasks, and homophone choice tasks), Cunningham et al. (2001) found that orthographic processing explained significant unique variance in word recognition after the variance contributed by phonological processing measures was accounted for.

Since orthographic knowledge is assumed to result from extended exposure to written symbols and their configuration (Berninger 1995), L2 learners can be expected to have a weaker knowledge of such inter-letter connections than L1 readers because L2 readers have far more limited exposure than L1 readers to L2 orthography. Such limited knowledge of orthographic representations may, in turn, negatively affect L2 readers' word-recognition processes and reading comprehension (Koda 2005). Indeed, research with L2 learners has attested to such observations. In examining the contribution of phonological awareness and letter knowledge to L2 learners' reading development among learners from different language backgrounds, Muter & Diethelm (2001) found that letter knowledge was a strong predictor of reading performance among both English L1 and L2 readers. Furthermore, when the contribution of letter knowledge and phonological awareness (phoneme segmentation) was compared between L2 readers, the only variable found to be a significant predictor of later reading skills (after one year) was letter knowledge. Letter knowledge, however, turned out to be a more powerful predictor among L1 English readers than L2 readers, confirming the idea that the amount of past experience with the target orthography affects the efficiency with which learners process orthographic information. Similar findings were also obtained by Verhoeven (2000), who compared the difference between orthographic processing skills (knowledge of spelling and orthographic patterns) in beginner L1 and L2 readers of Dutch, and found that L2 readers were significantly less efficient in processing orthographic information than their L1 counterparts.

There is also evidence to suggest that as L2 learners become more proficient they become more capable of using orthographic knowledge. Haynes & Carr (1990) explored the role of orthographic processing skills in ESL reading in two groups of proficient and less proficient Chinese university students. They found a significant relationship between orthographic processing skills, as measured by efficiency on same/different visual matching tasks, and ESL reading success. The same readers also performed significantly less well in their reading comprehension skills than L1 readers, which then suggests an association between orthographic skills and L2 reading comprehension. Chikamatsu (2006) examined the role of orthographic processing in the development of word-recognition strategies by L2 Japanese learners whose L1 was English. Two proficiency groups participated in the study. The higher-proficiency readers were found to show more visual orthographic reliance, while the less proficient groups showed more phonological reliance in processing both contextualized and decontextualized words. Finally, using non-word orthographic choice tasks, Nassaji (2003a) examined the contribution of orthographic processing skills among advanced learners of L2 English. He found a significant contribution of orthographic processing skills to both reading comprehension and word recognition. He also found that the contribution of orthographic knowledge remained even after the contribution of other skills such as phonological, syntactic, and semantic processing skills was partialed out. Such a contribution was not found for phonological processing skills. Such findings highlight the contribution of orthographic knowledge to L2 reading and also provide evidence that, as readers become

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

more skilled, they might rely more on orthographic than phonological knowledge for word recognition.

3.3. Syntactic and semantic processes and their role in word recognition

In order to comprehend texts, readers must be able to interpret phrases and sentences and, to be able to do this, they need to know the structure of the language, how words are combined, and what rules govern their combination. It is clear that the ability to process and use syntactic and semantic information is critical for reading comprehension and there is substantial research that provides empirical evidence for the importance of these factors (Verhoeven 2000; Droop & Verhoeven 2003; Deacon & Kirby 2004; Cain 2007; Gelderen et al. 2007; Kieffer & Lesaux 2008; Landi 2010; Pasquarella et al. 2011; Verhoeven & Perfetti 2011; Kirby et al. 2012). This research has shown that fluent readers not only possess adequate knowledge in these areas but are also efficient at using it when processing text for comprehension (Hyltenstam 1988; Cupples & Holmes 1992; M. L. Hoover & Dwivedi 1998; Liu 2009).

However, despite strong evidence for the importance of syntactic and semantic processes for reading comprehension, the role that such knowledge sources play in word recognition has been a matter of considerable debate. An important issue has concerned the role of these processes in lexical access. Research has found that words are read or recognized faster when they appear in syntactically or semantically predictable contexts (Ehrlich & Rayner 1981; Frisson, Rayner & Pickering 2005). However, the question here has been whether the facilitative effects of syntactic and semantic processes occur before the activation of the word meaning in the lexicon or after the primary propositional meanings of the word have been encoded.

One view suggests that word recognition takes place mainly through the use of contextual knowledge sources, including syntactic and semantic information, and that the activation of propositional meanings of words is heavily constrained by syntactic and semantic context (Smith 1994; Goodman 1996, 2011). The other view contends that the procedure based on complex syntactic and semantic analyses is slow, and it is unlikely that such a procedure can be carried out within the few hundred milliseconds that a fluent reader requires to recognize most words (Stanovich 2000). In the latter view, syntactic and semantic processes serve more to disambiguate the semantic alternatives already activated through the visual input or to verify the results of identification processes, rather than to facilitate lexical access (Stanovich 1980, 2000; Zeelenberg et al. 2003; Seidenberg 2005; Perfetti 2007). In other words, the facilitative effect of syntactic and semantic processes in fluent reading occurs at the post-lexical rather than the pre-lexical level.

It seems premature at this stage to argue definitely for or against the role of syntactic and semantic context in word recognition because there is still a host of questions to be answered about how context influences stimulus analysis, on the one hand, and comprehension processes, on the other. Nonetheless, current research seems to support the view that word recognition in skilled reading is a rapid process far less affected by expectancies generated by the use of higher-level knowledge sources such as syntactic and semantic resources than

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

is usually assumed (Briggs, Austin & Underwood 1984; Seidenberg et al. 1984; Wright & Garrett 1984; Stanovich 2000; Perfetti 2007). Research also seems to suggest that the information provided through syntactic and semantic sources is used primarily during text integration processes rather than word-meaning encoding (Briggs et al. 1984; Seidenberg et al. 1984; Wright & Garrett 1984; Stanovich 2000; Perfetti 2007). For example, research using online processing techniques has shown that when fluent readers read words, they quickly and automatically activate all the semantic information pertaining to that word; after these meanings are encoded, contextual processes may exert their influence (Liu 2009). This research also suggests that the facilitative effects of semantic and syntactic information on fluent word recognition may come from the sum of priming effects rather than from a process operating in a top-down fashion. For example, in a series of studies, Stanovich & West (1983, 1989) found that syntactic and semantic information produced differential effects for processing words, depending on the time available to readers. At short delay intervals, it produced positive effects only. At longer delays, it still produced positive effects, but those effects were associated with certain attentional costs. Stanovich & West (1983) argued that with longer delays associated with costs, the readers could have employed a conscious prediction mechanism. However, with short delays associated with a positive effect and no costs, words could have been identified through automatic priming flowing from the previous words to the lexical entry of the next possible word in the sentence. In another study, West et al. (1983) found that context facilitated the word recognition of skilled and less skilled readers in terms of reaction times. However, the use of sentential context, while producing facilitative effects, produced more inhibition effects in the less skilled readers. This phenomenon was taken to indicate that the contextual effect in less skilled readers came more through conscious prediction rather than automatic activation whereas, in skilled readers, it was due more to automatic spreading-activation (see also Schwantes, Boesl & Ritz 1980; Hyona & Lindeman 1994).

Few studies have directly examined the facilitative effects of syntactic and semantic processes in L2 lexical access; however, studies in instructional settings have shown that L2 readers are less able than is often assumed to use syntactic and semantic information as an effective strategy to arrive at word meanings. For example, studies examining the inferring of word meaning from context have revealed that readers are generally less capable than assumed at predicting words even if they are given a large amount of time and instruction (Schatz & Baldwin 1986; Nagy, Anderson & Herman 1987; Jenkins, Matlock & Slocum 1989; Nagy 1997; Nassaji 2003b, 2004; Hu & Nassaji 2012). Bensoussan & Laufer (1984) found that the effect of context in helping EFL students to guess word meanings was minimal. Context aided guessing for only 24% of the words, with no positive effect on the remaining 76% of words in their study. Nassaji (2003b) found that ESL students were more than half of the time completely inaccurate in their attempts to infer the meanings of new words from context, even when they used the various syntactic and semantic knowledge sources they had at their disposal. Finally, Bernhardt (1986) reported that it was the less skilled L2 readers, as opposed to the skilled readers, who relied more on higher-level semantic and L1 literacy strategies when processing L2 written words. Of course, as noted earlier, these studies do not show what processes are at work during L2 lexical access, but they suggest that syntactic and semantic processes are not dependable sources for the accurate identification of word meaning during L2 reading.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

4. Cross-linguistic studies of L2 lower-level processes

The studies reviewed so far provide evidence for the contributions of lower-level word-recognition processes to L2 reading. They do not, however, tell us much about cross-linguistic similarities or differences in such skills. As noted earlier, L2 reading is a cross-linguistic process, so a major difference between L1 and L2 reading stems from the fact that L2 learners already know or may have experience reading in another language. This may then lead to instances of both positive and negative transfer, depending on the similarities and differences between the L1 and the L2.

A growing number of cross-linguistic studies have recently been carried out to address the relationships between L1 and L2 lower-level processes. These studies can be divided into two groups. One has focused on determining cross-linguistic commonalities between the two languages (Geva & Wang 2001). Based on the theoretical concept that lower-level L1 and L2 reading sub-skills are interrelated (Bernhardt & Kamil 1995; Cummins 2000), these studies have focused on the extent to which the reading processes developed in the L1 can be carried over or transfer to L2 reading. The other group of studies has dealt specifically with cross-linguistic variations. Languages differ in their linguistic systems, including their orthographic, phonological, and morphological systems. Although there is now significant evidence that lower-level processes such as phonological and orthographic processing skills are major processes underlying reading development in general, it is suggested that their relative contributions may differ across languages, depending on the nature of the linguistic system involved.

In L2 acquisition, cross-linguistic research has been conducted into the effects of various L1 linguistic features and knowledge sources including syntax, semantics, and even discourse features. As far as word recognition is concerned, an important area of cross-linguistic investigation has been the effects of L1 orthographic properties. In this respect, since L2 readers often come from languages with different orthographies, studies have looked at how certain L1-based orthographic features, as well as processing strategies, affect L2 reading, including word-recognition processes.

