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The contributions of reading and phonological awareness for spelling in grade three isiXhosa learners

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The first and second authors are part of the research team on the literacy intervention from which the secondary data was accessed for the replication study. However, the authors have declared that no competing interests exist.

Availability of data and material

The materials used in the studies are available in the supplementary material either in whole or as links. The data are available via request from the corresponding author.

Code availability

The code for the initial study analysis, the preregistration of the power analysis and replication study are included at OSF (<https://osf.io/cesgf/>).

Authors' contributions

Mikaela Daries - Conceptualisation, Methodology, Writing – original draft, Writing - Review & Editing; Tracy Probert - Conceptualisation, Writing – original draft, Writing - Review & Editing, Supervision; Maxine Schaefer - Conceptualization, Analysis, Writing - Review & Editing

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For both the initial and replication studies, the parents/guardians provided informed consent on consent forms written in isiXhosa. The child participants provided their verbal assent to participate in the research.

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ABSTRACT

Background: One factor, which is consistently highlighted in research on literacy, is the lack of understanding of how literacy develops in the Southern-Bantu languages. In particular, little is known about spelling in the Southern-Bantu languages such as isiXhosa.

Objectives: Through the use of an initial exploratory study and a conceptual replication study, we examined the relationships between reading, phonological awareness (PA), and spelling in isiXhosa grade 3 learners. The initial exploratory study sought to describe the relationships between reading and spelling, and PA and spelling in a sample of 49 grade 3 isiXhosa learners. We then conceptually replicated this study with a larger sample of 200 grade 3 isiXhosa learners. We expected that both reading and PA would be related to spelling and that the strength of the relationship between reading and spelling, and PA and spelling would vary with spelling ability, due to the changes that occur in the development of spelling.

Method: Cross-sectional, quantitative secondary data was used from two different projects to answer the research questions. Tasks of PA, oral reading fluency and spelling were developed and administered to the participants.

Results: We found that reading was a replicable predictor of spelling for grade 3 isiXhosa learners and that PA was influential only at the mid-range of spelling performance.

Conclusion: Our findings emphasise the importance of the reading-writing connection, and lend support for what has been found for other consistently written languages, adding to the growing body of knowledge of universal predictors of spelling development.

Keywords: spelling; phonological awareness; oral reading fluency; literacy; isiXhosa; replication

INTRODUCTION

Reading and spelling are essential academic skills necessary for future educational success and successful participation in modern societies (Ehri 1987; Pretorius & Mokhwesana 2009; Zarić et al. 2020). It is, therefore, concerning that most South African learners cannot read, write, and comprehend at grade-appropriate levels, with many learners declared functionally illiterate (Spaull 2013). The 2016 Progress in International Literacy Study (PIRLS) re-emphasized this, revealing that 78% of South African grade 4 learners are not able to read for meaning (Howie et al. 2017). There are a number of contributory factors to South African learners' underachievement (De Vos et al. 2015; Van der Berg et al. 2016). One factor, which is consistently highlighted, is the lack of understanding of how literacy develops in the alphabetically written Southern-Bantu languages (Spaull et al. 2020; de Vos et al. 2015). In particular, little is known about spelling in the Southern-Bantu languages such as isiXhosa, with most studies focusing on decoding ability and the related role of phonological awareness (PA) (Makaure, 2021; Schaefer, Probert & Rees, 2020; Wilsenach 2013, 2019). Consequently, the predictors of spelling are not yet well understood in isiXhosa and further research is needed to enhance our understanding of spelling development in the Southern-Bantu languages.

In this manuscript, the relationships between reading, PA, and spelling in isiXhosa were examined using secondary data from two studies. The first study was an exploratory cross-sectional study. The aim of the first study was to describe the relationships between reading and spelling, and PA and spelling in a small sample of grade 3 isiXhosa learners. The first study was limited as it was cross-sectional and had a small sample size, giving us minimal evidence for the developmental relationship between variables, and leading to large confidence intervals of the estimates, respectively. We addressed these limitations by conducting a second, confirmatory, study with four times the sample size.

