Introduction to This Special Issue: Dyslexia Across Languages and Writing Systems

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Kenneth Pugh[a] and Ludo Verhoeven[b]

[a]Haskins Laboratories; [b]Behavioural Science Institute, Radboud University Nijmegen

ABSTRACT

Research suggests that a phonological deficit primarily underlies developmental dyslexia. However, the existing evidence is mainly based on studies in children learning to read English. In recent years, the research base has broadened, as research around the world has provided new insights into the neural and cognitive foundations of developmental dyslexia in different languages. The present issue aims to bring together observations on reading disabilities across languages and writing systems within cross-linguistic and cross-writing system perspectives while taking into account a broad multidisciplinary scope. An attempt is made to advance theoretical models of developmental dyslexia through systematic analyses of reading disabilities in Arabic, Chinese, Dutch, English, German, Greek, and Spanish in perspective of universal and particular underlying cognitive principles. It is also discussed how within- and cross-language observations may affect the conceptualization of developmental dyslexia.

Reading involves decoding written language in order to understand it. In learning to read, children implicitly learn how their writing system encodes their spoken language and thus how they can decode printed words into spoken words to get meaning (see Verhoeven & Perfetti, 2017). However, many children around the world have problems in learning to read, failing to acquire fluent decoding, and are thus diagnosed as being dyslexic. A large body of research supports the notion that underlying developmental dyslexia is primarily a phonological deficit that takes various forms. However, much of the existing evidence and debate is based on studies in children learning to read English, which has an opaque orthography and is one of the hardest orthographies to master. In recent years, the research base has broadened, as studies around the world have provided new information on different languages. There have been suggestions that the etiology of dyslexia might differ somewhat across languages and writing systems involving not only metaphonological problems but also, especially in more transparent languages, fluency-related skills or other language and nonlanguage factors. Whether such differences reflect only superficial variation around a common (phonological) cause or deeper variation in causes related to linguistic and writing system differences is not yet clear. The time is right to bring together observations on reading problems across languages and writing systems within cross-linguistic and cross-writing system perspectives while taking into account a broad multidisciplinary scope, and this is the primary focus of this special issue.

Current theoretical frameworks

As noted, the most prominent models of dyslexia have tended to focus on phonological processing deficits, predicated on the findings that for the vast majority of struggling readers, a core difficulty in reading manifests itself as a deficiency within the language system, particularly at the level of phonological processing. To learn to read successfully in an alphabetic writing system, a child must

develop an appreciation of the segmental nature of speech and come to realize that spoken words are composed of the smallest of these segments, the phonemes. This appreciation of the segmental nature of speech is termed *phonemic awareness* (PA). It is PA and the understanding that the constituents of a printed word—its letters—bear a relationship to phonemes that allow the beginning readers to connect printed words to the corresponding words in their speech lexicon. There is considerable evidence that PA is characteristically deficient (or lacking) in young readers with reading disorders who, during literacy instruction, will have difficulty developing efficient routines for mapping alphabetic characters into the phonetic constituents they represent (Bradley & Bryant, 1983; Liberman, 1992).

Although the underlying mechanisms of the development of PA are not fully understood, there is some support for the claim that at least part of the difficulty resides in the phonological component of a larger specialization for spoken language. If that component is imperfect in an individual, the individual's perception of phonemes may be less than ideally distinctive. For children with adequate phonological representations, orthographic (O), phonological (P) and semantic (S) codes can become well integrated into high-quality lexical representations (Perfetti et al., 2007) and with practice word decoding becomes more fluent or automatic (Pugh et al., 2013; Verhoeven & Van Leeuwe, 2009). There is also broad agreement that skilled word decoding in any writing system must contain at least two major processing pathways (Harm & Seidenberg, 2004): A phonological pathway by which the phonological representation of a printed word is computed via O to P mapping routines and a lexical/semantic pathway with direct O to S mapping routines. More recently, this phonological deficit framework has framed much of the work on the neurobiological basis of skilled and less skilled reading development where left hemisphere component dorsal and ventral networks that support orthographic to phonologic and/or orthographic to semantic mapping have been shown to be poorly organized in untreated dyslexia (Pugh et al., 2013; Van den Bunt et al., 2017).