The following sections review cross-linguistic studies of L2 lower-level processes, beginning with those that have examined cross-linguistic transfer of such processes, followed by those that have studied the effects of L1 orthography.

4.1. Cross-linguistic transfer of lower-level processes

When learning to read in an L2, learners may also be developing (in the case of concurrent bilinguals) or have already developed (in the case of adults) a variety of lower-level word-recognition skills and strategies in their L1. One question that has interested L2 researchers is the extent to which readers carry over these strategies from one language to the other, and what factors affect the transferability of such processes. As mentioned earlier, two major lower-level processes involved in word recognition are phonological and orthographic processes. Therefore a number of studies have examined the relationship of these processes among different groups of bilinguals. One of the first studies that examined and also provided evidence for the transferability of lower-level phonological processes was that of Durgunoglu,

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Nagy & Hancin-Bhatt (1993), which investigated the relationship between phonological processing in English and Spanish. They found that phonological processing skills (measured in terms of learners' ability to segment and blend sounds in both Spanish and English) were significantly interrelated in the two languages and that these skills in both languages were significant predictors of L2 English word recognition. They also found that children with a stronger Spanish phonological awareness and word-recognition skills outperformed those with weaker skills, confirming that those learners transferred those skills from their L1 into their L2. Sun-Alperin & Wang (2011) examined transfer effects of both phonological and orthographic processing skills between L1 Spanish and L2 English. Using a number of phonological measures (such as phoneme deletion and pseudoword reading tasks) and orthographic knowledge tests (such as pseudoword spelling and homophone choice tasks), their results showed that transfer effects occurred for both phonological and orthographic processing from Spanish to English. Haigh et al. (2011) compared phonological processing skills in English and French, and found that English phoneme awareness was a significant predictor of both English and French reading measures, after the contribution of other baseline reading skills such as letter-name knowledge and word reading skills were partialed out. Studies have also compared phonological or orthographic processing skills among other bilingual children, such as Turkish–Dutch (Verhoeven 2007), Hebrew–English (Geva, Wade-Woolley & Shany 1993), Persian–English (Gholamain & Geva 1999), Italian–English (D'Angiulli, Siegel & Serra 2001), and Arabic–English (Abu-Rabia & Siegel 2002). These studies have all reported similar findings, providing evidence for the transferability of lower-level phonological and orthographic processing.

Transfer can occur not only from L1 to L2 but also from L2 to L1. Verhoeven (1991) examined the development of L2 literacy skills among two groups of Turkish children in the Netherlands, one group receiving L2 reading instruction before L1 instruction and the other receiving instruction in L1 before receiving it in the L2. Learners showed a strong transfer from early-acquired decoding skills (including word reading, word spelling, and phoneme distinction skills) to their later-acquired skills both in L1 and L2. This study provided evidence for the interrelatedness of lower-level processes and suggested that the development of literacy skills in one language predicts the development of similar skills in another language acquired subsequently, whether in the L1 or the L2.

Word recognition is affected not only by the way orthography represents phonology but also by how easily learners can process the morphological constituents of the word (Geva & Wang 2001). Thus, morphological features can also be a critical component of word recognition. Indeed, in a recent analysis of this issue, Verhoeven & Perfetti (2011) discussed and reported research evidence for a number of morphological factors that can impact the accuracy and efficiency of word recognition, including the frequency of the morpheme, its family size (i.e., how many words include it), and its productivity. Research has also found that higher levels of morphological processing skills (knowledge of prefixes and suffixes) are strongly correlated with both accuracy of text processing and recognition of words with complex morphological structures (Deacon & Kirby 2004; Schiff & Calif 2007; Kieffer & Lesaux 2008; Pasquarella et al. 2011; Verhoeven & Perfetti 2011; Kirby et al. 2012).

Although evidence for the role of morphological factors exists, fewer studies have examined the transfer effects of morphological processes. The issue of how and to what extent

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

morphological similarities or differences between the L1 and the L2 facilitate L2 reading or word-recognition processes is therefore still an open question. However, evidence from a few recent studies seems to suggest that morphological skills may also transfer cross-linguistically, particularly if the two languages have similar morphological structures. Deacon, Wade-Woolley & Kirby (2007), for example, found a significant relationship between measures of English morphological awareness (performance on past tense analogy tasks) and reading in both English (L1) and French (L2) among French immersion students. These effects were substantial when measured early (in grade 1) but weakened in subsequent grades (grades 2 and 3), which suggests that the cross-linguistic effect of these skills may change over time. Saiegh-Haddad & Geva (2008) examined the relationship between phonological and morphological awareness in English (L1) and Arabic (L2) bilingual children. They found a significant correlation between measures of phonological awareness in the two languages, but no correlation between measures of morphological awareness. This lack of correlation was explained in terms of the differences in morphological structures between Arabic and English. Although the two languages are alphabetic, English uses prefixes and suffixes attached to independent words (morphemes) to derive new word meanings. Arabic, however, has a root-based morphology in which word formation involves the concurrent affixation of two bound morphemes, neither of which can occur independently.

4.2. Effects of L1 orthography

Studies that have investigated the role of lower-level processes have found evidence for a relationship between L1 and L2 phonological and orthographic processes. However, languages also vary in how their orthography represents phonology and meaning. While some languages, such as English and French, use an alphabetic system in which alphabetic letters represent speech sounds (phonemes), other languages, such as Chinese, use a logographic system in which characters represent syllables and morphemes instead of individual phonemes. There is also variation in the regularity of sound–symbol correspondences in alphabetic languages. Given these differences, researchers have been asking whether the processes involved in reading in different orthographies are the same or different, and to what extent cross-orthographic differences affect L2 reading.

There are currently a number of accounts of how cross-orthographic variations may influence reading. A major theoretical framework that has informed much of the research in this area is the Orthographic Depth Hypothesis (ODH) (Turvey, Feldman & Lukatela 1984; Frost, Katz & Bentin 1987; Frost & Katz 1989; Katz & Frost 1992). According to this hypothesis, there are variations in the degree of consistency with which a writing system represents the language phonology. In some languages there is a direct one-to-one relationship between graphemes and phonemes (e.g., Greek and Spanish), but in others, this relationship is less direct (e.g., English), and the orthography does not represent the phonology in a one-to-one manner. The orthography of the former group of languages is described as 'shallow', while that of the latter group is described as 'deep'. One consequence of the ODH is that language orthography may affect readers' reliance on the two paths suggested for lexical access: the phonological route and the lexical route. When reading languages with a

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

shallow or consistent orthography (e.g., German), readers may rely more on a phonological strategy to read and access word meaning, while when reading languages with deep or inconsistent orthography, they may rely less on grapheme–phoneme correspondence and therefore take a more holistic approach to word recognition. This theory also suggests that readers may experience different degrees of difficulty when learning to read languages with different orthographic depth. For example, readers may have less difficulty in learning to read languages with shallow orthographies than those with deep orthographies.

Another framework recently used to understand cross-orthographic variations is the Psycholinguistic Grain Size theory (Ziegler & Goswami 2005; Goswami 2008). This hypothesis posits that in addition to consistency of spelling–sound relationships, languages also differ in the size of the phonological units that are represented by orthographic units. In shallow orthographies, because of the consistency of the grapheme–phoneme relationship, single orthographic units represent single individual phonemes. Thus such orthographies use smaller phonological grain sizes. Deeper orthographies may involve both smaller and larger grain sizes, as their orthography may represent individual sounds or phonemes as well as larger phonological units such as syllables or rimes. The theory proposes that learners' processing strategies are differentially affected by such grain size differences: the bigger the grain size the leaner needs to develop, the harder the task of learning to read, because the learner needs to learn more orthographic units to resolve orthographic inconsistencies. Also, to learn languages with deeper orthographies such as English, small 'grains', such as vowels or consonants, are not reliable sources of information. Therefore, to recognize words in such languages, learners need to develop strategies to use other sources with larger grain sizes such as whole words, phonological onsets and rimes, and syllables (Goswami 2008; Roberts, Christo & Sheflebine 2011).

4.2.1. Studies of cross-orthographic effects

Many L1-based studies have examined the consequences of cross-orthographic variations in L1 reading and have confirmed that different processing mechanisms are involved in reading in different orthographies (Henderson 1982; Turvey et al. 1984; Frost & Katz 1989; Baluch 1993; Nakagawa 1994; Tan & Perfetti 1998; Ellis et al. 2004; Frost 2005; Ziegler & Goswami 2005; Goswami 2008). The role of cross-orthographic variations in L2 reading has only recently attracted attention. Research in this area has attempted to understand how similarities or differences between L1 and L2 orthography facilitate or impede L2 reading development. As mentioned earlier, it has been shown that phonological recoding is implicated in both L1 and L2 word recognition. However, most of these studies have involved readers from alphabetic backgrounds. The question therefore arises: What strategies do non-alphabetic L1 learners use and do their L1 orthographic systems have any effect on these processes? If phonological processing skill develops as a result of exposure to alphabetic scripts, it is possible that non-alphabetic L1 learners may be seriously disadvantaged when learning alphabetic languages such as English (Koda 2005).

A number of studies have recently examined the implications of L1 orthographic variations for L2 reading (Koda 1988; Haynes & Carr 1990; Koda 1990; Chitiri et al. 1992; Holm &

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Dodd 1996; Muljani, Koda & Moates 1998; Wade-Woolley & Geva 1999; Wang & Geva 2003; Wang, Koda & Perfetti 2003; Wang & Koda 2007). These studies have shown varying but significant degrees of cross-orthographic effects on L2 word recognition and its subcomponent processes. In particular, they have shown that discrepancies between L1 and L2 orthography can have negative impacts on L2 word-recognition processes.

One of the first studies that provided evidence for the effect of L1 orthography was conducted by Bernhardt & Everson (1988, cited in Chitiri et al. 1992), which used eye-movement analysis to examine the word-recognition patterns of two groups of native speakers of English reading German and Chinese. Their results showed that while the eye movements of the L2 German readers were similar to those of native readers, those of the L2 Chinese readers were not, thus indicating that when L1 and L2 orthographic characteristics are unrelated, readers may use different processing strategies than when they are. Chitiri et al. (1992) analyzed the word-recognition patterns of two groups of English–Greek bilinguals and monolingual readers in terms of two phonologically defined properties – syllable and stress – within specific content and function words. Using a letter cancellation task, Chitiri et al. found that the English bilinguals exhibited a stronger stress effect in processing content and function words than did the Greek monolinguals. These results were partly attributed to the differences between the orthographic characteristics of the readers' L1 (Greek) and their L2 (English). While both languages are alphabetic, English has a more irregular and complex orthography in terms of letter–sound correspondences.

