THE INFLUENCE OF ORTHOGRAPHIC OPACITY ON READING DEVELOPMENT AMONG NYANJA-ENGLISH BILINGUALS IN ZAMBIA: A CROSS-LINGUISTIC STUDY

A Dissertation

by

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ABSTRACT

Learning to read is critical to school success and also plays an important role in everyday life. Several studies show that reading proficiency among students differ significantly according to the orthographic depth of the language of instruction. Students taught in transparent orthographies acquire reading skills almost effortlessly and faster than their counterparts taught in opaque orthographies. The English language is considered to have one of the most orthographically opaque writing systems, while Finnish is highly transparent. Accordingly, studies show that students taught to read in English face significantly more challenges than Finnish students. The purpose of this study was to evaluate the effects of orthographic depth on reading proficiency by comparing Zambian bilingual students in a local highly transparent orthography, Nyanja, and English.

Equivalent Nyanja and English versions of the Zambia Achievement Test (ZAT) were administered to 240 grades four to six participants drawn from five basic (elementary) schools in Lusaka, Zambia. The ZAT consisted of five linguistically comparable measures of letter discrimination, phonological awareness, word reading, pseudoword decoding, and reading comprehension skills. Of the 240 participants comprising the sample, 119 students received the assessments in Nyanja, while 121 were tested in English. The samples were relatively evenly distributed across the three grade levels and gender. The age of the participants varied widely ranging from 8 to 18 years.

The results revealed that participants tested in Nyanja out-performed their English counterparts, and the mean reading proficiency difference was statistically significant on all measures except phonological awareness. Model analysis showed that the English data fitted the reading comprehension model better than the Nyanja data, as all the four model fit indexes used met the required thresholds for the English data, with only two meeting the threshold for Nyanja. The four measures—letter discrimination, phonological awareness, word reading, and pseudoword decoding—accounted for 58% and 49% of the English and Nyanja comprehension variance respectively. Generally, the findings reflect trends in the existing literature that acquiring reading skills is relatively easier in transparent than reading in opaque orthographies. However, in comparison to cross-national monolingual studies, the mean reading differences are slightly moderated probably by the effects of cross-linguistic transfer between Nyanja and English languages. As skills students acquired in one language may have been applied in learning to read in the other language.

DEDICATION

To my beloved family,

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Edward, Nchimunya, Brenda, Mwaka, Mweene, and Chabota:

You gave up so much during my studies, but I hope my long absences from home and loss of fatherly presence will be an inspiration for you to seek knowledge and has imbued in you a deep affection for learning.

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I know it was very challenging and you made many sacrifices for us to get the basics,

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INTRODUCTION

1.1. Introduction

Learning to read is critical to students' school success and plays an important role in their everyday endeavors later in life (Adams, 1990). The acquisition of reading skills, however, vary significantly across individuals, schools, and even languages of literacy instruction. Although majority of students acquire reading skills easily and almost effortlessly, quite a substantial number struggle considerably in the process (National Institute of Child Health and Human Development, 2000). This reading developmental lag among some students is not only attributed to the quality of instruction provided, but is also influenced by the orthographic opacity, or depth, exhibited by the language in which instructions are carried out (Goswami, 2005; Joshi & Aaron, 2006). Cross-national literacy studies have shown that reading problems differ in both severity and persistence based on orthographic depth of the language used in the country (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour, Aro, & Erskine, 2003; Ziegler, Perry, & Zorzi, 2014).

There are large differences in correspondences between phonology and orthography across languages (Caravolas, Lervag, Defior, Malkova, & Hulme, 2013; Cook & Bassetti, 2005; Landerl & Wimmer, 2008; McDougall, Brunswick, & de Mornay Davies, 2010; Ziegler et al., 2014). Even within alphabetic writing systems, the level of letter-sound consistence varies widely and affects reading development accordingly. For example, some orthographies are characterized by close to one-on-one letter-sound mappings—where one grapheme would only represent a single sound—in others, these correspondences are highly inconsistent (opaque), as one grapheme has a multiple of phonemes. The Finnish orthography considered to have one of the most consistent (transparent) orthography among alphabetic languages, while the English language is arguably the most phonologically inconsistent. This is because some of its phonemes map into multiple graphemes, e.g., the sound /s/ in the words *cite* and *site*; while in some cases, one grapheme may be pronounced differently such as *a* in *hate* and *bat* (Aro & Wimmer, 2003; Seymour et al., 2003). Consequently, languages can be listed on a continuum based on orthographic distances among them starting with the most transparent in order of increasing orthographic depth to more highly opaque. Cross-linguistic comparisons show that orthographic depth influences the development of literacy skills among novice learners (Hanley, Masterson, Spencer, & Evans, 2004; Landerl & Wimmer, 2008; Seymour et al., 2003). The rate at which reading skills are acquired is, to a large extent, a function of the orthographic opacity of the language of instruction.

Hanley et al.'s (2004) longitudinal study which compared reading developmental trajectories of Welsh and English from first to fourth grade also revealed that English children's reading proficiency initially lagged behind. However, the developmental lag between the two orthographies with regard to reading regularly spelled words and non-words was bridged before the students entered fourth grade, English children continued struggling with low and medium frequency irregular words. Similar findings were posited by studies examining cognitive skills predicting early reading development in children

(Georgiou, Parrila, & Papadopoulos, 2008; Holopainen, Ahonen, & Lyytinen, 2001; Jared, Cormier, Levy, & Wade-Woolley, 2011; Muller & Brady, 2001) and characterization of reading disabilities (Landerl et al., 2013; Peterson, Pennington, & Olson, 2014; Spenger-Charoles, Siegel, Jimenez, & Ziegler, 2011).

Experts in the field of reading also surmise that the observed variations in reading proficiency across orthographies are determined by the size of orthographic units at which words processed (Ziegler & Goswami, 2005). Mastery of word reading skills in languages whose grapheme-phoneme correspondences are highly consistent is relatively easier and faster compared to opaque orthographies because in transparent orthographies learners depend almost entirely on their sublexical knowledge—through manipulation of letter-sound correspondences (Nijakowska, 2010; Ziegler & Goswami, 2005). On the other hand, sublexical manipulation are supplemented by lexical knowledge to decipher words that do not follow regular phonetic conventions in less transparent orthographies. For example, sublexical skills are sufficient for deciphering words like *cat* or *sat*, but this strategy will fail learners when required to read the words *aisle* or *yacht* (Geown, Johnston, & Moxon, 2013). Therefore, to be a successful reader of both regular and irregular words, students need to switch between sublexical and lexical strategies constantly during the reading process depending on the orthographic structure being deciphered.

Ziegler and Goswami (2005) proposed the psycholinguistic grain size theory (PGST) to explain developmental variations in reading acquisition among languages based on the dual route model of reading (Coltheart, 2005; Seidenberg & McClelland, 1989).

This theory states that the successful development of reading skills across orthographies depends on the grain size units used in processing words in a particular orthography. As noted earlier, students reading in transparent orthographies employ small grains (manipulations letter-sound correspondences), whereas in opaque orthographies successful readers use both large grains (letter clusters or word level) and small grains. According to Nijakowska (2010), the choice of the orthographic unit used to read words or part of the words depends on word length, frequency, and orthographic neighborhood.

The simpler and consistent structure of transparent orthographies ensures that learners' basic knowledge of letter-sound associations are sufficient in facilitating the self-teaching process in reading words (Share, 1995; Wang, Nickels, Nation, & Castles, 2013). According to Share, "The self-teaching hypothesis proposes that phonological recoding functions as a self-teaching mechanism enabling the learner to independently acquire an autonomous orthographic lexicon" (p. 151). Wang and colleagues found statistically significant differences among English second graders between their ability to decode regularly and irregularly spelled unfamiliar words. These findings suggest that participants can apply phonological recoding skills to decode regular words, a feat limited by orthographic complexity in reading low frequency irregular words. Since the sublexical route is not sufficient, the lexical strategy is invoked in reading irregular spelled words by focusing on recognizing rimes, onsets, and whole words using common letter patterns and repeated exposure to print to deal with multiply varying grain sizes (Nijakowska, 2010). Therefore, in order to build a corpus of personal lexicon, novice readers require exposure to individual low frequency and irregular words repeatedly.

Orthographic opacity also determines how reading disabilities are characterized in learners (Nijakowska, 2010). Phonological awareness and rapid naming skills are the main predictors of early reading proficiency in all orthographies. However, while the influence of phonological awareness is constant across all grade levels in opaque languages, its effects diminish as students gradually progress to higher grades in transparent orthographies (Furnes & Samuelsson, 2010). Rapid naming skills, specifically rapid automatized naming, continues to contribute substantially to the variance in reading skills of students in orthographically transparent languages. Therefore, impaired reading speed characterizes reading disability in regular orthographies because—unlike in deep orthographies where readers use lexical strategies thereby retrieving whole words from memory when reading—readers depend almost entirely on grapheme-phoneme assembly. Attending to every single letter-sound in the word slows down students' reading fluency. Nijakowska (2010, p. 26) states that "In cross-linguistic comparisons, readers in English typically commit more errors with regard to both word and pseudo-word reading than readers of regular orthographies."

Bilingualism and cross-linguistic skill transfer are also important aspects in evaluating reading proficiency across orthographies of varying complexity. Reading constructs acquired in one language tend to transfer across languages and facilitate reading development in the second language, especially when the two languages have a shared and common writing system, e.g., if both first and second languages are based on alphabetic orthography (Durgunoglu & Öney, 2000; Pullinat & Adone, 2009). Once students master metalinguistic skills such as phonological and print awareness in one language, they can apply these skills in the second language. They do not have to relearn these skills in the second language.

1.2. Statement of the Problem

Many studies have shown that orthographic depth influences rates at which novices acquire reading skills (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour et al., 2003), nature of cognitive abilities predicting its development (Caravolas et al., 2013; Furnes & Samuelsson, 2010; Holopainen et al., 2001), and characteristics of reading disabilities students face such as dyslexia (Spenger-Charoles et al., 2011; Furnes & Samuelsson, 2010, 2012). However, these assertions are based on monolingual studies from relatively higher and uniform socio- economic status (SES) in the western world (Share, 2008). The questions that need to be answered are: (a) can the observed differences in reading proficiency in these cross-national monolingual studies be replicated among transparent-opaque orthography bilingual students?; (b) If not, what differences would be observed in reading constructs as a result of orthographic variations?; (c) What would be the effects of multilingual complexities and poor socio-economic status on reading proficiency on resource-limited communities?; and (d) How do current models of reading development compare across languages with varying orthographic depth?

1.3. Purpose of the Study

The purpose of this study was to evaluate the effects of orthographic opacity on reading proficiency in Nyanja—a transparent orthography—and English—an orthographically opaque language—among bilingual students in grades four to six in Zambian schools. Specifically, the study sought to establish the degree to which orthographic depth influences the rate of reading acquisition and assess how long variations in reading proficiency between the two languages persist, and how well Nyanja and English reading data fit the model of reading development. It also examines how orthography influences cognitive abilities predicting reading development.

1.4. Rationale of the Study

Experts in literacy studying the dynamics of reading development among novice readers have been interested in how orthographic opacity influences literacy development in both monolingual and bilingual students (Alcock & Ngorosho, 2003; Pullinat & Adone, 2009; Seymour et al., 2003). Regrettably, there is a scarcity of empirical research focusing on the influence of orthographic depth among bilinguals, more especially in resource-limited and linguistically complex settings (Reich, Tan, Hart, Thuma, & Grigorenko, 2013). While most monolingual children receive reading instructions in their mother tongue, there is an increasing proportion of bilinguals expected to master reading in transparent mother tongue and an opaque second language, particularly in English (Joshi & Aaron, 2006).

Therefore, studying the dynamics of reading competence in transparent-opaque orthography bilingual students is of special interest because it provides important insights into how orthographic opacity affects reading development beyond the research paradigms based almost exclusively on the English language. This rationale is in line with Share's

(2008) call for deviation from heavy reliance on the Anglocentric perspective in describing and developing both theories and models of initial literacy acquisition. Share further argues that most of the current reading models may be flawed or lack universal applicability because the English language used to shape "contemporary reading" research has an "*outlier* orthography in terms of spelling-sound correspondence" and, therefore, has "only limited significance for a universal science of reading" (p. 584). This study may provide an opportunity to further and probably review our understanding of the reading process as currently conceptualized based primarily on the English language.

As noted in the review of literature, most of the studies on the effects of orthographic opacity are mostly, if not exclusively, on monolingual and usually among resource-rich populations in the western world. Although, this study only investigated reading proficiency in a Sub-Saharan developing country where local languages are highly transparent and, therefore, facilitate easy and quick acquisition of reading skills, there may be other factors impacting the facilitative effect of Zambian languages' orthographic transparency. Firstly, Zambia—being a multilingual country with 70 languages and dialects—may be uniquely different from other research sites studied (Ohannessian & Kashoki, 1978; Reich et al., 2013). Reich and colleagues noted that Zambia's "complex multilingual context creates challenges for literacy education" (p. 68), which may also interfere with a particular student's process of learning to read in either Nyanja or English languages. The dynamics of these factors need to be incorporated in developing models explaining the development of proficiency in reading.

Zambian languages, like most languages in Anglophone Africa, have borrowed many English words of concepts that did not have local names before the advent of western education (Kashoki, 1995). Consequently, children constantly code-switch between their mother tongue and the English language both at school and at play. This study, therefore, provides an opportunity to study the reading process in a culturally and linguistically complex situation and this may provide new insights based on a different context.

1.5. Background of the Study Area

The main purpose of this study was to compare reading proficiency among Nyanja-English bilingual learners in Zambia. In Zambian schools, the English language is the main medium of reading instructions from second grade onwards. It is, however, only introduced after one year of reading initial instructions in the student's mother tongue or most familiar language (Sampa, 2005). The Zambian Ministry of Education recently changed the language policy to allow students master basic cognitive skills of the reading process in familiar languages to facilitate skills transfer when English is introduced at second grade. Nyanja is one of the seven local languages used for initial reading instruction. The seven were selected based on their wide intelligibility and regional distribution across the country.

Most studies assessing reading skills among Zambian learners have constantly reported very poor levels of proficiency (Chikalanga, 1991; Matafwali & Bus, 2013; Sharma, 1973; Williams, 1998). For instance, Williams assessed English reading comprehension skills of Zambian students in elementary school and found that 85% of third graders and 88% of fourth graders failed to meet the national minimum expected levels. This state of affair is what prompted the implementation of the Primary Reading Program with a view of taking advantage of learners' oral competence in their respective Zambian languages. However, even after the implementation of the Primary Reading Program, recent studies by Matafwali and Bus (2013), and Tambulukani and Bus (2011) still reported very marginal gains in reading performance.

1.6. Definitions of Terms

Orthography – "is a system for presenting a language in written form... An orthography also covers relative placement of ... symbols, word breaks, punctuations, diacritics, capitalization, hyphenation and other aspects which might be regulated in a written standard" (Cahill & Karan, 2008, p. 3).

Opaque (or Deep) Orthographies – orthographies with less direct or highly inconsistent letter-sound correspondences, which makes decoding print more challenging for novices.

Transparent (or Shallow) Orthographies – orthographies with highly regular sound-symbol correspondences. The consistent letter-sound correspondences make word decoding relatively easy because of fewer letter-sounds mappings to deal with.

Psycholinguistic Grain Size Theory (PGST) – presumes that "dramatic differences in reading accuracy and reading speed found across orthographies reflect fundamental differences in the nature of the phonological recoding and reading strategies that are developing in response of the orthography" (Ziegler & Goswami, 2006, p. 431). As a result, reading in transparent orthographies relies almost exclusively based on grapheme-phoneme recoding (small grains) strategies, while in less consistent languages, small grains manipulation need to be complemented with large grain sizes for irregularly spelled words.

Orthographic Depth Hypothesis – states that "lexical word recognition in shallow orthographies is mediated primarily by phonemic cues generated pre-lexically by grapheme-to-phoneme translation. In contrast, lexical access for word recognition in a deep orthography relies strongly on orthographic cues" (Frost, Katz, & Bentin, 1987, p. 113).

Connectionist Models – are computer-based simulations mimicking human performance during skilled and poor word reading process developed by Seidenberg (Harm & Seidenberg, 1999; Seidenberg & McCelland, 1989).

Single Route Model – this theory presumes that there is only one route of word reading through which letter strings are processed using sub-lexical orthographic coding before it is pronounced through sub-lexical phonological coding (Frost, 1998).

Dual Route Model – defines the oral reading process (word recognition) as an integration of lexical orthographic (word recognition) and the phonological processing (grapheme-phoneme correspondences) output routes, where orthographic route depends on repeated print exposure necessary for reading irregular words, while the phonological output necessitates decoding of new word, especially phonetically regular words, and non-words.

CHAPTER II

REVIEW OF THE LITERATURE

2.1. Introduction

In this section, literature relevant to the present study is reviewed. The reviewed literature include studies investigating the effects of orthographic opacity on reading development and how long the reading developmental gap between students' taught in transparent to those learning in opaque languages persists. Additionally, studies evaluating how differences in the depth of orthography influences cognitive skills that predict reading development are also presented, in addition to research looking at the characteristics of reading disabilities.

2.2. Orthographic Transparency and Initial Reading Acquisition

The correspondences between phonology and orthography differ significantly across writing systems, even among alphabetic languages (Caravolas et al., 2013; Cook & Bassetti, 2005; Landerl & Wimmer, 2008; McDougall et al., 2010; Ziegler et al., 2014), and rates of acquiring reading skills among novice learners vary according to the degree of transparency of the language in which instructions are done (Goswami, 2005; Ziegler & Goswami, 2005). Phonological transparency, or depth, is defined as the "regularity of the correspondences between phonology and written forms, even for the same language" (Cook & Bassetti, 2005, p. 7). It is a function of the degree of the density in the number of graphemes mapping into the language's phonology. For some languages, these relationships are quite straight forward because each letter in the alphabet represents only one sound. In opaque orthographies, on the other hand, there is a systematic degree of irregularity because some graphemes represent more than a single phonemes.

Based on a study of the influence of orthographic opacity on early reading in 14 European languages (Austrian [German], Danish, Dutch, English, Finnish, Icelandic, German, Greek, Italian, Norwegian, Portuguese, Scottish, Spanish, Swedish], Seymour et al., (2003) were able to list these languages in orthographic opacity continuum with Finnish and English languages at each end of this spectrum. Differences in orthographic differences also seem to influence the syllabic structures between Romance and Germanic languages. Romance languages (e.g., Italian and French) are characterized by simple open CV syllables with a few initial or final diverse clusters. Contrastingly, the Germanic group (German and Norwegian) have a predominantly closed CVC syllable structure with complex clusters in both onset and coda positions. Although, both German and Greek have shallow orthographies, German has complex syllabic structure. French, on the other hand, is orthographically opaque, its syllabic structure is quite simple.

Variations in both orthographic transparency and syllabic structure impose different degrees and types of challenges when teaching novices to read. Orthographic transparency affects developmental rates and trajectories of reading, (Aro & Wimmer, 2003; Caravolas et al., 2013; Landerl & Wimmer, 2008; McDougall et al., 2010; Seymour et al., 2003), cognitive abilities predicting foundation reading development (Ziegler et al., 2014), and the characterization of reading problems among disabled readers. The two theories explaining early reading acquisition—the orthographic depth hypothesis [ODH] (see Brunswick, 2010; Ellis et al., 2004; Katz & Frost, 1992 for review) and the psycholinguistic grain size theory [PGST] (Goswami, 2005; Ziegler & Goswami, 2005)—posit that learning to read in opaque orthographies, like English, is much more challenging than in more transparent Finnish. This is because to be a successful reader in English requires mastery and application of both sublexical and lexical strategies.

Both ODH and PGST are refined off-shoots of the dual route model (Coltheart, 2005: Seidenberg & McClelland, 1989) which on based on the assumption that effective readers must draw on both their pre-existing lexicon through instant word recognition and use of sublexical skills to decipher new words and build their word repertoire. Reading of new and low frequency words sublexically is facilitated by the self-teaching process in which readers use their knowledge of letter-sound relationships to decipher (Share, 2008). The ODH "suggests that languages that differ in complexity, or depth, of their phoneme-grapheme rules are read in different ways—that is, readers rely to different degrees on lexical (whole word) and sublexical (phonological) reading processes" (Brunswick, 2010, p. 132). In a similar vein, the PGST proposes that;

> "…reading in any language entails converting spelling into sound, the size of the letter string—the 'grain size'—into which words are broken down depends on the depth of the language. In shallow [transparent] languages, in which single letters consistently represent single sounds, the grain size is very small… In deep [opaque] languages children cannot rely solely on letter-by-letter reading if they are to avoid making frequent errors. Instead, these children need to learn to convert strings of letters with larger sizes (e.g., *alk, ough, tion*) into their corresponding sounds to enable them to read effectively and accurately (Brunswick, 2011, p. 75-76).

Both theories are well supported in the literature (Goswami, Ziegler, Dalton, & Schneider, 2001). Goswami and colleagues administered a list of pseudohomophones [PsH]—non-words that sound like real words—and non-words in English (experimental; *faik, toffi, dynosor,* control: *dake, loffee, hinosaur*) and German (experimental: *Hunt, Fänster, Karramäll,* control: *Tund, Lenster, Laramel*) to test the hypothesis underlying the PGST. The difference between experimental and control stimuli was that the PsH's were only phonologically, but not orthographically similar to real words, whereas the non-words were both phonologically and orthographically similar to real words. The results showed a significant advantage for English children in reading PsH's than non-words (e.g., read *faik* better than *daik*) than their German counterparts. According to Ziegler and Goswami (2005),

> "This suggests that English children were more affected by whole-word phonology when reading non-words than were German children. German children decoded non-words that did not sound like real words as efficiently as non-words that did sound like real words, resulting in an absence of the PsH effect in naming" (p. 13).

This implies that English learners used their prior word part knowledge in decoding non-words, hence large grains for non-words and small grain sizes for PsH words, whereas German students relied almost entirely on small grain sizes through phonological recoding.

2.3. Effects of Orthographic Depth on Rates of Reading Development

Many comparative studies provide support that initial reading instruction differ based on the orthographic depth of the language used (Aro & Wimmer, 2003; Landerl, Wimmer, &

Frith, 1994; Oney & Goldman, 1984; Seymour et al., 2003; Wimmer & Goswami, 1994) and it is also well established that differences in strategies used or grain sizes adopted across orthographies are main causes. Brunswick (2010, p. 132) noted that “It is unsurprising that the orthographic depth of a language has a direct bearing on the ease with which children learning.” And Spencer and Hanley (2003, p. 2) stated that “learning to read and write a transparent orthography may be characterized by more rapid development of word-decoding skills than is learning to read an opaque orthography.” Word recognition strategies required for the various grain sizes in opaque—rimes, letter clusters, and whole words—are not only difficult to master, but also take time to learn if not systematically taught.

In a major cross-linguistic literacy study of 5- to 7-year-old first graders from 14 European countries referred to above, Seymour et al. (2003) demonstrated how orthographic transparency affect developmental trajectories of reading. Participants were tested on measures of letter knowledge, familiar, and non-words at the beginning and end of their first grade. By the end of the school year, results revealed close to 100% word reading accuracy for Finnish, Greek, and German-speaking participants (Austrian and German), mean scores around 92-95% were recorded among learners immersed in Dutch, Icelandic, Italian, Norwegian, Spanish, and Swedish languages, 70-80% scores were posted by French, Portuguese, and Danish children. English speaking children, on the other had a lowly mean of 34%.

A Similar distribution of results was posited on the non-words reading assessments. When English speaking students were reading at an average of 29%, Finnish, German, Greek, and Norwegian speaking were approaching ceiling (90-95%). Students learning in the other 12 languages also made significant reading progress in comparison to English first graders; the means for Dutch, French, Icelandic, Italian, Spanish, and Swedish students ranged from 82 to 89%, while Portuguese and Danish had 77% and 54% respectively. As expected, English speaking students had still not attained ceiling reading at the end of the second school year on all measures with the exceptions of letter identification which had a mean of 94%. The mean scores for real word reading and non-word decoding were 76% and 64% respectively. The distribution of European languages in Seymour et al.'s (2003) study reflects the variations in challenges imposed on beginning readers in acquiring reading skills based on the regularity of their grapheme-phoneme correspondences. Oney and Goldman (1984) had earlier reported similar findings in their evaluation of word reading accuracy between Turkish and American first graders. This study found that when the mean of Turkish children's word reading accuracy was at 94% threshold, their American counterparts posited a mean score of only 54%.