The following two research questions were addressed in each study:

1. What are the unique contributions of reading and phonological awareness to spelling in grade 3 isiXhosa learners?
2. To what extent does the relationship between reading and spelling, and phonological awareness and spelling, differ by spelling ability level?

In this manuscript we start by providing an overview of spelling development and its relation to reading and phonological awareness. We then address the method, results and a brief discussion of each study respectively, highlighting the differences between study 1 and study 2 in the description of study 2. We end with a general discussion of our findings and provide a conclusion.

LITERATURE REVIEW

Spelling development

Spelling is the ability to recognize and reproduce spoken language into a correct sequence of written symbols (Mpiti 2012; Moats 2010; Santoro et al. 2006; Weiser & Mathes 2011). While there is not a consensus on the development of spelling across languages, the main theories and perspectives are briefly reviewed below. These theories are, however, based mainly on English studies. Cross-linguistic studies on spelling development are relatively limited (Babayigit 2009).

The earliest and most well-known model of spelling development was introduced by Gentry (1982), who suggested that learning to spell takes place in five stages, from a reliance on phonological knowledge to a dependence on orthographic and morphological knowledge (Bourassa & Treiman 2010; Schlagel 2007). He posited that learners begin at the “precommunicative stage” where the learner has partial knowledge of the alphabet but does not yet understand letter-sound relationships (Gentry 1982). At this stage, spellings are characterized by the strategy of randomly selecting letter strings to represent words (Ellis 1994). The second stage is the “semi-phonetic stage”, where learners have some grasp of letter-sound relationships, with spellings containing a partial mapping of phonetic content. It is at this stage that children often represent words, sounds or syllables with letters that match their letter names, for example, “U” for “you” (Ellis 1994). In the “phonic” or third stage, they begin to use phonics to map letter-sound correspondences, for example, “haws” for “house” (Ellis 1994). In the later stages (transitional and correct stages), learners move from phonological spelling and start to incorporate morphological and orthographic knowledge when spelling (Gentry 1982).

Critiques of the stage theory have stated that it provides a linear account of spelling and oversimplifies the picture with little consideration of the linguistic characteristics of the language

being learnt (Bourassa & Treiman 2010). For example, different languages have specific morphological and orthographic knowledge needed to be acquired by learners and therefore some skills are grasped more easily than others and at different periods in spelling development (Bourassa & Treiman 2010). Nevertheless, the theory acknowledges the developmental shifts when learning to spell, especially from a reliance on phonological knowledge to a dependence on orthographic and morphological knowledge (Bourassa & Treiman 2010; Ravid 2012; Schlagal 1989). However, Babayiğit (2009) argued that children may utilize both phonological and orthographic spelling processes in the early stages of development depending on the demand of the task, their level of alphabetic knowledge, PA and print experience.

Cross-linguistic studies which have examined spelling development and the specific skills most relevant for spelling development across languages are growing but most studies have focused on English (Caravolas 2004; Georgiou et al. 2020). Nevertheless, there is a general acknowledgment that spelling relies on letter knowledge (e.g., Finnish, Greek and English: Georgiou et al. 2012), PA (e.g., English, Spanish, Slovak, and Czech: Caravolas et al. 2012), morphological awareness (e.g., English: Apel et al. 2012), orthographic knowledge (e.g., English: Apel 2009) and reading experience (e.g. Finnish: Lerkkanen et al. 2004; Leppänen et al. 2006; French, Dutch, German and Greek; Georgiou et al. 2020). As noted above, PA and reading are related to spelling ability. The interrelation between these concepts are addressed in more detail in the next sections.

