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BECAUSE TRUCKS AREN'T BICYCLES: ORTHOGRAPHIC COMPLEXITY AS AN
IMPORTANT VARIABLE IN READING RESEARCH

Susan A Galletly, Bruce Allen Knight
CQ University, Australia

Address for Correspondence:

Professor Bruce Allen Knight
Faculty of Arts, Business, Informatics & Education,
CQ University, Australia.
b.knight@cqu.edu.au

Author Bionotes

Susan Galletly is a school-based researcher, teacher and speech language pathologist, affiliated with CQ University. Her research foci include assessment and instruction for improving literacy outcomes of lower achievers, and cross-linguistic differences in literacy development, difficulties and instruction.

Bruce Allen Knight is Deputy Associate Dean (Research & Innovation) of the Faculty of Arts, Business, Informatics & Education at CQ University, Australia. His current research interests include improving reading outcomes for low achievers and engaging students in learning. He was elected a Fellow of the International Academy for Research in Learning Disabilities in 2006.

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ABSTRACT

Severe enduring reading- and writing-accuracy difficulties seem a phenomenon largely restricted to nations using complex orthographies, notably Anglophone nations, given English's highly complex orthography (Geva & Siegel, 2000, Landerl, Wimmer, & Frith, 1997, Share, 2008, Torgesen & Davis, 1996, Vellutino, 2000). They seem rare in transparent orthography nations such as Finland, which use highly regular spelling and few spelling rules beyond letter sounds, and most children read and write with impressive accuracy by the end of Year 1 (Holopainen et al., 2001, Seymour, Aro, & Erskine, 2003, Spencer & Hanley, 2003, 2004). Orthographic complexity has strong and diverse impacts on reading, writing and academic development (Aro, 2004, Galletly & Knight, 2004, submitted). Despite these strong effects, orthographic complexity is rarely included as a variable in reading research studies considering evidence from both Anglophone (complex orthography) and transparent-orthography readers, or included in discussion of factors influencing results.

This paper discusses the differences in reading-accuracy development and difficulties evidenced in studies of Anglophone (complex-orthography) and transparent-orthography readers. It then explores instances of orthographic complexity not being considered in studies where it may have impacted results. This disregarding of orthographic complexity as a variable in research studies appears an oversight, one likely to be contributing to continuing confusion on many aspects of reading and writing development in both healthy- and low-progress readers. Needs for research in these areas are discussed.

INTRODUCTION

Reading accuracy is the recognition of the spoken equivalent of written words. Fluent reading accuracy is a key subskill of effective reading comprehension, where words and texts are read for consideration of their message, using reading-accuracy (Gough & Tunmer, 1986). In like manner, fluent writing accuracy, the sibling of reading accuracy, enables the effortless writing of words where thoughts are transferred to paper using writing-accuracy. Reading accuracy uses a text decoder role, and supports other reading actions and purposes, including meaning making and critical analysis of texts (Luke & Freebody, 2000). It partners prosody (intonation and stress) as a key subskill of reading fluency. For Anglophone students not sufficiently confident and fluent at reading accuracy by mid-primary school, reading accuracy weakness can become a powerful block to literacy, academic and life progress (Marks, 2006, Torgesen, Alexander, & Wagner, 2001, O'Shaughnessy & Swanson, 2000). As such, reading-accuracy development may be a gateway skill separating those able to effectively access and thrive in literacy and academic learning, from those whose access is impeded by weak reading accuracy (Knight & Galletly, 2006).

Orthographic complexity refers to the number and types of spelling patterns in a nation's written language where it is often discussed in terms of a transparent (highly regular orthographies) versus opaque (English orthography), and grapheme-to-phoneme correspondences (GPCs, Dewey, 1970, 1971, Fry, 2004, Galletly, 2008). Each nation's level of orthographic complexity thus builds from the number and types of spelling patterns (GPCs) present in its written language. Written words differ across nations in many ways additional to orthographic complexity, including word length, number of syllables and syllabic complexity. These latter factors seem to have little impact on ease of reading-accuracy development compared to the impact of orthographic transparency (Aro, 2004, Galletly & Knight, 2004, Seymour et al., 2003, Share, 2008, Ziegler & Goswami, 2005). Most nations have transparent orthographies with less than 50 GPCs and these GPCs have close to one-to-one correspondence, with each grapheme representing a single phoneme, and vice versa (Goswami, 2002, Seymour, Aro, & Erskine, 2003, Ziegler & Goswami, 2005). In contrast, English has a very complex orthography with many hundreds of GPCs and many-to-many, rather than one-to-one, correspondences of graphemes-to-phonemes (Dewey, 1970, 1971, Fry, 2004, Galletly, 2008, see Figure 1).

The 44 phonemes of spoken Australian English with common GPCs

24 consonant phonemes commonly using by 18 graphs and 4 digraphs, with 219 spellings in total (Dewey, 1971)
[b d f g (for /g/as in go) h j k l m n p r s t v w y z] [ch sh th(2) ng] [zh] treasure)

20 vowel phonemes represented by common and less common GPCs with 342 spellings in total (Dewey, 1971):

[a] mat	[e] met [ea]	[i] mit	[o] not	[u] mut
[a-e] mate[a ai ay]	[e-e] mete [e ea ee y]	[i-e] mite [i ie igh y]	[o-e] mote [o oa]	[u-e] mute [u ew ue]
[ar] car [a]	[er] her [ir ur ear]	[or] for [aw au al]	[ow] now [ou]	[oi] oil [oy]
[oo] foot	[ou] you [oo]	[air] bear	[ear] deer	[schwa(ə)] bitter, ago

Frequency and regularity of common GPCs

Unit of orthographic knowledge	Examples	Syllable frequency	Consistency of GPCs
Commonest letter-sounds	b t n a e	43.3%	Consonants: Initial >95% Final >90% Vowels >50%
VC & CVC /ă ě ĭ ō ũ/ words	cat Sam vip		
Consonant blends & digraphs	<u>shop</u> <u>ring</u> <u>clip</u> <u>thin</u>		
Rimes	<u>fad</u> <u>fade</u> <u>fall</u> <u>fight</u>		Vowels >75%
Final-e vowels	mate hope	6.7%	76% [e-e]-100% [a-e]
/ă ā ĭ ō ũ/ vowels in open (CV) sylls	he go <u>paper</u> <u>virus</u>	28.9%	40% [a]-99% [u]
R-vowels	far her sir for fur	10.2%	70% [ir]-99% [ur]
W-vowels	saw now dew	9.5%	Varying
Vowel graphemes saying long-vowel sounds: ai, oa, ea, ee, y(e), y(i), ie.	he wait boat meat		
	meet my happy pie		
oi oy ai ay	boil boy bait bay		
Ea (2 sounds)	dead meat		
Oo (2 sounds)	good food		
Ou (many sounds, usually [out])	ouch youth double could		
Less common vowel digraphs	sue	Varying	
Regular multisyllabic words	kidnap butter baby		
Longer multisyllabic words & schwa	<u>virus</u> <u>different</u>		
Less frequent orthographic units	gnome tough nation		