More recent studies comparing other L2 readers and using other measures have also demonstrated varying but significant degrees of cross-orthographic effects on L2 word recognition and its subcomponent processes. Muljani et al. (1998) compared ESL word recognition among learners whose L1s were Indonesian and Chinese. Using an English lexical decision task, they found that Indonesian learners of English were more efficient than Chinese learners at processing English words, suggesting that L1 alphabetic experience has a positive effect on processing L2 alphabetic words. Wang & Koda (2007) and Wang et al. (2003) examined the effects of L1 orthography on English word-recognition skills among readers whose L1 was Chinese (deep orthography) or Korean (shallower orthography). Using a series of word and non-word naming tasks, Wang & Koda found that Korean students (who came from an alphabetic L1 background) were more accurate than Chinese students in all the word-naming tasks. Using a semantic category judgment task, Wang et al. (2003) went on to find that, while L1 Chinese readers were affected more by orthographic than phonological interference in their meaning judgments, L1 Korean participants were affected more by phonological than orthographic interference.

Hamada & Koda (2008) examined whether L1 orthography affected L2 phonological processing skills and the resulting learning of new L2 words. Participants were college-level English L2 learners from two language backgrounds: Korean and Chinese. Hamada & Koda found that Korean students were both faster and more accurate in pronouncing pseudowords. Korean learners also outperformed Chinese learners in a series of subsequent recall tests used to measure learning and retention of the new words (tests of spelling, picture recognition, and word recognition). These findings suggest that congruity between L1 and L2 orthography not only facilitates L2 phonological decoding but may also enhance word learning.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

The above studies demonstrate that L1–L2 orthographic differences affect L2 word processing skills. However, most of them used English as the target language. A few studies have recently examined cross-orthographic effects when learners are learning non-alphabetic languages, and have found evidence for L1 orthographic effects. Chikamatsu (1996), for example, compared the lexical decision performance of native English and native Chinese readers reading L2 Japanese, and found that Chinese participants depended more on orthographic information in processing L2 Japanese words, while English participants relied more on phonological information. Mori (1998) examined L1 orthographic effects on reading L2 Japanese by native speakers of English, Chinese, and Korean. Using Japanese Kanji pseudocharacters manipulated for phonological accessibility, Mori found that the performance of L1 English participants was more affected than other L1 readers by the absence of phonological information in the characters. Mori's results provide support for the idea that English speakers, due to their L1 alphabetic background, rely more on phonological recoding in L2 than readers coming from non-alphabetic backgrounds. Of course, the question here is why Korean learners, who also come from an alphabetic language background (and were found to perform differently from Chinese learners in Wang & Koda's study), performed similarly to Chinese students in this study. This is an issue that needs further investigation.

4.2.2. Effects of cross-orthographic distance

The studies reviewed above provide clear evidence that L2 readers rely on their L1 orthographic processing knowledge and strategies when processing L2 texts, and that when the orthographies of L1 and L2 are unrelated this might adversely affect the development of lower-level word-recognition processes in an L2. However, these studies do not tell us much about the strength of such effects. Nor do they consider the extent of cross-orthographic differences. Although there are differences between alphabetic and non-alphabetic languages, even within alphabetic languages there may still be differences, not only in the degree of consistency of the relationship between grapheme and phonemes, but also in other linguistic features. The question therefore becomes whether the influence of cross-orthographic differences is the same across different languages or whether these effects vary depending on the degree of cross-orthographic regularity or the orthographic distance between languages. A few studies have recently addressed this question by comparing multiple languages that differ in their degree of orthographic disparity (Koda 1990; Holm & Dodd 1996; Akamatsu 2003). These studies have found evidence not only that L1 orthography affects L2 reading processes but that the magnitude of such effects depends on the degree of cross-orthographic divergence. Koda (1990), for example, investigated L2 phonological recoding among readers from four L1 orthographic backgrounds, three alphabetic (Arabic, Spanish, and English) and one non-alphabetic (Japanese). She used two types of texts: one in which phonological information regarding certain key words became inaccessible and another in which such information was provided by substituting the words with pronounceable English nonsense words. Koda found that when phonological information was absent in the visual configuration of words, the reading performance of the L2 readers with alphabetic L1 backgrounds was

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

seriously impaired. However, the magnitude of the effect was greatest on English L1 readers, followed by Spanish, Arabic, and then Japanese readers. Holm & Dodd (1996) compared phonological skills between four reader groups: two groups of Chinese speakers (one from China with a pinyin background and one from Hong Kong without a pinyin background), a Vietnamese group, and an Australian English group. They found that Hong Kong learners who had no experience in pinyin had more difficulty in completing a series of phonological awareness tasks in English (e.g. phoneme segmentation, rhyme judgment, and phoneme manipulation) than the Vietnamese and Australian speakers, who came from alphabetic writing systems. However, Hong Kong learners also had greater difficulty than Chinese learners who had exposure to pinyin. The former group was affected the most because they had not developed the phonological awareness needed for reading English in their L1. Akamatsu (2003) examined the effects of L1 orthography among three groups of L2 readers from three different L1 orthographic backgrounds: Chinese (logographic), Japanese (logographic and syllabary), and Persian (alphabetic). Results indicated that the Chinese and Japanese L1 readers' reading performance was more affected by word-shape manipulations (case alteration) than that of the Persian readers, whose L1 was alphabetic.

4.2.3. Other factors affecting cross-linguistic effects

4.2.3.1. Effects of L1 and L2 proficiency

The studies above have shown that L1 orthography has an impact on how readers process L2 written texts. Some of the individual differences between L2 readers in processing L2 text may therefore be accounted for by the orthographic differences between L1 and L2. However, other important differences between L1 and L2 learners are that L2 learners have limited L2 knowledge compared to L1 readers, but a high level of proficiency in their L1. The question that arises, then, is whether the degree of L1 or L2 proficiency has any consequences for the influence of L1–L2 cross-linguistic effects. Some recent studies have begun to shed light on this issue by examining the word-recognition behavior of L2 readers with different levels of L2 proficiency, and have shown that differences in L1 and L2 proficiency affect both the kind of strategies and also the kind of information learners use during word recognition or lexical access. Chikamatsu (2006) compared the word-recognition strategy of two proficiency groups of English native speakers learning L2 Japanese. Using lexical judgment tasks in which visual familiarity was manipulated, the study found that the high-proficiency group showed more reliance than the low proficiency group on visual information. Since their L1 (English) was alphabetic, it was hypothesized that these readers would transfer their L1 decoding strategy and rely more on phonological coding in L2 word recognition. However, this was found to be true only for the low-proficiency group, not for the high-proficiency group, suggesting that the interfering effects of L1 orthography may weaken as readers gain more L2 proficiency. Similar effects of L2 proficiency were also found in Haynes & Carr's study (1990), which examined the efficiency of English orthographic processing (measured by a same/different visual matching task) among two groups of proficient and less proficient Chinese L1 readers and English native readers. The study found that the high L2 proficient readers' performance

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

was more similar to that of L1 native readers than low proficient readers, suggesting that level of L2 proficiency affected the extent to which L1 orthography influenced L2 orthographic processing. Atwill et al. (2007) investigated the cross-linguistic effects of phonemic awareness among L2 learners with different levels of L1 vocabulary proficiency. Their results showed a strong correlation between phonemic awareness tasks in both L1 and L2. However, later analyses found that this transfer occurred only for learners whose L1 receptive vocabulary knowledge was above average, not for those whose knowledge was below average. These results suggest that the level of learners' L1 and L2 linguistic knowledge affects the transfer of lower-level processes to the L2. In particular, they suggest that low levels of L1 proficiency can have an adverse effect on cross-linguistic transfer of phonological processing skills from L1 to L2 reading.

4.2.3.2. Effects of L2 reading tasks, context, and word frequency

Studies that have examined the role of lower-level word recognition, including those on cross-orthographic effects, have usually used individual words out of context. However, research has also shown that these effects may also vary with the type of word-recognition task and context. For example, some studies have shown that L2 readers differ in their reliance on phonological codes during word recognition, depending on whether they are processing single words out of context or words in an extended text. As noted above, Chikamatsu (2006) examined L2 word-recognition processes among Japanese L2 readers and found an interaction between L2 proficiency and the readers' reliance on phonological and orthographic information (the higher proficiency group relied more on visual information while the lower proficiency group relied more on phonological information). However, this interaction effect was evident only when the words were isolated and out of context, not when they were embedded in a text. As the researcher pointed out, this might have been because of the difference in the nature of phonological processing involved in reading connected texts and isolated words (that is, context-free word recognition requires mainly pre-lexical phonology and reading connected text for comprehension also requires post-lexical phonology). Segalowitz & Hébert (1990) found similar effects of context when examining the role of phonological processing among French and English bilinguals. Their findings showed that bilingual readers who had a slower rate of reading in their L2 produced a homophone effect in their L2 reading tasks when performing a sentence verification task but not when performing isolated word and nonword lexical decision tasks. As noted earlier, Akamatsu examined word-recognition processes among skilled L2 readers of Japanese, Chinese, and Persian. In Akamatsu (2002), participants read, out of context, regular and irregular words with low or high frequency. The results showed that all three groups performed very similarly, all recognizing high frequency regular and irregular words with the same speed. However, they recognized high-frequency words more quickly than low-frequency. In Akamatsu (2003), the participants read connected passages, half of them using normal orthography, the other half visually distorted words. The results showed that learners coming from different languages varied in performance, the Chinese and the Japanese L1 readers being more affected than the Persian readers by intra-word distortions when reading the connected texts. A comparison of the findings of these two

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

studies suggests that L2 word recognition and its relationship with L1 orthography may be mediated by the context of reading as well as the nature of the word, including its spelling patterns and frequency.