Although it is generally well accepted that phonological processing is vulnerable in dyslexia, four strains of thought have, in different ways, taken some issue with the canonical account. The first is the attempt to link problems of phonology to nonlanguage mechanisms such as basic sensorimotor processes (Goswami et al., 2011), or other domain general mechanisms like attention (Bosse & Valdois, 2009), or procedural learning (Nicolson & Fawcett, 2007). A second, staying within the language domain, broadens focus beyond phonology alone to include other domains such as morphological awareness that can impede the development of adequate word decoding (Kirby et al., 2012). A third multifactorial framework starts from the observation that dyslexia symptoms can be quite heterogeneous and allows that there may be many paths (or combinations of deficits) that can get to the same end state (Pennington, 2006). Finally, a fourth strain, of particular relevance to the current articles, is the notion that any of these models (from canonical to multifactorial) may be more or less relevant depending on the transparency of the writing system (Daniels and Share), and we turn to this next.

Dyslexia across languages and writing systems

An important question is how universals and particulars in developmental dyslexia across languages and writing systems can be explained. As noted, dual pathway accounts of word reading are generally adopted by researchers in many languages to account for the processing of visual word forms. However, specific models were generally developed with alphabetic reading in mind, although their principles should be extendable to any writing system with written words that have constituent components that can be assembled to produce word identification as well as a whole word form for direct accesses. In recent years, the research base has broadened and provided new information on different languages, and clearly the time is right to bring together observations across languages and writing systems within cross-linguistic and cross-writing system perspectives. These perspectives allow a focus on those aspects of developmental dyslexia that might be relatively specific to language properties and those aspects that are common to all languages and orthographies.

Thus, in some basic ways fluent word reading must depend both on the quality of phonological knowledge and on the capacity to transition from accurate to fluent decoding. It has been argued by some researchers that the relative contributions to dyslexia from indices of phonological knowledge such as PA or fluency such as rapid automatic naming or decoding fluency may vary across writing systems (cf. Winner et al., 2000; but also see Caravolas et al., 2013, for a contrastive view). Whether differences in the relative predictive utility of one or another cognitive test is actually indicative of fundamental differences in etiology is debatable. Indeed, as PA shares a bidirectional relation to word decoding skills (Wagner, Torgesen, & Rashotte, 1994), and as decoding skills unfold more quickly in transparent orthographies (Seymour, Aro, & Erskine, 2003), it might be that PA distributions are reduced as well and the variance accounted for therefore shits to measures with greater range. We note this here simply to illustrate that speculative can be made for or against notions of universality or language specificity and increased data on transitions to literacy (including neurobiological) will be needed to adjudicate the debates. The questions of universality versus language specificity for typical and atypical reading development become especially relevant when contrasting alphabetic languages (of any degree of transparency) with consonantal root-based writing systems such as Arabic and Hebrew and nonalphabetic morpho-syllabic writing systems such as Chinese. On first consideration, it might seem that parallels with O to P and O to S division of labor that form key elements in alphabetic systems would be unlikely given the grain size of phonological units in Chinese. However, some neurocognitive evidence suggests similarity both for typical development (Rueckl et al., 2015) and in dyslexia (Hu et al., 2010), whereas other studies appear to argue for significant neurocognitive variation along the morpho-phonological dimension (Perfetti et al., 2007; Tan, Laird, Li, & Fox, 2005). Thus, it is crucial at this juncture that we begin to acquire comparable developmental data and (informed by news tools from computational modeling and brain imaging) to identify what is universal and what is not. We see the current collection of articles as making a contribution to all of these cross-language questions.