Orthographic knowledge aspects creating confusion for beginning readers

A. Confusable consonant graphemes

- Many letter names not containing commonest phoneme (not in name: CGHQRWY, at end of name: FLMNSX)
- Common graphemes with 2 common phonemes: [g] saying /g/ & /j/ c saying /k/ & /s/
- Common graphemes with 2 common phonemes: [g] saying /g/ & /j/ c saying /k/ & /s/
- Infrequently used single consonants representing consonant blends q (kw) x (ks)
- Single consonants not saying their common sound in digraphs: sh th ch gh ph wh gn kn pn psy tch dge
- Silent consonants, e.g., ghost psychē lamb sick bridge horse gnome knee calm cupboard fetch who
- Consonant [y] used as a vowel, e.g., *my party gym*
- Consonants [r y w] used as vowel markers, following single vowel letters to form vowel graphemes: [ar er ir or ur ear our ore oor eer ay ey oy uy aw ew ow].

B. Confusable vowel graphemes (All):

- Vowel letter names not containing commonest phoneme (AEIOU)
- Many: many correspondences: No vowel grapheme has just one phoneme, e.g. [a] has only one common sound, as in *hat*, but represents at least 4 phonemes, e.g. /ar ə a-e/ in *Ask Dad again later*.
- The schwa phoneme (ə, neutral vowel) uses ≥15 graphemes, e.g. virus, gracious, began, nation, mountain

C. Many highly frequent words which do not use common GPCs and thus model rule 'irregularities':

[of, one, two, four, eight, was, what, who, come, some, done, do, gone, have, could, would, should]

D. High ratios in many-to-one, one-to-many, and many-to-many GPCs

Many-to-one GPCs:

- 6 graphemes for /sh/, as in shin station mission social chef sure
- 4 graphemes for the phoneme unit /al/: canal little panel special
- 11 graphemes for /or/: for sore pour raw awe taught bought sauce talk roar war

One-to-many GPCs:

- [p] has 4 phonemes, as in *pin phone psyche pneumatic*
- [ough] has 8 phonemes or phoneme units, as in *bough cough dough tough through thought thorough hiccough*
- [o] has ≥9 phonemes, as in *ox go or now too book boy come word*

Many-to-many GPCs:

- [c] is used in ≥6 graphemes which are used for ≥4 phonemes; each grapheme represents multiple phonemes, and each phoneme is represented by additional graphemes. These additional graphemes are shown in brackets: cheese hatch/ cat kick school (quay) / Cheryl social (nation hession shoe) / rice scent (sent hissing psyche)
- [a] is used in many diverse graphemes for ≥14 phonemes (shown separated by /), which are also written with many diverse additional graphemes (not shown due to their excessive number):
at / gate later gauge ray great gaol / any said says dead / sea / aisle aye / was / beau goal mauve / beauty / ha ask far are half laugh / earn / hear / air (d)are (b)ear / naughty war saw sauce / ago again.

Figure 2. The complex relationships of English orthography (from Dewey, 1970, 1971, Fry, 2004, Galletly, 2008, Treiman et al., 1995)

English orthography is considered the most complex alphabetic orthography by crosslinguistic researchers (Share, 2008), so complex that it is an outlier to the continuum of alphabetic orthographic complexity (Aro, 2004, Aro & Wimmer, 2003, Galletly & Knight, 2004, Submitted, Katz & Frost, 1992, Seymour, Aro, & Erskine, 2003, Share, 2008, Ziegler & Goswami, 2005). In order to expedite citizens' transition to Sophisticated Literacy, many nations have controlled their orthographies using a constancy principle where spelling rules are steadfastly applied and one-to-one GPCs (Galletly & Knight, 2004, Submitted, Share, 2008, Venezky, 2004). English orthography, however, has evolved relatively freely (Venezky, 2004, p. 148):

English appears also to have been based, at least in part, on an etymological principle; however, the resulting orthography is not a result of the careful application of this and other principles but a pastiche of different tendencies at different time periods, with chaos a constant companion.

This has resulted in English orthography's exceptionally high complexity. As seen in Figure 1, while English consonants are largely regular, English's plethora of vowel graphemes and many high-frequency words make English relatively opaque for beginning readers (Dewey, 1970, 1971, Fry, 2004, Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). Fledgling Anglophone readers find vowels unpredictable and hence not trustworthy, making their expected sound only half the time (Treiman et al., 1995). This greatly increases the cognitive load of learning to read English, and many children have significant reading-accuracy difficulties (Galletly & Knight, 2004, Submitted, Gathercole & Pickering, 2000, Landerl, Wimmer, & Frith, 1997, Spencer & Hanley, 2003, 2004).

It is important to note that while English orthography is highly irregular compared to other orthographies, it is still sufficiently regular for the teaching of phonics to be valuable and effective (Galletly, 2008, Share, 2008), particularly when highly frequent words with less common spelling patterns (e.g., *of*, *was*, *one*, See Figure 1) are learned as sight-words (Goswami, 2002). As such, theories suggesting that, because English orthography is so irregular, children should not be taught reading accuracy skills have little basis (Goodman, 1986, Smith, 1994). As shown in Figure 1, English consonants are overwhelmingly regular, and vowels in rime form (followed by a consonant) are regular over 70% of the time (Treiman et al., 1995). This makes the teaching of phonics using regular words a powerful tool for beginning readers (Byrne, 1998, Share, 2008), providing a relatively secure base of skills and self-confidence from which learners can progress into coping with less common GPCs. Given the large number of highly-frequent irregular (exception) words

that a beginning reader encounters, the teaching of sight-words is a valuable partner skill to phonics instruction (Goswami, 2002).