Aro and Wimmer (2003) extended Wimmer and Goswami's (1994) six nation cross-linguistic study of first to fourth graders learning to read in Finnish, French, Dutch, German, Spanish, and English. This study also strongly affirmed the argument that orthographic opacity has significant effect on reading development among beginning readers. This study was extension of an earlier study by Wimmer and Goswami (1994) among German and English 7-, 8-, and 9-year olds. Participants in both studies were administered three measures of numeral reading (e.g., 1, 2, 3 ...), number name reading (e.g., one, two, three, ...), and a pseudo-word reading tasks. Both studies found that although the time taken to read numerals and number names were very similar across the languages tested, participants from orthographically transparent languages had a significant advantage over their English counterparts on pseudo-word reading. The key finding of these studies was that English children excelled on identifying numerals and reading number names due to stimulus familiarity, but when unfamiliar pseudo-words were presented they faced significant difficulties. Wimmer and Goswami explained that, "This pattern of results is interpreted as evidence for the initial adoption of different strategies for word recognition…" (p. 91). English children performed poorly on pseudo-words decoding because "the acquisition of phonological recoding is the major hurdle in reading development …due to general difficulty of breaking down spoken words into phonemic segments … However, it seems this hurdle is easily surmounted by children reading transparent orthographies" (Aro & Wimmer, 2003, p. 630).

Studies directly assessing the effects of orthography on phonological awareness, a key predictor of early reading achievement, are not definitive. Näslund, Schneider, and van den Broek (1997) evaluated the phonological segmentation skills (phoneme manipulation, phoneme representation, and phoneme take-away) of German and US first and second graders. This study showed that the mean difference between the two languages was not statistically significant on phoneme deletion task and phoneme representation. However, German children were more accurate on the phoneme manipulation assessment than their English counterparts and the difference between the mean scores was statistically significant.

Studies have also shown that transparent languages offer a reading processing advantage even for dyslexics for reading and spelling (Goswami, Porpodas, & Wheelwright, 1997; Landerl et al., 1997; Thorstad, 1991). Dyslexics learning to read in more orthographically consistent languages tend to be more accurate and have lower reaction time than dyslexics receiving instructions in languages with inconsistent letter-sound correspondences. Landerl and colleagues tested the orthographic depth effects on German- and English-speaking dyslexic children ranging from 11 to 13 years old by administering word reading, non-words decoding, and phonological processing tasks. Results showed that German speaking dyslexics performed significantly better on both words and non-words than English dyslexics, but the two groups experienced similar levels of difficulties on the phonological awareness. For instance, more word reading errors were committed in English than in the German language (LFW[1] = 50% vs 7%; HFW[2] = 10% vs 2%) by both the experimental and control groups.

When dyslexic students in both languages were compared with matched controls of normally developing children, the study revealed that English children faced severe difficulties in word and non-word reading than the German group. However, while the performances of German non-dyslexic and dyslexic children on word reading and reading

[1] LFW = low frequency words
[2] HFW = high frequency words

rates were quite comparable, the achievement gap between English non-dyslexics and dyslexics were not only significantly large, but the number of reading errors committed were substantially bigger and reading rate was labored and slow. This implies that the high consistency of the German orthography facilitates the reading process more easily than in English, and hence, the degree of reading disabilities is more severe in English-speaking children.

Bilingual students learning to read in both a transparent and opaque also exhibit significant similarities in patterns of reading performances as those reported by cross-national studies cited above (Aro & Wimmer, 2003; Seymour et al., 2003). Reading performance in transparent languages is relatively easier in comparisons to opaque languages on both measures of reading fluency—accuracy and reading speed. For instance, Pullinat and Adone's (2009) used a repeated-measures design to test basic decoding skills of German-English bilinguals cross-linguistically. The study revealed that differences in mean performance between the two languages were statistically significant.

Orthographic opacity may also explain the variations in proportions of students who are symptomatic of dyslexic and reading disabilities in the general population across alphabetic orthographies (Wolf, Pfeil, Lotz, & Biddle, 1994). Most of the studies reviewed by Wolf and colleagues show that there is a low incidence of developmental dyslexia among students learning to read in transparent languages in comparison to those taught to read more inconsistent orthographies. For instance, compared to the approximated 10% incidence of dyslexia among English learners, research shows that the incidence range from 3% to 6% among Italian- and German-speaking students respectively. Variations in proportions of reading disabilities across languages can be directly or indirectly attributed to differences in orthographic depth.

In summary, orthographic opacity has significant effects, not only on reading acquisition, but also on the characterization of reading disabilities. In fact, Landerl's (2000) conclusion over a decade ago that none of the available studies have reported results that found that acquiring reading skills is easier in the English language compared to more consistent orthographies could still be true today. According to Share (2008), the reading developmental lag among English learners reflects challenges the language poses to novice readers in the initial stages of reading instructions and, therefore, confirms its outlier status in facilitating acquisition of reading skills. This is the reason why it is important to account for orthographic depth in defining and proposing theories and models of reading acquisition, especially in the early stages of instructions.

2.4. How Long Does the Advantage of Learning to Read in a Transparent Orthographies Last?

Developmental disparities observed in reading acquisition and proficiency across orthographies usually persist beyond the first grade (Hanley et al., 2004; Spencer & Hanley, 2003). However, majority of students showing poor reading achievement initially in opaque languages eventually become just as proficient at reading as their transparent orthography immersed counterparts after sustained and systematic literacy instruction. Spencer and Hanley's longitudinal study examining developmental trajectories of Welsh and English students found that although at the end of first grade Welsh children out-performed English children, the latter had attained comparable proficiency at the end of second grade. Although, English students were still functioning below expectations on reading low and medium frequency irregular words. Additionally, the mean achievement gaps on regular words and non-words were no longer statistically significant by the end of third grade. The low performing 25% among English children continued to read significantly poor—becoming even worse in some cases—compared to the lowest 25% of the Welsh children. This finding is interesting as it implies that orthographic depth has detrimental effects to poor readers compared to more proficient readers.

Another longitudinal study by Oney and Goldman (1984) reported similar reading development patterns between English and Turkish students in grades one to three. Similar to German and Italian learners, Turkish participants had out-performed English children and were reading close to ceiling by the end of first grade. Nevertheless, English learners were reading at the same level of proficiency as Turkish children before graduating to fourth grade, although, the latter was more fluent than their English counterparts.

These findings have significant implications for transparent-opaque language instructed bilinguals and raise a number of pertinent questions which require further empirical investigation. Some of the questions arising are; what are the characteristic differences in reading performance between transparent and opaque languages among bilinguals? How long does the difference in reading performance, if any, last among bilingual readers? Are there any cross-linguistic transfer effects on reading acquisition and/or proficiency between shallow and deep orthographies? If there are any cross-linguistic transfer effects across orthographies, do transfer effects moderate or aggravate the achievement gap? How do cognitive constructs predicting reading achievement compare across diverse orthographies? What are the similarities and/or differences in models of reading development between transparent and opaque languages? Assessing how long discrepancies in reading performance either longitudinally or cross-sectionally would provide important insights for reading researchers.

2.5. Predictors of Reading Acquisition across Orthographies

Cross-linguistic research has not only been key to unveiling the effects of orthographic depth on reading acquisition (Landerl & Wimmer, 2008; Seymour et al., 2003), but also in establishing the nature of factors that predict its development (Brunswick, 2010; Caravolas et al., 2013; Melberg-Lervag & Lervag, 2011). And although orthographic transparency has significant effects on reading development, cognitive requisites necessary for acquiring reading skills—especially in alphabetic orthographies are relatively universal (Holopainen et al., 2001; Muller & Brady, 2001) differing mostly in the amount of variance explained (Caravolas, Volin, & Hulme, 2005; Caravolas et al., 2013; Jared et al., 2011; Landerl et al., 2013; Ziegler et al., 2010).

Based on findings from available research, the main cognitive skills predicting word reading are letter knowledge, phonological awareness, and rapid automatized naming [RAN] (Hogan, Catts, & Little, 2005; Holopainen et al., 2001; Mann & Wimmer, 2002). It must be noted here that a significant amount of the early research on literacy development came from English monolingual populations, but recent studies involving other languages varying in orthographic depth reveal some inconsistencies in these constructs' predictive power (Caravolas et al., 2013; Furnes & Samuelsson, 2010, 2011; Share, 2008). As Caravolas and colleagues noted "Some authors have argued that in consistent orthographies, phoneme awareness is a less important, and RAN a more important, predictor of variations in reading ability than in English" (p. 1399).

Furnes and Samuelsson's (2010) study provided some noteworthy support for the Caravolas et al.'s (2013) arguments regarding differences in predictive power among the three main constructs necessary for reading development. In this study, the authors tested the variances contributed by phonological awareness and RAN to both reading and spelling development among English, Norwegian, and Swedish children. Students from preschools to second grade were given parallel measures of phonological awareness and RAN. The findings revealed that phonological awareness had time-limited effects in relatively transparent Norwegian and Swedish compared to English, but had similar effects on spelling proficiency across all the three languages. RAN skills, on the other hand, have stronger and long term predictive effects in less opaque orthographies than in orthographically inconsistent languages.

However, when Caravolas et al. (2013) longitudinally administered measures of phoneme awareness, letter knowledge, and RAN to children in reception and kindergarten classes in English, Czech, and Spanish languages over a period of three years, the study did not find significant differences in achievement. All the three constructs contributed comparable amounts of variance to the reading process. They concluded that "although children may learn to read more rapidly in more consistent than in less consistent orthographies, there may nevertheless be universal cognitive prerequisites for learning to read in all alphabetic orthographies" (Caravolas et al., 2013, p. 1398). The findings also seemed to suggest that individual differences in reading proficiency among students in all languages were a function of the three core cognitive skills—phoneme awareness, letter-knowledge, and RAN—while the emerging predictive patterns of these constructs seem to suggest similar mechanisms involved in reading development without regard to orthographic depth.

2.6. Zambia: Geography, Economy, and Education

Zambia is a land-locked sub-Saharan country lying between latitudes 8 and 18 degrees south, and between longitudes 20 and 35 degrees east. The country covers 290,585 square miles (about 2.50% of the African land mass) and has shared boundaries with Angola, Botswana, Democratic Republic of Congo (DRC), Malawi, Mozambique, Namibia, Tanzania, and Zimbabwe. It is divided into 10 provinces for administrative purposes, namely; Central, Copperbelt, Eastern, Luapula, Lusaka, Muchinga, Northern, North-western, Southern, and Western provinces. Although each province has an administrative center, the country is centrally administered from the capital city, Lusaka. Based on the 2010 national census report projections, Zambia had a population of 14 million in 2012 (Census Statistics Office, 2012), and a per capita gross national income (GNI) of US$ 1,490, compared to US$ 48,820 for the USA in 2011 (World Bank, 2013).

Zambia practices a three-tier education system comprising of seven years of primary (elementary school equivalent), five of secondary (high school), and tertiary levels whose duration can vary from a few months to seven years in community colleges and universities. With the exception of a few private education institutions, the government through the Ministry of Education is responsible for the running and funding the entire education system. Literacy levels—defined by the ability to write and read in any language (self-reported)—is approximately 70.3% among individuals aged 5 years old and above. There are significant gender and rural-urban education achievement gaps. On average, school enrolment levels and progression rates are higher among males than females. The gender parity index—an index showing the proportion of enrolled females compared to males—is less than one, while urban residents are significantly more literate than their rural-based counterparts. This is because urban areas have better and more accessible educational facilities than rural areas.

2.7. Linguistic Structure and Education Language Policy in Zambia

There are more than 70 indigenous languages and dialectics spoken in Zambia, while English is the main and official language used across the country. The languages and dialectics are classified according to the speakers' ethnicity around the 10 main tribal groupings (Ohannessian & Kashoki, 1978). Each of these linguistic groupings are unique and classified based on their geographical locations. However, most local languages are mutually intelligible, especially those within close proximity of each other. According to Baker and Jones (1998), "English has been the official language of Zambia. It is the language of government, business and education," (p. 369). The country's adoption of the English language was premised on its ethnic and politically neutrality, and was meant to be used a tool for the promotion of peace and inter-tribal harmony in the country (Linehan, 2004).

In a bid to maintain the prominence of local languages and also increase literacy levels in the population, seven major languages—Bemba, Nyanja, Tonga, Lozi, Luvale, Lunda, and Kaonde—were also adopted using wider intelligibility and regional distribution criteria across Zambia (Ohannesian & Kashoki, 1978). Accordingly, the Zambian Ministry of Education adopted the English language as a medium of school instructions. The United Nations Educational, Scientific and Cultural Organization (UNESCO) encouraged the adoption of the *straight-for-English* language policy—all school instructions were conducted using the English language from first grade onwards—at independence in 1964 by recommending that "the medium of instruction should be English, from the beginning of schooling," (UNESCO, 1964, p. 105). In addition to learning in English, learners were also taught to read in one of the seven predominate indigenous languages in school districts where they were broadly spoken.

Due to poor reading standards exhibited by students across the country (Chikalanga, 1991; Matafwali & Bus, 2013; McAdam, 1973; Sharma, 1973; Williams, 1996), many attempts were made to change the language of instruction policy from *Straight-for-English* to local languages in lower grades from 1965 to the early 2000s (Ministry of Education, 1977, 1992; 1996; Sampa, 2005). However, although educationists have for a long time acknowledged the advantages of mother tongue reading instructions, the *1977 Educational Reforms: Proposals and Recommendations* felt that their implementation was "impracticable in the case of every child in multi-lingual societies, such as the Zambian society," (Ministry of Education, 1977, p. 32). Consequently, instead of a curriculum wide implementation of mother tongue instruction, classroom teachers were encouraged to use local languages in teaching concepts which are difficult to explain in English.

The Zambian government only started speeding up the introduction of local languages following the *Education For All* declarations of the 1990 World Conference (Kelly & Kanyika, 2000; Nkamba & Kanyika, 1998; Williams, 1993; 1996; 1998). Recent language policies—Focus on Learning (Ministry of Education, 1992), Educating our Future (Ministry of Education, 1996), and Primary Reading Program (Sampa, 2005)—emphasize the use of students' mother tongue or the students' most familiar language in first grade before English is introduced from second grade onwards.

2.8. Nyanja Orthography

Nyanja, also known as Chichewa in Malawi, is a Bantu language belonging to the "Benue-Congo branch of the Niger-Kordofanian language family," (Mchombo, 2004, p. 1). It is spoken by more than 1.5 million people in Malawi, Mozambique, Zambia, and Zimbabwe. Nyanja is the second of the seven most widely spoken languages—Bemba, Tonga, Lozi, Luvale, Kaonde, and Lunda—after Bemba (Ohannessian & Kashoki, 1978; Sampa, 2005).

Due to Zambia's Anglo-Saxon colonial legacy, Nyanja, like all other indigenous orthographies, is based on the Latin alphabet.

Nyanja orthography has 29 graphemes consisting of five traditional vowels and 24 consonants (Chimuka, 1977). The graphemes *a, e, I, o,* and *u* constitute vowels, while *b, c, d, f (pf), g, h, j, k, l, m, n, p, r, s (ts), t, w, y,* and *z (dz)* make up the orthography's consonants. Apart from these conventional graphemes, Nyanja has six dialectal digraphs consisting of *ph* as in *phiri (hill), th* in *nthawi (time), ch* in *Chipata (name of a town in Zambia), kh* in *nkhwangwa (axe), bv* in *bvuto (problem), ng'* in *ng'ombe (cattle),* and *ŵ* in *Malaŵi (name of African country in Central Africa)*. The orthography has a both feed forward (orthography to phonology) and feed backward (phonology to orthography) orthographic consistent as word spelling map directs into a single phonemes and vice versa. Additionally, syllables are characteristically open syllables of the consonant-vowel type (type CV) and ending in vowels (Kreidler, 2001).

Tone is another fascinating feature of the Nyanja orthography. Tone in Nyanja is orthographically characterized into two tonal levels—low and high (Chimuka, 1977; Mchombo, 2004). According to Chimuka (1977, p. 16), there are some Nyanja "words which are spelt the same, but which are different in meaning and pronunciation. The difference is due to tone … the pitch of the voice on certain syllables of one is different from that on corresponding syllables in another word." Some typical examples of tonal variations are: *bala* (a cut or wound) and *bala* (to reproduce, or bear), *mbale* (a plate) and *mbale* (a relative), *mtengo* (tree) and *mtengo* (price), and *kuti* (where) and *kuti* (to say).

2.9. Comparing Nyanja and English Orthographies

The 29 graphemes in the Nyanja writing system map into exactly 29 different phonemes. Unlike the highly consistent English orthography which has 44 phonemes mapping into more than 200 graphemes, Nyanja orthography has an almost one-to-one grapheme-phoneme correspondences. Therefore, novices learning to read in Nyanja have fewer combinations of letter-sound correspondences to master in comparison to the multiplicity of correspondences resulting from the inconsistences of the English orthography. And as revealed by the cross-linguistic studies of reading development reviewed above, variations in orthographic depth influences reading patterns, time taken to master reading skills, and the nature of basic cognitive skills predicting reading proficiency (Caravolas et al., 2013; Jared et al., 2011; Landerl et al., 2013; Seymour et al., 2003; Ziegler et al., 2010).

Similar achievement patterns are observed in other studies comparing students' reading proficiency in indigenous Zambian languages and English (Kaani, 2008; Ojanen, 2007; Williams, 1998). These studies reveal that the transparent nature of Nyanja orthography, just like all other Zambian languages, facilitates the reading process better than the English orthography. Consequently, although the recent policy change from *Straight-for-English* to initial reading instructions in local languages was not a direct result of Zambian languages' orthographic transparency, but rather based on the inherent benefits of background knowledge and oral language familiarity to comprehension (Sampa, 2005; Tambulukani, Sampa, Musuku, & Linehan, 2001), there is no doubt that the new Primary Reading Program (PRP) policy will profit significantly from orthographic transparency.

2.10. Research on Reading Performance in Zambia

Findings from studies evaluating the reading competence of Zambian students been revealing significantly low proficiency since the introduction of English reading instruction (Kelly & Kanyika, 2000; Matafwali & Bus, 2013; McAdam, 1973; Sharma, 1973). Sharma documented the first evidence of poor literacy performance in post-independence Zambia among grades one to three students. This study reported that on a 40-item measure of word recognition only 4.20% of the sample were able read all items correctly although test items were drawn from grade level Zambia Primary Course (ZPC) English textbooks. While more than 5% of the participants could not read a single test item on the test. Similarly, McAdam (1973) compared fourth graders' reading performance in English and a Zambian language and found a bimodal distribution on the English test scores. Almost half of the English taught students performed as poorly as their Zambian language instructed counterparts. These findings are symbolic of the handicapping effects of the orthographic inconsistences of the English language when it is not explicitly and systematically taught.

Other large scale cross-national studies assessing the acquisition of literacy skills also found that the *Straight-for-English* language of instruction policy was detrimental to the students' reading success in Zambia (Kelly & Kanyika, 2000; Nkamba & Kanyika, 1998; Williams, 1996). In 1996, Williams measured the reading comprehension skills of

Zambian and Malawian fifth grade students in English and Nyanja languages. Unlike the *Straight-for-English* language policy used in Zambia, in Malawian schools Chewa (the name used for Nyanja language in Malawi) is used for instruction from first to fourth grade, when English instructions are introduced. The study reported that Malawian students out-performed their Zambian counterparts both in English and Nyanja. The mean difference was statistically significant despite the former experiencing only two years of formal English instructions compared to six years for the latter.

Another comparative study of reading and mathematics proficiency in 14 southern African countries by the South African Consortium Measuring Educational Quality (SACMEQ) found that only 25% and 3% of sixth graders in Zambia could read at the minimal acceptable level and desirable level on English assessments respectively. Thus, making Zambia the 13th ranked country overall among the 14 participating countries. The findings of the 1996 Monitoring Learning Achievement (MLA) did not significantly deviate from the results of the SACMEQ report. Serpell (1978, p. 433) had attributed this "gross retardation … to a failure in learning to read in English." The continued and sole use of the English language for reading instructions was hampering students' competence even in transparent Zambian languages.

The need to ameliorate low literacy skills among learners culminated into the development and implementation of several educational policies. The first policy introduced in 1992 was *Focus on Learning*—themed *quality education for all* (Linehan, 2004; Ministry of Education, 1992). The Focus on Learning policy was ephemeral and was later replaced by *Educating our Future* in 1996 (Ministry of Education, 1996). Both policies were meant to overhaul the entire country's education system to improve quality and access. In the early 2000s, the Primary Reading Primary (PRP) policy was developed and implemented within the broader framework of both *Focus on Learning* (Ministry of Education, 1992) and *Educating our Future* (Ministry of Education, 1996) policies with the specific object of improving reading instructions and proficiency. The PRP consists of a stepwise and graduated structure spanning from first to seventh grade. Children start with *New Break-through To Literacy* in first grade, during which literacy instructions are exclusively in the learner's mother tongue or most familiar language. Students also receive oral English lessons (*Pathway to English)* to boost their spoken English skills. Instructions in reading and writing English are introduced in grade two (*Step into English*). At this stage, English instructions take advantage of the basic literacy skills in the local language and oral English skills students acquire in first grade. The last stage—*Read on Course*—spanning from grade three to seven focuses on consolidating skills and using it as a bedrock for students' eventual bilingual reading acquisition.

Preliminary findings from the pilot studies in selected Zambian languages across the country from 1998 to 2002 showed significant improvement in reading proficiency in both English and indigenous languages. For example, during pilot studies reading proficiency in local languages increased by 780% between 1999 and 2002, English reading scores improved by 575%. Reading scores improved by 484% overall between second to seventh grades (Sampa, 2005; Tambulukani et al., 2001).

2.11. Other Factors Affecting Reading Levels among Zambian Students

Apart from the effects of orthographic opacity on reading proficiency, there are other factors that may explain persistent low reading achievement in Zambia. The first factor relates to teacher's knowledge of the reading process, specifically their pedagogical content knowledge. A significant amount of research has recently been conducted to empirically understand how teacher knowledge affects their students' learning outcomes (Applegate & Applegate, 2004; Cantrell et al., 2012). Due to the nature of both pre-service training and professional development programs available, Zambian teachers lack pedagogical content knowledge (Shulman, 1986), an essential element of effective reading instruction. Pedagogical content knowledge is a combination of content knowledge and strategic knowledge—knowledge of how the content knowledge can be effectively presented in the teaching process. Teacher preparation programs in Zambian colleges of education treat content and pedagogical knowledge as mutually exclusive aspects of the teaching process. Hence, a teacher may have good knowledge and understanding of the subject content, but lack related pedagogical knowledge or vice versa.

Cantrell and colleagues (2012) have argued—based on Applegate and Applegate's (2004) Peter Effect hypothesis which posits that teachers cannot teach what they do not know or give knowledge they do not have (Acts 3: 6)—that teachers cannot be effective in reading instruction unless they are well trained and have full understanding of the fundamentals of the reading process and how proficient readers integrate all these elements. In other words, the Peter Effect implies that poorly trained teachers cannot be expected to provide appropriate knowledge about the reading process that they do not possess. Students' reading performance reflects their teachers' competence levels and effectiveness. For instance, in Cantrell et al.'s study "students whose teachers were both knowledgeable and devoted more time to explicit decoding instruction made significantly higher gains in word reading" (p. 529).

A good understanding of content-specific pedagogical knowledge is particularly essential for teachers of second language learners of English because it is considered to be the most orthographically inconsistent alphabetic language. As noted earlier in this chapter, several studies have shown that learning to read in English can be challenging compared to other alphabetic languages (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour et al., 2003; Ziegler et al., 2014). However, evidence from emerging research also show that the English orthography is not chaotic as often construed, the observed differences in reading performance across orthographies may in part be due to the poor instructional methods used (Cantrell et al., 2012; Joshi, Treiman, Carreker, & Moats, 2008/2009, McCardle & Chhabra, 2004; National Institute of Child Health and Human Development, 2000). Cantrell et al. and Joshi et al. argue that when appropriate linguistic constructs underlying the reading process are taught explicitly and systematically, the challenges associated with its orthographic depth decrease drastically.

The leading problem with reading instructions in Zambian school is the failure to develop and implement instructional programs that focus on:

i. The five major components of the reading process (phonemic awareness, phonics, fluency, vocabulary, and text comprehension),

ii. Make word reading more systematic using strategies based on word origins and history (e.g., teaching words from Anglo-Saxon, Latin, and Greek origins, syllable patterns and meaningful parts of words, and letter patterns).

Systematically organizing reading instructions based on strategies can help students to avoid whole word memorization which are currently encouraged by teachers. The use of spelling rule-based strategies to build individual lexicon significantly improves both word reading and comprehension among students (Joshi et al., 2008/2009).

The second factor that could be influencing reading proficiency levels in Zambia relates to education stakeholders' lack of understanding of the impact of students' characteristics to the teaching-learning process. This factor is also linked to pedagogical content knowledge, but related specifically to students' predisposition to respond to reading instruction. Effective reading instructions take into account students' prior knowledge, their SES characteristics and limitations, and their responsiveness to lessons as presented and learning activities. In other words, it relates to the fact that the methods used are culturally responsive to all the needs of the students (Gay, 2010). Some reading theories and models stress the importance of the interaction between the learner's decoding and listening comprehension. For instance, the simple view of reading (Gough & Tunmer, 1986), presumes that reading comprehension (RC) "is equal to the product of two separate components: decoding (D) and linguistic comprehension (C), thus RC = D ×

C" (Georgiou, Das, & Hayward, 2009, p. 76). This implies that successful reading comprehension requires well developed decoding skills—both word recognition and phonics-based manipulation of letter-sound correspondences—and listening comprehension.