5. Conclusions and implications

In this article, I have reviewed current research on the role of L2 lower-level processes, including word recognition and graphophonic processes. I will now draw a few main conclusions and in the subsequent sections discuss the implications of these results for L2 reading instruction and future research. First, as outlined in the review, studies exploring the nature and contribution of lower-level processes to L2 reading have shown that an accurate and efficient execution of these processes is key to successful L2 reading comprehension and development. Such processes contribute significantly to L2 reading even for L2 learners who are very advanced readers. In addition, visual word recognition is mainly a lower-level process depending heavily on the reader's skills in accurately and efficiently processing the graphophonic features of the print. This process is less affected by conscious prediction based on syntactic and semantic skills than previously assumed. Furthermore, cross-linguistic studies have shown both similarities and differences in basic reading sub-skills between L1 and L2. Many L2 learners have experience of reading in an L1 and have already developed a variety of lower-level word-recognition skills and strategies in that language. Such skills may transfer across languages. Properties of L1 orthography also affect the development of L2 word-recognition processes and strategies. Such effects may be positive or negative, depending on the degree of similarity between the orthography of the L1 and L2. If the L1 and L2 are orthographically similar, the development of lower-level processing skills in the L1 may facilitate such development in the L2. On the other hand, if the two languages are very different, interference or negative effects may result. Finally, in addition to prior reading experience and L1 orthographic influences, differences in the degree of L2 proficiency, reading tasks, and context, as well as the nature of the word and its frequency, may also influence the kind of strategies and information used by readers during L2 word recognition and lexical access.

5.1. Instructional implications

If teachers are to understand the implications of research for instruction, they need to have a good understanding of the nature of the reading process, and how it works and develops (Grabe 2009). Traditionally, it has been assumed that reading is predominately a concept-driven process. It was therefore believed that reading abilities are best fostered through instruction that focuses on developing higher-order background knowledge and metacognitive strategies. Pedagogical activities thus focused mainly on knowledge-based processes and, with those in mind, attempted to improve higher-level comprehension skills and strategies such as predicting, skimming, scanning, and guessing meanings from context. However, as discussed before, a growing body of research with L2 children and adults has

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

provided evidence that both the accuracy and efficiency of lower-level processes, including word recognition and graphophonic processes, are also critical components of L2 reading. Even when L2 learners have achieved a high level of language proficiency (including good speaking and listening skills), they have still been found to have difficulties in such reading tasks as efficient word recognition and phonological and orthographic processing. Such findings have important implications for L2 reading instruction both in the early and advanced stages of L2 reading. One important implication is that students learning to read in an L2 should be helped to develop the lower-level skills needed for successful decoding, and L2 reading instruction should attempt to find ways to maximize the effects of such practices.

Learning to read is a developmental process, so learners may need different types of instruction at different stages. Fast and accurate use of phonological information provides an essential basis for the development of reading skills. Thus, if beginning L2 readers lack or have limited knowledge of such processing abilities in the L2, they are likely to have difficulty in both word identification and reading comprehension. Furthermore, many L2 learners may begin reading instruction with much lower levels of oral proficiency compared to L1 readers, so they may be weaker at phonological processing skills than L1 readers. These L2 learners need additional instructional support in these areas, and research has shown that such support facilitates their reading skills. Walter (2008), for example, found that activities that enhanced the exposure of L2 readers of alphabetic languages to phonemic awareness in the target language increased their reading comprehension, even more than activities that targeted the development of higher-level reading strategies.

Other aspects of L2 knowledge such as syntactic, lexical, and morphological skills are all essential. L1 readers have already developed advanced knowledge in these areas of the language. This is not necessarily true of L2 learners. Therefore, L2 reading instruction should also pay particular attention to the development of these basic areas in L2 readers.

For beginner-level learners, and depending on the type of L2, instruction may need to begin with activities that enhance the learner's basic knowledge of decoding skills, such as alphabetic (orthographic) principles, phonetic awareness, sound–symbol correspondences, and spelling patterns, as well as the syntactic and morphosyntactic foundations of the language. Advanced-level learners may not have much difficulty with basic decoding elements or basic syntactic and morphosyntactic patterns in the target language. They may be able to decode and comprehend accurately, but they may not have developed enough fluency and automaticity in these areas. To be fluent, readers should not only have knowledge of lower-level processes, but also be able to apply that knowledge rapidly, effortlessly, and automatically. It is this skill that reduces the burden on the reader's limited cognition capacity and releases enough attentional resources for comprehension processes to take place efficiently. Thus, as learners become more advanced, instructional strategies can shift their focus from activities that enhance accuracy to those that promote fluency and automaticity of lower-level processes.

Fluency in reading is acquired after extensive periods of reading and practice. L1 learners usually achieve a high degree of automaticity as a result of ample exposure to and experience with reading in their L1. L2 learners are at a greater disadvantage in this respect, because of more limited reading opportunities. This suggests that L2 reading pedagogy should make deliberate attempts to provide L2 students with similar reading opportunities by incorporating extensive reading activities into L2 reading instruction. Extensive reading does not target

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

specific lower-level skills, but it provides ample opportunities for exposure to target words in meaningful contexts, thereby developing fluency and automaticity of word recognition and lexical access. By engaging readers in reading and understanding connected texts, extensive reading also promotes effective and efficient integration of lower-level and higher-level processes, or what Breznitz (2006) referred to as 'synchronization of processes', needed for fluent reading comprehension.

Extensive reading activities are mostly meaning-oriented procedures in which the main focus is on understanding the text. Although such activities are essential, the development of word-recognition skills may also benefit from activities with a more explicit and narrower focus. In this respect, the use of various word-recognition training tasks and exercises can usefully be incorporated into the teaching of reading. A number of empirical studies have recently examined the benefits of word-recognition exercises among different reader groups and have reported positive results (Taguchi 1999; Fukkink, Hulstijn & Simis 2005; Chung & Nation 2006; Akamatsu 2008; Macalister 2010; Taguchi & Gorsuch 2010). Akamatsu (2008), for example, examined the usefulness of word-recognition training in a group of EFL university students and found that such training had significant impact on learners' word-recognition speed and automaticity. Fukkink et al. (2005) examined the effects of L2 word-recognition training among intermediate L2 learners and found that students who received word-recognition training achieved faster lexical access than those who did not.

Of course, one concern about single-word training exercises is whether these activities improve reading comprehension. Although there is strong evidence that decoding individual words may be linked to reading difficulties, it is not clear to what extent such an ability may have an effect on understanding connected texts (Buly & Valencia 2002; Kuhn & Stahl 2003; Kuhn 2004; Fukkink et al. 2005). This is because readers may be able to read or identify context-free words rapidly, but with little comprehension. Indeed, Fukkink et al. (2005) found that, although word-recognition training increased the speed with which participants recognized individual words, it did not increase their text-reading comprehension. This suggests that word-recognition training tasks would be more effective in combination with tasks in which learners are engaged in reading level-appropriate connected texts. There are also a number of other more contextualized reading activities that can be used to promote fluency of word recognition in the context of reading connected texts, such as speed reading, repeated reading, assisted reading, and timed reading.

Another important pedagogical implication of research on lower-level processes comes from cross-linguistic research that has compared L2 reading in readers across different languages and orthographies. It is difficult to draw any firm pedagogical conclusions from these studies because cross-linguistic effects usually interact with a number of other variables. However, there is persuasive evidence that L1 reading experience and the properties inherent in L1 orthography affect L2 learners' reading sub-skills. The implication of these findings for reading instruction is that L2 learners' L1 reading experience and writing system should be taken into account in L2 reading instruction. L2 teachers should be familiar with the consequences and effects of cross-linguistic variation and should attempt to adapt their instructional strategies accordingly. In particular, they should be aware of the difficulties that students may have due to L1–L2 differences and should seek instructional strategies to help them overcome those difficulties.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

For example, findings related to cross-linguistic transfer of lower-level processing skills from L1 to L2 in languages with similar orthographies suggest that, once learners learn how to manipulate various constituents of words in their L1, they may find it easy to use this ability in their L2 without the need to learn it separately (Geva et al. 2000). Thus, many decoding skills, such as phonetic awareness (the ability to manipulate sound structures), print concepts, alphabetic letters (for languages that share the same alphabetic systems), directionality of the alphabet, and even sound–symbol correspondences, may not need to be re-taught once they are learned in the L1, or may need different degrees of instructional emphasis, depending on the degree of similarity with the L1 orthography. However, in cases where readers' L1 is very different from their L2, they may benefit from instruction that directs their attention to L2-specific processing knowledge or other L2 processing strategies such as phonological and orthographic processing. For example, Guan et al. (2011) found that L2 learners of Chinese benefited from tutorial sessions in which they were asked to handwrite the Chinese characters as opposed to merely reading them. They also found that a combination of character-handwriting and pinyin typing enhanced the learning of the meaning and the phonology of the new characters.

As a final note, although in this section I have reviewed some of the practical implications of research on lower-level processes, reading comprehension is a complex meaning-construction task involving the combination and integration of many lower-level cognitive and linguistic text-based as well as higher-level conceptual and extra-linguistic components. An adequate reading curriculum has to be balanced and include instructional strategies that can aid the development of all the relevant areas.

5.2. Directions for further research

Although the role of lower-level processes in L2 reading has received increasing attention, research in this area is still very limited and there are many issues that merit further investigation. I will outline some of them below. In view of the fact that L2 reading involves both common and L2-specific processes, an investigation of lower-level component skills should address questions related to both areas; that is, how such processing skills contribute to L2 reading in general and also how they interact with more L2-specific factors. As for the general contributions of lower-level processes, there is a growing body of literature that has investigated the importance of L2 phonological and orthographic processes in L2 reading. However, the majority of these studies have been at the word-recognition level. One set of issues that can be addressed here concerns the similarities and differences between the contributions of these processes to L2 word recognition versus reading comprehension. Indeed, the extent to which these processes contribute to reading connected texts has remained unclear. Furthermore, most research in this area has taken a single-level approach, centering on variables from only one level of the reading process. The question of how lower-level processes interact with other aspects of linguistic knowledge such as syntactic and semantic processes, and how they collectively or independently contribute to L2 reading, has therefore been largely ignored. If lower-level processes, including word recognition, phonological, and orthographic processes, can be shown to make contributions to L2 reading

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

comprehension over and above the contributions of syntactic and semantic knowledge, this would provide significant insight into models of L2 reading comprehension and reading development (Nassaji 2003a).