There has long been dissention on the role of reading-accuracy (though, curiously, not writing-accuracy) in literacy development, instruction and difficulties, in what has sometimes been termed the Reading Wars (DEST, 2005, Pressley, Allington, Wharton-McDonald, Collins Block, & Mandel Morrow, 2001). There has also been dissention on research practices used in reading research, including post-positivist versus qualitative research paradigms (Lovat, 2003); the ecological validity of experimental versus applied reading research (Stanovich, 2004); and the purposes of specific studies and disseminated findings (Lingard, 2001). It is recognised that effective research directions need to value diverse research practices (Lingard, 2001, Rogers, 2003). One premise of all research paradigms is the power and value of accumulated knowledge built from multiple studies and perspectives. It is thus important that research papers are clear on factors likely to be impacting their results.

This paper explores indicators that orthographic complexity has not been considered as a variable impacting the different results obtained in studies of readers in transparent-orthography and Anglophone nations. An assumption of population equivalence between Anglophone and transparent-orthography readers is not appropriate given available evidence on the many differences in reading-accuracy development, difficulties, and instructional needs of Anglophone and transparent-orthography nations (Galletly, 2008, Galletly & Knight, Submitted, Share, 2008). This assumption is likely to be hindering development of clear understanding of the characteristics of reading- and writing- development, difficulties, and instruction.

The paper first discusses the impact of orthographic complexity on reading-accuracy development, then explores a diverse range of studies showing disregard of the impacts of orthographic complexity. Suggested directions towards understanding the impacts of orthographic complexity are then considered. The term 'Anglophone' is used throughout to refer to native-English speakers living in nations where most people are native-English speakers, and reading and writing uses English orthography. Terms used for school year-levels, such as 'Kindergarten, Grade 1, Year 1', vary across the discussion, being those terms which are used in the specific nations which are being discussed.

H1 ORTHOGRAPHIC COMPLEXITY AS AN IMPORTANT VARIABLE

Orthographic complexity is a sociocultural option, established by each nation through its official spelling standard (Galletly & Knight, Submitted, Share, 2008). Korea and many European nations achieve and maintain high orthographic transparency through strategic national management of spelling (Kim-Renaud, 1997), while several Asian nations use transitional transparent orthographies as a bridge to, or parallel to, reading of their logographic orthographies. There is a large body of research reporting rapid mastery of fluent reading-accuracy by the vast majority of transparent-orthography readers (Aro, 2004; Cossu, 1999; Goswami, 2002; Holopainen, Ahonen, & Lyytinen, 2001; de Jong & van der Leij, 1999; Landerl, 2000; Lyytinen et al., 2004; Schneider, Ennemoser, Roth, & Kuspert, 1999; Share, 2008; Spencer & Hanley, 2003; 2004; Wimmer & Mayringer, 2002; Ziegler & Goswami, 2005). In a study of Grade-1 reading-accuracy achievement in 14 European nations (Seymour et al., 2003), readers of 10 nations with highly transparent orthographies had close to 100% accuracy (Norwegian, Dutch, Icelandic, Swedish, Spanish, Italian, Finnish, Turkish, German and Greek). In contrast, Grade 1 Anglophone readers were reading with only 34% accuracy and even end-Grade 2 Anglophone readers still only achieved 76% accuracy, despite having received twice the amount of instruction as the transparent-orthography readers had received to reach ceiling level by the end of Grade 1.

With regard to older readers, Landerl et al's (1997) comparison of German and Anglophone weak readers reported that the weak German readers read the most difficult words (3 syllable pseudowords) with higher accuracy than the weak English readers read the easiest words (1 syllable pseudowords); and that the English readers made 16 times more vowel errors (324: 20 errors).

Given that children in Anglophone nations start school at younger ages than their peers in many European nations, it is likely that the younger age of Grade 1 English readers is a factor in many crosslinguistic studies comparing Anglophone children with European peers. Being in different nations, sociocultural factors may also be thought to play a strong role in crosslinguistic differences in literacy development. It is established, however, that orthography is the key factor impacting reading development, and not age or socio-cultural factors (Galletly & Knight, 2004; Share, 2008). Orthography's status as an important variable is clearly established by studies of same age children learning to read different orthographies in the same nation (e.g., Geva & Siegel, 2000; Hanley, Masterson, Spencer, & Evans, 2004; Spencer & Hanley, 2003; 2004). Spencer and colleagues studied the reading-accuracy development of English-speaking (Anglophone) children learning to read English, and Welsh-speaking children learning to read Welsh (a transparent orthography) in the same Welsh locality and school system (Hanley, Masterson, Spencer, & Evans, 2004; Spencer & Hanley, 2003; 2004). The authors reported the Anglophone readers to be severely delayed relative to their Welsh peers in Grades 1 and 2, and to still be significantly delayed at Grade 6 (Hanley et al., 2004; Spencer & Hanley, 2003; 2004). As shown in Figure 1, Spencer and Hanley

(2003) reported the lowest quartile of Grade 2 Anglophone readers to be reading at very low levels, while the lowest quartile of Welsh readers were reading well, at almost the same level as the second highest quartile of English readers.

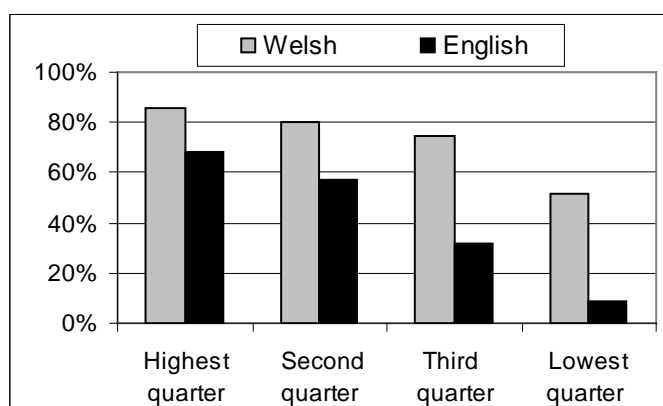


Figure 1. Reading-accuracy achievement of Grade 2 Welsh and Anglophone readers (Spencer & Hanley, 2003).

Further evidence for the pivotal role of orthographic complexity, rather than age and sociocultural factors, is seen in Geva and Siegel's (2000) studies of native English-speaking (Anglophone) Canadian children who were learning to read and speak Hebrew (a transparent orthography) while also learning to read English-Hebrew bilingual school. Despite their limited skills in speaking Hebrew, the children's Grade 1 Hebrew reading-accuracy was well in excess of not just their Grade 1 English reading-accuracy, but also their Grade 5 English reading-accuracy. Orthography, not age, being a highly influential factor is further established in studies in transparent-orthography nations, showing it to be usual for children with intellectual disability, and thus low intellectual age-equivalents, to master reading-accuracy proficiently with relatively little intervention (Cossu, 1999; Olofsson & Niedersoe, 1999; Schneider, Ennemoser, Roth, & Kuspert, 1999).