However, although English is officially Zambia's first language, majority of the first grade students are not fluent English speakers at the time of school enrolment. The 2010 National Census Statistics Report shows that English language was only spoken as a first language by 1.7% of the population, while 74.2% claimed that English as a second language (Central Statistics Office, 2012). Consequently, even if students are able to decode English words, they would still have challenges with reading comprehension if their listening or oral comprehension of the English language is not fully developed or compromised. Thus, if native English speakers face significant challenges with reading comprehension, the task is insurmountable for Zambian students who lack listening comprehension. The challenges would, however, have been manageable if PRP could have an extensive oral English instruction component before the introduction of formal reading instruction in English at second grade.

Apart from teachers' inadequate pedagogical-content knowledge, Zambia also faces significant shortages of teaching staff in schools. Nzioka and Ramos (2008) cited staff shortages as a major hindrance hampering the attainment of education for all (EFA) goals in 2015 in sub-Saharan Africa. In Zambia, the average national student-to-teacher ratio is 51.65 (i.e., more than 50 students per teacher per class) in the grades one to seven cohort (Ministry of Education, 2008). The ratio is even higher for the grades one to four cohort, where the average ratio is 72 students per teacher. High student-teacher ratios places significant strains on the quality of instruction teachers provide because they struggle not only in offering individualized attention to their students, but planning lessons is also ominously compromised.

Teacher shortage is caused by fewer graduates coming from colleges of education mainly due to low institutional capacity. The number of new graduates from training colleges is not commensurate to the annual teacher demands in Zambian schools. The demand for more teachers stems from the ever increasing number of student populations coupled with limited infrastructure expansion. These factors inevitably lead to over-enrolment in the existing schools. It is also not uncommon to find untrained teachers taking charge of reading classes, especially in the remote parts of the country. When the Ministry of Education trained teachers are in short supply, communities recruit untrained local high school graduates (Grades 9 or 12 graduates) to complement the efforts of the available teachers, which further compromises the quality of instruction and worsening the already desperate situation.

Additionally, there are high levels of attrition in the teaching service as majority of the recruited teachers who take up appointments are rarely retained for long periods. In 2008, 11,187 teachers left from the teaching service and the numbers keep increasing annually (Ministry of Education, 2008). According to Muunga, Mufalo, and Jule (2008, p. 1), “The most common reasons given for the attrition were those of illness, teachers being given non-teaching jobs, retirements, and resignations.” The ravages of the HIV/AIDS epidemic have also decimated substantial numbers of teachers over the years. Although the rates of teacher attrition through HIV/AIDS has reduced drastically in recent years due to the availability of anti-retroviral therapy, most HIV positive teachers are frequently absent from work due to opportunitionistic infections.

Das, Dercon, Habyarimana, and Krishnan (2007) evaluated the impact of HIV/AIDS-related teacher absenteeism in Zambia and found that the “Shocks associated with a 5% increase in the teacher’s absence rate resulted in a decrease in learning of about 4% for English and Mathematics of the average gains across the two years” (p. 852). Even when they are not infected, by virtue of their positions, teachers are still affected by the HIV/AIDS pandemic because they frequently play the role of surrogate parents for students who may be sick or nursing sick parents at home. They also contend with the demands of their own sick relatives (Baggaley, Sulwe, Chilala, & Mashambe, 1999).

These factors further lead to high levels of grade retention/repetition and raise the number of school dropouts. The Zambian Ministry of Education (2005) reports that 7.2 % of students population are not allowed to progress because of unsatisfactory performance. Although grade retention—repetition a grade for another year—is meant to allow the students to improve their grades, it also has some undesirable effects on academic performance. A study by Wu, West, and Hughes (2009) found that apart from the increased possibility of dropping out of school, repeating a grade for another year affects students’ morale to learn. Most students perceive grade retention as punishment for flunking and invokes feelings of rejection. Consequently, as Holmes (1989, p. 14) noted "On average, retained students do more poorly than matched control on follow-up measures of social adjustment, attitudes towards school, behavioral outcomes, and attendance."

All these factors put together could to considerable extent explain individual differences in reading proficiency among students in Zambia, that are otherwise attributed to variations in orthographic depth. As noted earlier, studies from the reviewed literature consistently show statistically significant mean differences in reading proficiency between transparent and opaque orthographies (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour et al., 2003; Ziegler et al., 2014). Additionally, since most of the results are based on monolingual cross-national studies, reading differences could be due to low SES and educational policy variations, some of the reading variance explained orthographic opacity. Similarly, Zambia's unique characteristics explained above may affect the reading outcomes of the current study.

2.12. The Present Study

The present study sought to investigate the effects of orthographic opacity on reading proficiency among grades 4-6 Nyanja-English bilinguals in Zambia. Nyanja is one of the major languages spoken in Zambia and, unlike English, it has a highly isomorphic orthography with almost one-to-one graphemes-phonemes correspondences which provides relatively easy access to print for decoding (see Chimuka, 1977). Specifically, the research questions of the study are as follows;

A. (i). Does the advantage of reading in orthographically transparent languages among monolingual students replicate among Nyanja-English bilinguals? (ii). If yes, what is the extent of the differences due to orthographic opacity in reading proficiency between the two languages?
B. How long does the discrepancy in reading proficiency between Nyanja and English orthographies, if any, persists?
C. How do cognitive skills predicting reading comprehension compare between languages of different orthographic opacity?
D. Are there marked differences in path coefficients in the Path Model diagrams between Nyanja and English reading data? Which data set (Nyanja or English) fits the proposed reading model better?

Although it may be hypothesized that the mean reading achievement across the two orthographies would differ in favor of Nyanja, it is important to note that the main effects were not expected to be as robust as the results obtained in cross-national comparative studies in monolingual societies because of the following reasons. Firstly, the cross-linguistic transfer effects across languages as basic reading skills from first language help to lessen reading difficulties in the second language (Durgunoglu & Öney, 2000; Melby-Lervag & Lervag, 2011). Secondly, Zambian society is linguistically diverse with 70 languages and dialects spoken in the country. As a result apart from being bilingual educationally, students—in addition to learning to read in English and a second school language—are exposed to other languages or dialects outside the learning environment.

Extra languages may facilitate or hinder the acquisition of reading skills (Tambulukani & Bus, 2012). Finally, students in Zambian schools have persistently shown low reading and spelling performance, a situation frequently attributed to inherent poor quality of teaching (Chanda, 2008; Kaani & Joshi, 2013; Matafwali & Bus, 2013; Reich et al., 2013; Stemler et al., 2009). These factors were expected to have a moderating influence on Nyanja-English orthography reading achievement mean differences.

CHAPTER III

THEORETICAL FRAMEWORK

3.1. Introduction

This chapter presents a theoretical framework of reading development underpinning the current study. The chapter is divided into three sections. The first provided a general discussion of linguistic characteristics and how they influence the reading process, while the second section described the specific characteristics and assumptions of the three theoretical perspectives—orthographic depth hypothesis, central processing hypothesis, and psycholinguistic grain size theory. The final section covered the theoretical reading model which was tested to evaluate how various constituents of the reading process varies between a transparent and an opaque orthography

3.2. Reading across Languages with Varying Orthographic Depth

Writing systems differ significantly with regard to the degree in which their phonology correspond with orthography. For some orthographies, there are consistent correspondences between the written and the spoken forms, while others orthographies have highly inconsistent grapheme-phoneme correspondences (Joshi & Aaron, 2006; Koda & Zehler, 2008; Seidenberg, 1992). This transparent versus opacity dichotomy become even more apparent when orthographies have a lot shared characteristics such as alphabetic orthographies. Grapheme-phoneme correspondences can range from one-on-one grapheme-phoneme correspondences to highly inconsistent associations where a single phoneme is represented by multiple graphemes (Katz & Frost, 1992). So unless readers understand rules governing the spelling conventions in the language, they will not be able to read and write certain words correctly or/and pronounce properly (Joshi et al., 2008/2009). The degree to which orthographies vary have significant implications on students' ability to acquire psychological processes underpinning the development of literacy skills using the alphabetic principle (Joshi & Aaron, 2006; Landerl & Wimmer, 2008).

Word reading in alphabetic orthographies is achieved either through grapheme-phoneme correspondence (GPC) rules or the whole word recognition route. In using the word recognition routes, the new letter strings or words are read by comparing them to the known words or word patterns stored in the reader's lexicon through *direct access* to reproduce the appropriate pronunciation and meaning of the target word (Grainger & Ziegler, 2011; Seidenberg, 1992). According to Grainger and Ziegler, the lexical route, which "is also referred to as the direct route … provide access to whole-word phonology…, and higher-level semantic information…" (p. 1) by activating both the semantic lexicon and the phonological output lexicon. Using the grapheme-phoneme correspondence route, the reader determines the correct pronunciation and meaning of the target word by assembling orthographic segments indirectly into phonological recoding. By knowing individual letter names and the sound that each letter makes, the reader is able to decode the sound of the word.

Orthographies that exhibit inconsistent grapheme-phoneme correspondences are described as *deep* or *opaque* orthographies, whereas those characterized by highly consistent correspondences are called *shallow* or *transparent* orthographies. It has been observed that the quality and nature of oral reading across orthographies vary according to the degree of grapheme-phoneme correspondence characterizing languages of instruction (Landerl & Wimmer, 2008; Joshi & Aaron, 2006; Seymour et al., 2003; Ziegler & Goswami, 2005). By virtue of the consistent nature of associations between graphemes and phonemes, transparent orthographies are relatively easily to read because they facilitate ease access to words through phonological recoding. Seidenberg (1992), and Geva and Siegel (2000) noted that phonological recoding strategies permit students to decipher new and unfamiliar words through simple and direct one-on-one letter to sound manipulations as long as they have a working knowledge and understanding of the grapheme-phoneme correspondence rules. According to Share (2008), easy print-to-sound translations invokes the self-teaching mechanism, which enables "the learner to acquire the detailed orthographic representations necessary for fast, efficient, visual word recognition and for proficient spelling" (p. 770).

On the other hand, reading words in opaque orthographies requires more complex and multiple print-to-sound conversions because of the inconsistent nature of the associations between the orthography and phonology. Consequently, the use of direct letter-sound conversions through phonological recoding is not always possible and readers have to learn the pronunciation of individual irregular words or word parts (Besner &

Smith, 1992). Pritchard, Coltheart, Palethorpe, & Castles (2012) aptly describe this process:

> The other mechanism, termed the lexical route, is the process whereby skilled readers can recognize known words by sight alone without first accessing phonological word representations or the phonemes associated with the constituent graphemes. Direct recognition of the entire written word allows the reader to determine the associated spoken word as a whole, and produce this when reading aloud (p. 1268).

This process depends on prior exposure to part or the whole target word in order for the reader to read it. As a novice reader gets exposure to more letter patterns, their pronunciations, and meanings, she or he begins to create his or her own lexical repertoire which is applied or used to decipher new words with similar orthographic patterns when encountered later.

Subsequently, the reader's ability to read a word through either the indirect route or direct route is to a certain extent a function of the linguistic characteristics and orthography of the language concerned. Orthographic depth of the language being read guides the reader in selecting appropriate reading strategies to suit its characteristics. Until recently, there has been two major theoretical frameworks used to account for children's differential literacy development across orthographies; the orthographic depth hypothesis (Katz & Frost, 1992) and the central process hypothesis (Geva & Siegel, 2000; Gleitman, 1985). However, a new theoretical model of reading has emerged and has taken prominence in the last decade called the psycholinguistic grain size theory (Ziegler & Goswami, 2005). This study is guided by these three theoretical perspectives and they are explained in the following section

3.3. Central Processing Hypothesis

The central processing hypothesis presumes a singular route underlying the reading process regardless of the nature of the orthography (Gleitman, 1985). According to this theory, orthographic characteristics do not in any way impact learners' ability to develop reading skills. Its advocates argue that instead working memory, verbal ability, speeded naming, and phonological processing are the major and universal psychological processes that impact literacy development and define individual differences in reading proficiency. According to Geva and Siegel (2000, p. 2), "individuals with deficient cognitive and linguistic skills will experience difficulties in acquiring basic reading skills, regardless of the language and script involved, and regardless of whether it is their L1."

This implies that students who experience specific reading difficulties in first language are also likely to face similar problems in the second language. Therefore, there are no significant achievement variations between languages, students' performance on the underlying cognitive and linguistic factors, working memory, verbal ability, speeded naming, and phonological processing, should correlate highly across languages (Geva, 2006; Geva & Siegel, 2000). Geva further surmises that:

> If the same processing factors are found to be important when children are learning to read in their L1 and L2, then we can expect that these skills will "transfer" from the L1 to the L2 (and from the L2 to the L1). That is, one can expect positive transfer if the same underlying processing factors facilitate the acquisition of literacy skills in the L2, just the way they do in the L1 (p .1).

3.3.1. Research evidence in support of the central processing hypothesis

Due to inconsistent findings, there has been very little empirical support for the central processing hypothesis in recent years in comparison to orthographic depth hypothesis and its variants, especially the psycholinguistic grain size theory (Geva & Siegel, 2000; Gleitman, 1985). Majority of the studies reviewed were premised on the assumption that there are no differences in prevalence and nature of reading difficulties students experience across orthographies because of the presumed universality of predictors of reading development. The second assumption is that observed individual differences in literacy proficiency are instead a function of deficiency in one or more of the underlying cognitive and linguistic skills—working memory, verbal ability, serial naming, and phonological processing.

Some studies conducted using clinical samples and bilinguals facing difficulties acquiring literacy skills in both L1 and L2 reviewed by Geva and Siegel provided some credence to this theoretical perspective. In a case study of a learning disabled student named Jenny, Wiss (1987) found that apart from experiencing similar reading difficulties in English and French, the subject also committed comparable spelling errors. Similar findings were reported in other case studies (Obler, 1989; Petrie & Geva, 1991) in cross language comparison between English and Hebrew, but the authors admitted that the errors committed by their subjects reflected orthographic characteristics of language concerned.

However, recent models of reading development have questioned these assumptions and empirical evidence favoring the central processing hypothesis. For example, van der Leij (2004) argued that:

> … although the universality of the sequence of phonological development and the universality of phonemic awareness as a predictor of reading development are both supported by conclusive studies, rimes awareness is a strong predictor of reading and spelling development in English, but not in more transparent orthographies (p. 58).

Such assertions imply the existence of an alternative explanation to the observed differences in reading proficiency across orthographies.

3.4. Orthographic Depth Hypothesis

The orthographic depth hypothesis, also known as script-dependent theory, is a forerunner of the dual route (Coltheart, 2005; Grainger & Ziegler, 2011). The orthographic depth hypothesis postulates that "… lexical word recognition in shallow orthographies is mediated by phonemic cues generated prelexically by grapheme-to-grapheme translation. In contrast, lexical access for word recognition in a deep relies strongly on orthographic cues, whereas phonology is derived from internal lexicon" (Frost, Katz, & Bentin, 1987, p. 107). This implies that word reading and naming bypasses the lexical input loop when reading in shallow orthographies. Because orthography-to-phonology correspondences are direct and highly consistent in transparent orthographies, students do not have to learn the minute details of the relations between orthographic patterns and semantics. Word reading in a shallow orthography is entirely through the phonological assembly route.

In emphasizing the exclusiveness of the choice of word reading route, Turvey, Feldman, & Lukatela (1984, p. 88) tested Yugoslavian third and fifth graders using a set of ambiguous and regular words in Serbo-Croatian scripts, and concluded that … "the Serbo-Croatian orthography is phonologically very regular … and such encourages neither the development of options for accessing the lexicon, nor, relatedly, a sensitivity to the linguistic situations in which one option fares better than another." Bridgeman (1987, p. 331) expressed similar sentiments by arguing that:

> Completely regular languages…are read with strategies that differ from those used with less regular ones. In many regular languages, a small set of grapheme-phoneme correspondences can unambiguously define all of the utterances in the language. It is possible that in these languages the lexical route simply does not exist.

Proponents of the orthographic depth hypothesis further argue that reading deep orthographies is exclusively based on visual cues by comparing orthographic patterns and semantics. Opaque orthographies, by nature encourage word processing through morphology, instead of relying on the language's phonology, through the target word's visual-orthographic structure (Katz & Frost, 1992). Learning to read, according to this view, requires memorization of individual words or word patterns, which can be retrieved from the existing lexicon and used when the same words or similar orthographic patterns are encountered in future. Ziegler (2011) summarized the assumptions of the orthographic depth hypothesis as follows: "The lexical route is necessary for the correct pronunciation of irregular words, and the non-lexical route is necessary for the pronunciation of novel words and non-words" (p. 169), and the two routes are mutually exclusive without overlap.

There is, however, a less radical perspective of the orthographic depth hypothesis which incorporates the use of phonological recoding in word reading (Katz & Frost, 1992). This view posits that for regularly spelled words—for instance, English words such as *at* and *hat*—which can be decoded through the application of grapheme-phoneme correspondence rules as /a/ /t/ and /c/ /a/ /t/, the sublexical route can be used, but reserves the lexical route for irregularly spelled words like *yacht*. Similarly, in shallow orthographies, word reading is not limited to the sublexical process alone, as lexical access is possible for words that the reader has encountered before and committed to memory. Therefore, the degree to which each decoding route is not only contingent to the language's orthographic depth, but also whether the word in question is low or frequency word.

In addition, proponents of this perspective contends that variations in grapheme-phoneme associations across languages impact both the acquisition of reading skills and developmental trajectories at which literacy progress among novice readers (Aro & Wimmer, 2003; Hanley et al., 2004; Landerl & Wimmer, 2008; Landerl et al., 2013; Ziegler & Goswami, 2005). Orthographic opacity also impacts the prevalence and nature of reading difficulties that students experience during reading instruction (Furnes & Samuelsson, 2010; Holopainen et al., 2001; Jared et al., 2011; McGeown, Johnson, & Moxon, 2014; McDougall et al., 2010; Muller & Brady, 2001). Generally, orthographically opaque languages pose significant challenges due to their complicated phonetic structure, which ultimately aggravate the prevalence and severity of reading disabilities students exhibit.

3.5. Psycholinguistic Grain Size Theory

The psycholinguistic grain size theory (Ziegler & Goswami, 2005), is a variant of the orthographic depth hypothesis, hence share considerable characteristics and assumptions. For instance, both theories presumes writing systems vary significantly regarding the translation of phonology into their respective orthography, and that these variations call for diverse decoding strategies (Georgiou, Parrila, & Papadopoulos, 2008; Seymour et al., 2003; Ziegler & Goswami, 2005; Ziegler et al., 2010). Whereas reading in transparent orthographies require simple GPC rules, deeper orthographies call for complex and multiple pathways. However, advocates of psycholinguistic grain size theory believe that the orthographic depth hypothesis is too rigid to properly account for the wide spectrum of reading characteristics exhibited by students across languages.

However, Maike, Nel, and van de Vijver (2014) acknowledged that while the two theories have some considerable overlap between them, orthographic depth hypothesis emphasizes mutually exclusive routes, with the phonological non-lexical route, on one end, and the orthographic lexical-based route on the other. While the psycholinguistic grain size theory focuses on a single phonological route in which specific reading strategies are determined by the nature of orthography. Ziegler and Goswami (2005) argue that lexical and sublexical routes are not mutually exclusive, but decisions regarding the choice of route used are defined by the grain sizes. The psycholinguistic grain size theory places “special emphasis on the development and use of different grain sizes across visual and auditory domains and across languages” (Ziegler & Goswami, 2005, p. 4), based on the following three linguistic characteristics; (i) availability—the accessibility of phonological units in the spoken language to ease the process of learning to read, (ii) consistency—regularity of mappings between phonological and orthographic units should ease learning to read, and (iii) granularity—number of mappings a single grain size represents.

In short, students reading transparent orthographies focus on more letter sound associations (smaller grains) to be successful word readers because of the predictable grapheme-phoneme correspondences. Letter-sound knowledge allows novice readers to decode new words or letter strings whose meaning they do not know. The size of large grains which vary depending on whether it is only part of the word or a whole word can be read using rimes, syllable patterns, and whole words strategies. This is because strategies based on small grain sizes will not be appropriate in processing words such as *yacht* which do not follow consistent letter-sound spelling conventions. This is a significant departure from orthographic depth hypothesis, which advocates for the existence of two independent lexical and sublexical routes.

3.5.1. Empirical support for orthographic depth hypothesis and the psycholinguistic grain size theory

The psycholinguistic grain size theory has gained prominence both over the central processing and orthographic depth hypotheses primarily due to its flexibility regarding the level of word processing. Instead of adhering to the traditional presumptions arguing for rigid mono or mutually exclusive dichotomous routes of reading development, Ziegler and

Goswami (2005) opted for a single phonological processing-based route of reading whose development is determined by the degree of orthographic depth. Compared to central processing and orthographic depth hypotheses, it provides a more plausible explanation because its flexible nature makes it applicable to a wide range of orthographic variability.

Studies evaluating the efficacy of the orthographic depth hypothesis assume that word reading is exclusively via either visual cues in opaque orthographies or through the GPC rules in shallow orthographies. There are two major weaknesses associated with the radical view of this script-dependent framework (Katz & Feldman, 1983; Katz & Frost, 1992). First, the types of reading assessments used in evaluating its efficacy do not capture the specific variables involved. Secondly, recent studies challenged the assumptions underpinning the theory as incorrect, especially regarding the associations between the degree of orthographic opacity and word reading processing. Research findings, particularly in alphabetical orthographies, show that reading across has more similarities than differences (Goswami, 2005; Holopainen et al., 2001; Landerl & Wimmer, 2008; Share, 2008). Skilled reading relies on varying levels of phonological processing—a characteristic consistent with the psycholinguistic grain size theory.

A comparison of reading proficiency in Cyrillic and unvowelled Hebrew orthographies provide the best and extreme example illustrating the weakness of the orthographic depth hypothesis (Feldman, Lukatela, & Turvey, 1985). Cyrillic has a highly transparent orthography which provides easy access to word decoding only through the indirect phonological recoding route. While reading words in unvowelled Hebrew is only possible through direct access because of omitted vowels. In between these two orthographic depth extremes, there is a wide range of grain sizes ranging anywhere from relatively transparent to somewhat opaque. For example, the highly transparent Finnish may lie close to the Cyrillic end due its high consistent in GPC, while English would fit well near the Hebrew end of the orthographic continuum.

Although it appears that the two script-dependent theories (orthographic depth hypothesis and the psycholinguistic grain size theory) and the central processing hypothesis are significantly different from each other, they have some basic similarities. For instance, most studies report some noteworthy and positive cross-linguistic transfer of basic reading skills between the first (or language of reading instruction) and the second languages (Koda & Zehler, 2008). Languages have universal characteristics as they all depend on phonology which is coded into print through orthography. As Perfetti and Dunlap (2008, p. 14) noted "Learning to read in a new language (L2) would be facilitated to some extent if the reading has universal properties that apply to all writing systems and all orthographies across all languages." Additionally, cognitive and linguistic skills such as working memory, rapid letter naming, and non-verbal intelligence define individual differences in reading across all orthographies (Geva & Siegel, 2000; Lesaux & Siegel, 2003).

Since in transparent orthographies, the knowledge of the letter sound associations is adequate to decode both familiar and new words, and reading in opaque orthographies depends on different sizes of large grains (Goswami, 2005; Ziegler & Goswami, 2005), it can be argued that orthographic depth hypothesis and psycholinguistic grain size theory complement each other. Reading instruction in English may emphasize the lexical route for irregularly spelled words and mastery of conventional grapheme-phoneme correspondence rules for regular words. This is because as Ziegler and Goswami (2005) explained:

> Psycholinguistic grain size theory proposes that phonological awareness of syllabic and intrasyllabic structure is an emergent property of phonological similarity at the lexical level …. Redundancies within neighborhoods of similar sounding words highlight invariant units that are shared across all words in that neighborhood… The orthographic similarity is far greater for *dome* (*home*, *Rome*, etc.) than for *comb*, and so according to grain size theory, this affects the phonological restructuring of individual word representations (p. 18).

Thus, according to Geva and Siegel (2000), instead of treating the models as competing points of view, the three theories are actually complementary in accounting for reading proficiency individual differences across the orthographic depth spectrum.