The relationship between phonological awareness and spelling

PA is defined as the awareness of the sound structure of a language and the ability to perceive or manipulate sounds within a linguistic sequence (Moll et al. 2014). PA is typically divided into the following linguistic components: onset-rime, syllables and phonemes (Anthony & Francis 2005; Chard & Dickson 1999; Stahl & Murray 1994; Treiman 1991).

There is an extensive body of research which confirms that PA is a significant predictor of both reading and spelling across different languages (Adams 1990; Babayiğit & Stainthorp 2007; Bryant et al. 1990; Caravolas et al. 2005; Landerl & Wimmer 2008; Hulme & Snowling 2015; Zarić et al. 2020). Notably it has been revealed that phoneme awareness is the strongest predictor of early word reading in alphabetic languages (Melby-Lervåg et al. 2012). Similarly, research on

the Southern-Bantu languages converge on the importance of PA for reading (Lekgoko & Winskel 2008; Malda et al. 2014; Wilsenach 2013, 2015, 2019). However, the relationship between spelling and PA in the Southern-Bantu languages is less clear.

International research reports that PA plays a concurrent and longitudinal role in spelling performance (Caravolas et al. 2012; Harrison et al. 2016; Landerl & Wimmer 2008; Lervåg & Hulme 2010; Veber et al. 2016). In particular, research has suggested that PA and spelling should have a stronger relationship in languages with transparent orthographies due to the consistent nature of the phoneme to grapheme and grapheme to phoneme mappings (e.g., Leppänen et al. 2006; Oney & Durgunoglu 1997). PA is a necessary prerequisite for the conversion of phonemes to graphemes, the primary requirement of spelling across all alphabetically written languages. However, as noted in Georgiou et al. (2012), these assertions are not made in consideration of the individual characteristics which exist within languages with transparent orthographies.

de Bree and van den Boer's (2019) study of Dutch spelling in grades 1 and 2 found that PA significantly predicted spelling in regression analyses. However, when reading was added into their regression model, PA along with other contributors (visual attention span and rapid automatized naming) were no longer significant, confirming the importance of reading for early spelling (de Bree & van den Boer 2019; Desimoni et al. 2012; Keuning & Verhoeven 2008; Leppänen et al. 2006) and reaffirming the link between PA and reading (Frith 1985; de Bree & van den Boer 2019). De Bree & van den Boer (2019) suggest that PA constitutes mainly as an underlying skill of reading and that PA relates to spelling but that it is not necessarily sufficient in explaining how learners convert phonemes to graphemes. Thus, they suggest that further research is needed to investigate specific correlates and underlying skills related to spelling, for example, vocabulary knowledge, morphological awareness, and orthographic learning (Kim et al. 2013; de Bree & van den Boer 2019). These results are of particular significance as Dutch, like isiXhosa, is considered to have a transparent orthography in which the regularity of the orthographic system is higher in grapheme-phoneme relations (forward regularity, e.g., reading) than it is in phoneme-grapheme relations (backward regularity, e.g. encoding) (Daries & Probert 2020; Bosman et al. 2006). For example, in isiXhosa, there are a number of complex graphemes for which multiple letters represent single sounds e.g. <dl>, <ph>, <tsh> (Spaull et al. 2020). An outline of isiXhosa language structure is included in the supplementary material.

Southern African research on spelling in languages other than English confirms the relationship between PA and spelling. PA was associated with spelling ability in Herero for a sample of grade 2-5 learners (Veii 2003), in Oshikwanyama for a sample of grade 1 learners assessed again in grade 2 (Nghikembua 2020), and in isiXhosa for a small sample of grade 3 isiXhosa learners (Diemer 2015). Makuare (2021) found similar results with 134 Northern Sotho-English bilingual learners. The study's findings showed that phonological skill was one of the best predictors of Northern Sotho spelling. Common to all these studies was the need to develop tests of PA suitable to each language, and sample. These were real word PA tests of phoneme isolation using sound matching (e.g. Which one is the odd one out: *sava*, *sina*, *zuva*? (Veii 2003), real word phoneme isolation tasks (e.g. What is the first sound of *pedu*? (Nghikembua 2020), and pseudoword tasks of segmenting (e.g. Break up this word into its sounds: *gofotsa*) and elision (Say *hlenama* without /hl/) (Diemer 2015). Although various tasks have been used, an effect of PA on spelling was found across different South African languages and grade levels.