When rules are few and obvious, transparency is high; when rules are many and subtle with many inconsistencies, transparency is low. Orthographic transparency translates into the trustworthiness of letters and sounds for beginning readers as they work out unfamiliar words using phonemic recoding. Children learning to read highly transparent orthographies such as Finnish and Italian, with close to perfect one-to-one correspondence of GPCs, can confidently rely on every grapheme using its one sound and being successful when reading words. Once transparent-orthography students have mastered the sound of each grapheme and the phonemic-recoding sequence, grapheme-phoneme reliability means virtually every word can be read successfully using phonemic recoding, and virtually no words are unable to be read. Transparent orthographies are ideal for self-teaching. As Aro (2004, p.35) comments:

A transparent orthography treats even a phonologically immature reader in a lenient manner. It helps in explicating the alphabetic principle, the correspondence between spoken and written language...it does not burden the beginning reader with a plethora of correspondence rules; and together with systematic phonics teaching it provides the beginning reader with a simple tool for successful word recognition.

Whereas transparent orthographies have few spelling patterns beyond each grapheme having its single phoneme, English uses perhaps 20 times more spelling rules than most nations to represent its 44 common phonemes, with many of these rules highly ambiguous for beginning readers (See Figure 1). Learning to read words in transparent-orthography nations seems akin to learning to ride a bicycle in pleasant relaxed and confident circumstances, where it requires co-ordination of relatively few skills, success comes relatively quickly and inspires enthusiasm, and it's fun. Once mastered, effortless bike-riding can be done in diverse circumstances with little need to think about the skills involved. In contrast, learning to read English is more akin to learning to drive an off-road vehicle (a truck) in oft changing and relatively unpredictable terrain and weather, where some learners will love the experience, others will find it overwhelming; and it will require conscious thinking for a long period of time before automaticity in all circumstances is reached. As indicated in the title to this paper, trucks are certainly not bicycles, particularly when it comes to learning to use them and the levels of success achieved by the full range of learners. In like manner, Anglophone and transparent-orthography reading-accuracy development are non-equivalent in major ways.

In a recent paper, we have proposed Transition-from-Early-to-Sophisticated-Literacy (TESL) paradigms as an important variable differentiating nations on literacy development, effectiveness of literacy instruction, and international competitiveness (Galletly & Knight, Submitted). Early Literacy means 'learning to read and write' (Chall, 1989), including mastering reading accuracy and writing accuracy (spelling) to proficient levels, a precursor for effective progress through to Sophisticated Literacy. Sophisticated Literacy is akin to 'reading and writing to learn' (Chall, 1989) at school and across adulthood. Sophisticated Literacy instruction at school focuses on building increasingly higher level language skills (comprehension and expression) for with diverse use texts in diverse contexts for diverse purposes. Whereas Early Literacy uses a Text Decoder role of a reader (Luke & Freebody, 2000), Sophisticated Literacy uses the higher order roles, including Meaning Maker, Text User, and Text Analyst.

TESL paradigms are built from the levels of orthographic complexity which different nations choose. These levels establish the potential speed and ease which learners will experience in mastering Early Literacy and arriving at Sophisticated Literacy, and the level of "orthographic advantage" that nations will experience for optimising literacy and academic learning (Galletly & Knight, 2004). Nations can be categorised within multiple Transition-from-Early-to-Sophisticated-Literacy (TESL) paradigms, as a result of the orthographic complexity they choose to use. Three widely used TESL paradigms we have proposed are the Resolved, Facilitated, and Complex TESL paradigms (Galletly & Knight, Submitted).

The Resolved TESL paradigm is used by Korea and many European nations, for example, Finland, Greece, Italy, and Estonia. These nations have resolved difficulties learners might encounter in mastering Early Literacy and thus transitioning to Sophisticated Literacy by using highly regular (transparent) orthographies, which expedite reading-accuracy and spelling development. Early Literacy instruction and learning takes little time, so resolved TESL nations can use Early and Sophisticated Literacy sequentially if they prefer, focussing initially just on Early Literacy, then, once those skills are automatised, cease Early Literacy instruction and focus fully on Sophisticated Literacy. Resolved TESL readers transition rapidly from Early to Sophisticated Literacy, and education is optimised through strong orthographic advantage, as discussed elsewhere and below (Galletly & Knight, 2004, Submitted).

The Facilitated TESL paradigm is used by Asian nations, including China, Japan, and Taiwan. These nations, which use highly complex logographies, facilitate a rapid transition from Early to Sophisticated Literacy by the use of highly regular transitional orthographies which students learn then use in conjunction with logographic script. These transitional orthographies include China's Pinyin, Japan's Hiragana, and Taiwan's Zhu-Yin-Su-Fao. They are taught for very short periods by Anglophone standards, for example, Taiwanese children are taught Zhu-Yin-Fu-Hao, a completely regular 37 grapheme orthography, for just the first 10 weeks of Grade 1 (Huang & Hanley, 1997). This orthography then transitions self-teaching of Chinese logographic characters through being written beside these characters in reading texts. Facilitated and Resolved TESL paradigms are collectively termed Rapid TESL paradigms. Both experience rapid transition from Early to Sophisticated Literacy and the gamut of orthographic advantage which accompanies Rapid TESL, including high achievement in PISA international studies of reading, science and mathematics, and ability to improve student results without high spending on education (Galletly & Knight, Submitted, PISA, 2008, 2009).

The Complex TESL paradigm is used by nations with highly complex orthographies, including Anglophone nations and Thailand. With Early Literacy development taking many years, it is not possible to delay Sophisticated Literacy instruction until Early Literacy skills are mastered, thus Sophisticated Literacy instruction is conducted alongside Early Literacy instruction. These nations experience strong orthographic disadvantage, as discussed elsewhere and below (Galletly & Knight, 2004, Submitted).