This current study was guided by both script-dependent and central processing hypotheses. The aim was to compare reading proficiency in Nyanja, a language with a highly transparent orthography and English, an orthographically opaque language. Nyanja orthographies, like most recently developed African orthographies, is characterized mostly by simple consonant-vowel (CV) type of syllables. The syllables are easily decodable through grapheme-phoneme correspondence manipulation because they are open syllable type and always ending with a vowel (Alcock & Ngorosho, 2003). English, on the other hand, poses significant challenges due to a multiplicity of strategies required to be a successful reader. Therefore, students reading or tested in Nyanja were not expected to face significant challenges because its transparent orthography would mask their phonological deficits compared to English readers. However, in comparison to findings from monolingual studies, it was expected that reading differences between Nyanja and English orthographies would be moderated by factors such as instructional methods and teacher knowledge, as well as cross-linguistic transfer of basic reading skills.

3.6. Proposed Theoretical Model of Reading

A reading model reflecting the interrelationships and predictive flow among variables underpinning the reading process was proposed based on the three theories described in the theoretical framework. The literature reviewed show that there are cognitive and linguistic skills which universally predict reading development among students in alphabetical orthographies (Brunswick, 2010; Caravolas et al., 2013; Melberg-Lervag & Lervag, 2011). Based on the phonological deficit model (Shaywitz & Shaywitz, 2001), phonological processing—especially phonemic awareness—is the main determinant of individual differences in reading and is "highly correlated with word recognition and spelling" (Durgunoglu, 2002, p. 193). Because phonemic awareness, defined as the awareness that speech can be segmented into individual sounds, is exclusively oral, beginning readers must be able to relate individual sounds with letters in their alphabet—phonics.

Therefore, the proposed theoretical model for the current study in Figure 1 postulates that letter knowledge (LTD) and phonological awareness (PAW) directly predict word reading (WRD) and pseudo-word decoding (PWD). And word reading and pseudoword abilities further predict reading comprehension. Apart from directly influencing students' reading comprehension abilities, the path diagram also suggests that level of pseudoword decoding skills also has mediated indirectly through word reading.

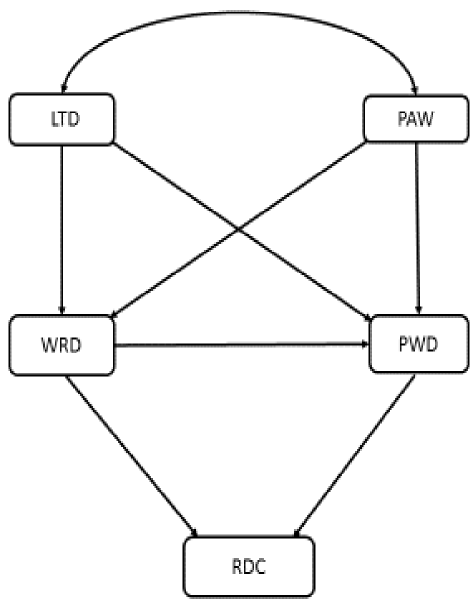

Figure 1. Revised Reading Path Model
Note: LTD = Letter discrimination, PAW = Phonological awareness, PWD = Pseudoword decoding, WRD = Word reading, and RDC = Reading comprehension.

Although RAN has frequently been cited in literature as a major predictors of reading across writing systems, especially transparent orthographies (Holopainen et al., 2001; Mann & Wimmer, 2002), it was not included for the current study because the psychometric properties of the RAN measure from the pilot study were not satisfactory. This was because English names of numbers instead of Nyanja names were used, it was problematic to develop an exclusively Nyanja RAN measure. Additionally, Nyanja names of objects are longer, difficult to pronounce, and rarely used in oral conversations, reading, and writing as English words are preferred. Differences in word length also made it difficult to create uniform test items in the two languages, as reciting the words would inevitably have taken longer in Nyanja than English. Moreover, most students did not know names of objects and numbers in their languages.

CHAPTER IV

METHODOLOGY

4.1. Introduction

This chapter presents the methodology used in the study. The chapter includes a brief description of study participants' characteristics, the study design, measures of reading proficiency in both orthographies, psychometric properties of the tests, testing procedures used for data collection, and finally the details of the methods and techniques used for analysis of the data.

4.2. Participants

The participants in this study were initially tested as part of a large epidemiological research project called Zambia Disabilities Learning Project whose main aim was identifying genetic predisposition and environmental risk factors for Specific Reading Disability (SRD) in Zambian basic schools. The Zambia Learning Disabilities Project focused on all students at basic school level. Participants were drawn from grades four to seven (Stemler et al., 2009). The basic school level in Zambia is equivalent to elementary school level in the US education system. The overarching objective of the project was to initially identify the low performing 25% subsample of the tested students who would later be subjected to further genetic and environmental risk factors analyses to determine students experiencing or predisposed to experience SRD later in life. The study covered five Basic Schools in Lusaka, the capital city of Zambia.

Two hundred and forty (240) students from grade four to six comprised the sample of the current study. Participation was voluntary and students chose to be tested either on the Nyanja or English language assessment on their own volition. Subsequently, 119 and 121 students were tested on Nyanja and English language tests respectively. In Nyanja, 40 participants each were drawn from grades four and five, and 39 sixth graders. While in English, there were 41 fourth and sixth graders each, the remaining 39 participants were fifth graders. Table 1 shows the overall distribution of the participants based on gender was almost equal (boys = 50.44%; girls = 49.56%). Although at grade four there were slightly fewer girls (46.84%) than boys (53.16%). On the other hand, the proportion of boys (47.44%) was smaller than the proportion of girls (52.56%) in grade six.

Table 1

Means, Standard Deviations of Participants' Ages, and Gender Percent Distribution

Grade	Gender		Age*	
Level	Boys	Girls	*M*	*SD*
Grade 4	53.16%	46.84%	10.79	2.12
Grade 5	50.00%	50.00%	11.44	1.61
Grade 6	47.44%	52.56%	12.70	3.54
Overall	50.44%	49.56%	11.65	2.50

*Age measured in years

4.2.1. Students' age versus grade level

The age of the participating students ranged from 8 to 18 years with an overall mean age of 11.65 years (SD = 2.50). Table 1 shows that mean ages varied across grades; fourth grade (M = 10.79; SD = 2.12), fifth grade (M = 11.44; SD = 1.61), and sixth grade (M = 12.70; SD = 3.54). The large age range and variability within and between grade levels is a direct result of two factors. First, students in Zambia are not always enrolled into their first grade at the age of seven years as required by law. Consequently, some students get enrolled as young as four years while others as late as 10 year old. Secondly, the high rate of grade retention and repetition prevalent throughout basic school level also exacerbate age variability. According to the Ministry of Education (2008) annual statistical bulletin, an average of 2.65% of students in the school population repeat at least one grade between first and seven grade.

Therefore, instead of using students' chronological age as a school progress independent variable, grade level was used. In fact, some studies report that grade level is a better quantifier of individual differences in school achievement in the absence of age uniformity (Reich et al., 2013). Reich and colleagues' study on reading proficiency of students in Zambia "found that grade, more often than age has a consistent relationship with the stages of reading development, supporting the importance of direct literacy education in the development of reading skills" (p. 84). Therefore, grade level provided a more reliable alternative in the face of widely variable chronological age in the developing world because where access to education opportunities is limited by socioeconomic factors and infrastructure development.

4.2.2. Participants' home versus school language

Nyanja is the Mother tongue for majority and most familiar language for most of the study participants. The 2010 Census Report (Central Statistical Office, 2012) shows that of the 70 ethnic and dialectical groups living in Lusaka Province, more than 61% speak Nyanja as either their mother tongue or the most familiar language. Because of its wide regional distribution and intelligibility in the province, Nyanja is also used for initial reading instructions in schools before the introduction of the English language from second grade onwards. Even after the introduction of instructions in English at second grade, Nyanja language continues to be taught as one of the school subjects.

It must, however, be noted that other than Nyanja, students are usually orally fluent in two or three other languages. Due to its central location and socioeconomic pull factors like availability of employment opportunities, Lusaka is a linguistic melting pot as migrants from the rest of the country converge in the administrative capital. Additionally, even if Nyanja is Lusaka province's dominant indigenous language, Bemba, Lozi, and Tonga are also widely used as students' home and play languages. Therefore, a student may use different a language at home, at school, and at play. It is not uncommon to find students code-switching between various languages within one conversation, especially between Zambia's most commonly used languages, Bemba and Nyanja (Martens & Kula, 2008).

4.2.3. Characteristics of schools in the study

The five schools for the current study were specifically sampled because they typically represent a wide range of the urban and peri-urban characteristics of the Zambian public education system. Two schools had student populations drawn from relatively high SES based on their geographical location. The third school by virtue of its location enrolls children from both low and high SES families, while the last two schools drew students from almost exclusively from the low SES communities of the city. Although Zambia claims to provide free education because the central government is responsible for teachers' remuneration and capital expenditure for school infrastructure, the costs of textbook books, school uniforms, transportation to school, and other local school requirements borne by parents are prohibitive for students from low SES households. Therefore, peri-urban and rural schools are usually disadvantaged and academic achievement of their students are significantly lower than the well-financed urban public schools.

4.3. Study Design

The present study was designed to compare the effects of orthographic opacity on reading proficiency in Nyanja and English languages—a transparent and an opaque orthography respectively—among bilingual students in Zambia. The study was a quasi-experimental quantitative study using a cross-sectional research design and targeted at students from grades fourth to sixth. A cross-sectional design was appropriate and convenient for data collection because the study targeted three cohorts of participants defined by differences in grade level, but tested simultaneously (Teti, 2005). The main weakness of the cross-sectional design is that it cannot capture patterns of the participants' growth curves over time.

The study was designed to facilitate the collection of data from two samples of participants using two equivalent versions of the Zambia Achievement Test (ZAT) in Nyanja and English orthographies. The ZAT measured the following reading skills; basic letter discrimination, phonological awareness, word reading, pseudoword decoding, and reading comprehension. Comprehensive descriptions of the ZAT subtests are given in the following section. The study focused on literacy skills because they constitute the underlying core processes of the reading process, especially in the early stages of instructions. It was envisioned that this design would facilitate statistical analyses to determine main and interactions effects of orthographic transparency (transparent versus opaque) and across grade levels (grades 4, 5, and 6).

4.4. Measures of Reading Achievement

4.4.1. Zambia Achievement Test (ZAT)

Reading skills were measured using two equivalent version of the Zambia Achievement Test in Nyanja and English languages. The ZAT is an individually administered battery of tests specifically developed to quantify academic achievement in Zambia. The main purpose of this assessment battery identifying learning difficulties among students from grades one to seven in Mathematics and Reading. Reading subtests covered the following three core areas: reading recognition [ZAT-RR], pseudo-word decoding [ZAT-PWD], and reading comprehension [ZAT-RDC] (Stemler et al., 2009). ZAT-RR subdivided into five subtests (i), letter discrimination (LTD), (ii), sound matching [SMA], (iii), sound discrimination [SDI], (iv), letter sound matching [LSM], and (v), word reading [WRD], which was used in the current study in addition to PWD and RDC. Letter discrimination, sound matching, sound discrimination, and letter-sound matching subtests were treated as a measure of phonological awareness (PAW). Figure 2 shows a sample of the letter discrimination test item from the ZAT reading battery. Review Appendix A for more sample test items of the other ZAT subtests. Test items on each subtest are presented in order of increasing difficulty.

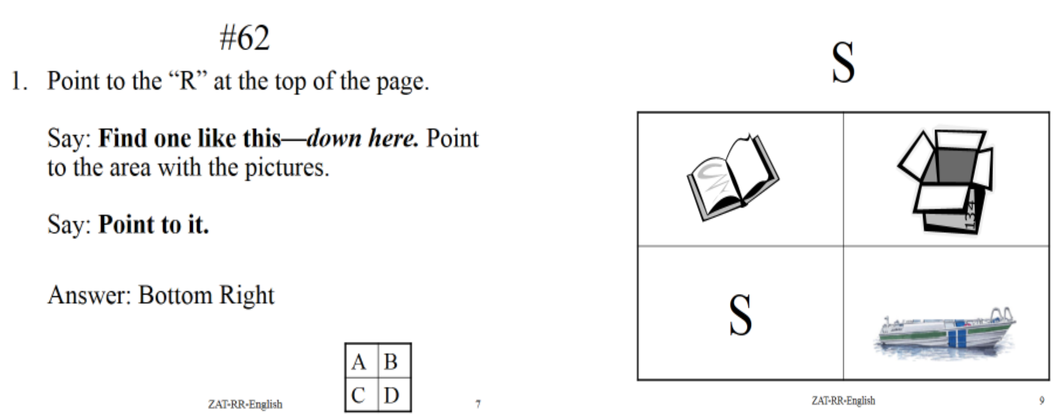

Figure 2: Sample test item from the Zambia Achievement Test – Reading Recognition Subtest.

On the LTD subtest, students were presented with single letters, letter combinations, or short two- or three-letters at the top of the test page and asked to match them to one of the four options presented either in isolation or embedded in letter clusters further down the page. The LTD subtest has 20 test items. On the SMA items, a picture was presented at the top of the page and students were asked to point to one of the four pictures at the bottom whose initial sound matched the corresponding sound in the stimulus picture. The SDI items required students to choose one picture from the four in the stimulus which began with a different sound from the rest after the pictures have been named aloud to the child by the assessor. The LSM items had one picture at the top with four words below from which a student chose a word beginning with a sound similar to the initial sound of the picture. Finally, the students were asked to read the 76 single words (WRD) aloud individually in a four words per page format.

The ZAT-PD subtest is made up of 38 phonetically regular pseudowords (PWD) presented in groups of four per page. Like the single words in WRD, the pseudowords were read aloud by the examinee. The test items began with simple consonant-vowel combinations, such as *ig*, *ak*, increasing in length and becoming more phonetically challenging gradually. The ZAT-RC assessment had 24 performance response test items. Participants were asked to silently read a word, phrase, or sentence presented on each page of the test booklet and perform the action described by the item afterwards. Theoretically, all items in the ZAT-RC subtest were presented in such way that they progressively become more challenging. For example, in measuring reading comprehension the first test item was simply: *jump* and the last item was: *Acknowledge your acquaintance's arrival* *by gesturing with your hand rather than with your voice*. Participants were required to read the word or sentence silently and perform the action.

4.4.2. Psychometric properties of the ZAT subtests

The English and Nyanja versions of the ZAT battery exhibited appropriate statistical stability levels over time during the test validation process. The test-retest Spearman rank correlation coefficients were $\rho = .90$ ($p < .001$) for ZAT-RR, $\rho = .81$ ($p < .001$) for ZAT-PWD, and $\rho = .82$ ($p < .001$) for ZAT-RDC. Stemler and his colleagues also reported the following Cronbach internal consistency estimates for the ZAT: WRD = .94 and .86; PWD = .83 and .87; RDC = .72 and .70 for the English and Nyanja orthography versions respectively (Stemler et al., 2009).

4.5. Testing Procedure

Testing of reading skills took place in the participants' respective school premises and were conducted by trained administrators following a standardized and predetermined testing protocol. The test administrators were graduate students at the University of Zambia. Participants were assigned to one of the two conditions, Nyanja or English languages. This means one group took the reading assessments in English and the other group was tested in Nyanja. Two testing stations were set up for ZAT English and Nyanja testing. The testing time ranged from 45 to 90 minutes depending on how faster the participant answered the questions.

4.6. Research Variables

4.6.1. Independent variables

The purpose was to evaluate the effects of variations in orthography on reading proficiency, orthography depth (transparent versus opaque) was the main independent variable. And since the study was cross-sectional, grade level (fourth, fifth, and sixth grades) was also used as independent variable to determine whether it had main effects on reading proficiency. The interaction effects between orthographic opacity and grade level were also statistically analyzed.

4.6.2. Dependent variables

Dependent variable included reading comprehension (RDC), word reading (WRD), pseudo-word decoding (PWD), and phonological awareness (PAW) and letter discrimination (LTD) scores.

4.7. Statistical Procedures

Data analyses comprised of two parts according to the questions being answered. The first part of data analysis involved a 2-MANOVA with orthographic depth and grade level as A- and B-ways respectively. This analysis also involved a Descriptive discriminant analysis (DDA), as follow-up to statistically significant main effects from MANOVA results, to determine where the mean differences in reading proficiency across orthographies and grade levels were coming from. The second part of statistical analysis involved testing model fit and cross-model comparison of variables predicting reading comprehension in both Nyanja and English data sets.

4.7.1. Two-way MANOVA

A 2-way MANOVA was used to answer the following research questions:

A. (i). Does the advantage of reading in orthographically transparent languages among monolingual students replicate among Nyanja-English bilinguals?

(ii). If yes, what is the degree of mean differences in reading proficiency between the two orthographies?

(iii). To what extent does orthographic opacity discriminant mean differences in reading proficiency between Nyanja and English orthographies, if any, persists?

Both MANOVA and DDA statistical analyses were conducted using version 21 of the IBM Statistical Package for the Social Sciences (SPSS - 21).

4.7.2. Path analysis and model fit testing

Path analysis and model fit analysis were conducted to answer the following questions;

C. How do reading-related cognitive skills predicting reading acquisition compare between languages of different orthographic opacity?

D. Are there marked differences in path coefficients in the Path Model diagrams between Nyanja and English reading data? If model fit variations exist, which data set [Nyanja or English] fits the proposed reading path model better?).

The analysis will generate two path diagrams for each language based on the path diagram of the proposed reading comprehension in Figure 1 (see path diagram on page 52) were tested independently using path analysis for Nyanja and English data.

Path analysis was used to generate path coefficients of each measured predictor and also used to fit the two sets of data to the model. Model fit were evaluated by comparing the following goodness of fit indices; X^2 test of statistical significance, Normed Fit Index [NFI], Comparative Fit Index [CFI], and Root-Mean-Square-Error-Approximation [RMSEA] in each orthography. The Analysis of MOment Structures (IBM SPSS AMOS - 22) computer software was used to yield path coefficients and model fit indices.

CHAPTER V

RESULTS

5.1. Introduction

This chapter presents the results of the study. Results of the statistical analyses conducted are reported in four sections. The first section covers preliminary results related to exploration of score reliability of the five reading measures used. The second section covers descriptive statistics including means, standard deviations, and bivariate correlations of the two samples on the five Zambia Achievement Tests (ZAT) subsets. The third section covers inferential statistics regarding the mean differences Nyanja and English orthographies and between grade levels. Inferential tests carried out included MANOVA and descriptive discriminant analysis (DDA) as follow-up analysis to MANOVA. The fourth section, dealt with statistics pertaining to path analysis and model fit indices to test how well Nyanja and English data sets fit the proposed reading model.

5.2. Preliminary Results

5.2.1. Test reliability

Score reliability estimates were calculated using the Cronbach's alpha to determine each ZAT subtest's internal consistency among test items. Evaluating an assessment instrument's Cronbach's alpha coefficient is important because it helps to determine the usefulness of each item or its contribution to the whole assessment. For any construct measure to be considered reliably useful, Nunnally and Bernstein (1994) recommended score reliability coefficients of at least .70. Test items failing to meet the minimum standards may not only be redundant, but could also injure the overall functioning of the instrument. Table 2 shows the summary of Cronbach's alpha coefficients for both Nyanja and English ZAT reading subtests. Alpha coefficients of word reading, pseudoword decoding, and reading comprehension subscales arranged from .95 to .99 in both Nyanja and English orthographies. However, with the exception of the sound discrimination subtests whose reliability estimates of .76 and .73 respectively, letter discrimination (α = .40 and .58) and two measures of phonological awareness subtests—sound matching (α = .47 and .60), and letter-sound matching (α = .49 and .67) measures—did not meet Nunnally and Bernstein's (1994) recommended .70 threshold both in the transparent and opaque orthography.

Table 2

Summary of the Cronbach's Alpha Coefficients for ZAT Reading Assessment Subtests by Orthographies before and after item reduction

	ZAT Subtest	# of items	Nyanja	English
1	(a) Letter discrimination (LTD)	20	.40	.58
	(b) Letter discrimination (LTD)[3]	10	.75	.72
2	Phonological Awareness (PAW)[4]	20	.79	.81
	(a) Sound matching (SMA)	6	.47	.60
	(b) Sound discrimination (SDI)	8	.76	.73
	(c) Letter-sound matching (LSM)	6	.49	.66
3	Word reading (WRD)	20	.99	.97
4	Pseudoword Decoding (PWD)	38	.95	.96
5	Reading Comprehension (RDC)	24	.96	.95

When an assessment test fails to meet minimum reliability estimate standards, statisticians recommend deleting poorly functioning items until the minimum requirement is achieved (Thompson & Levitov, 1985). Thompson and Levitov recommend that "The total test reliability is reported first and then each item is removed from the test and the reliability for the test less that item is calculated" (p. 167) to achieve an appropriate alpha-

[3] Cronbach's alpha coefficient after the item reduction process by deleting redundant items from letter discrimination subtest because when they are included the coefficients fall below the recommended minimum of .70 (Nunnally & Bernstein, 1994).
[4] Composite alpha coefficient combining all phonological awareness subtests (sound matching, sound discrimination, and letter-sound matching).

if-item-deleted coefficient for that particular test and sample size. Consequently, because the reliability coefficients of the letter discrimination subtests were lower than expected, both tests were subjected to the alpha-if-item-deleted analyses until both their alpha coefficients were equal or above the recommended threshold of .70. The results of the alpha-if-item-deleted analysis for letter discrimination subtests are also displayed in Table 3. According to Table 3, after the item reduction process through listwise deletion of redundant items, the new Cronbach's alpha coefficients rose to .75 and .72 as required in Nyanja and English languages respectively (see Appendixes B.1 to B.10 for review of the rest of the Cronbach's alpha coefficients).

Due to the small number of test items on the three sub-measures of phonological awareness (sound matching, sound discrimination, and letter-sound matching), instead of conducting item reduction analysis, the subtests were combined to form a single measure of phonological awareness in each language and Cronbach's alphas for the full scale were calculated. The alphas of the combined measures of phonological awareness subscales were .79 and .81 for the Nyanja and English respectively. The alphas for three phonological awareness measures and final Cronbach's alpha for full scale phonological awareness measures are displayed in Table 2.

Table 3

Alpha-if-item-deleted analysis for Letter Discrimination Subtests

ZAT Test Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
Nyanja Language				
Item# 3	8.80	.62	.09	.77
Item# 6	8.81	.56	.32	.75
Item# 7	8.80	.62	.09	.77
Item# 8	8.82	.52	.34	.75
Item# 9	8.81	.53	.52	.72
Item# 11	8.82	.47	.66	.70
Item# 12	8.83	.41	.73	.67
Item# 13	8.81	.55	.41	.74
Item# 14	8.80	.57	.47	.73
Item# 16	8.82	.49	.49	.72
English Language				
Item# 1	8.63	.92	.27	.72
Item# 5	8.61	.97	.21	.72
Item# 8	8.60	.96	.41	.70
Item# 9	8.60	.93	.55	.68
Item# 11	8.60	.94	.38	.70
Item# 12	8.60	.94	.48	.69

Table 3 Continued

ZAT Test Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
Item# 14	8.59	.96	.62	.69
Item# 16	8.62	.87	.45	.68
Item# 17	8.77	.63	.47	.72
Item# 18	8.60	.89	.56	.68

5.3. Descriptive Statistics

Before using inferential statistics to evaluate differences in reading proficiency between Nyanja and English orthographies, descriptive statistics of five ZAT reading subtests (letter discrimination, phonological awareness, word reading, pseudoword decoding, and reading comprehension were calculated. Based on the Cronbach's alpha analysis described in detail in the previous section which culminated into a combined phonological awareness measure in each orthography, the study was finally based on five measured variables. The means and standard deviations of the raw scores of each ZAT reading subtest are displayed in Table 4.

Means and standard deviations of both Nyanja and English reading subtests are displayed in Table 4. These results are based on students' raw scores, which implies that the means are basically proportions of the total number of test items on a given subtest. With the exception of phonological awareness, students' overall means were higher in Nyanja in comparison to English, which supports existing research that transparent orthographies facilitate reading development better than opaque ones. The distribution of subtests based on mean differences by percentage ranging from the largest to the smallest were; phonological awareness, 15.15% (([16.20 – 13.17]/20) *100), word reading (14.96%), pseudoword decoding (11.78%), letter discrimination (2.11%), and reading comprehension (1.71%). Letter discrimination had ceiling effects in both languages, as the means were both above 90% of the total test items. This is not unexpected as most, if not all, students are expected to have mastered majority of both letter names and associated sounds by their fourth grade.

Mean reading scores were also calculated per subtest according to grade and orthography, and the results are displayed graphically in Appendix C. As expected, students in fourth grade had the lowest mean scores on each subtest, while sixth graders had the highest mean scores in almost all reading assessments. On the letter discrimination Nyanja subtest, the means for all grade levels were clustered together, but varied quite widely on the English language. There was a substantial increase in English reading comprehension mean performance at fifth grade level compared to Nyanja, while on phonological awareness, fifth graders were the poorest performers in Nyanja, but highest scorers in English.