The present issue

The aim of this special issue is to advance theoretical models of developmental dyslexia through systematic analyses of languages, writing systems, and orthographies in relation to the conceptualization and etiology of reading disabilities. Our claim, as noted, is that reading reflects a learned sensitivity to the systematic relationships among the surface forms of words and their meanings. This is a universal aspect of reading, and the causes of failures in learning these relationships are the core causes of dyslexia as a universal disability. However, because writing systems vary in how they represent the languages they encode and languages substantially differ in phonological, syntactic, and morphological structures, on one hand, and in script characteristics, on the other hand, particular effects across writing systems and orthographies can also be anticipated. To address the role of cross-linguistic differences, reading researchers who represent a broad sampling of written languages examined how reading disabilities become manifest within typologically different languages and writing systems and how within- and cross-language observations do affect the conceptualization of developmental dyslexia. Alphabetic orthographies varying in orthographic depth (Dutch, German, Spanish, Greek, and English) are contrasted with Arabic as an unvoweled root-based orthography and Chinese as a morpheme-based logographic orthography to uncover universal and particular underlying cognitive principles in developmental dyslexia.

In the first article, Verhoeven and Keuning investigate the nature of developmental dyslexia in Dutch as a transparent orthography. They assess lexicality and length effects in accuracy and efficiency of decoding in typical children and their peers with dyslexia across Grades 3–6. For typical readers, orthographic learning was found to be largely a matter of increasing speed. For readers with dyslexia, difficulties manifested themselves for both accuracy and efficiency of decoding but more for pseudowords than for words. They were also more sensitive to word-length effects. Decoding ability turned out to be much more sensitive for the prediction of dyslexia than phonological ability as

measured by phonological awareness, serial rapid naming, and phonological working memory. It is concluded that Dutch children with dyslexia have relatively intact phonological representations but persistent problems with accessing phonology during decoding.

In the next article, Gangl et al. focus on online dysfluent reading in German, which is often assumed to result from failure to build up an orthographic lexicon and overreliance on phonological decoding. They investigate variations in reading style in an eye-tracking paradigm with German dysfluent third and fourth graders. Both readers with fixations in the typical ranges and readers with increased fixation counts showed lexical access in that words were read more efficiently than nonwords and pseudohomophones. Typical fixation readers evidenced stronger reliance on lexical reading than increased fixation readers. Besides, smaller length effects for number of fixations and total reading time were evidenced, along with stronger lexicality effects for gaze duration and stronger word-pseudohomophone effects for mean saccade amplitude. It is concluded that in both groups, both sublexical and lexical reading processes were impaired due to inefficient visual–verbal integration.

In the ensuing article, Cuetos, Martínez, and Suárez go beyond standard phonological measures by also focusing on prosodic and visual perception in Spanish dyslexia. They assess several prosodic perception, rise perception, phonological processing, and visual tasks in three groups of participants: children with dyslexia, typical readers matched by age, and typical readers matched by reading level. They found that children with developmental dyslexia scored lower than the typical readers not only on phonological and reading tasks but also on prosodic tasks, although no differences were found in rise time tasks. There were no differences on the visual tasks. These results show that on top of standard phonological problems Spanish dyslexic children have a prosodic impairment, possibly originating from subtle auditory processing deficits.

In the following article, Diamanti, Goulandris, Campbell, Stuart, and Protopapas compare the profiles of developmental dyslexia and chronological age and reading-level control groups in Greek and English on reading accuracy and fluency, phonological awareness, short-term memory, rapid naming, orthographic choice, and spelling. Materials were carefully matched across languages in item properties and structure. English children with dyslexia were more impaired on reading accuracy and phoneme deletion, but not on reading fluency, memory, naming, or orthographic choice. No cross-language differences in lexicality effects were observed across languages. There were also no differences in prefix and stem orthographic choice, but English children were less successful in spelling inflectional suffixes despite greater morphological richness in Greek, highlighting the need for additional considerations beyond grain size in cross-linguistic research.