Another set of issues concerns the role of lower-level processing skills in beginners versus more skilled L2 readers. Most studies on lower-level graphophonic processes have used children or learners who are at the early stages of learning to read. There are far fewer studies with adult or skilled readers and even fewer comparing beginner-level and advanced-level learners. One question that can be addressed here concerns the similarities and differences in the role of basic component skills at the early versus more advanced stages of L2 reading. Furthermore, most L2 research in this area has concentrated on the accuracy of these processes. Given the importance of the efficiency with which readers use lower-level processes, investigation of the efficiency of these processes, how they develop, and how they interact with other aspects of reading, is essential.

Other questions concern the influences of L1 on L2 reading, the role of L2 proficiency, and the impact of the differences between L2 instructional contexts (such as ESL vs. EFL). As for the effects of L1 on L2 reading, there is a growing body of cross-linguistic research in this area, but most of this has centered on L1 writing systems or L1–L2 orthographic differences. There is little research examining similarities and differences in other L1–L2 domains such as syntax, semantics, and morphology, and their effects on L2 reading in general and on the development of lower-level processes in particular. In addition, most cross-orthographic research has focused on alphabetic languages. Studies comparing L1–L2 non-alphabetic bilinguals are scarce, so there is a need for further research in this area. As for the role of L2 proficiency, an important issue concerns the extent to which difficulties in L2 reading stem from low levels of L2 proficiency versus linguistic processing skills and strategies. There is now growing evidence from L1 research that general linguistic knowledge (including oral proficiency) and lower-level recognition processing skills involve distinct processes and thus contribute independently to reading. However, in L2 research no clear distinction has been made between the two, so the problems of L2 readers with respect to lower-level processes have often been attributed to low levels of L2 knowledge. Given the relationship between general L2 knowledge and reading and the greater variation in this knowledge among L2 readers than L1 readers, it is important to investigate the implications of these variations for the development of both L2 reading comprehension and word-recognition skills.

With regard to context, most L2 reading research has been conducted in 'second-language contexts', that is, contexts in which the L2 is the language spoken in the society in which the learner lives (such as ESL). Fewer studies have examined the development of L2 reading abilities in 'foreign-language contexts', that is, contexts in which the target language is not spoken in the society. L2 learners who learn an L2 in a second-language context usually have a greater exposure to the spoken form (and the phonology) of the language. Learners learning an L2 in a foreign-language context may not have such a degree of exposure to the spoken form of the language, but instead have substantial exposure to the written input or the orthography of the language (as they may have been reading more in that language than speaking in it). An important issue here is thus whether such differences in the kind of exposure have any effects on the development of L2 lower-level processes. It can be hypothesized that, due to a greater degree of exposure to orthographic input, EFL learners, for example, might

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

be stronger at using a more orthographically and lexically-oriented strategy when processing L2 words than using phonological strategies, while ESL learners might be better at using phonological strategies. Such hypotheses need to be examined in future research.

Finally, although an investigation of lower-level component processes, including word recognition and graphophonic processes, has recently received much attention, most of the research in this area has been theory-driven, aiming at testing or verifying the validity of specific theoretical ideas or concepts. There are far fewer classroom-based or instructional studies, exploring the feasibility or the implications of such research for instructional practices. There is therefore a real need for more pedagogical research in this area too.

References

Abu-Rabia, S. & L. S. Siegel (2002). Reading, syntactic, orthographic, and working memory skills of bilingual Arabic-English speaking Canadian children. *Journal of Psycholinguistic Research* 31, 661–678.

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.

Akamatsu, N. (2002). A similarity in word-recognition procedures among second language readers with different first language backgrounds. *Applied Psycholinguistics* 23, 117–134.

Akamatsu, N. (2003). The effects of first language orthographic features on second language reading in text. *Language Learning* 53, 207–231.

Akamatsu, N. (2008). The effects of training on automatization of word recognition in English as a foreign language. *Applied Psycholinguistics* 29, 175–193.

Alario, F. X., B. De Cara & J. C. Ziegler (2007). Automatic activation of phonology in silent reading is parallel: Evidence from beginning and skilled readers. *Journal of Experimental Child Psychology* 97, 205–219.

Anderson, R. C. & P. D. Pearson (1984). A schema-theoretic view of basic processes in reading comprehension. In P. D. Pearson (ed.), *Handbook of reading research* (Vol. 1). New York: Longman, 255–291.

Atwill, K., J. Blanchard, J. S. Gorin & K. Burstein (2007). Receptive vocabulary and cross-language transfer of phonemic awareness in kindergarten children. *The Journal of Educational Research* 100, 336–346.

Baluch, B. (1993). Lexical decisions in Persian: A test of the orthographic depth hypothesis. *International Journal of Psychology* 28, 19–29.

Barker, T. A., J. Torgesen & R. K. Wagner (1992). The role of orthographic processing skills on five different reading tasks. *Reading Research Quarterly* 27, 335–345.

Barron, R. W. (1986). Word recognition in early reading: A review of the direct and indirect access hypotheses. *Cognition* 24, 93–119.

Bell, L. & C. A. Perfetti (1994). Reading skill: Some adult comparisons. *Journal of Educational Psychology* 86, 244–255.

Bensoussan, M. & B. Laufer (1984). Lexical guessing in context in EFL reading comprehension. *Journal of Research in Reading* 7, 15–23.

Bernhardt, E. B. (1986). Cognitive processes in L2. In J. Lantolf & L. Labarca (eds.), *Research in second language learning: Focus on the classroom*. Norwood, NJ: Ablex, 35–51.

Bernhardt, E. B. (2010). *Understanding advanced second-language reading*. New York: Taylor & Francis.

Bernhardt, E. B. & M. L. Kamil (1995). Interpreting relationships between L1 and L2 reading: Consolidating the linguistic threshold and the linguistic interdependence hypotheses. *Applied Linguistics* 16, 15–34.

Berninger, V. W. (1994). Introduction. In V. W. Berninger (ed.), *The varieties of orthographic knowledge I: Theoretical and developmental issues*. Dordrecht: Kluwer, 1–25.

Berninger, V. W. (1995). Introduction. In V. W. Berninger (ed.), *The varieties of orthographic knowledge II: Relationships to phonology, reading, and writing*. Dordrecht: Kluwer, 1–21.

Berninger, V. W., K. Vaughan, R. D. Abbott, A. Brooks, K. Begay, G. Curtin, K. Byrd & S. Graham (2000). Language-based spelling instruction: Teaching children to make multiple connections between spoken and written words. *Learning Disability Quarterly* 23, 117–135.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Braze, D., W. Tabor, D. P. Shankweiler & W. E. Mencl (2007). Speaking up for vocabulary: Reading skill differences in young adults. *Journal of Learning Disabilities* 40, 226–243.
Breznitz, Z. (2006). *Fluency in reading: Synchronization of processes*. London: Lawrence Erlbaum.
Briggs, P., S. Austin & G. Underwood (1984). The effects of sentence context in good and poor readers: A test of Stanovich's interactive-compensatory model. *Reading Research Quarterly* 20, 54–61.
Bryant, P. E., M. MacLean, L. L. Bradley & J. Crossland (1990). Rhyme and alliteration, phoneme detection, and learning to read. *Developmental Psychology* 26, 429–438.
Buly, M. R. & S. W. Valencia (2002). Below the bar: Profiles of students who fail state reading assessments. *Educational Evaluation and Policy Analysis* 24, 219–239.
Cain, K. (2007). Syntactic awareness and reading ability: Is there any evidence for a special relationship? *Applied Psycholinguistics* 28, 679–694.
Carrell, P. L. (1988). Some causes of text-boundedness and schema interference in ESL reading. In P. L. Carrell, J. Devine & D. E. Eskey (eds.), *Interactive approaches to second language reading*. New York: Cambridge University Press, 101–113.
Carrell, P. L. & J. C. Eisterhold (1983). Schema theory and ESL reading pedagogy. *TESOL Quarterly* 17, 553–573.
Castles, A. & M. Coltheart (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition* 91, 77–111.
Chiappe, P. & L. Siegel (1999). Phonological awareness and reading acquisition in English- and Punjabi-speaking Canadian children. *Journal of Educational Psychology* 91, 20–28.
Chiappe, P., L. S. Siegel & L. Wade-Woolley (2002). Linguistic diversity and the development of reading skills: A longitudinal study. *Scientific Studies of Reading* 6, 369–400.
Chikamatsu, N. (1996). The effects of L1 orthography on L2 word recognition: A study of American and Chinese learners of Japanese. *Studies in Second Language Acquisition* 18, 403–432.
Chikamatsu, N. (2006). Developmental word recognition: A study of L1 English readers of L2 Japanese. *The Modern Language Journal* 90, 67–85.
Chitiri, H. F., Y. Sun, D. M. Willows & I. Taylor (1992). Word recognition in second-language reading. *Advances in Psychology* 83, 283–297.
Chung, M. & P. Nation (2006). The effect of a speed reading course. *English Teaching* 61, 181–204.
Coady, J. (1979). A psycholinguistic model of the ESL reader. In R. Mackay, B. Barkman & R. R. Jordan (eds.), *Reading in a second language*. Rowley, MA: Newbury House, 5–12.
Coltheart, M. (2005). Modelling reading: The dual route approach. In M. J. Snowling & C. Hulme (eds.), *The science of reading*. Oxford: Blackwell Publishing, 6–23.
Coltheart, M. (2006). Dual route and connectionist models of reading: An overview. *London Review of Education* 4.1, 5–17.
Coltheart, M. (2012). Dural route theories of reading aloud. In J. S. Adelman (ed.), *Visual word recognition: Models and methods, orthography and phonology* (Vol. 1). London: Psychology Press, 3–27.
Coltheart, M., K. Rastle, C. Perry, R. Langdon & J. Ziegler (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review* 108, 204–256.
Corcos, E. & D. M. Willows (1993). The processing of orthographic information. In D. M. Willows, R. S. Kruk & E. Corcos (eds.), *Visual processes in reading and reading disabilities*. Hillsdale, NJ: Erlbaum, 163–190.
Cummins, J. (2000). *Language, power, and pedagogy: Bilingual children in the crossfire*. Clevedon, UK: Multilingual Matters.
Cunningham, A. E., K. Perry & K. E. Stanovich (2001). Converging evidence for the concept of orthographic processing. *Reading and Writing* 14, 549–568.
Cunningham, A. E. & K. E. Stanovich (1990). Assessing print exposure and orthographic processing skill in children: A quick measure of reading experience. *Journal of Educational Psychology* 82, 733–740.
Cunningham, A. E., K. E. Stanovich & M. R. Wilson (1990). Cognitive variation in adult college students differing in reading ability. In T. Carr & B. A. Levy (eds.), *Reading and its development: Components skills approaches*. San Diego, CA: Academic Press, 129–159.
Cupples, L. & V. M. Holmes (1992). Evidence for a difference in syntactic knowledge between skilled and less skilled adult readers. *Journal of Psycholinguistic Research* 21, 249–274.
Cutting, L. E. & H. S. Scarborough (2006). Prediction of reading comprehension: Relative contributions of word recognition, language proficiency, and other cognitive skills can depend on how comprehension is measured. *Scientific Studies of Reading* 10, 277–299.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