Table 4

Descriptive Statistics for Reading Skills in Nyanja and English Orthographies by Grade

Grade		Nyanja Language					English Language				
		LTD	PAW	WRD	PWD	RDC	LTD	PAW	WRD	PWD	RDC
4	*M*	9.78	12.78	38.65	18.98	18.75	9.46	15.44	19.68	11.59	13.37
	SD	(.89)	(3.70)	(29.87)	(11.98)	(14.50)	(.98)	(3.41)	(17.64)	(10.39)	(11.14)
5	*M*	9.80	12.15	44.00	19.95	22.73	9.62	16.82	38.03	18.26	24.28
	SD	(.65)	(4.00)	(27.40)	(11.13)	(12.83)	(1.33)	(3.14)	(19.95)	(12.09)	(12.420)
6	*M*	9.80	14.62	54.51	24.66	23.79	9.66	16.37	43.51	20.54	26.49
	SD	(.86)	(3.77)	(25.09)	(10.26)	(13.92)	(.76)	(3.93)	(18.08)	(10.56)	(10.96)
Overall	*M*	9.79	13.17	45.65	21.17	21.74	9.579	16.20	33.68	16.77	21.33
	SD	(.80)	(3.93)	(28.09)	(11.33)	(13.82)	(1.04)	(3.53)	(21.15)	(11.59)	(12.81)

Note: LTD = Letter Discrimination; PAW = Phonological Awareness; PWD = Pseudoword Decoding; WRD = Word Reading; RDC = Reading Comprehension.

5.3.1. Assumption checking

Assumption checking analyses were conducted to determine how well both sets of data meet assumptions required for inferential statistical analyses. There was minimal multicollinearity among all reading variables as most of their bivariate correlation coefficients were below $r = .80$. Visual inspection of the Normal Q-Q plots of scores for phonological awareness, word reading, and reading comprehension subtests approached normal distribution in both orthographies. Additionally, although the homogeneity of variance assumption was not fully satisfied based on the results of the Levene's *F* tests in Table 5, three of the five *F* statistics were not statistically significant ($p > .05$). In fact, despite the Levene's *F* test statistics suggesting that the variances for some measures were not homogenous ($p < .05$), none of their largest standard deviations displayed in Table 5 were more than four times the size of the corresponding smallest value (Howell, 2007).

Table 5

Levene's Test of Equality of Variances

Reading Variable	*F*	df^1	df^2	*p*
Letter Discrimination	1.76	5	234	.12
Phonological Awareness	1.31	5	234	.26
Word Reading	7.81	5	234	.01
Pseudoword Decoding	.73	5	234	.60
Reading Comprehension	2.51	5	234	.03

5.3.2. Bivariate correlations

Pearson's product-moment correlation analysis was computed to assess the relationships among reading subtests between Nyanja and English orthographies. Bivariate correlations are useful in examining the strength of associations between variables (Kremelberg, 2011). In the current study, close associations among variables were hypothesized because of similarities in constructs involved both between and within orthographies. Results of the correlation analysis are displayed in Table 6. There were very low to high correlations ranging from -.15 to .87. The Table shows that only 14 out of the 45 bivariate correlation coefficients were statistically significant and were greater or equal to $r = .22$, $p < .05$, two-tailed. With the exception of Nyanja letter discrimination subtest, which had moderate but statistically significant correlation with English word reading ($r = .22$, $p < .05$) and pseudoword decoding ($r = .23$, $p < .05$), results show no other statistically significant cross-orthography associations among the 14 correlation coefficients.

There were moderate to high positive statistically significant within-language correlations. For instance, correlations between phonological awareness and the following subtests were statistically significant ($p < .01$); word reading, pseudoword decoding, and reading comprehension in both Nyanja and English orthography. Other within-language statistically significant associations were word reading with pseudoword decoding, word reading with reading comprehension, and pseudoword decoding with reading comprehension. Word reading and pseudoword decoding had the highest correlations in orthographies—with $r = .87$ ($p < .01$) and $r = .85$ ($p < .01$) in Nyanja and English respectively. In general, correlation coefficients suggest that reading skills are language specific, which is surprising considering that both of Nyanja orthography's graphemic and phonetic structures are based on the English orthography (Chimuka, 1977; Kashoki, 1978).

5.4. Inferential Statistics

The goal of the current research was to examine the effects of orthographic opacity on reading performance by comparing students' reading in transparent (Nyanja) and opaque (English) orthographies. Inferential statistics were used to statistically evaluate the magnitudes of group differences among reading variables with reference to the influence of orthographic depth and students' grade levels. The objective of the first set of inferential statistics was to answer the following questions; (a) Does students' reading proficiency differ significantly according to the orthographic depth of the language of assessment? In other words, does orthographic opacity have statistically significant main effects on reading proficiency between Nyanja and English orthographies? (b). Does students' reading proficiency differ according to the grade level of the students? Are there statistically significant mean differences in reading performance based on grade level within- and between the two orthographies?

Table 6

Pearson Product Moment Correlations among Measured Variables, Means and Standard Deviations

Variable	1	2	3	4	5	6	7	8	9	10	*M*	*SD*
1. NLTD	1										9.79	.80
2. NPAW	.03	1									13.17	3.93
3. NWRD	.03	**.42****	1								45.65	28.09
4. NPWD	-.01	**.53****	**.87****	1							21.17	11.33
5. NRDC	-.15	**.41****	**.65****	**.65****	1						21.74	13.82
6. ELTD	-.05	-.10	.10	.12	.10	1					9.58	1.04
7. EPAW	.07	-.09	-.03	.06	-.01	.10	1				16.20	3.53
8. EWRD	**.23***	-.11	-.01	-.02	-.14	.13	**.40****	1			33.67	21.15
9. EPWD	**.22***	-.07	.05	.04	-.06	.03	**.34****	**.85****	1		16.77	11.59
10. ERDC	.07	-.12	.02	.05	-.06	.13	**.38****	**.75****	**.65****	1	21.33	12.81

Note: NLTD = Nyanja Letter Discrimination; NPAW = Nyanja Phonological Awareness; NPWD = Nyanja Pseudoword Decoding; NWRD = Nyanja Word Reading; NRDC = Nyanja Reading Comprehension; ELTD = English Letter Discrimination; EPAW = English Phonological Awareness; EPWD = English Pseudoword Decoding; EWRD = English Word Reading; ERDC = English Reading Comprehension. * $p < .05$. ** $p < .01$.

5.4.1. Multivariate analyses of variance: Main and interaction effects

A 2 X 3 multivariate analysis of variance (MANOVA) was conducted to evaluate the effects of orthographic opacity (transparent vs opaque), grade level (grade 4 vs grade 5 vs grade 6), and their interaction effects on reading proficiency. Since the data did not fully meet the all inferential statistics assumptions, the Pillai-Bartlett's V Test was used to assess the multivariate main effects of orthographic opacity on reading proficiency because this test is more robust in analyzing data that does not meet some assumptions. MANOVA results are displayed in Table 7.

MANOVA results showed that both orthographic opacity and grade level had statistically significant main effects on the combined reading variables, $F(5, 230) = 19.09$, $p < .01$; Pillai-Bartlett's V =.29; partial $\eta^2 = .29$ and $F(10, 462) = 3.51$, $p < .01$; Pillai-Bartlett's V = .14; partial $\eta^2 = .07$ respectively. However, the main effect of the interaction between orthographic opacity and grade level was not statistically significant, $F(10, 462) = .06$, $p = .19$; Pillai-Bartlett's V = .06; partial $\eta^2 = .03$. This implies that 29.3% and 7.1% of the variance in the canonically derived dependent variable was accounted for by orthographic differences and students' grade level respectively, while the orthographic depth and grade level interaction accounted for only 2.9% of the reading proficiency variance. These findings, therefore, support the hypothesis from available literature that reading in transparent orthographies is relatively easier than in orthographically opaque languages (Caravolas et al., 2012; Caravolas et al., 2013; Landerl & Wimmer, 2008).

Table 7

Pillai-Bartlett's Test for MANOVA Effects

Effect	Value	*F*	Hyp. *df*	Error *df*	*p*	Partial η^2
Orthography	.29	19.09	5	230	.001	.29
Grade Level	.14	3.51	10	462	.001	.07
Ortho. * Grade	.06	1.38	10	462	.19	.03

Note: Ortho = Orthography, hyp. = hypothesis

5.4.2. Descriptive discriminant analysis

Following statistically significant main effects of both orthographic depth and grade level on the five reading variables, two descriptive discriminant analyses (DDA) were conducted as follow-ups to MANOVA to examine specific differences in reading proficiency across the two languages. On the orthographic opacity way, the mean differences in reading proficiency between Nyanja and English samples differed significantly on three of the five measures based on Tests of Equality of Group Means (Table 8): phonological awareness, Wilks' $\Lambda = .86$, $F\,(1, 238) = 39.47$, $p < .001$; Word reading, Wilks' $\Lambda = .95$, $F(1, 238) = 13.95$, $p < .001$; and pseudoword decoding, Wilks' $\Lambda = .96$, $F(1, 238) = 8.84$, $p < .01$. Unlike word reading and pseudoword decoding on which performance was better in Nyanja, students' phonological awareness proficiency was better on the English assessment.

Table 8

Tests of Equality of Group Means

DV	*Wilks' Λ*	*F*	*p*
Letter Discrimination	.99	3.11	.08
Phonological Awareness	.86	39.47	.001
Word Reading	.95	13.95	.001
Pseudoword Decoding	.96	8.84	.001
Reading Comprehension	1.00	.06	.81

Note: df1= 1, df2 = 238.

One statistically significant linear discriminant function emerged from the descriptive discriminant analysis; Wilks' $\Lambda = .71$, χ^2 (5, 240) = 79.99, $p < .001$; eigenvalue = .40; canonical correlation = .54. This implies that overall the five variables differentiated reading proficiency based on orthographic opacity (transparency versus opaque). The model explained 29.16% of the variation in the grouping variable as defined by squaring the canonical correlation ($.54^2 = 29.16\%$). In order to further understand group differences, standardized discriminant function and structure coefficients displayed in Table 9 were examined.

Based on Table 9, the standardized discriminant function coefficients show that the two levels of orthographic depth were maximally differentiated by canonical variates (function coefficients > |.30|) by three reading measures; phonological awareness (.96), word reading (-.68), and pseudoword decoding (-.32). Letter discrimination (-.19) and reading comprehension (.27) skills, on the other hand, made smaller contributions in determining the group differences on overall reading proficiency. The group centroids were; Nyanja = -.64 and English = .63. Based on the difference between these group centroids, there appears to be a considerable "separation" between the two levels of orthographic depth in reading performance the transparent and opaque orthography tested groups. In addition, an inspection of Figure 3 which illustrating the distribution of discriminant scores also shows a relatively minimal overlap between Nyanja and English function scores implying that the function was able discriminate the two groups reasonably well.

Table 9

DDA Standardized Function and Structure Coefficients of Reading Measures for Orthographic Opacity

Variable	Function	Structure
Phonological Awareness	**.96**	**.64**
Reading Comprehension	.27	-.02
Letter Discrimination	-.19	-.18
Pseudoword Decoding	**-.32**	**-.30**
Word Reading	**-.68**	**-.38**

Note: Coefficients > |.30| are **bolded**. The function score centroids/means were -.64 for Nyanja and .63 for English.

The negative discriminant function coefficients recorded for word reading and pseudoword decoding measures indicate that Nyanja's transparent orthography positively facilitated performance on these reading measures compared to the orthographically opaque English. Whereas the positive function coefficients for phonological awareness shows that performance was better on English than Nyanja orthography. Overall, the results, as expected, show that orthographic depth determines the differences in reading proficiency, and three of the five variables—phonological awareness, word reading, and pseudoword decoding—contributed most in defining the orthographic differences between Nyanja and English languages. Contrastingly, letter discrimination and reading comprehension contributed the least in discriminating groups. This finding seem to suggest that reading abilities in English, even as late as grade six, are determined by phonological awareness—a low order skill—whereas in Nyanja, reading skills depends by higher order decoding-related skills—word reading and pseudoword decoding. All in all, the discriminant analysis successfully predicted differences in reading proficiency between Nyanja and English for 75.8% of the cases; with a 73.9% correct prediction of the readers in the transparent orthography and 77.7% accurate prediction in the opaque orthography.

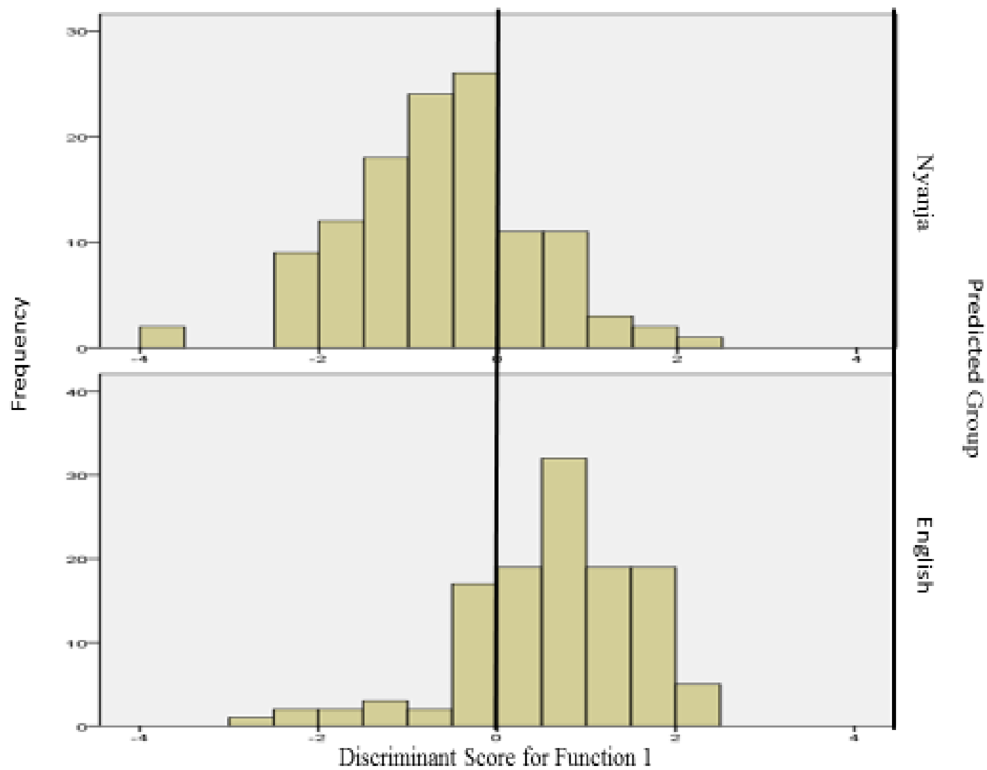

Figure 3. Histograms showing the distribution of discriminant scores for Nyanja and English tested students.

The second descriptive discriminant analysis focused on evaluating group differences on the five reading variables—letter discrimination, phonological awareness, word reading, pseudoword decoding, and reading comprehension—based on the three grade levels. Similarly, the Tests of Equality of Group Means (Table 10) found three statistically significant mean differences on the following variables: Word reading, Wilks' $\Lambda = .90$, $F(2, 237) = 13.66$, $p < .001$; pseudoword decoding, Wilks' $\Lambda = .93$, $F(2, 237) = 8.44$, $p < .001$; and reading comprehension, Wilk's $\Lambda = 91$, $F(2, 237) = 11.79$, $p < .001$. The results show that the higher the students' grade the better their reading performance.

Table 10

Tests of Equality of Group Means

DV	*Wilks' Lambda*	*F*	*p*
Letter Discrimination	.99	.31	.73
Phonological Awareness	.98	2.64	.07
Word Reading	.90	13.66	.001
Pseudoword Decoding	.93	8.44	.001
Reading Comprehension	.91	11.79	.001

Note: df1= 2, df2 = 237.

Two discriminant functions emerged from the descriptive discriminant analysis. The first lambda was statistically significant, Wilks' $\Lambda = .87$, χ^2 (10, 240) = 33.96, $p < .001$; eigenvalue = .14; canonical correlation = .34. The implication of this finding was that overall the five variables optimally discriminated reading proficiency among the three grade levels. However, after partialling out the effects of the first discriminant function, the residual Wilk's lambda of the second discriminant function was not statistically significant, Wilks' $\Lambda = .98$, χ^2 (4, 240) = 4.07, $p = .40$. Therefore, because the second discriminant function failed to significantly discriminate students' reading proficiency based on three grade levels, only the first discriminant function was interpreted.

The function and structure coefficients of the two discriminant functions are displayed in Table 11. According to these coefficients, word reading skills (.89) followed by reading comprehension (.47) and pseudoword decoding (-.35), in that order, had the largest function coefficients, whereas phonological awareness (.07) and letter discrimination (.07) exhibited the smallest function coefficients. Therefore, from these results, it can be assumed that higher order reading constructs—word reading, comprehension, and decoding—were the major determinants of reading differences between grades four and six levels.

Table 11

DDA Standardized Function and Structure Coefficients of Reading Measures for Grade Level

	Function Coefficients		Structure Coefficients	
Predictors	Function 1	Function 2	Function 1	Function 2
Word Reading	**.89**	**.31**	**.92**	**.27**
Reading Comprehension	**.47**	**-1.08**	**.85**	-.29
Phonological Awareness	.07	**.67**	**.35**	**.56**
Letter Discrimination	.07	-.12	.14	-.06
Pseudoword Decoding	**-.35**	**.57**	**.71**	**.38**

Note: Coefficients > |.3| are **bolded**. The function score centroids/means for were Grade 4 = -.40 and .05; Grade 5 = .12 and -.18; and Grade 6 = .38 and .13 for Functions 1 and 2 respectively.

Interestingly, the structure coefficients demonstrated increased predictive effects for both discriminant functions than associated the function coefficients. Even phonological awareness whose function coefficient was lower than |.30| had a structure coefficient of .35 which was greater than its function coefficient. Figure 4 shows the plot of the three group centroids. From the plot, there appears to be reasonable "separation" among the three dimensions, especially between the fourth and sixth grade groups. Fifth and sixth grade groups seems to have the smallest degree of "separation".

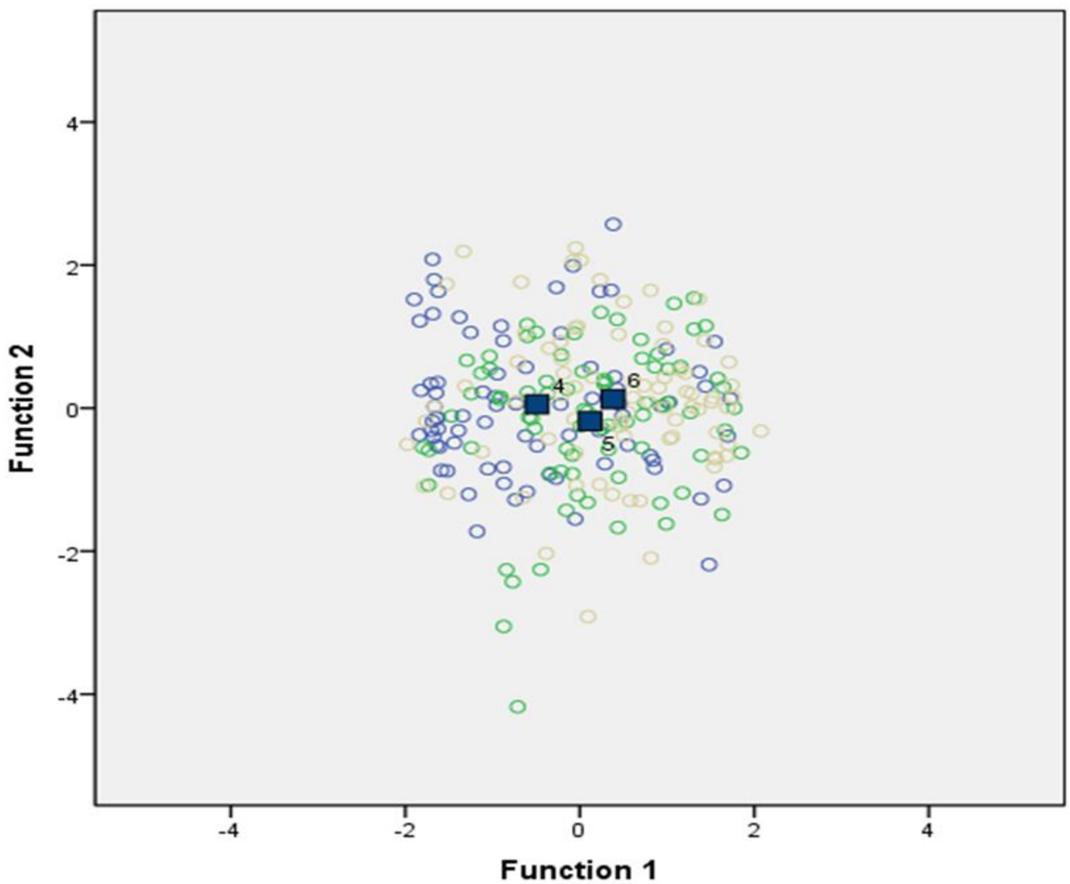

Figure 4. Plot of Group Centroids for the Three Grade Levels.
Note: Dark Blue squares represent the 3 Group Centroids, light blue circles represent Grade 4 canonical discriminant scores, green circles for Grade 5, and yellow circles for Grade 5.

5.5. Path Analysis

In order to assess how well both Nyanja and English reading data fit the hypothesized reading model and evaluate the magnitudes of each of the five variable's influence on reading comprehension in each orthography, path analysis was conducted. Path analysis, first conceptualized by Wright (1921; 1934), is a variant of the regression model whose main "aim is to provide estimates of the magnitude and significance of hypothesized causal connections among sets of variables displayed through the use of path diagrams" (Stage, Carter, & Nora, 2004, p. 5). In path analysis, path diagrams provide directional representations of hypothesized causal models among variables—which unlike the common simple regression—estimates all possible regression equations in a single analysis (Lleras, 2005). Path analyses are conducted based on the assumptions that research variables have linear relationships and no set of variables have reciprocal relationships. Other data requirements include assumptions that the observed variables are at least intervally-scaled and normally distributed (Streiner, 2005; Thompson, 2006).

Figure 1 (see diagram on page 52) illustrates the conceptualized path diagram of the reading comprehension model being tested in this study using both Nyanja and English data. As explained earlier, these analyses addressed relationships of two direct predictors (pseudoword decoding and word reading variables) and two indirect predictors (phonological awareness and letter discrimination variables) of reading comprehension in the path model. It was hypothesized that the direct effect of word or sight word reading would significantly predict students' English reading comprehension skills while pseudoword decoding skills would be more salient to Nyanja reading comprehension. Indirect phonological awareness and letter discrimination skills—which also have some shared covariance—influences reading comprehension through both word reading and pseudoword decoding in both orthographies. Based on existing research, the effects of phonological awareness skills are more potent in predicting English word reading than Nyanja word reading because in transparent orthographies, the effects of phonological awareness mainly impact on reading comprehension more in the early stages of literacy acquisition (Caravolas et al., 2013; Holopainen et al., 2001; Muller & Brady, 2001). Finally, indirect pseudoword decoding affects reading comprehension mediated by word reading were assessed. This is important because available literature also indicate that word reading is a function of decoding through grapheme-phoneme correspondence manipulation, print exposure, and reading practice (National Institute of Child Health and Human Development, 2000).

Reading data from each orthography were separately entered into the hypothesized reading model using the IBM SPSS AMOS 22 (Arbuckle, 1995) a computer-based statistical program. Path estimates of corresponding paths were also compared across the orthographies to determine differences in magnitudes between corresponding path coefficients. Statistical analyses, including a multiple regression and Sobel Tests, were conducted to determine the estimates of direct, indirect, and total effects of the reading variables in the proposed reading comprehension model across the orthographies. Multiple regression was used to determine the variance contributed by each of the fourth reading (letter discrimination, phonological awareness, word reading, and pseudoword decoding) to reading comprehension in each orthography, while the Sobel Test evaluated null hypothesis statistical significance of indirect effects in the path diagrams.

Finally, the following goodness of Fit indices were used to assess the fit model of the two data sets—Nyanja and English; chi-square, Root Mean Square Error of Approximation (RMSEA), normed fit indices (NFI), and the non-normed comparative fit indices (CFI). NFI and CFI are derivatives of comparisons between the hypothesized and independent models; their values range from 0 to 1 and values equal to or greater than .95 are accepted model fit statistics. For RMSEA, on the other hand, values less than or equal to .05 indicate good model fit, although values of up to .08 may also be considered adequate fit (Kline, 2011; Mellard, Fall, & Woods, 2010).