H1 THE IMPACTS OF ORTHOGRAPHIC COMPLEXITY

Differences in orthographic complexity have been shown to make many and diverse differences in reading-accuracy development. As discussed elsewhere (Galletly & Knight, 2004, Submitted; Galletly, Knight, Dekkers, & Galletly, In press),

- For Rapid TESL (transparent orthography) nations, reading accuracy and phonemic awareness develop rapidly to ceiling level with most readers proficient by the end of Grade 1 (Aro, 2004; Holopainen, Ahonen, & Lyytinen 2001; Seymour et al., 2003; Spencer & Hanley, 2003).
- In transparent orthography nations, readers with delayed reading-accuracy are few and respond very effectively to reading-accuracy remediation (Cossu, 1999; Schneider, Ennemoser, Roth, & Kuspert, 1999).
- Transparent-orthography reading-accuracy development has few prerequisites (Lyytinen et al., 2004; Poskiparta et al., 1999), and healthy working memory and IQ levels are not prerequisites, such that even readers with severe intellectual disability master reading-accuracy and spelling (Cossu, 1999).
- Weaknesses in phonemic awareness and Rapid Automatic Naming (RAN) have very different impacts on reading-accuracy development in Anglophone and transparent-orthography readers (de Jong & van der Leij, 1999; Landerl & Wimmer, 2000; Wimmer et al., 2000; Wolf, Pfeil, Lortz, & Biddle, 1994). In addition, phonemic awareness development accompanies reading-accuracy development, so Rapid-TESL readers have mature phonological representations from their earliest school years (Goswami, 2002).
- Anglophone weak readers have heightened impact from the high cognitive load of English reading-accuracy and writing-accuracy development (Cossu, 1999; Gathercole & Pickering, 2000; Landerl et al., 1997; Spencer & Hanley, 2003). This includes high proportions of children with reading-accuracy and spelling-weakness, with this weakness being enduring for many children and adults (Galletly et al., In press; Knight & Galletly, 2006; Leach, Scarborough, & Rescorla, 2003); and relatively poor response to intervention by many weak readers (Torgesen & Davis, 1996; Vellutino, 2000).

Additionally, and unfortunately for Anglophone readers and nations, the impact of orthographic complexity extends well beyond reading-accuracy and spelling development. It creates multiple socio-cultural and academic differences between Rapid-TESL nations with strong orthographic advantage and Anglophone nations with strong orthographic disadvantage. It can be logically assumed that orthographic transparency would offer a cascade of continuing advantages to Rapid TESL nations (Galletly & Knight, 2004, Submitted), including:

- Reading-accuracy and spelling (Early Literacy) curricula and instruction being uncomplicated and uncontroversial.
- Preservice and inservice training on reading-accuracy instruction taking minimal time.
- Formal Early Literacy (reading-accuracy and spelling) instruction taking minimal time.
- The time and effort saved in schools, universities and professional associations then being available for focus on other priority areas using Sophisticated Literacy.
- Rapid transition from early to sophisticated literacy, with virtually all children able to read and write all words after less than two years at school.
- Empowerment of students' academic self-identity and self-esteem through their early mastery of reading-accuracy and spelling.
- No students prevented by weak Early Literacy (reading accuracy and spelling) from participating in Sophisticated Literacy instruction in different academic areas.
- All classes from perhaps Grade 3 being homogenous in terms of all students being automatic on Early Literacy skills.
- No older students being disengaged or exhibiting behaviour difficulties due to literacy weakness resulting from ineffective Early Literacy skills, and resultant frustrations when participating in Sophisticated Literacy learning.
- Mature phonemic awareness (Goswami, 2002), which is likely to empower subsequent language and literacy development from their first year at school.
- Equalisation of oral (listening and speaking) and print (reading and writing) vocabularies from the first year of school, such that children can:
 - Decode every print text they encounter, with no modification of texts needed to make reading-accuracy easier (Reading vocabulary = Listening vocabulary).
 - Write all words they want, with negligible need to allocate thought to the spelling of words being written (Writing vocabulary = speaking vocabulary).

- Secondary effects of continuing weak literacy being avoided, including depression, lower income, likelihood of unemployment, and reduced home literacy practices (Marks, 2006).
- Workplace illiteracy from weak reading-accuracy being virtually nonexistent.
- Every parent being able to read.
- Minimal expense in schools and workplaces for reading remediation and managing the secondary impacts of reading failure.

It can be seen from the above discussion that the impacts of English orthographic disadvantage are many and of considerable consequence. For this reason, it is important that reading researchers be aware of orthographic complexity as an important variable impacting reading-accuracy development, difficulties and instruction. At the current time, there are many indicators in the reading research knowledge base that this variable has not been considered, and that many reading researchers assume population equivalence between Anglophone and transparent-orthography populations. As referred to in the title of this paper, the wide differences between these populations discussed above suggest this is akin to considering trucks and bicycles to be identical vehicles.

H1 INAPPROPRIATE ASSUMPTIONS OF POPULATION EQUIVALENCE

There seems to have been relatively little awareness in recent decades of the impact of English orthographic complexity on reading-accuracy development in English-speaking nations (Share, 2008). For example, major reviews of reading research do not discuss this factor apart from occasional references to some orthographies being less complex than English (National Research Council, 1998; Neuman & Dickinson, 2002; Simmons & Kameenui, 1998; Swanson, Harris, & Graham, 2003). Once the reading-accuracy development of beginning readers of English and transparent orthographies is compared, however, this impact is revealed as being strong and multifaceted (Aro, 2004; Cossu, 1999; Goswami, 2002; de Jong & van der Leij, 1999; Landerl & Wimmer, 2000; Landerl et al., 1997; Lyytinen et al., 2004; Poskiparta, Neimi, & Vauras, 1999; Seymour et al., 2003; Spencer & Hanley, 2003; Wimmer, Mayringer, & Landerl, 2000; Ziegler & Goswami, 2005).

Since the middle of last century, a plethora of crosslinguistic research has been conducted by researchers with a particular interest in orthography and its impacts in different nations on diverse aspects of reading-accuracy development and instruction. However, many reading researchers not specialising in this area have only recently begun to be aware of the impacts of orthographic complexity (Share, 2008). This has resulted in many of these researchers conducting studies

without awareness or acknowledgement that Anglophone and transparent-orthography populations are non-equivalent in major ways.