D'Angiulli, A., L. S. Siegel & E. Serra (2001). The development of reading in English and Italian in bilingual children. *Applied Psycholinguistics* 22, 479–507.
Deacon, S. & J. Kirby (2004). Morphological awareness: Just 'More phonological'? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics* 25, 223–238.
Deacon, S., L. Wade-Woolley & J. Kirby (2007). Crossover: The role of morphological awareness in French immersion children's reading. *Developmental Psychology* 43, 732–746.
Denton, C. A., J. E. Hasbrouck, L. R. Weaver & C. A. Riccio (2000). What do we know about phonological awareness in Spanish? *Reading Psychology* 21, 335–352.
Dickinson, D. K., A. McCabe, N. Clark-Chiarelli & A. Wolf (2004). Cross-language transfer of phonological awareness in low-income Spanish and English bilingual preschool children. *Applied Psycholinguistics* 25, 323–347.
Droop, M. & L. Verhoeven (2003). Language proficiency and reading ability in first- and second-language learners. *Reading Research Quarterly* 38, 78–103.
Durgunoglu, A. Y., W. E. Nagy & B. J. Hancin-Bhatt (1993). Cross-language transfer of phonological awareness. *Journal of Educational Psychology* 85, 453–465.
Ehrlich, S. F. & K. Rayner (1981). Contextual effects on word perception and eye movements during reading. *Journal of Verbal Learning and Verbal Behavior* 20, 641–655.
Ellis, N., M. Natsume, K. Stavropoulou, L. Hoxhallari, V. Van Daal, N. Polyzoe, M.-L. Tsipa & M. Petalas (2004). The effects of orthographic depth on learning to read alphabetic, syllabic, and logographic scripts. *Reading Research Quarterly* 39, 438–468.
Everson, E. (1998). Word recognition among learners of Chinese as a foreign language: Investigating the relationship between naming and knowing. *The Modern Language Journal* 82, 194–204.
Favreau, M. & N. S. Segalowitz (1983). Automatic and controlled processes in the first-and second-language reading of fluent bilinguals. *Memory & Cognition* 11, 565–574.
Ferrand, L. & J. Grainger (1994). Effects of orthography are independent of phonology in masked form priming. *The Quarterly Journal of Experimental Psychology, A: Human Experimental Psychology* 47, 365–382.
Frisson, S., K. Rayner & M. Pickering (2005). Effects of contextual predictability and transitional probability on eye movements during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 31, 862–877.
Frost, R. (2005). Orthographic systems and skilled word recognition processes in reading. In M. Snowling & C. Hulme (eds.), *The science of reading*. Malden, MA: Blackwell, 272–295.
Frost, R. & L. Katz (1989). Orthographic depth and the interaction of visual and auditory processing in word recognition. *Memory & Cognition* 17, 302–310.
Frost, R., L. Katz & S. Bentin (1987). Strategies for visual word recognition and orthographical depth: A multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance* 13, 104.
Fukkink, R. G., J. Hulstijn & A. Simis (2005). Does training in second-language word recognition skills affect reading comprehension? An experimental study. *The Modern Language Journal* 89, 54–75.
Gelderen, A. V., R. Schoonen, R. D. Stoel, K. d. Glopper & J. Hulstijn (2007). Development of adolescent reading comprehension in language 1 and language 2: A longitudinal analysis of constituent components. *Journal of Educational Psychology* 99, 477–491.
Geva, E., L. Wade-Woolley & M. Shany (1993). The concurrent development of spelling and decoding in two different orthographies. *Journal of Reading Behavior* 25, 383–406.
Geva, E. & M. Wang (2001). The development of basic reading skills in children: A cross-language perspective. *Annual Review of Applied Linguistics* 21, 182–204.
Geva, E. & Z. Yaghoub Zadeh (2006). Reading efficiency in native English-speaking and English-as-a-second-language children: The role of oral proficiency and underlying cognitive-linguistic processes. *Scientific Studies of Reading* 10, 31–57.
Geva, E., Z. Yaghoub-Zadeh & B. Schuster (2000). Understanding individual differences in word recognition skills of ESL children. *Annals of Dyslexia* 50, 121–154.
Gholamain, M. & E. Geva (1999). Orthographic and cognitive factors in the concurrent development of basic reading skills in English and Persian. *Language Learning* 49, 183–217.
Goodman, K. S. (1967). Reading: A psycholinguistic guessing game. *Literacy Research and Instruction* 6, 126–135.
Goodman, K. S. (1988). The reading process. In P. Carrell, J. Devine & D. E. Eskey (eds.), *Interactive approaches to second language reading*. New York: Cambridge University Press, 11–21.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Goodman, K. S. (1996). *On reading*. Portsmouth, NH: Heinemann.
Goodman, K. S. (2011). The process of reading in non-alphabetic languages: An introduction. In K. S. Goodman, S. Wang, M. Iventosch & Y. Goodman (eds.), *Reading in Asian languages: Making sense of written texts in Chinese, Japanese, and Korean*. New York: Routledge, Taylor & Francis Group, 3–15.
Goswami, U. (2000). Phonological representations, reading development and dyslexia: Towards a cross-linguistic theoretical framework. *Dyslexia* 6, 133–151.
Goswami, U. (2008). The development of reading across languages. *Annals of the New York Academy of Sciences* 1145, 1–12.
Goswami, U. & P. E. Bryant (1990). *Phonological skills and learning to read*. Hillsdale, NJ: Laurence Erlbaum.
Gottardo, A. (2002). The relationship between language and reading skills in bilingual Spanish-English speakers. *Topics in Language Disorders* 22.5, 46–70.
Gottardo, A., P. Collins, I. Baciu & R. Gebotys (2008). Predictors of grade 2 word reading and vocabulary learning from grade 1 variables in Spanish-speaking children: Similarities and differences. *Learning Disabilities Research & Practice* 23, 11–24.
Gottardo, A., K. E. Stanovich & L. Siegel (1996). The relationships between phonological sensitivity, syntactic processing, and verbal working memory in the reading performance of third-grade children. *Journal of Experimental Child Psychology* 63, 563–582.
Gottardo, A., B. Yan, L. Siegel & L. Wade-Woolley (2001). Factors related to English reading performance in children with Chinese as a first language: More evidence of cross-language transfer of phonological processing. *Journal of Educational Psychology* 93, 530–542.
Gough, P. B. (1972). One second of reading. In J. F. Kavanagh & I. G. Mattingly (eds.), *Language by ear and eye*. Cambridge: Cambridge University Press, 331–358.
Gough, P. B., W. A. Hoover & C. Peterson (1996). Some observations on a simple view of reading. In C. Cornoldi & J. Oakhill (eds.), *Reading comprehension difficulties: Processes and interventions*. Mahwah, NJ: Laurence Erlbaum, 1–13.
Gough, P. B. & W. E. Tunmer (1986). Decoding, reading, and reading disability. *Remedial and Special Education* 7, 6–10.
Grabe, W. (2009). *Reading in a second language: Moving from theory to practice*. New York: Cambridge Universiy Press.
Grainger, J. & M. Jacobs (1996). Orthographic processing in visual word recognition: A multiple read-out model. *Psychological Review* 103, 518–565.
Grainger, J., K. Kiyonaga & J. Holcomb (2006). The time course of orthographic and phonological code activation. *Psychological Science* 17, 1021–1026.
Grant, A., A. Gottardo & E. Geva (2011). Reading in English as a first or second language: The case of grade 3 Spanish, Portuguese, and English speakers. *Learning Disabilities Research & Practice* 26, 67–83.
Guan, C. Q., Y. Liu, D. H. L. Chan, F. Ye & C. A. Perfetti (2011). Writing strengthens orthography and alphabetic-coding strengthens phonology in learning to read Chinese. *Journal of Educational Psychology* 103, 509–522.
Haigh, C., R. Savage, C. Erdos & F. Genesee (2011). The role of phoneme and onset-rime awareness in second language reading acquisition. *Journal of Research in Reading* 34, 94–113.
Halderman, L. K., J. Asby & C. A. Perfetti (2012). Phonology: An early and integral role in identifying words. In J. S. Adelman (ed.), *Visual word recognition: Models and methods, orthography and phonology*. (Vol. 1). London: Psychology Press, 207–228.
Hamada, M. & K. Koda (2008). Influence of first language orthographic experience on second language decoding and word learning. *Language Learning* 58, 1–31.
Harlaar, N., L. Cutting, K. Deater-Deckard, L. S. DeThorne, L. M. Justice, C. Schatschneider, L. A. Thompson & S. A. Petrill (2010). Predicting individual differences in reading comprehension: A twin study. *Annals of Dyslexia* 60, 265–288.
Harm, M. W. & M. S. Seidenberg (2004). Computing the meanings of words in reading: Cooperative division of labor between visual and phonological processes. *Psychological Review* 111, 662–720.
Haynes, M. & T. Carr (1990). Writing system background and second language reading: A component skills analysis of English reading by native speakers of Chinese. In T. Carr & B. A. Levy (eds.), *Reading and its development: Component skills approaches*. San Diego, CA: Academic Press, 375–421.
Henderson, L. (1982). *Orthography and word recognition in reading*. London: Academic Press.
Hinton, G. E., J. L. McClelland & D. E. Rumelhart (1986). Distributed representations. *Parallel Distributed Processing: Explorations in the Microstructure of Cognition* 1, 77–109.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Hoien, T., I. Lundberg, K. E. Stanovich & I. K. Bjaalid (1995). Components of phonological awareness. *Reading and Writing* 7, 171–188.
Holm, A. & B. Dodd (1996). The effect of first written language on the acquisition of English literacy. *Cognition* 59, 119–147.
Holmes, V. M. (2009). Bottom-up processing and reading comprehension in experienced adult readers. *Journal of Research in Reading* 32, 309–326.
Hoover, M. L. & V. D. Dwivedi (1998). Syntactic processing by skilled bilinguals. *Language Learning* 48, 1–29.
Hoover, W. A. & P. B. Gough (1990). The simple view of reading. *Reading and Writing* 2, 127–160.
Horiba, Y., P. van den Broek & C. Fletcher (1993). Second language readers' memory for narrative texts: Evidence for structure-preserving top-down processing. *Language Learning* 43, 345–372.
Hu, H. M. & H. Nassaji (2012). Ease of inferencing, learner inferential strategies, and their relationship with the retention of word meanings inferred from context. *Canadian Modern Language Review* 68, 54–77.
Hulme, C., M. Snowling, M. Caravolas & J. Carroll (2005). Phonological skills are (probably) one cause of success in learning to read: A comment on Castles and Coltheart. *Scientific Studies of Reading* 9, 351–365.
Hyltenstam, K. (1988). Lexical characteristics of near-native second-language learners of Swedish. *Journal of Multilingual and Multicultural Development* 9, 67–84.
Hyona, J. & J. Lindeman (1994). Syntactic context effects on word recognition: A developmental study. *Scandinavian Journal of Psychology* 35, 27–37.
Jackson, N. E. (2005). Are university students' component reading skills related to their text comprehension and academic achievement? *Learning and Individual Differences* 15, 113–139.
Jared, D. & M. S. Seidenberg (1991). Does word identification proceed from spelling to sound to meaning? *Journal of Experimental Psychology: General* 120, 358–394.
Jenkins, J., B. Matlock & T. Slocum (1989). Two approaches to vocabulary instruction: The teaching of individual word meanings and practice in deriving word meaning from context. *Reading Research Quarterly* 24, 215–235.
Just, M. A. & P. A. Carpenter (1987). *The psychology of reading and language comprehension*. Boston, MA: Allyn and Bacon.
Katz, L. & R. Frost (1992). Reading in different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (eds.), *Orthography, phonology, morphology, and meaning*. Amsterdam: New Holland, 67–84.
Kendeou, P., van den P. Broek, M. J. White & J. S. Lynch (2009). Predicting reading comprehension in early elementary school: The independent contributions of oral language and decoding skills. *Journal of Educational Psychology* 101, 765–778.
Kieffer, M. & N. Lesaux (2008). The role of derivational morphology in the reading comprehension of Spanish-speaking English language learners. *Reading and Writing* 21, 783–804.
Kim, D., W. Kim & K. Lee (2007). The relationship between phonological awareness and early reading for first grade Korean language learners with reading difficulties. *Asia Pacific Education Review* 8, 426–434.
Kirby, J., S. Deacon, P. Bowers, L. Izenberg, L. Wade-Woolley & R. Parrila (2012). Children's morphological awareness and reading ability. *Reading and Writing: An Interdisciplinary Journal* 25, 389–410.
Koda, K. (1988). Cognitive process in second language reading: Transfer of L1 reading skills and strategies. *Second Language Research* 4, 133–156.
Koda, K. (1990). The use of L1 reading strategies in L2 reading. *Studies in Second Language Acquisition* 12, 393–410.
Koda, K. (1992). The effects of lower-level processing skills on FL reading performance: Implications for instruction. *The Modern Language Journal* 76, 502–512.
Koda, K. (2005). *Insights into second language reading*. Cambridge: Cambridge University Press.
Kuhn, M. (2004). Helping students become accurate, expressive readers: Fluency instruction for small groups. *The Reading Teacher* 58, 338–344.
Kuhn, M. & S. A. Stahl (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology* 95, 3–21.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