5.5.1. Results of multiple linear regression

Two multiple linear regression analyses were done to evaluate the degree of predictability of reading comprehension proficiency of the reading variables in each orthography. Letter discrimination, phonological awareness, word reading, and pseudoword decoding scores were used to predict reading comprehension variance in the regression equation. Table 12 displays both unstandardized and standardized regression coefficients of the predictors of reading comprehension. Generally, the reading model was statistically significant in both the Nyanja, $F(4, 114) = 26.85$, $p < .001$, and the English data, $F(4, 116) = 39.38$, $p < .001$, with the four variables accounting for approximately 49% ($R^2 = .49$, Adjusted $R^2 = .47$) and 58% ($R^2 = .58$, Adjusted $R^2 = .56$) of the reading comprehension variances respectively. Taking multiple regression results as a measure of goodness of fit, it appears that the English data fits the proposed model better than the Nyanja data, judging by the close to 10% difference in variance-accounted for (R^2) between the two orthographies. Reading comprehension proficiency in Nyanja orthography was primarily predicted by students' word reading skills, and to a lesser extent by letter discrimination, whereas in English, the reading comprehension variance is almost exclusively explained by word reading skills.

Results indicate that letter discrimination had a statistically significant predictive influence on reading comprehension in Nyanja, $\beta = -.17$, $t(114) = -2.46$, $p < .05$, but not in English ($\beta = .03$, $p = .66$). However, its predictive power was unexpectedly negative, and thus for every one standard deviation increase in students' letter discrimination knowledge there was .17 standard deviation decrease in reading comprehension, which is counterintuitive. On the other hand, the students' word reading abilities had considerable predictive effects on reading comprehension proficiency in both orthographies. The effects were statistically significant, $\beta = .41$, $t(114) = 2.97$, $p < .01$, and $\beta = .69$, $t(116) = 5.71$, $p < .001$ in Nyanja and English respectively. However, while in the Nyanja orthography, one standard deviation increase in word reading only had a corresponding .41 rise in reading comprehension. In English, one standard deviation had a corresponding increase of .69 *SD* in comprehension. This suggests that word reading predicts reading comprehension better in the English orthography than in Nyanja. Phonological awareness ($\beta = .12$) and pseudoword decoding ($\beta = .09$) were not statistically significant predictors of comprehension in both languages. However, an inspection of structure coefficients for both Nyanja and English orthographies suggests that, with the exception of English letter discrimination, the rest of the reading predictors—even those whose beta weights were not statistically significant—appear to be strong predictors of the latent variables described by the models in both languages.

Table 12

Multiple Linear Regression Results Summary: Unstandardized Weights, Beta Weights, and Structure Coefficients

Model	B	β	*P*	r_s
Nyanja Orthography				
Letter discrimination	-.2.86	-.17	.02	$-.22^{*}$
Phonological Awareness	.43	.12	.13	$.59^{**}$
Word Reading	.20	.41	.01	$.93^{**}$
Pseudoword Decoding	.28	.23	.12	$.93^{**}$
English Orthography				
Letter discrimination	.34	.03	.66	.17
Phonological Awareness	.32	.09	.18	$.50^{**}$
Word Reading	.42	.69	.01	$.99^{**}$
Pseudoword Decoding	.03	.03	.80	$.85^{**}$

Note. The dependent variable was reading comprehension. R^2 = .49 and .58; Adjusted R^2 = .47 and .56 in Nyanja and English orthographies respectively. $^{*}p < .05$, $^{**}p < .01$.

There were, however, some major differences between beta weights and structure coefficients—bivariate correlations between reading variables and the synthetic Y variable. Structure coefficients are advantageous because they are consistent the researcher's expectations. In fact, Bowling (1993, p. 9) noted that "Thompson and Borrello (1985) expressed a preference for structure coefficients because they are more consistent with the researcher's stated interest in an omnibus system of variables." All structure coefficients, unlike related beta weights were statistically significant in Nyanja, while in English, phonological awareness, word reading, and pseudoword decoding were statistically significant, instead of only word reading for beta weights. The predictive patterns of the reading variables seem to have been reversed with variables showing smaller beta weights having larger structure coefficients and vice versa. These coefficient changes may have been resulted from suppression effects or collinearity among variables.

5.5.2. Results of path analysis

Path Analysis generated path coefficients analogous to regression weights (Thompson & Borrello, 1985). Some path coefficients were used to further generate indirect effects which were inferentially compared with corresponding measured variables across the orthography in the conceptual path model. Similarities and differences in magnitudes of corresponding paths of the model were evaluated using null hypothesis statistical significance testing. Path analysis generated both standardized and unstandardized path coefficients for statistical comparison. Standardized and unstandardized path coefficients with associated *p*-values estimating the direct effect of each reading measure on another are displayed in Table 13 and Figure 5. Unstandardized coefficients cannot be interpreted as relative magnitudes of the contributed variances to the outcome variable in the model, but are merely reflections of the various metrics of the assessment tools used (Mellard et al., 2010; Thompson, 2006). Standardized coefficients, on the other hand, can "be used to compare models across different normative samples, whether an entirely different sample or the same sample tested at different points of time" (Mellard et al., 2010, p. 160). Therefore, standardized path coefficients were used in evaluating similarities and differences between Nyanja and English reading proficiency, "so that the weights can be compared with each other apples-to-apples" (Thompson, 2006, p. 283).

5.5.2.1. Path coefficients

Table 13 shows that phonological awareness had statistically significant ($p < .001$) path coefficients to pseudoword decoding ($\beta = .53$; $\beta = .34$) in both orthographies. For letter discrimination measure, the only statistically significant path coefficient ($p > .05$) was with English pseudoword decoding path. All the other path coefficients were not statistically significant in both languages. The path from word reading to phonological awareness only had statistically significant effects in English ($\beta = .11$, $p < .05$). The magnitudes of the effects of path coefficients from pseudoword decoding skills to word reading proficiency were almost equal both in terms of path coefficients and *p*-values in Nyanja ($\beta = .90$; $p < .001$) and English ($\beta = .81$; $p < .001$). Pseudoword decoding strongly predicted students' word reading proficiency in both languages (p < .001). Although the direct effects of word reading on both Nyanja ($\beta = .36$, $p < .01$) and English ($\beta = .74$, $p < .001$) reading comprehension were statistically significant, an examination of the two path coefficients shows that it had stronger effects on English performance. Pseudoword decoding proficiency only had statistically significant direct effects on Nyanja comprehension (β = .36, $p < .001$), but not in English ($p > 05$). These findings corroborate evidence from existing literature that word reading skills in transparent orthographies are preceded and depend, to some extent, on more students' pseudoword decoding abilities than in opaque writing systems (Caravolas et al., 2013; Holopainen et al., 2001; Muller & Brady, 2001). Depending on the teaching-learning strategies used in reading instruction in school and/or how well trained teachers are, students may be skipped phonics-based decoding to word recognition.

Nyanja Reading Model	English Reading Model

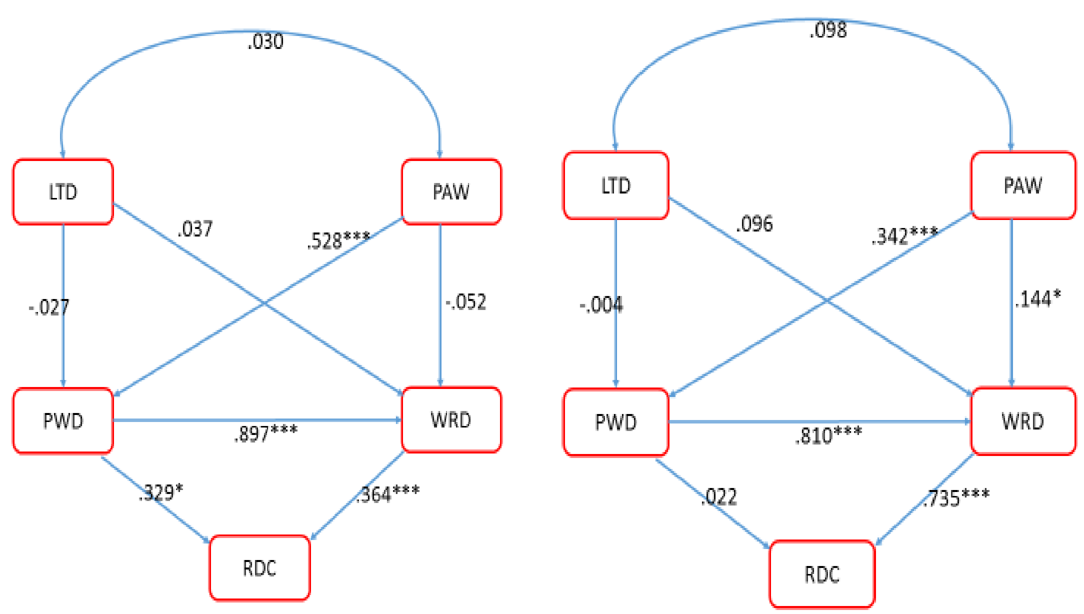

Figure 5. Path analysis results for the theoretical reading comprehension model tested in Nyanja and English. LTD = letter discrimination; PAW = phonological awareness; PWD = pseudoword decoding; WRD = word reading; RDC = reading comprehension. *. $p < .05$. ** $p < .01$. *** $p < .001$.

Table 13:

Path Analysis: Path Coefficients in Nyanja and English Orthographies

			Nyanja				English			
Path			*B*	Β	*SE*	*p*	*B*	β	*SE*	*p*
PWD	<---	LTD	-.38	-.03	1.11	.73	-.05	-.00	.96	.96
WRD	<---	LTD	1.31	.04	1.59	.41	1.96	.10	.946	.04*
PWD	<---	PAW	1.52	.53	.23	***	1.12	.34	.28	***
WRD	<---	PAW	-.37	-.05	.38	.33	.69	.11	.29	.02*
WRD	<---	PWD	2.22	.90	.13	***	1.48	.81	.09	***
RDC	<---	PWD	.40	.33	.17	.02*	.02	.02	.13	.85
RDC	<---	WRD	.18	.36	.07	.01**	.45	.74	.07	***

Note: LTD = letter discrimination; PAW = phonological awareness; PWD = pseudoword decoding; WRD = word reading; RDC = reading comprehension.

5.5.2.2. Path analysis: Indirect effects

Research has shown that the acquisition of proficient reading comprehension is not spontaneous, but a well-structured multidimensional process which progresses from basic skills such as phonological awareness and letter knowledge through phonics knowledge (decoding) to the manifestation of a corpus of personal lexicon (word recognition) before full text comprehension is attained (Joshi & Aaron, 2000; Katz & Frost, 1992; National Institute of Child Health and Human Development, 2000). Path analysis was used to map this network of skills by capturing the various paths of direct and indirect effects influencing reading comprehension in the model. In the conceptual model, pseudoword decoding and word reading skills both mediated the effects of letter discrimination and phonological awareness on reading comprehension. Word reading proficiency also mediated indirect effects of pseudoword decoding on comprehension. Hence, indirect effects of the following five mediated paths were evaluated; letter discrimination (i), LTD → PWD → RDC, (ii), LTD → WRD → RDC, phonological awareness (iii), PAW → PWD → RDC, (iv), PAW → WRD → RDC, and pseudoword decoding (v), PWD →WRD →RDC.

According to Preacher and Hayes (2004, p. 717), mediation analysis is used to "indirectly assess the effect of a proposed cause on some outcome through a proposed mediator." After calculating the magnitudes of the indirect effects for five mediated paths in the conceptual reading model, degrees of statistical significance were performed by the Sobel Test (Sobel, 1982) using a Sobel Statistic calculator developed by Preacher and

Hayes (2008). Sobel testing uses the following guidelines to generate Sobel statistics and associated *p*-values. For each mediated path; firstly, estimate unstandardized path coefficients defining the magnitude of relationships between the predictor variables and the mediating variables (a), together with associated standard errors (SE_a). Secondly, determine the unstandardized coefficients for associations between respective mediators and the outcome variables (b), and associated standard errors (SE_b). Following the guidelines just outlined, Sobel statistics displayed in Table 14 were generated.

The coefficient of the indirect effect of pseudoword decoding on reading comprehension mediated by word reading were .40 and .66 in Nyanja and English orthographies respectively, and were judged to be statistically significant by the Sobel Test analyses, $z = 2.60$, $p < .01$ and $z = 6.01$, $p < .001$. The interesting aspect of phonological awareness' indirect effect on comprehension is that its direct effects were not statistically significant (refer to Table 12) in both orthographies, which suggests that word reading positively mediated the relationships between pseudoword decoding and reading comprehension. Sobel test statistics also show that pseudoword decoding skills had statistically significant mediation effects on phonological awareness-reading comprehension association only in the transparent orthography, with an indirect effect of .61, $z = 2.23$, $p < .05$. Indirect path coefficients also showed that the direct effects between phonological awareness and comprehension were not statistically significant, which similarly suggests that the effects of phonological awareness on comprehension tend to be more robust when mediated by decoding proficiency. No other Nyanja mediated association was statistically significant.

Sobel statistics in the English orthography revealed that, unlike the Nyanja orthography results, word reading had statistically significant mediating influence on the indirect effects of both letter discrimination and phonological awareness on reading comprehension. The Sobel test statistics were .87, $z = 1.99$, $p < .05$ and .31, $z = 2.20$, $p < .05$ respectively. Therefore, while pseudoword decoding's mediating effects were unique to phonological awareness Nyanja, word reading also uniquely mediated both letter discrimination and phonological awareness in English, suggesting that two mediators' effects are orthography-specific.

Table 14

Sobel Test Statistics for Mediated Effects on Reading Comprehension

			NYANJA			ENGLISH		
IV		Med.	Ind. Effect	Test Stat.	*p*	Ind. Effect	Test Stat	*p*
1. LTD	→	PWD	-.15	-.35	.73	-.00	-.05	.96
2. LTD	→	WRD	.24	0.78	.46	.87	1.99	.05
3. PAW	→	PWD	.61	2.23	.02	.02	.19	.85
4. PAW	→	WRD	-.37	-.91	.36	.31	2.20	.03
5. PWD	→	WRD	.40	2.60	.01	.66	6.01	.01

Note: IV = independent variable; Med. = mediating variable; Test Stat. = Test Statistics; Ind. Effect = indirect effect.

5.5.3. Model Fit Evaluation for Nyanja and English Reading Data

The results of the model fit analysis are presented in Table 15. The English data appear to have fitted the hypothesized model better, $\chi^2 = 2.13$ (*df* = 2, *p* < .35, RMSEA = .02, NFI = .99, and CFI = 1.00, than the Nyanja data, $\chi^2 = 8.05$ (*df* = 2, *p* = .05), RMSEA = .16, NFI = 0.97, and CFI = .98. English data met all fit index threshold recommendations by Mellard et al. (2010)—a non-significant chi square (*p* > .05), RMSEA less than .050, both NFI and CFI greater than .95—while the Nyanja data met only the NFI and CFI requirements.

Table 15

Model Fit Indices for Nyanja and English

Index		Nyanja	English
Chi-square			
	χ^2-Value	8.05	2.13
	df	2	2
	p	.05	.35*
RMSEA		.16	.02*
CFI		.97*	1.00*
NFI		.98*	.99*

Note. χ2 = chi-square; df = degrees of freedom for the model; p = p-value; NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation. * Met criteria for model fit

5.6. Results Summary

The results from the MANOVA, bivariate correlation analysis, multiple regression analysis, path analysis and tests for mediation effects, and model fit provided some important insights into how orthographic opacity affects the developmental trajectories of reading skills in transparent and opaque orthographies. Overall, it appears that the transparent orthography seem to favor students' reading proficiency, with the exception of phonological awareness measures. However, the data from the opaque orthography, English, appear to fit the conceptualized model better than the data from the transparent orthography, Nyanja. A more detailed discussion of the results, their implications for reading research and practice across the orthographic transparency spectrum, and recommendations for future research, in general, and Zambia, in particular, are presented in the following chapter.

CHAPTER VI

DISCUSSION AND CONCLUSIONS

6.1. Introduction

In this chapter, a discussion of the research findings and some recommendations are presented. The chapter has four sections. In the first section, the summary findings of the research are discussed starting with MANOVA through to model fit evaluation. The second section covers the implications of the study for reading research. In the third section, the recommendations and directions for future research are presented. Finally, section four looks at some of the study's significance and limitations.

6.2. Discussion of Summary Findings

The main purpose of this study was to examine the effects of orthographic depth on reading proficiency by comparing performance of two similar samples of basic (elementary) school students in grades four to six on Nyanja (transparent) and English (opaque) versions of ZAT reading in Zambia. The main research question focused on evaluating and comparing variations in reading proficiency on measures of letter discrimination, phonological awareness, pseudoword decoding, word reading, and reading comprehension. Variations in reading proficiency found among students taught to reading in different languages are usually attributed to differences in degree of orthographic depth across orthographies.

6.2.1. Effects of orthographic depth on reading proficiency

Generally, the results of the study show statistically significant variations in reading performance between Nyanja and English languages. Participants who were tested in the more transparent Nyanja orthography out-performed their counterparts tested in the deeper English orthography. This implies that in general the consistent nature of grapheme-phoneme correspondences in the Nyanja orthography facilitated reading proficiency better than English. This corroborates findings from studies by Seymour et al. (2003), Landerl and Wimmer (2008), and Aro and Wimmer (2003) who found that students taught to read in orthographically transparent languages such as Finnish faced significantly less challenges than those reading in opaque ones like English.

Nevertheless, the magnitude of the cross-orthography mean differences between Nyanja and English bilinguals in Zambia was not as highly manifest as comparisons of student performances in monolingual education systems in, for example Finnish-English, cross-national studies. The overall mean differences in reading proficiency for Zambian participants were significantly smaller than Finnish-English mean differences reported in Seymour et al.'s (2003). Some researchers have argued that one of the reasons for small achievement gap among bilingual students is cross-linguistic transfer of basic reading skills between the two orthographies (Durgunoglu, 2002; Durgunoglu & Oney, 2000; Pillunat & Adone, 2009). Basic reading skills, such as print and phonemic awareness and, in this case, letter names and associated sounds acquired in Nyanja, their first language, can be applied to read in English.

However, although the overall reading achievement was better in Nyanja compared to English, when the five reading variables were evaluated independently and not as a single measure, some interesting cross-orthography reading variations emerge. First, results showed distinct bivariate correlations between the two orthographies. Students' performances were exclusively and highly correlated to other within-orthography measures. For example, with the exception of the letter discrimination measures, all other Nyanja measures had statistically significant associations with other Nyanja measures. English measures showed a similar pattern of correlation coefficients. Contrastingly, all other cross-orthography associations did not yield statistical significance. However, these findings were not unexpected considering the large orthographic distance between Nyanja and English languages. Caravolas et al. (2005) reported comparable variations in bivariate correlations between Czech and English orthographies, although phoneme awareness was commonly correlated highly with word reading in both languages.

The main reason for the continued reading achievement gap at this stage of reading instruction may be the ineffectiveness of instructional methods adopted as a result of poor teacher preparation programs. Because teachers are not equipped with appropriate pedagogical content knowledge, they fail to focus on the transmission of appropriate linguistic constructs necessary for boosting students' skilled reading (Cantrell et al., 2012; Joshi et al., 2008/2009; Shulman, 1986). Most of the literacy teaching approaches adopted by teacher preparation colleges in the Zambia do not adopt culturally responsive instructions (Gay, 2010). Reading instructions do not focus on strengthening linguistic abilities that students bring to the classroom such as oral vocabulary in their first language or mother tongue.

Teaching methods and activities are out of touch with students' background knowledge, thereby failing to inspire them to build on what they already know. Ronnås (2009) noted that in Zambia,

> …problems within education have not only to do with scarce resources but with a handful of other characteristics of the school system. These features include old fashioned teaching and an inclination to eject less successful or fortunate students. It also has to do with the clash between the local culture with its own language and the foreign educational language of English, representing something alien … (p. 8).

Nichols, Rupley, Webb-Johnson, and Tlusty (2000, p. 5) advised that "Teachers should be responsive to the student's home language by allowing the students' cultural language to exist in the classroom and build upon this first language." Majority of Zambian students enter the education systems with literally no oral or written English skills, but they have a very substantial wealth of oral skills in their mother tongues and/or play languages, which reading instructions do not take advantage of. Therefore, it is possible that the observed advantage of learning to read in Nyanja, in addition to orthographic transparency, is also a consequence of students' differential oral fluency in the two languages.

Furthermore, the variation in reading proficiency between the two orthographies was based only three of the five reading measures. Only phonological awareness, word reading, and pseudoword decoding subtests—in order of decreasing function coefficient magnitude—contributed significantly in discriminating reading proficient. However, unlike performances on word reading and pseudoword decoding which was better on Nyanja measures, English tested students out-performed the Nyanja tested on phonological awareness performance. This finding is interesting, but not unexpected because it is corroborated by a number of earlier studies (Caravolas et al., 2013; Furnes & Samuelsson, 2010; Holopainen et al., 2001). According to Furnes and Samuelsson, phonological awareness, particularly phonemic awareness proficiency, is a stronger predictor of both word reading and comprehension in the opaque than transparent orthographies. Specifically, their study found that in transparent orthographies, phonemic awareness had relatively similar effects in the early stages of reading development, but loses its potency as learners become more acquainted with phonological recoding—grapheme-phoneme correspondence rules. On the contrary, students in opaque orthographies continue relying on phonemic awareness skills to decode words until later stages of their reading development. It is not surprising, therefore, that the current study found students had heightened awareness of phonological processing in the English orthography than Nyanja.

On both word reading and pseudoword decoding, the findings were similarly consistent with several available studies comparing reading between contrasting orthographies (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour et al., 2003). This is because as students become familiar with and competent in letter sounds, they tend to employ the self-teaching mechanisms to decode. In other words, they use their knowledge of grapheme-phoneme correspondence rules through phonological recoding in teaching themselves to read unfamiliar words or any phonologically logical letter strings they encounter (Share, 1995; 2008). Additionally, Nyanja tested students may also have used oral familiarity to their advantage because oral vocabulary can be used to decipher the meaning of words or sentences encountered in the text. Alternatively, it is possible that English comprehension was not comparable to Nyanja because the participants did not have adequate oral vocabulary in the former.

The low discriminative effects of orthographic depth for both letter discrimination and reading comprehension subtests may be explained by floor and ceiling effects, which could have attenuated their power to predict reading differences. Students' performance on both Nyanja and English subtests of the letter discrimination measures had some ceiling effects, implying that students found the letter discrimination subtest relatively easy, which raised the mean scores and reduced the standard deviations considerably. Contrastingly, the scores on both reading comprehension subtests were fairly low, which also affected both their means and standard deviations. Noonan, Kopec, Noreau, Singer, Mâsse, and Dvorak (2010, p. 42) argued that "Floor and ceiling effects limit an instrument's ability to detect changes or differences in individuals or between groups." It is essential to note here that the observed floor effects and floor effects were not totally unexpected because by fourth grade students would have adequately mastered both names and sounds associated with letters of the alphabet through print exposure, while reading comprehension may be challenging skills in either languages, albeit teachers' failure to teach their students appropriate reading comprehension strategies.

The study also revealed that reading performance varied progressively according to grade level. As expected, sixth graders out-performed both fifth and fourth graders, while fifth graders posted better reading performance than fourth graders. On average, the participants' reading performance in Nyanja was superior to the English participants' achievement across all grade levels. However, fifth graders' performance fluctuated considerably on some reading measures. For instance, fourth graders out-performed fifth graders on the phonological awareness subtest by a substantial margin, but the achievement gap between the two grade levels was significantly bigger in favor of fifth graders on reading comprehension. Overall, however, these results seem to simulate findings from Hanley et al.'s (2004) study, who longitudinally followed cohorts of Welsh and English students for the first six years of their literacy instruction. Like the results from this study, they reported statistically significant mean differences between the orthographies in the early stages of reading instruction. The achievement gap between grade levels gradually narrowed as students progressed to higher grades and disappeared entirely by the sixth year of formal reading instructions.

Similarly, three of the five reading measures determined the mean reading differences across grade levels. But unlike orthographic depth, the main discriminating variables were, in order of decreasing function coefficients, word reading, reading comprehension, and pseudoword decoding. It was unexpected that phonological awareness would not be among the discriminating variables because it is considered to be a good predictor of reading. Equally noteworthy was the emergence to prominence of reading comprehension in predicting the reading differences among grade levels. This could be explained by the shift in instructional focus from mere decoding to comprehension as learners progress to higher grades, especially because of pending bridging examinations at seventh grade. Additionally, Share (1995; 2008) argued that after students acquire enough vocabulary their reading goals shift towards improving comprehension, although word reading and pseudoword decoding skills are still important in figuring out meaning through both small and large grains based strategies in English, and small grains in transparent Nyanja.