In the subsequent article, Tibi and Kirby examine the double-deficit hypothesis in Arabic. According to this hypothesis, phonological awareness and naming speed predict reading ability in young children with the claim that children with deficits in both abilities are most severely affected. Grade 3 students in Dubai were administered tests of phonological awareness, naming speed, and reading measures (word reading, pseudoword reading, word reading speed, text reading speed, and maze comprehension). Regression analyses showed phonological awareness and naming speed effects on each reading measure, after controlling for age, gender, and verbal and nonverbal ability. Phonological awareness made a stronger contribution than naming speed. Significant phonological awareness and naming speed effects for differential reading outcomes were also evidenced but no significant interactions. These results confirm the potential applicability of the double-deficit hypothesis to Arabic readers.

In the prefinal article, Tzeng, Hsu, Lin, and Lee claim that Chinese literacy does not uniquely depend upon memorization of characters alone, as most characters are phonograms of semantic and phonetic radicals. In an EEG study, they used ensemble empirical mode decomposition to decompose semantic retrieval and integration indices to find out how children with and without dyslexia process Chinese-based characters, pseudocharacters, and noncharacters. The results are congruent with the dual semantic word processing model with automatic lexical retrieval in left temporal region and controlled lexical integration and selection in left frontal region being evidenced. This study further points to the utility of brain-based dependent measures in addressing cross language questions

In the final article, Daniels and Share further explore the consequences of writing systems variation for reading and dyslexia. In doing so they go beyond current dominant theoretical frameworks for describing cross-script diversity, which are thought to be too deeply entrenched in Anglophone and alphabetical perspectives, giving little or no consideration to non-European alphabets or to nonalphabetic scripts and promoting a one-dimensional view of script variation, namely, spelling-sound consistency. They claim that consideration of the full spectrum of the world's writing systems reveals multiple dimensions of writing system complexity, each with important implications for understanding normal and abnormal reading development. Accordingly, they identify 10 dimensions of writing system complexity and relate these to variation in reading ability and dyslexia: linguistic distance, nonlinearity, visual complexity, historical change, spelling constancy despite morphophonemic alternation, omission of phonological elements, allography, dual purpose letters, ligaturing, and inventory size. These dimensions can be seen as very useful for describing orthographies in future cross-linguistic studies on learning to read and developmental dyslexia.

Conclusions and outlook

The studies reported in this special issue employ a range of approaches, from conventional standardized testing to brain-based measures (EEG), and varied theoretical perspectives in addressing questions about why some children struggle with learning to read in contrastive written languages. In aggregate, they can be seen as exemplars or starting points to help guide next-step research into the question of whether the neural and cognitive bases of typical or atypical reading outcomes are similar or dissimilar across languages that differ on a number of dimensions (including phonological transparency). Although to some extent we see evidence that broadly construed phonological processing skills play a role in alphabetic languages ranging in orthographic depth, in root-based orthographies like Arabic, and in a morpheme-based logographic orthography like Chinese, which involves not only memorization of characters but also identification of phonetic and semantic radicals.

It is interesting to note that, at a more detailed level of analysis, there is also evidence of language specific influences on reading outcomes. Each study does provide a new window on important issues, debates, and relevant measurement choices that arise in distinct orthographies (and distinct cultural contexts), and this can help set the stage for next step studies that will more directly contrast these languages with one another, like the comparative study on English and Greek in this issue.

Indeed, in future studies there will be a premium of developing common tools to dig down on cognitive and neural bases of reading so that the question of whether universalist as opposed to language-specific accounts are most plausible can be addressed. Large-scale direct cross-language comparative designs are challenging to perform with respect to issues of measurement and control but will be crucial going forward. But even as we move toward comparative neurocognitive designs, the diversity of ideas and framing assumptions that arise within a given language (and discussed eloquently by Daniels and Share) must be considered and valued. Finally, as we think about next steps, we are of the opinion that increased emphasis on the detection of biomarkers with multiple types of brain imaging will be critical to addressing questions of variation or invariance. The focus on shared and unshared pathways and relevant brain/behavior models across the languages and domains exemplified here have real promise in developing cross language understanding relevant not only to theory but eventually to practice as well.

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