LaBerge, D. & S. Samuels (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology* 6, 293–323.
Landi, N. (2010). An examination of the relationship between reading comprehension, higher-level and lower-level reading sub-skills in adults. *Reading and Writing* 23, 701–717.
Lesaux, N. & L. Siegel (2003). The development of reading in children who speak English as a second language. *Developmental Psychology* 39, 1005–1019.
Liu, Y. T. (2009). Attainability of a native-like lexical processing system in adult second language acquisition: A study of advanced L2 Chinese learners. *Language and Linguistics* 10, 489–520.
Macalister, J. (2010). Speed reading courses and their effect on reading authentic texts: A preliminary investigation. *Reading in a Foreign Language* 22, 104–116.
Massaro, D. W. & T. Sanocki (1993). Visual information processing in reading. In D. M. Willows, R. S. Kruk & E. Corcos (eds.), *Visual processes in reading and reading disabilities*. Hillsdale, NJ: Laurence Erlbaum, 139–161.
McBride-Chang, C. (2004). *Children's literacy development*. New York: Oxford University Press.
McClelland, J. L. (1988). Connectionist models and psychological evidence. *Journal of Memory and Language* 27, 107–123.
McLeod, B. & B. McLaughlin (1986). Restructuring or automaticity? Reading in a second language. *Language Learning* 36, 109–123.
McLeod, P., D. C. Plaut & T. Shallice (2001). Connectionist modelling of word recognition. *Synthese* 129, 173–183.
Mori, Y. (1998). Effects of first language and phonological accessibility on kanji recognition. *The Modern Language Journal* 82, 69–82.
Muljani, D., K. Koda & D. Moates (1998). The development of word recognition in a second language. *Applied Psycholinguistics* 19, 99–113.
Muter, V. & K. Diethelm (2001). The contribution of phonological skills and letter knowledge to early reading development in a multilingual population. *Language Learning* 51, 187–219.
Nagy, W. (1997). On the role of context in first- and second-language vocabulary learning. In N. Schmidt & M. McCarthy (eds.), *Vocabulary: Description, acquisition and pedagogy*. Cambridge: Cambridge University Press, 64–83.
Nagy, W., R. C. Anderson & P. A. Herman (1987). Learning word meanings from context during normal reading. *American Educational Research Journal* 24, 237–270.
Nakagawa, A. (1994). Visual and semantic processing in reading kanji. *Journal of Experimental Psychology. Human Perception and Performance* 20, 864–875.
Nassaji, H. (2002). Schema theory and knowledge-based processes in second language reading comprehension: A need for alternative perspectives. *Language Learning* 52, 439–481.
Nassaji, H. (2003a). Higher-level and lower-level text processing skills in advanced ESL reading comprehension. *The Modern Language Journal* 87, 261–276.
Nassaji, H. (2003b). L2 vocabulary learning from context: Strategies, knowledge sources, and their relationship with success in L2 lexical inferencing. *TESOL Quarterly* 37, 645–670.
Nassaji, H. (2004). The relationship between depth of vocabulary knowledge and L2 learners' lexical inferencing strategy use and success. *Canadian Modern Language Review* 61, 107–134.
Nassaji, H. (2011). Issues in second-language reading: Implications for acquistion and instruction. *Reading Research Quarterly* 46, 173–184.
Nassaji, H. & E. Geva (1999). The contribution of phonological and orthographic processing skills to adult ESL reading: Evidence from native speakers of Farsi. *Applied Psycholinguistics* 20, 241–267.
Netten, A., M. Droop & L. Verhoeven (2011). Predictors of reading literacy for first and second language learners. *Reading and Writing* 24, 413–425.
Paap, K. R., R. W. Noel & L. S. Johansen (1992). Dual-route models of print to sound: Red herrings and real horses. In R. Frost & L. Katz (eds.), *Advances in psychology: Orthography, phonology, morphology, and meaning*. Amsterdam: North-Holland, 293–318.
Pasquarella, A., X. Chen, K. Lam, Y. C. Luo & G. Ramirez (2011). Cross-language transfer of morphological awareness in Chinese-English bilinguals. *Journal of Research in Reading* 34, 23–42.
Perfetti, C. A. (1985). *Reading ability*. New York: Oxford University Press.
Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading* 11, 357–383.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Perfetti, C. A. & L. Hart (2001). The lexical basis of comprehension skill. In D. S. Gorfien (ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity*. Washington, DC: American Psychological Association, 67–86.
Perfetti, C. A. & A. M. Lesgold (1977). Discourse comprehension and sources of individual differences. In M. A. Just & P. A. Carpenter (eds.), *Cognitive processes in comprehension*. Hillsdale, NJ: Laurence Erlbaum, 141–183.
Perfetti, C. A. & S. F. Roth (1981). Some of the interactive processes in reading and their role in reading skill. In A. M. Lesgold & C. A. Perfetti (eds.), *Interactive processes in reading*. Hillsdale, NJ: Laurence Erlbaum, 269–298.
Perfetti, C. A. & S. Zhang (1991). Phonological processes in reading Chinese characters. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 17, 633–643.
Plaut, D. C. (2005). Connectionist approaches to reading. In M. Snowling & C. Hulme (eds.), *The science of reading*. Malden, MA: Blackwell, 24–38.
Plaut, D. C., J. L. McClelland & M. S. Seidenberg (1995). Reading exception words and pseudowords: Are two routes really necessary? In J. P. Levy, D. Bairaktaris, J. A. Bullinaria & P. Cairns (eds.), *Connectionist models of memory and language*, 145–159.
Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin* 124, 372–422.
Rayner, K. & A. Pollatsek (1989). *The psychology of reading*. Englewood Cliffs, NJ: Prentice Hall.
Rayner, K. & A. Pollatsek (2006). Eye-movement control in reading. In M. Traxler & M. A. Gernsbacher (eds.), *Handbook of psycholinguistics* (2nd edn). San Diego, CA: Academic Press, 613–657.
Reichle, E. D., A. Pollatsek, D. L. Fisher & K. Rayner (1998). Toward a model of eye movement control in reading. *Psychological Review* 105, 125.
Reichle, E. D., K. Rayner & A. Pollatsek (2003). The E-Z reader model of eye-movement control in reading: Comparisons to other models. *Behavioral and Brain Sciences* 26, 445–476.
Rizzardi, M. C. (1980). Reader and text in comprehension. In G. Cortese (ed.), *Reading in a foreign language*. Milan: Franco Angeli, 449–458.
Roberts, T. A., C. Christo & J. A. Sheflebine (2011). Word recognition. In M. Kamil, P. D. Pearson, E. Moje & P. Afferbach (eds.), *Handbook of reading research* (Vol. IV). New York: Routledge, 226–258.
Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce & W. F. Brewer (eds.), *Theoretical issues in reading comprehension*. Hillsdale, NJ: Laurence Erlbaum, 33–58.
Russak, S. & E. Saiegh-Haddad (2011). Phonological awareness in Hebrew (L1) and English (L2) in normal and disabled readers. *Reading and Writing* 24, 427–442.
Saiegh-Haddad, E. & E. Geva (2008). Morphological awareness, phonological awareness, and reading in English-Arabic bilingual children. *Reading and Writing* 21, 481–504.
Schatz, E. K. & R. S. Baldwin (1986). Context clues are unreliable predictors of word meanings. *Reading Research Quarterly* 21, 439–453.
Schiff, R. & S. Calif (2007). Role of phonological and morphological awareness in L2 oral word reading. *Language Learning* 57, 271–298.
Schotter, E. R. & K. Rayner (2012). Eye movement and word recognition during reading. In J. S. Adelman (ed.), *Visual word recognition: Meaning and context, individuals and development* (Vol. 2). London: Psychology Press, 73–101.
Schwantes, M., L. Boesl & G. Ritz (1980). Children's use of context in word recognition: A psycholinguistic guessing game. *Child Development* 51, 730–738.
Segalowitz, N. & M. Hébert (1990). Phonological recoding in the first and second language reading of skilled bilinguals. *Language Learning* 40, 503–538.
Segalowitz, N. & S. J. Segalowitz (1993). Skilled performance, practice, and the differentiation of speed-up from automatization effects: Evidence from second language word recognition. *Applied Psycholinguistics* 14, 369–385.
Segalowitz, N., V. Watson & S. Segalowitz (1995). Vocabulary skill: Single-case assessment of automaticity of word recognition in a timed lexical decision task. *Second Language Research* 11, 121–136.
Seidenberg, M. S. (1992). Beyond orthographic depth in reading: Equitable division of labor. In R. Frost & L. Katz (eds.), *Orthography, phonology, morphology and meaning*. Amsterdam: Elsevier, 85–118.
Seidenberg, M. S. (2005). Connectionist models of word reading. *Current Directions in Psychological Science* 14, 238–242.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Seidenberg, M. S., G. S. Waters, M. Sanders & P. Langer (1984). Pre- and postlexical loci of contextual effects on word recognition. *Memory & Cognition* 12, 315–328.
Shankweiler, D., E. Lundquist, L. G. Dreyer & C. C. Dickinson (1996). Reading and spelling difficulties in high school students: Causes and consequences. *Reading and Writing* 8, 267–294.
Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition* 55, 151–218.
Share, D. L. & K. E. Stanovich (1995). Cognitive processes in early reading development: Accommodating individual differences into a model of acquisition. *Issues in Education: Contributions from Educational Psychology* 1, 1–57.
Shiffrin, R. & W. Schneider (1977). Controlled and automatic human information processing: Perceptual learning, automatic, attending and a general theory. *Psychological Review* 84, 127–190.
Shiotsu, T. (2009). Reading ability and components of word recognition speed: The case of L1-Japanese EFL learners. In Z. Han & N. J. Anderson (eds.), *Second language reading research and instruction: Crossing the boundaries*. Ann Arbor, MI: University of Michigan Press, 15–39.
Siegel, L. & E. Ryan (1988). Development of grammatical-sensitivity, phonological, and short-term memory skills in normally achieving and learning disabled children. *Developmental Psychology* 24, 28–37.
Smith, F. (1994). *Understanding reading: A psycholinguistic analysis of reading and learning to read*. Hillsdale, NJ: Laurence Erlbaum.
Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly* 16, 32–71.
Stanovich, K. E. (1996). Word recognition: Changing perspectives. In R. Barr, M. L. Kamil & P. D. Pearson (eds.), *Handbook of reading research* (Vol. 2). Mahwah NJ: Laurence Erlbaum, 418–452.
Stanovich, K. E. (2000). *Progress in understanding reading: Scientific foundations and new frontiers*. New York: The Guilford Press.
Stanovich, K. E. & L. Siegel (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology* 86, 24.
Stanovich, K. E. & R. F. West (1983). On priming by a sentence context. *Journal of Experimental Psychology. General* 112, 1–36.
Stanovich, K. E. & R. F. West (1989). Exposure to print and orthographic processing. *Reading Research Quarterly* 24, 402–433.
Stanovich, K. E., R. F. West & A. E. Cunningham (1991). Beyond phonological processes: Print exposure and orthographic processing. In S. A. Brady & D. P. Shankweiler (eds.), *Phonological processes in literacy*. Hillsdale, NJ: Lawrence Erlbaum, 219–235.
Sun-Alperin, M. K. & M. Wang (2011). Cross-language transfer of phonological and orthographic processing skills from Spanish L1 to English L2. *Reading and Writing* 24, 591–614.
Taguchi, E. (1999). The effects of repeated readings on the development of lower identification skills of FL readers. *Reading in a Foreign Language* 11, 97–119.
Taguchi, E. & G. Gorsuch (2010). Developing reading fluency and comprehension using repeated reading: Evidence from longitudinal student reports. *Language Teaching Research* 14, 27–59.
Tan, L. H. & C. A. Perfetti (1998). Phonological codes as early sources of constraint in Chinese word identification: A review of current discoveries and theoretical accounts. *Reading and Writing* 10, 165–200.
Turvey, M., L. B. Feldman & G. Lukatela (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*. Hillsdale, NJ: Lawrence Erlbaum, 81–90.
Van Orden, G. C. & H. Kloos (2005). The question of phonology and reading. In M. S. Snowling & C. Hulme (eds.), *The science of reading: A handbook*. Malden, MA: Blackwell, 61–78.
Verhoeven, L. (1991). Acquisition of biliteracy. *AILA Review* 8, 61–74.
Verhoeven, L. (2000). Components in early second language reading and spelling. *Scientific Studies of Reading* 4, 313–330.
Verhoeven, L. (2007). Early bilingualism, language transfer, and phonological awareness. *Applied Psycholinguistics* 28, 425–439.
Verhoeven, L. (2011). Second language reading acquisition. In M. Kamil, P. D. Pearson, E. Moje & P. Afferbach (eds.), *Handbook of reading research* (Vol. IV). New York: Routledge, 661–683.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press