The relationship between reading and spelling

Reading can be understood as the starting point of spelling as what learners are able to read can provide the basis for what they are able to spell (Bear et al. 2004). When learners read or practice reading they are recognising common letter patterns in words, mapping sounds onto letters and letter patterns which develops their orthographic representations of words necessary for spelling (Conrad 2008). This suggests that spelling can provide an indication of learners' reading ability. Furthermore, Gentry (2004:11) states that "learners learn to read by spelling" and knowledge of the alphabetic principle necessary for spelling supports reading. This is because spelling and reading rely on the same lexical representations (Templeton 2004; Ehri 1997, 2005; Perfetti 1997).

While the exact nature of the relationship between reading and spelling is not clearly defined and understood, there are a number of studies which indicate strong and significant correlations between spelling and reading ability (de Bree and van den Boer 2019; Abbot et al. 2010; Caravolas et al. 2001; Ehri 1997; Foorman et al. 1991; Ritchey 2008; Georgiou et al. 2020; Foorman et al. 1991). There are few studies which examine the effect of reading on spelling in the African languages found in Southern Africa, but existing studies confirm that reading ability

is associated with spelling. For example, Nghikembua (2020) reported a significant association between grade 1 reading and grade 2 spelling using a path analysis model in Oshikwanyama. Given cross-linguistic evidence on the role of reading for spelling in orthographies which vary in transparency (e.g. Georgiou et al. 2020), one might expect to find a positive association between reading ability and spelling in other African languages.

STUDY 1

METHOD

Study 1 was exploratory. We used cross-sectional data first reported by Daries and Probert (2020).

Participants

The participants were 49 (20 female, 29 male; $M_{age} = 9.1$ years, $SD_{age} = 0.7$ years) grade 3 children attending one Quintile 3 isiXhosa medium of instruction school in a small low-income township of the Eastern Cape of South Africa. Participants were assessed in the third term of 2019.

Measures

Tasks of PA, ORF and spelling were developed and administered to the participants. The PA and spelling instruments used in both studies can be found on the Open Science Framework (OSF) (<https://osf.io/cesgf/>).

Spelling

The spelling task consisted of 12 real words which ranged from two to four syllables in length (Daries & Probert 2020). As described in Daries and Probert (2020), a number of linguistic decisions relating to word frequency, word length in syllables and grapheme complexity, were made in the design of the spelling task. The spelling task was scored using a binary set of codes, that is, correct and incorrect per item. The item scores were summed ($\max = 12$) for each learner. The reliability of the task was 0.95 as measured by Cronbach's alpha (Daries & Probert 2020).

Reading

Reading ability was measured using a one-minute timed Oral Reading Fluency (ORF) task. ORF is defined as the ability to read a text quickly, accurately, and with meaningful expression (Fuchs et al. 2001; Spaull et al. 2020). ORF is often used as a measure of learners' reading ability, and is traditionally calculated using a words correct per minute (WCPM) score which reflects both accuracy and speed (Spaull et al. 2020).

The ORF task required the learners to read aloud an isiXhosa short story from a grade 3 book for one minute. The story *Iyho! Mkhulu lo mnqathe! (Wow! A gigantic carrot)* was used from the Vula Bula books and was 102 words long with a mean of 6.8 words per sentence, and 7.4 letters per orthographic word. The errors made during the tasks were recorded and subtracted from the total words the learner attempted to read to provide a words correct per minute (WCPM) score. The WCPM score was used in the analysis.