6.2.2. Multiple regression: Comparing reading comprehension variance explained

This study was also compared the variance in students' reading comprehension explained by the measures of letter discrimination, phonological awareness, word reading, and pseudoword decoding skills to determine differences in their predictive power across the two orthographies. This hypothesis was based on the assumption that the ultimate goal of any reading activity is comprehension and that reading comprehension is a product of several interwoven sub-skills—among them phonological awareness, letter discrimination, word recognition, and pseudoword decoding (Gough & Tunmer, 1986; Hoover & Gough, 1990; Joshi & Aaron, 2000). Generally, the results showed that both models explained approximately half of the variance in students' reading comprehension. However, the proportion of the comprehension variance-explained was substantially large in English than in Nyanja. In other words, letter discrimination, phonological awareness, word reading, and pseudoword decoding measures explained the reading comprehension variance better in English. This is not surprising because most of the reading models are developed from the Anglo-Saxon perspective, an orthography which according to Share (2008) is "ill-equipped to serve the interests of a universal science of reading" (p. 584).

The major orthographic distinctions between Nyanja and English regression models was the number of variables predicting respective reading comprehension variances. In the Nyanja model, word reading and letter discrimination skills had statistically significant predictive power, while the variance in English was contributed almost entirely by students' word reading skills. The inverse association of letter discrimination, as defined by negative beta and structure coefficients, in Nyanja was counterintuitive. For the English model, the fact that word reading was the only statistically significant predictor was not totally unexpected because the nature of the English orthography encourages word processing based on large grain sizes (Share, 2008). What was surprising, though, was that phonological awareness—a basic and widely cited construct in literature as a major predictor of reading comprehension (Adams, 1990; Durgunoglu & Oney, 2000)—and pseudoword decoding did not have statistically significant contributions in English. In Nyanja, on the other hand, the non-significant prediction of pseudoword decoding was unexpected, considering that reading in transparent orthographies depends largely on small grain size manipulations (Goswami, 2005; Ziegler & Goswami, 2005). Conventionally, one would have expected phonological awareness, word reading, and pseudoword decoding, in the order of decreasing magnitude, to be major predictors of English comprehension, and pseudoword followed by word reading were expected contributors of comprehension in Nyanja.

Additionally, the dynamics and nature of the reading measures' predictive power across the two orthographies were altered radically when the structure coefficients, instead of beta weights, are interpreted. As in Nyanja, all the four reading measures had statistically significant structure coefficients in comparison to two beta weights, and the flow of the magnitude of predictions was interesting. Structure coefficients show that pseudoword decoding and word reading accounted the largest proportion of the variance explained followed by phonological awareness and letter discrimination. The magnitude of pseudoword decoding scores relative to word reading reflects its importance to reading development in transparent languages. While the magnitudes of phonological awareness and letter discrimination—although letter discrimination was the only statistically significant beta weights—reflect their declining prominence as students rise to higher grades. According to Furnes and Samuelsson (2010), basic literacy skills, especially phonological awareness, gradually become less potent in determining reading skills in transparent orthographies as learners advance. Differences in the dynamics of prediction could be attributed to collinearity and/suppression effects among some variables. This is one of the reasons why Thompson (2006) encourages researchers to interpret both beta weights and structure coefficients in evaluating relationships in linear regression analyses. Remarkably, an examination of corresponding structure coefficients seem to appropriately reflect predictive trends reported widely in the literature (Holopainen et al., 2001; Furnes & Samuelsson, 2010).

In the English orthography, word reading had the largest structure coefficient followed by pseudoword and phonological awareness. As noted above, this reflects the assumptions of the psycholinguistic grain size theory (Ziegler & Goswami, 2005), which surmised that reading proficiency in opaque orthographies is defined more by large than small grain sizes. These results also seem to suggest that getting to the level of automatized word reading and retrieval requires the invocation of the sublexical skills through small grains in the initial stages of reading instructions. Unlike in the Nyanja model, letter discrimination subtest did not yield statistically significant reading comprehension prediction. Generally speaking, these findings support the validity of the two script-dependent hypotheses—orthographic depth hypothesis and psycholinguistic grain size theory—rather than the central processing hypothesis.

6.2.3. Path analysis: Comparing relationships among variables in the path model

Path analysis evaluated the effects of orthographic depth on reading proficiency to determine variations in associations among the measured reading variables as proposed in the path diagram in Figure 5 between Nyanja and English languages. Path analysis results revealed some between-orthography parallels and variations in corresponding path coefficients. One path diagram was evaluated on Nyanja and English independently.

6.2.3.1. Path analysis: Direct effects

There were four statistically significant direct path coefficients in Nyanja, whereas English had five significant coefficients. This difference generally shows orthography-specific effects since the statistically significant path coefficients were not uniform across the languages. The direct effects of the following path coefficients were comparable and statistically significant in both orthographies: phonological awareness to pseudoword decoding, pseudoword decoding to word reading, and word reading to reading comprehension. These findings corroborate what several studies have previously found (Caravolas et al., 2012; 2013; Ehri, 2005; Goswami, 2005; Holopainen et al., 2001; Share, 1995; 2008; Ziegler & Goswami, 2005). The significance of the relationship between pseudoword decoding and word reading skills in reading was clearly manifested by the magnitude of the path coefficients in both Nyanja and English orthographies.

Reading development follows distinct stages through which all students have to undergo before becoming proficient readers. Ehri (2005) argued that decoding is preceded by phonemic awareness (awareness that words can be broken down into individual phonemes) and orthographic knowledge (letter names and associated phonemes). And through phonological recoding, learners string letters according to their related sounds to create words through a self-teaching mechanism (Share, 1995). It is, therefore, not surprising that there were strong associations among measures of phonological awareness, word reading, and pseudoword decoding in this study. Goswami (2005) stated that there are two phonics strategies which makes this possible depending on the size of grains involved. The two strategies are synthetic and analytic phonics. The synthetic phonics strategy is highly recommended in transparent orthographies because students rely heavily on small grains, but as writing systems become more orthographically opaque, analytic phonics becomes appropriate because learners focus on large grains such as syllables, word roots, prefixes, and suffixes.

There were also some major orthography-specific path coefficient differences between the orthographies. For instance, letter discrimination did not have substantial effects on pseudoword decoding in either orthographies, and its effects on word reading was only statistically significant in English. This is obviously because letter discrimination skills may have become redundant due to print exposure. Similarly, both covariances between letter discrimination and phonological awareness was marginally small, although their association significantly impacts word reading from preschool to early elementary (Hogan et al., 2005; Holopainen et al., 2001). However, the non-significant effects of phonological awareness on word reading in this level was expected because, as earlier noted, both letter discrimination and phonemic awareness skills was gradually becoming redundant in higher grade levels (Furnes & Samuelsson, 2010).

6.2.3.2. Path analysis: Indirect effects

The evaluation of indirect effects of both exogenous (phonological awareness and letter discrimination) and intermediate variables (word reading and pseudoword decoding) through indirect paths revealed some remarkable similarities and differences in reading proficiency between Nyanja and English. First, the indirect effects of pseudoword decoding on reading comprehension when mediated by word reading skills were statistically significant in both languages. This was not unexpected in both orthographies because as novices become more proficient readers their focus shift from exclusively relying on grapheme-phoneme correspondence rules to direct lexical-based word processing strategies (Ehri, 2005; Goswami, 2005). Lexicalizing word processing is important to reading comprehension because as Ehri noted:

> Being able to read words from memory by sight is valuable because it allows readers to focus their attention on constructing the meaning of the text while their eyes recognize individual words automatically. If readers have to stop and decode words, their reading is slowed down and their train of thought disrupted (p. 135).

Secondly, and the more prominent difference in indirect effects between the Nyanja and English orthographies were the variations in the influence of phonological awareness on comprehension when it was medicated by both word reading and pseudoword decoding skills. Whereas when mediated by word decoding, indirect effects of phonological awareness are only statistically significant in English. Contrastingly, when pseudoword decoding skills was the mediator, phonological awareness only had statistically significant effects in the Nyanja orthography. An interesting aspect about the mediation effects of pseudoword decoding is that the beta weight and the path coefficient of the direct effect in Nyanja was not significant. This also confirms the importance of the relationships that phonemic awareness shares with both word reading and decoding in facilitating reading comprehension across orthographies (Caravolas et al., 2012; 2013; Mellard et al., 2010). The effects of phonological awareness on reading comprehension when mediation by word reading and pseudoword decoding is script-dependent. This conclusion is supported by the assumptions of both script-dependent hypothesis (Katz & Feldman, 1983; Katz & Frost, 1992) and the psycholinguistic grain size theory (Ziegler & Goswami, 2005).

Finally, student's letter discrimination skills when mediated by word reading only had significant indirect effects on comprehension in English. This is probably because learners rely heavily on large grain word processing strategies in opaque orthographies (Frost et al., 1987; Katz & Frost, 1992; Ziegler & Goswami, 2005). But it is not surprising that the effects of letter discrimination on reading comprehension were strongly mediated by word reading in English. Ehri (2005) supported this view and stated that "Reading words from memory by sight is especially important in English because the alphabetic system is variable and open to decoding errors" (p. 135). Contrastively, the indirect effects of letter discrimination on reading comprehension when mediated by pseudoword decoding were not significant in either orthography.

6.2.3.3. Model fit comparison

Furthermore, Nyanja and English reading data were independently used to evaluate differences in model fit. This model fit evaluation was based on the assumption that if variations in orthographic depth do not influence reading proficient, then model fit statistics will be comparable. The analysis compared both sets of data on the path diagram used for path analysis in Figure 5.

Generally speaking, the results showed that the English data fit the proposed reading considerably well than the Nyanja data. All model fit statistics for the English data met the expected criterion thresholds—chi-square difference statistic, RMSEA, NFI, and CFI (Kline, 2011; Mellard et al., 2010). On the other hand, only two of the four model fit statistics used met the criteria for the Nyanja data. In other words, the chi-square statistic was not statistically significant in English, but statistically significant for the Nyanja data. A non-significant chi-square statistic indicates better model fit. The English RMSEA index was smaller than .06, while the Nyanja RMSEA statistic exceeded this threshold. However, both the Nyanja and English data sets had CFI and NFI indexes greater than .95 on the model. Additionally, Nyanja and English data also revealed different model fit characteristics when R-squared was used to quantify the models' goodness-of-fit. Although both R-squared were around 50% of the total variance for both models, the 10 percentage gap in variance-accounted for between the orthographies implies that the English data fit the reading comprehension model better than the Nyanja data.

Model fit evaluation results provided some definitive evidence questioning universal application of the current reading theories, models, and research paradigms to all languages (Frost, 2012; Share, 1995; 2008). The findings are consistent with Share's (2008) arguments that current models of literacy acquisition are almost entirely developed from the Anglo-centric perspective at the expense of insights based on variations in orthographic opacity other alphabetic languages. According to Share, the English orthography is not an appropriate specimen for the development of reading theories and models because it is orthographically an *outlier.* Share (2008) aptly explained the apparent biases inherent in most existing reading models as follows:

> Models of word reading acquisition developed by English language researchers almost invariably include one or more phases, or stages, in which the novice reader is unable to exploit all the grapheme–phoneme (or higher order orthography–phonology) information available in a printed word, relying instead either on partial letter–sound cues (often in conjunction with contextual cues) or on purely global visual information,

> such as word length and envelope, or salient visual (non-phonological) features of selected letters (p. 599).

Most current English-based models of reading development propose cascaded series of stages who ultimate goal to achieve reading comprehension through reading fluency facilitated by sight word. Ehri (2005), for instance, argued that to achieve reading proficiency students go through *partial alphabetic* and *logographic* stages, an argument which emphasizes large grain size word processing and fails to account for small grains inherently used in transparent orthographies. Share (2008) noted that this narrow perspective could be misleading because it does not account for students who are able to teach themselves to read using the self-teaching mechanism after mastering basic grapheme-phoneme correspondence rules.

6.3. Implications of Reading Instruction and Acquisition

Overall the results from this study revealed thought-provoking insights into the reading processes between the transparent and opaque orthographies. Reading proficiency of students who were tested in transparent Nyanja performed significantly better than their English counterparts. However, a close look at individual measures of reading reveal that although English tested students were out-performed on letter discrimination, word reading, pseudoword decoding, and reading comprehension, they had a significant advantage on phonological awareness. Additionally, path analysis also revealed a number of variations with reference to the reading measure's patterns of predicting reading comprehension.

These results have three main implications for reading instruction and development research, in general. First, future research should focus on establishing specific similarities and differences in reading processes across orthographies. Currently, especially in developing and resource-poor nations like Zambia, reading and teacher preparations programs are developed and implemented without a clear understanding what constitutes the reading process in the orthographies/languages used for instructions. Based on this study's findings, it is clear that the nature of reading proficiency differ significantly between Nyanja and English orthographies. Therefore, using the uniform reading instruction strategies for bilingual students may be detrimental to literacy development either in one or both languages. Goswami et al. (2001) compared word reading performance of Germany and English children, and found that English readers incurred *switching costs* caused by switching back and forth between small-unit and large-unit processing, which German students do not experience.

Secondly, any conceptualization of reading theories and models should take into account orthographic variations among languages or treated as orthography-specific. Since reading proficiency vary significantly according to orthographic depth, current reading frameworks should be re-examined through cross-orthography research and redefined underlying assumptions based on the empirical evidence. This new evidence will be helpful in re-conceptualizing theories and models by incorporating linguistic characteristics of transparent orthographies. Regarding the current thinking about the inadequacies reading models, Share (2008, p. 584) noted that "the idiosyncrasies of English, …, have shaped a contemporary reading science preoccupied with distinctly narrow Anglocentric research issues that have only limited significance for a universal science of reading." Consequently, failure to acknowledge and/or integrate a wide spectrum of orthographic characteristics in conceptualizing reading processes, theories, and models inevitably lead to biases and erroneous conclusions. Frost (2012, p. 264) concludes that "only models that are tuned, one way or another, to the full linguistic environment of the reader can offer a viable approach to modeling reading."

Thirdly, teacher education programs, especially for teachers of transparent-opaque orthography bilingual students, should be tailored to enable graduate teachers understand orthographic characteristics of both languages. The greatest weakness in teacher preparation programs is the Peter Effect—the exception that poorly trained teachers should teach reading effectively (Cantrell et al., 2012; Joshi et al., 2008/2009). Although the English orthography is perceived to be the most highly inconsistent and, thereby posing significant challenges for novice readers, Cantrell and colleagues stated that appropriately trained reading teachers can help students to learn more efficiently and faster. Organizing English words into manageable linguistic taxonomies based on syllable types, word roots, prefixes, and suffixes helps to reduce perceived orthographic idiosyncrasies.

On the other hand, for effectiveness, teaching of reading in transparent orthographies should focus on facilitating the self-teaching mechanism after providing basics in phonemic awareness and phonological recoding. Share (1995) aptly explained what is required of reading teachers in transparent orthographies as follows:

> Teachers can only provide simplified models of spelling-sound correspondence that offer the learner a functional scaffold for developing and refining this knowledge base. This implies that teachers cannot teach children to read as such, only teach them how to teach themselves. The self-teaching hypothesis is precisely this—a theory about how children teach themselves to read (p. 201).

However, for bilingual teachers, it is not enough to understand the linguistic constructs of opaque orthographies, they must also be knowledgeable of attributes of transparent orthographies. They should ensure that they adopt strategies which are suitable for teaching linguistic characteristics of all orthographies. More specifically, as Goswami (2005) proposed that effective teaching in more opaque orthographies require adequate knowledge of both synthetic and analytic phonics to help students decipher both small and large linguistic grain sizes.

6.4. Future Research Directions

First, research about the effects of orthographic depth on literacy development is a relatively new field. And most of the available literature is based almost entirely on the English language, as research in other languages is mostly confined to cross-national monolingual designs with a high Eurocentric biases. Such comparisons are susceptible to predispositions and influences of, not only variations in SES, but also in socio-cultural differences. For instance, although several studies have reported significant reading proficiency differences between students taught in highly transparent Finnish and English, it is not yet clear how factors such as variations in school enrolment ages attenuate the effects of orthographic depth (Aro & Wimmer, 2003; Landerl & Wimmer, 2008; Seymour et al., 2003). Therefore, more research based on transparent-opaque orthography bilingual population is needed to avoid confounding factors such as SES and socio-cultural differences. Bilingual populations provide a viable alternative to cross-national and circumvent other cross national policy variations.

Secondly, a similar study in Zambia should be done with more measures of reading skills should be conducted in future to get a more comprehensive picture. The reading model tested in the current study was limited to five reading measures—letter discrimination, phonological awareness, word reading, pseudoword decoding, and reading comprehension. Most studies examining literacy development incorporate RAN, oral comprehension, intelligence quotient (IQ), auditory working memory, vocabulary, and reading fluency which influence reading performance across orthographies (Caravolas et al., 2012; 2013; Furnes & Samuelsson, 2010; 2011; Holopainen et al., 2001; Mellard et al., 2010). For example, including a measure of oral comprehension would have been very insightful in this study because of the mismatch in oral language proficiency between Nyanja and English among Zambian students.

Third, studies examining the influence of inter-orthography reading transfer can also be informative because a lot of studies have shown that skills acquired in students' first language are transferrable across orthographies. This is expected if the languages involved have a small orthographic distance (Durgunoglu, 2002; Durgunoglu & Oney, 2000; Pillunat & Adone, 2009). Basic skills such as print awareness and phonological awareness acquired in the first language of reading instruction are obviously not re-learned in the second language. Hence, since Nyanja orthography is based on the same alphabetic system and phonological structure as the English writing system, there is definitely some transfer of skills between them, which could be affecting reading development.

6.5. Significance of the Study

The findings of this study extended the current understanding of the effects of orthographic depth on reading achievement among bilingual populations. Most current reading theories, models, and practices have traditionally been framed from the Anglocentric perspective, but because of the English orthography's outlier status due to its notoriously deep orthography, it is implausible to assume that theories based on English have universal application across languages (Share, 2008). Therefore, insights of these findings have extended our understanding of early reading development beyond the Anglocentric perspective and the monolingual cross-national research paradigms. Additionally, the study has also provided new insights into the patterns of reading trajectories of bilingual students in resource poor communities such as Zambia.

6.5. Limitations of the Study

The first major design limitation of this study was the exclusion of RAN—one of the key cognitive skills presumed to predict considerable variance of reading proficiency. It would have been valuable if RAN was also included in both MANOVA and path models to assess its effects separately and collectively. Secondly, although reading instructions in Zambian schools are initially conducted in the child's mother tongue or most familiar language, students' oral and reading proficiency may have been moderated by their knowledge of the English language. There is a general bias towards English when teaching in the content areas. Finally, the cross-sectional design of the study adopted limits the applicability of the findings beyond the study, hence a longitudinal design would have provided wider generalizability.

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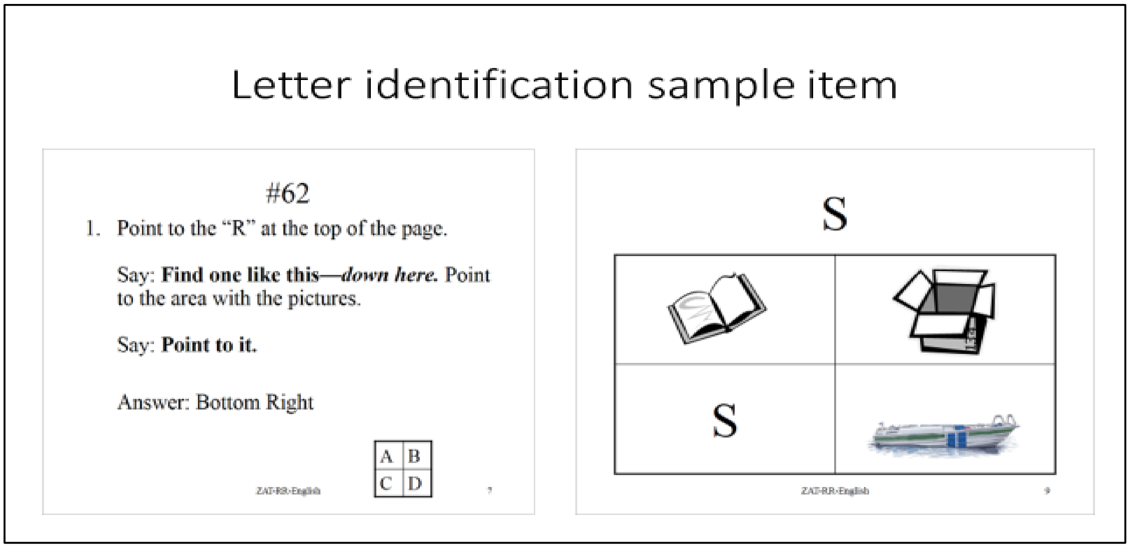
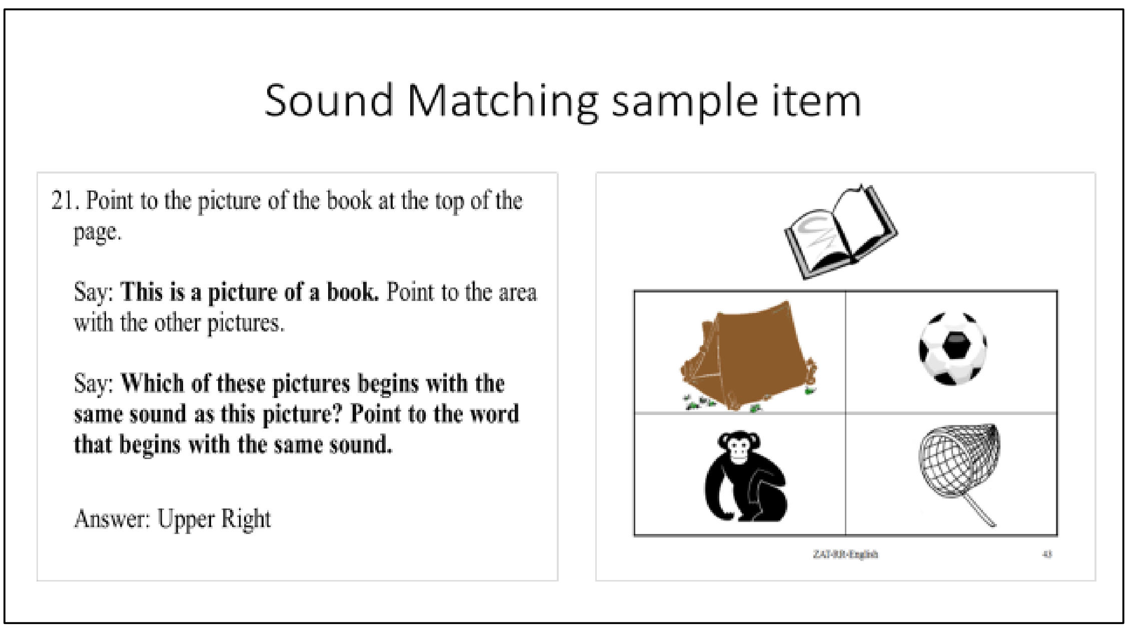
APPENDIX A

SAMPLE ITEMS FROM THE ZAMBIA ACHIEVEMENT TEST (ZAT) SUBTESTS





Sound discrimination sample item

#88

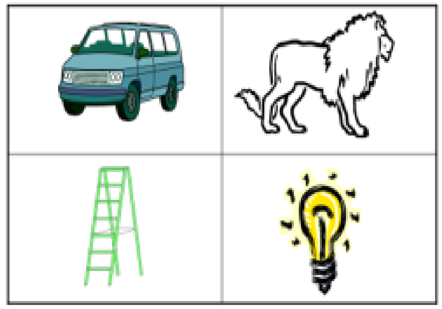
27. Point to the area with the four pictures.

Say: **One of these pictures starts with a different sound than the other pictures. Point to the picture that starts with a different sound.**

Answer: Upper Left

A	B
C	D

ZAT-RR-English 56



ZAT-RR-English 55

Letter-sound matching sample item

#100

39. Point to the picture of the boat at the top of the page.

Say: **This is a picture of a boat.** Point to the area with the other words.