Verhoeven, L. & C. A. Perfetti (2011). Morphological processing in reading acquisition: A cross-linguistic perspective. *Applied Psycholinguistics* 32, 457–466.
Verhoeven, L. & J. van Leeuwe (2008). Prediction of the development of reading comprehension: A longitudinal study. *Applied Cognitive Psychology* 22, 407–423.
Verhoeven, L. & J. van Leeuwe (2009). Modeling the growth of word-decoding skills: Evidence from Dutch. *Scientific Studies of Reading* 13, 205–223.
Wade-Woolley, L. & E. Geva (1999). Processing inflected morphology in second language word recognition: Russian-speakers and English-speakers read Hebrew. *Reading and Writing* 11, 321–343.
Wagner, R. K. & T. A. Barker (1994). The development of orthographic processing ability. In V. W. Berninger (ed.), *The varieties of orthographic knowledge I: Theoretical and developmental issues*. Dordrecht: Kluwer, 243–276.
Wagner, R. K. & J. K. Torgesen (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin* 101, 192–212.
Wagner, R. K., J. K. Torgesen & C. A. Rashotte (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology* 30, 73–87.
Walter, C. (2008). Phonology in second language reading: Not an optional extra. *TESOL Quarterly* 42, 455–455.
Wang, M. & E. Geva (2003). Spelling performance of Chinese children using English as a second language: Lexical and visual-orthographic processes. *Applied Psycholinguistics* 24, 1–25.
Wang, M. & K. Koda (2007). Commonalities and differences in word identification skills among learners of English as a second language. *Language Learning* 57, 201–222.
Wang, M., K. Koda & C. A. Perfetti (2003). Alphabetic and nonalphabetic L1 effects in English word identification: A comparison of Korean and Chinese English L2 learners. *Cognition* 87, 129–149.
West, R., K. Stanovich, D. Feeman & A. Cunningham (1983). The effect of sentence context on word recognition in second- and sixth-grade children. *Reading Research Quarterly* 19, 6–15.
Wright, B. & M. Garrett (1984). Lexical decision in sentences: Effects of syntactic structure. *Memory & Cognition* 12, 31–45.
Zeelenberg, R., D. Pecher, M. Shiffrin & W. Raaijmakers (2003). Semantic context effects and priming in word association. *Psychonomic Bulletin & Review* 10, 653–660.
Ziegler, J. & U. Goswami (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin* 131, 3–29.

HOSSEIN NASSAJI is Professor of Applied Linguistics in the Department of Linguistics, University of Victoria, Victoria, BC, Canada. His teaching and research interests include L2 reading and vocabulary learning, form-focused instruction, corrective feedback, and L2 classroom discourse. His research has been published in numerous leading journals in the field. His recent books are (with Sandra Fotos) *Teaching grammar in second language classrooms: Integrating form-focused instruction in communicative context* (Routledge 2010) and *Form-focused instruction and teacher education: Studies in honour of Rod Ellis* (Oxford University Press 2007). He is the winner (with Gordon Wells) of the twenty-first annual Kenneth W. Mildenberger Prize of the Modern Language Association of America and also the recipient of the 2012 Faculty of Humanities Award for Research Excellence, University of Victoria.

https://doi.org/10.1017/S0261444813000396 Published online by Cambridge University Press