The scientific knowledge base builds through researchers considering the findings of their own and others' research, then conducting new studies and subsequently adding their theory and findings to the knowledge base. Because many research papers have not listed the orthography participants were reading or its level of orthographic complexity in studies they discuss, the situation has occurred where Anglophone researchers have built theories on Anglophone readers from findings on transparent-orthography readers, and vice versa. It is therefore useful to revisit the theories and findings of earlier studies. Five areas of reading research where such confusion seems evident are discussed here, with reference to how assumptions of population equivalence may be creating confusion among reading researchers. These areas are chosen for two reasons: firstly, being influential in guiding directions and emphases in both research and practice; and secondly, the likelihood that, because of their influence, the disregard of orthographic complexity may create confusion amongst researchers, educators, and the general public. The research areas discussed are

1. The role of letters and their sounds in effectiveness of phonological awareness instruction.
2. The responsiveness of weakest reading-accuracy achievers to intensive intervention.
3. Large reviews and meta-analyses of reading-accuracy research.
4. OECD studies comparing education and educational achievement between nations.
5. Australian research on reforms of education and literacy instruction.

H2 Orthographic complexity in phonological-awareness interventions

Phonological awareness is considered an important part of Anglophone reading instruction, and many research studies have been conducted on this area. Research on the role of letter instruction incorporated within phonological awareness instruction is an area where disregard of orthographic complexity may cause confusion amongst reading researchers.

Researchers' citings of studies of phonological awareness interventions with and without letter instruction usually assume population equivalence in the studies they discuss (Al Otaiba & Fuchs, 2002; Bus & Ijzendoorn, 1999; Lundberg, 1999; Lundberg, Frost, & Peterson, 1988; Olofsson & Niedersoe, 1999; Poskiparta, Niemi, Lepola, Ahtola, & Laine, 2003; Schneider et al., 1999; Torgesen, Alexander, & Wagner, 2001; Torgesen & Davis, 1996; Vellutino, 2000). Disregard of orthographic complexity may have created confusion in this area, as seen in the following examples.

Lundberg, Frost and Petersen (1988) explored the impact on 6 year old Danish prereaders of 8 months of intensive phonological-awareness training which did not include work with letters. This intervention was found highly effective, having lasting impact on reading-accuracy development. Danish is less regular than many European orthographies, but still markedly more transparent than English (Seymour et al, 2003). In addition, Danish beginning readers are considerably older than Anglophone beginning readers, and hence have more efficient cognitive processing skills (Wimmer & Mayringer, 2002). In their paper, Lundberg et al (1988) do not consider orthographic complexity, and build their theorising using Bryant and Bradley's (1983) study of English readers. A cycle of continued inappropriate assumption of population equivalence then ensued, as researchers since 1988 cited and discussed Lundberg et al's study as evidence that letter training did not enhance the effects of phonological awareness training for all populations, including Anglophone readers. This was in contrast to other studies of Anglophone readers which have consistently shown that letter-training incorporated with phonological awareness training has higher effects for Anglophone early readers (Gillon, 2005).

Schneider et al. (1999) also assumed population equivalence when conducting their series of studies using phonological awareness training without letters with German delayed readers (German is highly transparent for reading). They reported, in line with Lundberg et al. (1988), that at-risk children made significant long-term gains without letter training, and concluded that the potential of phonological training without letter training may have been underestimated in previous research.

German and Danish early reader populations experience a simple reading-acquisition compared to Anglophone early readers. The reading-accuracy development they are being prepared for in their Kindergarten training is much easier than Anglophone reading-accuracy development. It is also possible that, similar to Finland, children are taught their letters and sounds as part of normal Kindergarten instruction, and that, unlike English, the names and sounds of the letters are very similar (In English, only eight letter names commence with their commonest phoneme [B D J K P T V Z], and twelve letter names don't contain their commonest phoneme [A C E G H I O Q R U W Y]). Unlike Danish and German preschoolers, Anglophone prereaders need to be prepared for a much more complex reading-accuracy development. For them, incorporating letters and their sounds within phonological awareness training, is helpful, supports reading development, and significantly improves the effectiveness of phonological awareness training (Gillon, 2005).

There seems value in considering different areas of reading research for areas where confusion regarding principles of reading instruction has been created through failure to consider population non-equivalence, and the impact of orthographic complexity on student needs for different aspects of prereading and reading instruction.

H2 Orthographic complexity and lowest achievers

The review of effectiveness of reading-accuracy instruction conducted by the National Reading Panel (2000), which was convened by the United States government, concluded that all children benefit from systematic phonics instruction. As recognised by Australia's National Inquiry into the Teaching of Literacy (2006a, 2006b), it seems this conclusion was an overstatement, beyond the boundaries of the data and studies considered. The studies considered were overwhelmingly studies of at-risk and low-achieving children, and few studies of healthy progress readers were considered. While it is logical that all children do benefit from systematic phonics instruction, there are needs to establish the extent and characteristics of such instruction needed by different groups of readers, including healthy progress, at-risk, mildly delayed, and severely delayed readers.

One area where disregard of orthographic complexity may impede progress is in Anglophone nations' unresolved search for principles of effective remediation for lowest achievers (O'Connor, Jenkins, Leicester, & Slocum, 1993; Olofsson, 1993; Schneider et al., 1999; Schneider et al., 1997; Torgesen & Davis, 1996; Vellutino, 2000). Anglophone and transparent-orthography at-risk and delayed readers differ greatly in their responsiveness to instruction. Studies of weakest readers in transparent-orthography nations include participants with intellectual disability, and multiple disabilities. They show strong effectiveness of interventions of moderate intensity, with students achieving healthy reading-accuracy levels with no loss of skill over time (Olofsson, 1993; Poskiparta, Neimi, & Vauras, 1999; Schneider, Ennemoser, Roth, & Kuspert, 1999). In contrast, studies of weakest Anglophone readers, which do not include readers with disabilities additional to learning disabilities, report many students making negligible gains even after highly intensive interventions of long duration (Torgesen, 2000; Torgesen & Davis, 1996; Vellutino, 2000), and loss of skills over time is common to most Anglophone studies of reading intervention (Ehri, Nunes, Willows, & Valeska Schuster, 2001; Ehri, Stahl, & Willows, 2001). This strong effectiveness of intervention for transparent-orthography studies and low effectiveness in Anglophone studies is even more impressive when it is considered that students with disabilities were included in the transparent-orthography studies, but not the Anglophone studies.

It is important that these different levels of responsiveness to instruction by Anglophone and transparent-orthography weakest readers be made known to researchers and practitioners, and that research elucidating principles of effective instruction for different groups of readers not be contaminated by assumptions that Anglophone and transparent-orthography weakest readers are equivalent populations.