Say: **Which of these words begins with the same sound as this picture? Point to the word that begins with the same sound.**

Answer: Bottom Right

A	B
C	D

ZAT-RR-English 80

Water	Rope
Cry	Bake

ZAT-RR-English 79

Word Reading sample item

#104

43. Point to each row of words.

Say: **This page has four words on it. Read each word aloud. Go slowly from one word to the next.**

ZAT-RR-English 88

Five	Green
Sing	Around

ZAT-RR-English 87

Pseudo-word decoding sample item

#125

Say: **I want you to read some words that are not real words. Tell me how they sound.**

Point to the first word: **How does this word sound?**

Point to the following words: **Read these words to me.**

Phonetically

130. thip (rhymes with hip)
131. chuff (rhymes with stuff
132. shom (rhymes with mom)
133. fash (rhymes with cash)

ZAT-RR-English 129

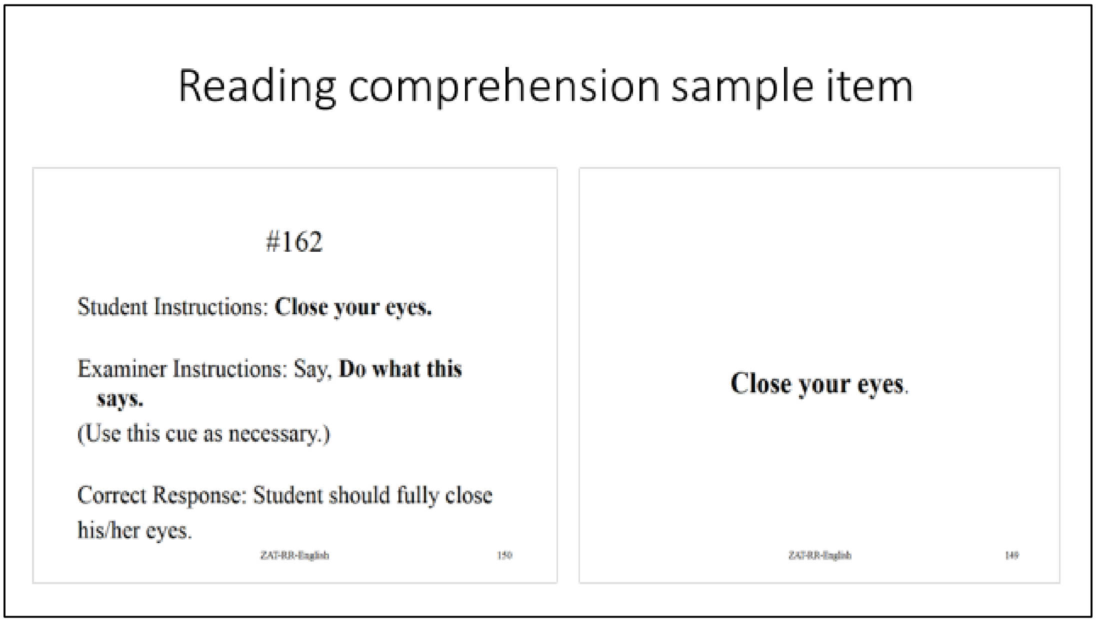
thip

chuff

shom

fash

ZAT-RR-English 128


Reading comprehension sample item
#162
Student Instructions: **Close your eyes.**
Examiner Instructions: Say, **Do what this says.**
(Use this cue as necessary.)
Correct Response: Student should fully close his/her eyes.
ZAT-RR-English 150
Close your eyes.
ZAT-RR-English 149

APPENDIX B

CRONBACH'S ALPHA COEFFICIENTS

1. Nyanja Letter Discrimination

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	8.80	.62	.09	.77
It. #2	8.81	.56	.32	.75
It. #3	8.80	.62	.09	.77
It. #4	8.82	.52	.34	.75
It. #5	8.81	.53	.51	.72
It. #6	8.82	.47	.66	.70
It. #7	8.83	.41	.73	.67
It. #8	8.81	.55	.41	.74
It. #9	8.80	.57	.47	.73
It. #10	8.82	.49	.49	.72
Cronbach's Alpha				**.75**

2. English Letter Discrimination

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	8.63	.92	.27	.72
It. #2	8.61	.97	.21	.72
It. #3	8.60	.96	.41	.70
It. #4	8.60	.93	.55	.68
It. #5	8.60	.94	.38	.70
It. #6	8.60	.94	.48	.69
It. #7	8.59	.96	.62	.69
It. #8	8.62	.87	.45	.68
It. #9	8.77	.63	.47	.72
It. #10	8.60	.89	.56	.68
Cronbach's Alpha				**.72**

3. Nyanja Phonological Awareness

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	12.48	13.78	.43	.78
It. #2	12.358	14.25	.37	.79
It. #3	12. 60	13.57	.46	.78
It. #4	12.34	14.19	.37	.79
It. #5	12.37	15.41	-.03	.81
It. #6	12.42	14.33	.29	.79
It. #7	12.87	14.07	.35	.79
It. #8	12.56	13.66	.44	.78
It. #9	12.46	13.71	.46	.78
It. #10	12.82	13.81	.41	.78
It. #11	12.63	13.35	.51	.78
It. #12	12.71	13.19	.56	.77
It. #13	12.63	13.32	.52	.77
It. #14	12.87	13.89	.41	.78
It. #15	12.45	14.78	.15	.80
It. #16	12.26	14.99	.18	.79
It. #17	12.44	14.38	.27	.79
It. #18	12.29	14.40	.39	.79
It. #19	12.38	14.42	.29	.79
It. #20	12.23	14.97	.25	.79
Cronbach's Alpha				**.79**

4. English Phonological Awareness

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	15.28	11.62	.41	.81
It. #2	15.27	11.58	.45	.80
It. #3	15.47	11.64	.21	.82
It. #4	15.47	11.50	.25	.81
It. #5	15.30	11.21	.58	.80
It. #6	15.31	11.53	.38	.81
It. #7	15.52	10.65	.52	.80
It. #8	15.47	11.00	.42	.80
It. #9	15.32	11.40	.42	.80
It. #10	15.72	10.99	.37	.81
It. #11	15.45	11.40	.30	.81
It. #12	15.46	10.65	.56	.79
It. #13	15.39	11.34	.36	.81
It. #14	15.34	11.43	.39	.81
It. #15	15.27	11.60	.44	.80
It. #16	15.28	11.95	.23	.81
It. #17	15.53	11.19	.33	.81
It. #18	15.30	11.54	.41	.81
It. #19	15.30	11.66	.35	.81
It. #20	15.31	11.23	.52	.80
Cronbach's Alpha				**.81**

5. Nyanja Word Reading

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	42.32	734.95	.72	.99
It. #2	42.32	734.12	.71	.99
It. #3	42.57	728.54	.81	.98
It. #4	43.18	707.56	.89	.98
It. #5	43.38	709.41	.88	.98
It. #6	43.47	710.20	.89	.98
It. #7	43.27	705.66	.90	.98
It. #8	43.53	710.78	.90	.98
It. #9	43.39	709.73	.89	.98
It. #10	43.38	703.73	.92	.98
It. #11	43.65	707.21	.90	.98
It. #12	43.53	707.10	.88	.98
It. #13	43.66	711.69	.89	.98
It. #14	43.41	708.36	.92	.98
It. #15	43.63	711.42	.90	.98
It. #16	43.91	716.42	.83	.98
It. #17	43.29	705.32	.89	.98
It. #18	43.87	711.81	.87	.98
It. #19	43.79	710.12	.87	.98
It. #20	43.77	709.96	.87	.98
Cronbach's Alpha				**.99**

6. English Word Reading

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	30.17	424.36	.54	.97
It. #2	30.49	407.45	.74	.97
It. #3	30.65	402.55	.75	.97
It. #4	31.29	394.36	.81	.97
It. #5	31.01	399.68	.78	.97
It. #6	31.10	395.31	.84	.97
It. #7	31.46	388.35	.86	.97
It. #8	31.79	394.35	.86	.97
It. #9	32.26	393.75	.83	.97
It. #10	31.95	399.46	.81	.97
It. #11	31.87	399.75	.87	.97
It. #12	32.46	402.85	.80	.97
It. #13	32.97	412.18	.74	.97
It. #14	32.65	403.78	.78	.97
It. #15	32.55	401.42	.80	.97
It. #16	33.02	415.52	.71	.97
It. #17	33.08	419.51	.62	.97
It. #18	32.87	408.70	.74	.97
It. #19	33.12	416.85	.67	.97
It. #20	32.96	410.97	.70	.97
Cronbach's Alpha				**.97**

7. Nyanja Pseudoword Decoding

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	20.58	124.49	.50	.95
It. #2	20.40	125.17	.54	.95
It. #3	20.56	123.25	.63	.95
It. #4	20.38	124.91	.59	.95
It. #5	20.51	124.10	.57	.95
It. #6	20.48	123.96	.60	.95
It. #7	20.51	122.98	.68	.95
It. #8	20.42	121.85	.34	.96
It. #9	20.60	122.67	.67	.95
It. #10	20.68	122.98	.62	.95
It. #11	20.55	123.22	.64	.95
It. #12	20.49	123.27	.67	.95
It. #13	20.76	122.91	.63	.95
It. #14	20.68	122.08	.71	.95
It. #15	20.58	121.88	.75	.95
It. #16	20.67	123.00	.62	.95
It. #17	20.56	123.85	.57	.95
It. #18	20.56	124.46	.51	.95
It. #19	20.56	124.01	.56	.95
It. #20	20.68	123.12	.61	.95
It. #21	20.66	122.93	.63	.95
It. #22	20.64	122.39	.68	.95
It. #23	20.64	123.77	.56	.95
It. #24	20.86	124.71	.49	.95
It. #25	20.53	122.23	.74	.95
It. #26	20.55	121.91	.76	.95
It. #27	20.54	122.11	.75	.95

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #28	20.65	123.42	.59	.95
It. #29	20.7863	124.27	.51	.95
It. #30	20.5556	122.75	.68	.95
It. #31	20.7863	123.14	.62	.95
It. #32	20.8120	122.86	.65	.95
It. #33	20.9231	124.97	.49	.95
It. #34	20.9744	126.20	.40	.95
It. #35	20.9231	125.45	.45	.95
It. #36	20.6923	123.61	.56	.95
It. #37	20.9744	125.78	.44	.95
It. #38	20.9145	124.56	.53	.95
Cronbach's Alpha				**.95**

8. English Pseudoword Decoding

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	16.45	125.47	.54	.96
It. #2	16.36	124.91	.64	.96
It. #3	16.40	125.20	.58	.96
It. #4	16.06	125.40	.58	.96
It. #5	16.10	124.50	.64	.96
It. #6	16.08	126.35	.47	.96
It. #7	16.21	124.86	.58	.96
It. #8	16.23	123.46	.71	.96
It. #9	16.24	124.11	.65	.96
It. #10	16.34	125.48	.53	.96
It. #11	16.28	124.20	.64	.96
It. #12	16.18	123.49	.71	.96
It. #13	16.49	124.98	.65	.96
It. #14	16.42	124.28	.68	.96
It. #15	16.30	123.94	.67	.96
It. #16	16.45	125.54	.57	.96
It. #17	16.20	125.74	.50	.96
It. #18	16.23	123.50	.70	.96
It. #19	16.40	126.65	.44	.96
It. #20	16.45	125.50	.57	.96
It. #21	16.31	124.37	.63	.96
It. #22	16.31	124.47	.62	.96
It. #23	16.27	124.78	.59	.96
It. #24	16.46	126.67	.46	.96
It. #25	16.28	124.56	.61	.96
It. #26	16.30	124.31	.63	.96
It. #27	16.33	123.71	.69	.96

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #28	16.26	124.35	.63	.96
It. #29	16.29	124.24	.64	.96
It. #30	16.25	123.68	.69	.96
It. #31	16.57	127.40	.47	.96
It. #32	16.35	124.40	.64	.96
It. #33	16.50	126.18	.54	.96
It. #34	16.56	127.11	.49	.96
It. #35	16.45	124.89	.63	.96
It. #36	16.33	123.15	.75	.96
It. #37	16.49	125.24	.62	.96
It. #38	16.46	125.10	.62	.96
Cronbach's Alpha				**.96**

9. Nyanja Reading Comprehension

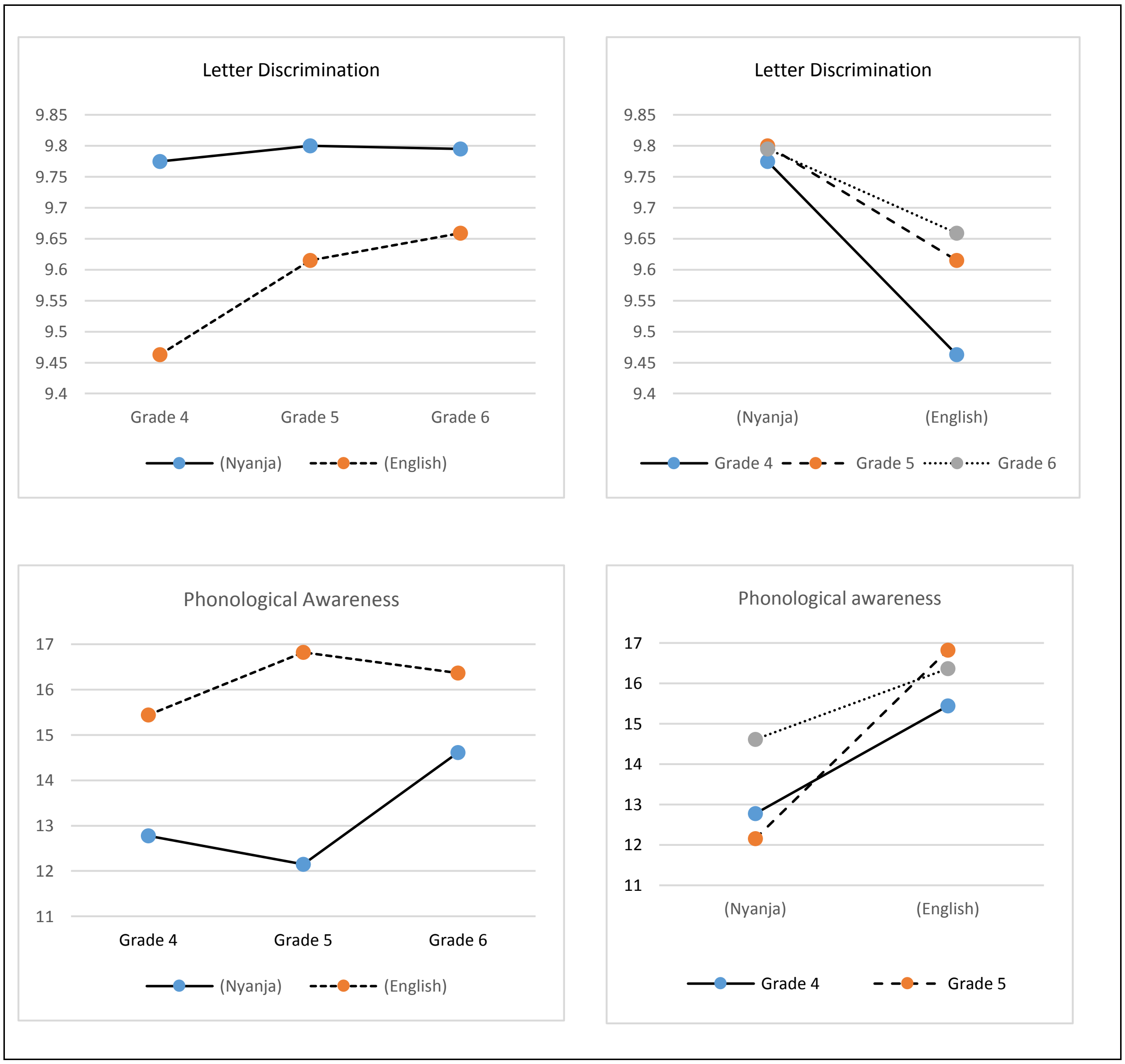
Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	20.11	175.26	.66	.95
It. #2	20.90	179.40	.55	.96
It. #3	20.22	175.88	.62	.96
It. #4	20.46	173.29	.74	.95
It. #5	20.63	175.08	.66	.95
It. #6	20.79	177.58	.60	.96
It. #7	20.15	172.99	.72	.95
It. #8	20.14	174.27	.69	.95
It. #9	20.38	173.91	.68	.95
It. #10	20.13	174.82	.68	.95
It. #11	20.78	176.21	.67	.95
It. #12	20.69	175.97	.64	.95
It. #13	20.79	177.88	.59	.96
It. #14	20.39	171.36	.79	.95
It. #15	20.71	175.00	.74	.95
It. #16	20.85	177.68	.76	.95
It. #17	20.70	173.85	.73	.95
It. #18	20.70	174.59	.72	.95
It. #19	20.86	177.55	.69	.95
It. #20	21.03	179.72	.62	.96
It. #21	20.73	172.91	.73	.95
It. #22	20.46	171.99	.74	.95
It. #23	21.17	183.20	.51	.96
It. #24	20.81	175.24	.69	.95
Cronbach's Alpha				**.96**

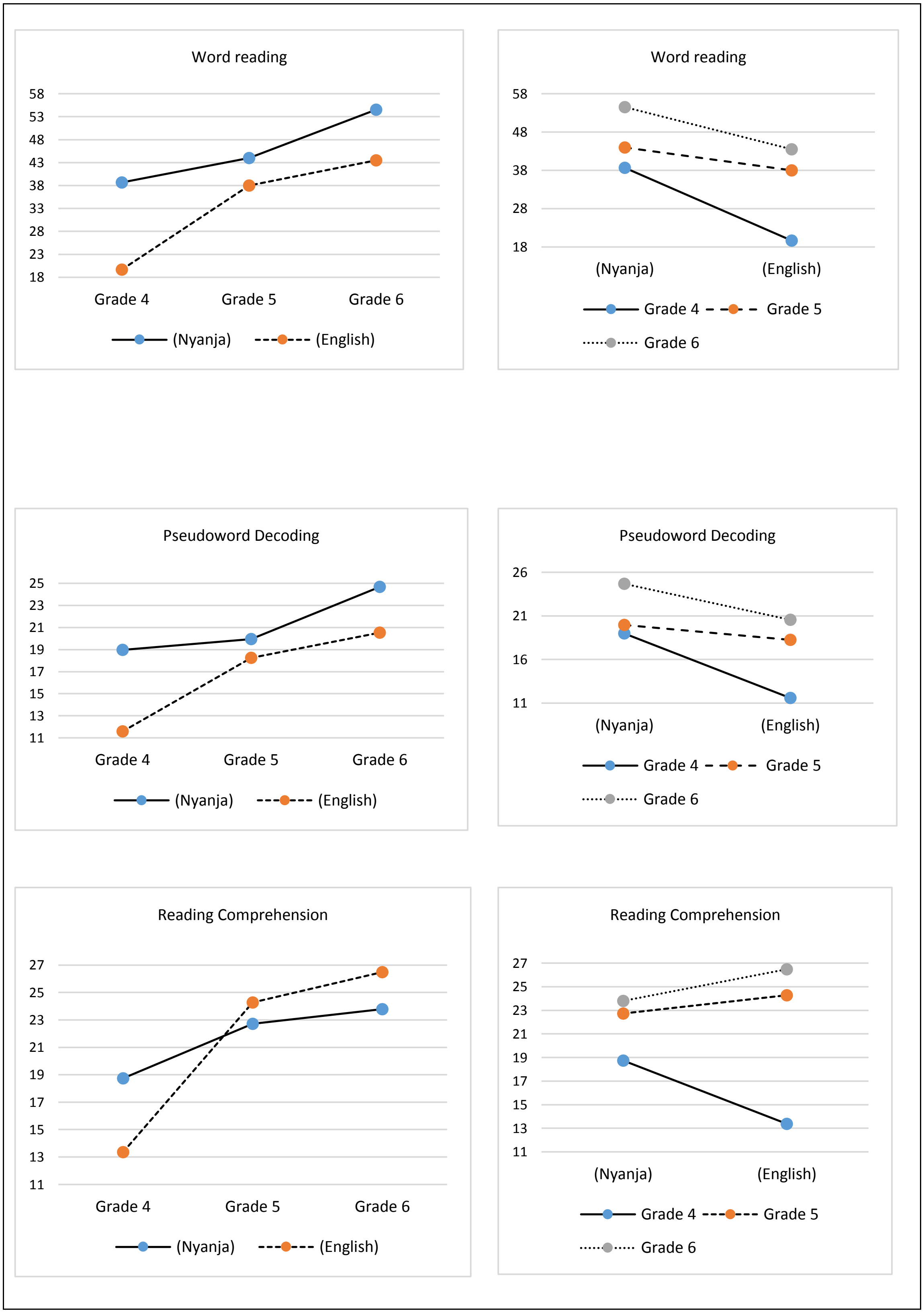
10: English Reading Comprehension

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
It. #1	19.30	155.08	.46	.95
It. #2	19.74	148.08	.72	.95
It. #3	19.58	148.67	.66	.95
It. #4	19.74	148.53	.67	.95
It. #5	19.68	146.44	.76	.95
It. #6	20.08	146.53	.70	.95
It. #7	19.56	148.06	.66	.95
It. #8	20.23	148.89	.65	.95
It. #9	20.13	146.18	.72	.95
It. #10	19.83	146.90	.73	.95
It. #11	20.26	146.11	.76	.95
It. #12	20.48	150.13	.59	.95
It. #13	20.41	149.31	.73	.95
It. #14	20.34	145.57	.73	.95
It. #15	20.40	148.48	.69	.95
It. #16	20.34	148.87	.73	.95
It. #17	20.34	146.24	.75	.95
It. #18	20.46	148.52	.71	.95
It. #19	20.40	149.58	.67	.95
It. #20	20.62	151.64	.62	.95
It. #21	20.45	148.10	.65	.95
It. #22	20.84	158.25	.30	.95
It. #23	20.80	156.06	.49	.95
It. #24	20.73	154.42	.47	.95
Cronbach's Alpha				**.95**

APPENDIX C

READING MEASURES MEANS BY GRADE AND ORTHOGRAPHY




Word reading
58
53
48
43
38
33
28
23
18
Grade 4
Grade 5
Grade 6
(Nyanja)
(English)
Word reading
58
48
38
28
18
(Nyanja)
(English)
Grade 4
Grade 5
Grade 6
Pseudoword Decoding
25
23
21
19
17
15
13
11
Grade 4
Grade 5
Grade 6
(Nyanja)
(English)
Pseudoword Decoding
26
21
16
11
(Nyanja)
(English)
Grade 4
Grade 5
Grade 6
Reading Comprehension
27
25
23
21
19
17
15
13
11
Grade 4
Grade 5
Grade 6
(Nyanja)
(English)
Reading Comprehension
27
25
23
21
19
17
15
13
11
(Nyanja)
(English)
Grade 4
Grade 5
Grade 6

APPENDIX D

IRB APPROVAL LETTER

DIVISION OF RESEARCH

Research Compliance and Biosafety

TEXAS A&M UNIVERSITY

DATE: August 08, 2014

MEMORANDUM

TO: R Joshi
TAMU - Texas A&M University - Not Specified

FROM: Dr. James Fluckey
Chair
Institutional Review Board

SUBJECT: Expedited Approval

Study Number:	IRB2014-0356D
Title:	THE INFLUENCE OF ORTHOGRAPHIC OPACITY ON READING DEVELOPMENT AMONG NYANJA-ENGLISH BILINGUALS IN ZAMBIA: A CROSS-LINGUISTIC STUDY
Approval Date:	08/08/2014
Continuing Review Due:	07/01/2015
Expiration Date:	08/01/2015

This research project has been approved. As principal investigator, you assume the following responsibilities:

1. **Continuing Review:** The protocol must be renewed by the expiration date in order to continue with the research project. A Continuing Review application along with required documents must be submitted by the continuing review deadline. Failure to do so may result in processing delays, study termination, and/or loss of funding.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB.
3. **Unanticipated Problems and Adverse Events:** Unanticipated problems and adverse events must be reported to the IRB immediately.
4. **Reports of Potential Non-compliance:** Potential non-compliance, including deviations from protocol and violations, must be reported to the IRB office immediately.
5. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB for review. The Amendment must be approved by the IRB before being implemented.
6. **Consent Forms:** When using a consent form or information sheet, you must use the IRB stamped approved version. Please log into iRIS to download your stamped approved version of the consenting instruments. If you are unable to locate the stamped version in iRIS, please contact the office.
7. **Audit:** Your protocol may be subject to audit by the Human Subjects Post Approval Monitor. During the life of the study please review and document study progress using the PI self-assessment found on the RCB website as a method of preparation for the potential audit. Investigators are responsible for maintaining complete and accurate study records and making them available for inspection. Investigators are encouraged to request a pre-initiation site visit with the Post Approval Monitor. These visits are designed to help ensure that all necessary documents are approved and in order prior to initiating the study and to help investigators maintain compliance.
8. **Recruitment**: All approved recruitment materials will be stamped electronically by the HSPP staff and available for download from iRIS. These IRB-stamped approved documents from iRIS must be used for recruitment. For materials that are distributed to potential participants electronically and for which you can only feasibly use the approved text rather than the stamped document, the study's IRB Protocol

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College Station, TX 77843-1186
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http://rcb.tamu.edu

number, approval date, and expiration dates must be included in the following format: TAMU IRB#20XX-XXXX Approved: XX/XX/XXXX Expiration Date: XX/XX/XXXX.

1. **FERPA and PPRA:** Investigators conducting research with students must have appropriate approvals from the FERPA administrator at the institution where the research will be conducted in accordance with the Family Education Rights and Privacy Act (FERPA). The Protection of Pupil Rights Amendment (PPRA) protects the rights of parents in students ensuring that written parental consent is required for participation in surveys, analysis, or evaluation that ask questions falling into categories of protected information.
2. **Food:** Any use of food in the conduct of human subjects research must follow Texas A&M University Standard Administrative Procedure 24.01.01.M4.02.
3. **Payments:** Any use of payments to human subjects must follow Texas A&M University Standard Administrative Procedure 21.01.99.M0.03.

This electronic document provides notification of the review results by the Institutional Review Board.