H2 Orthographic complexity in reviews and meta-analyses

Research reviews and meta-analyses sift through the many research studies on a specific research area to establish the important commonalities of their findings. Researchers, teachers, political parties and the media tend to consider their findings as the bottom-line on important principles of reading development and instruction. This broad scope of influence of these reviews makes it important that all likely variables have been appropriately considered.

There are indicators that disregard of orthographic complexity is present in some meta-analyses and major reviews of reading research studies. While the National Reading Panel (2000) controlled for orthographic complexity in their meta-analyses by categorising studies as English or 'languages other than English,' this does not seem the case in other meta-analyses. As an example, in Bus and Ijzendoorn's (1999) meta-analysis, the authors discuss Byrne and Fielding Barnsley's (1995) Australian study and Lundberg et al's (1988) Danish study as though findings are fully comparable. Bus and Ijzendoorn (1999) did calculate separate effect sizes for European versus USA studies, but if UK studies of Anglophone readers were included in the European group, this does not constitute consideration of orthographic complexity.

Theorising in large reviews not using meta-analysis techniques shows minimal evidence of orthographic complexity having been considered (Al Otaiba & Fuchs, 2002; DEST, 2005a; National Research Council, 1998; Neuman & Dickinson, 2002; Rowe, 2006; Simmons & Kameenui, 1998; Swanson, Harris, & Graham, 2003). This is evident in Al Otaiba and Fuchs' (2002) suggestion that higher rates of responsiveness by German lower achievers compared to American lower achievers was perhaps due to German interventions being implemented by classroom teachers and American interventions being implemented by graduate students, with no discussion of learning to read German being a simpler task than learning to read English.

Consideration of orthographic complexity is similarly not evident in the findings of the McKinley analyses of factors instrumental in high achieving schools and nations (Barber & Morshed, 2007;

PISA, 2009). In their summarising of the results of their study of 25 of the world's school systems, including 10 highest achieving systems, Barber & Morshed (2007, p.5) conclude that the three most important factors for achieving educational excellence are

- Getting the right people to become teachers.
- Developing them into effective instructors.
- Ensuring the system is able to deliver the best possible instruction for every child.

They further conclude that

These three things work irrespective of the culture in which they are applied. They demonstrate that substantial improvement in outcomes is possible in a short period of time and that applying these best practices universally could have enormous impact in improving failing school systems wherever they might be located.

It appears that the McKinley team did not consider orthographic complexity as a variable impacting achievement by the different school systems, or that many of the highest achieving nations are transparent orthography nations (Belgium, Finland, Hong Kong, Japan, and Netherlands). From an orthographic-complexity perspective, it is proposed that an important factor in achieving educational excellence in transparent orthography nations is not so much the above three points, but rather a baseline expectation (and experience) that all academic instruction from Grade 3 be conducted with classes in which all children are confident fluent readers and writers.

There seem strong needs for revisiting relevant major reviews and meta-analyses, to locate areas where orthographic complexity and population nonequivalence of Anglophone and transparent-orthography readers have blurred elucidation of key tenets of reading and academic development and instruction.

H2 Orthographic complexity in international comparison studies

In today's knowledge society, education is increasingly important, and most nations are strongly focussed on improving educational outcomes. Because of this, international comparison studies draw much attention and discussion by professions associated with education. These professions include researchers, educators, government educational advisors, policy makers, and the media. The latter is particularly influential in democratic nations, given that articles headlining educational success, failure and fix-it initiatives are avidly viewed by all interested parents, citizens (who all vote) as well as involved professionals. As a consequence, the influence of international

comparison studies can be enormous. It is therefore pivotal that such studies include influential variables such as orthographic complexity.

The Program for International Student Assessment (PISA) studies, conducted by the Organisation for Economic Co-Operation and Development (OECD) with member and partner nations, are probably the most influential international comparison studies at the present time. These triennial rounds of assessment test the reading, mathematics and science skills of 15-year old students, using well-constructed samples and relatively authentic assessment tasks. PISA 2000 was the inaugural study, with 43 participating nations, and 265 000 students, and PISA 2003 involved 41 nations. These two studies established the PISA studies as a reasonably effective means of comparing nations with regard to educational achievement and effectiveness, both at single time points and across time points. More nations joined in, and PISA 2006 involved 57 nations, with PISA 2009 involving 65 nations.

The PISA studies have generated an enormous amount of data which is publically available for consideration and analysis, and a plethora of documents considering at length the factors likely to be catalysts for improving educational achievement (Arinen, 2008; PISA, 2007; 2008; 2009; Scheinin, 2007; Schleicher & Stewart, 2008). In addition to student test data, interview forms completed at the time of testing gather information on a range of variables including gender, socio-economic status (SES) of students and their schools, private versus public schooling, immigrant status, language spoken at home, and interest and engagement in different aspects of Reading, Science and Mathematics (PISA 2007; 2008; 2009). Data on other economic and education factors are also gathered, including each nation's gross domestic product, expenditure on education, class sizes, time spent learning Reading, Science, and Mathematics, and hours of education. These many factors are then used as variables for exploration of the data.

There are, however, no indicators that OECD and PISA studies consider orthographic complexity or include it among the many PISA variables (Arinen, 2008; PISA, 2007; 2008; 2009; Scheinin, 2007; Schleicher and Stewart, 2008). This seems inappropriate, given that (Galletly & Knight, 2004, Submitted, Share, 2008):

- Most new world leaders in PISA 2003 and 2006 are nations with transparent orthographies, as are previous leaders. These include Finland, Japan, Korea, Hong Kong, Leichtenstein, Netherlands, Poland, Belgium, Estonia, Taiwan.
- Highest achieving nations with transparent-orthographies achieve highest results by having only very small proportions of low achievers, as well as large proportions of high achievers.
- High achieving Anglophone nations show polarised results with large proportions of high achievers but also large proportions of low achievers (which they have not been able to

reduce despite higher expenditure on education than the highest-achieving transparent-orthography nations).

- The only nations showing reduced proportions of low achievers are transparent-orthography nations.

Finnish PISA analysts (Arinen, 2008; Scheinin, 2007; Schleicher & Stewart, 2008) do not appear to consider orthographic complexity, and conclude that likely factors underlying Finnish excellence are those such as teacher education, safety, equity of education opportunities, and freedom of curriculum, assessment, and enquiry (Arinen, 2008). This ignoring of Finnish orthographic transparency and the consequent orthographic advantage experienced by Finland is curious given the many Finnish research studies focussed on the positive impact of Finnish orthography on early reading development (Aro, 2004; Aro & Wimmer, 2003; Holopainen et al., 2001; Seymour, Aro, & Erskine, 2003; Poskiparta, Neimi, & Vauras, 1999; Lyytinen et al., 2004). Perhaps the key Finnish difference, in addition to orthographic advantage, is highest spending on educational research, where Finland leads the world in exemplary fashion.

The considerable media publicity on lower achievement of Anglophone nations relative to highest achieving nations such as Finland, has implied that Anglophone teachers are less skilled than Finnish teachers (Arinen, 2008; Barber & Moreshed, 2007). Logical consideration of differences between Anglophone (Complex TESL) and Finnish (Rapid TESL) school instruction suggests this is not the case. When orthographic complexity perspectives are taken into consideration (Galletly & Knight, 2004), Finnish features of orthographic advantage seem likely to be more influential than the factors listed above. In Finnish schools, children learn to read words relatively effortlessly, due to Finnish orthographic transparency. From perhaps Grade 3, and again largely due to orthographic transparency, academic instruction in Finnish classrooms is delivered to classes in which every student is proficient in reading and writing all words, with negligible need for adult support of these skills, given the strong self-teaching support of transparent-orthographies. However, Anglophone classes usually contain considerable numbers of students with moderate or severe reading disabilities and varying levels of disengagement (Harris, 2008). This class heterogeneity necessitates extensive differentiation of instruction and skilful classroom management for students to remain engaged and learning. Despite these instructional complexities, Anglophone teachers produce very high proportions of high achievers, for example, almost 40% of Australian, Canadian and NZ students were high achievers in PISA 2006 Reading; a feat achieved by only four other nations (Korea, Finland, Hong Kong and Netherlands). This educational excellence suggests strong proficiency of Anglophone teachers despite the instructional complexity of their classes, and needs for better resourcing of Anglophone teachers, as per Barber and Moreshed's third recommendation above, so that they can achieve more effective outcomes with the approximately 30% of

Anglophone students currently performing as low readers (PISA, 2007). With PISA studies and analyses being so highly influential, it is important that orthographic complexity be considered as a variable in PISA analyses.

English orthographic complexity currently precludes Anglophone school systems from parity with transparent-orthography nations, such that they too could have 'a baseline expectation (and experience) that all academic instruction from Grade 3 be conducted with classes in which all children are confident fluent readers and writers,' as hinted above. In consequence, the most practical direction to take is to use Barber and Moreshed's third recommendation, 'Ensuring that the system is able to deliver the best possible instruction for every child,' within Anglophone nations' complex-TESL parameters. At the current time, most Anglophone nations have similar class sizes to Finland, spend little more on education than Finland, spend more on secondary education than primary education, as does Finland, and spend vastly less than Finland on educational research (Gill, 2004; PISA 2007; 2008; 2009). From orthographic complexity perspectives, these Anglophone practices work to prevent delivery of this 'best possible instruction for each child'.

From equity perspectives, nations who choose to use complex orthographies have a responsibility to ensure that their children are not disadvantaged by this choice. To reduce Anglophone orthographic disadvantage, including the weak literacy skills of many students, there would seem a need for effective individualised instruction tailored to children's reading and writing levels. This would require much lower teacher: child ratios than those of Finland, and hence considerably greater spending on education. This is particularly the case in early primary school as Anglophone children start school at much younger ages than Finnish children, and the combination of immature cognitive processing skills of younger children, the high cognitive load of learning to read English, and the low self-teaching capacity of English text, means beginning Anglophone readers have much higher needs for adult support than transparent-orthography readers.

If a primary premise of reading intervention is early intervention before children are entrenched in failure, Anglophone nations must optimise primary school literacy and reading instruction to achieve successful literacy skills in perhaps 95%, rather than 70% of readers (Knight & Galletly, 2006; PISA, 2007). At the current time, there is negligible data on principles of effective literacy and reading-accuracy instruction established for classroom instruction of different groups of readers, for example, healthy progress, at-risk, mildly delayed, and severely delayed readers (Galletly, 2008; Hsieh et al., 2005). This suggests strong needs for Anglophone nations to fund and encourage school level research by universities and schools focussed on establishing these principles of instruction (Rogers, 2003).

The above discussion suggests strong need for reanalysis of PISA results and the results of studies using PISA results (Barber & Moreshed, 2007; PISA 2007; 2008; 2009), using orthographic complexity as an additional variable.

H2 Orthographic complexity in Australian educational reforms

Educational reforms include changes in curriculum, instruction, assessment and research. The past decade has seen a continuing cascade of Australian educational reforms, at both state and national level. Researchers call for reforms of research funding, frameworks and emphases (Gill, 2004; Lingard, 2001; Lovat, 2003; Rogers, 2003), national testing of Years 3, 5, 7, and 9 is now conducted annually, and the nation awaits development and release of national curricula to be used across states. Australia spends less than half of Finland's expenditure on educational research, (PISA, 2009), and much of this research funding is spent on federal government knowledge building and national testing initiatives.

H1 CONCLUSION

In the above discussion, orthographic perspectives have been used to scrutinise the literature and suggest possible confusions present in different areas of reading research, namely reviews and meta-analyses, international comparison studies, phonological awareness treatment with and without letter training, and responsiveness of lowest achievers. There would seem great value in literacy researchers applying an orthographic-complexity lens to influential studies which have built the knowledge base in their areas of interest and investigation.

This paper has raised issues relevant to reading-accuracy development for different orthographies, and crosslinguistic studies of reading development. Reading accuracy is but a tool for accessing reading comprehension. For transparent-orthography readers, it is a simple tool which is mastered as easily as learning to ride a bicycle. For Anglophone readers, it is a very complex tool, mastered after many years by most but not all. With Anglophone and transparent-orthography reading-accuracy development being different in many and major ways, it is important that the variable of orthographic complexity be considered by reading researchers. Consideration of this variable needs past, present and future directions:

- Influential past research and conclusions need auditing for aspects where the variable of orthographic complexity has not been considered.

- Current practice, including principles of reading-accuracy, writing and literacy instruction need to be considered and developed with recognition of the different instructional needs of children and Anglophone versus transparent-orthography populations.
- Future research in different nations needs to be conducted to establish more precisely, the differences between these populations with regard to development of different aspects of literacy and academic learning.

Crosslinguistic research would seem to offer enormous potential for building knowledge for the optimising of reading and literacy development.

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