Phonological Awareness

PA was measured using 48 pseudoword items (12 items per condition) at the phoneme and syllable levels using elision and isolation tasks (Diemer 2015; Probert 2016). Pseudowords, ranging from two to four syllables long, rather than real words were used to reduce the influence of semantic information on responses. These tasks were developed in consideration of the linguistic and cognitive complexity appropriate for isiXhosa and for grade 3 learners (Diemer et al. 2015). The item scores per task were summed per learner and these total scores were used in the principal components analysis to derive a final score. The reliability of the overall task was 0.92 as measured by Cronbach's alpha.

Procedures

Ethical clearance for the study was granted by the University (2020-1195-3307), and the Eastern Cape Department of Basic Education. Participants' guardians signed informed consent forms and participants provided verbal assent to participate.

The order of task administration was fixed. The PA and ORF tasks were administered individually before the spelling task, which was administered in a group setting. Each word of the

spelling task was read aloud twice for dictation. Task presentation for PA was fixed so that phoneme subtasks (isolation then elision) were presented first, followed by the syllable subtasks (isolation then elision).

Data analysis procedures

We used R version 4.04 (R Core Team 2021) for the analysis. The code is available on OSF (<https://osf.io/cesgf/>). A principal components analysis, using the psych package (Revelle 2020), was run on the four PA indicators to reduce the number of variables in the later analysis. We first specified four factors (one for each measure). There was only one eigenvalue above one indicating that the data fit a one principal component model. We extracted the scores of the first principal component for later analysis and labeled this PA. We used the raw total score for spelling to make it more comparable across studies.

To estimate the predictors of spelling at the mean of spelling (research question 1), we used hierarchical linear regression analyses. We ran a series of models first with only the intercept, then added the covariate age, followed by reading, and PA in the final step so that we could estimate the unique effects of PA and reading ability, and calculated the change in R^2 at each step. The residuals were not normally distributed so we used 2000 bootstrap resamples to estimate the slopes and their confidence intervals.

To determine if the slope of PA for spelling, and the slope of reading for spelling differed by spelling ability level, we fitted quantile regression models using the quantreg package (Koenker 2021) in R. Quantile regression allows researchers to determine whether the relationship between predictors and an outcome variable depend on the value of the outcome variable, such as whether the outcome variable is low or high (Petersen & Logan 2014). For example, quantile regression was used by James et al. (2021) to determine whether morphological awareness had a similar contribution to reading comprehension for low, middle and high ability students on reading comprehension.

The data for study 1 comes from a cross-sectional design. To interpret the results of the quantile regression, we argue that students with low scores on the spelling task are at a different developmental level than students who score higher on the task. We interpret different total scores on the spelling task as reflecting performance that corresponds to different spelling ability levels. Thus, we fit the quantile regression to the data at the 10th, 50th and 90th quantiles (as done by James et al. 2021, and McIlraith & Reading Research Consortium 2018) corresponding to earlier spelling development, typical spelling development for the sample, and advanced spelling ability, respectively. We determined that quantile regression would best allow us to address the second research question.

The interpretation of a quantile model slopes differs slightly from that of linear regression (Peterscher & Logan 2014). It is recommended to use centered variables for the predictors such that zero represents mean ability. At each quantile, then, the intercept corresponds to the value of the outcome at that quantile. The slope of the predictor (let us call it x) should be interpreted as the difference in the outcome between a participant with mean of x and a participant at 1 SD on x (Peterscher & Logan 2014). The confidence interval indicates whether this difference (i.e. slope term) is different from zero. In this study, we performed 1000 bootstrap resamples to estimate the confidence intervals. Quantile comparisons are used to statistically test whether the slopes are different at each quantile (Peterscher & Logan 2021). A goodness of fit statistic is also calculated for each quantile (Koenker & Machado 1999).

RESULTS

The descriptive statistics and correlations among the variables are presented in Table 1. Visualisations of the spread of the raw data, and assumptions of the linear regression, are presented in the OSF project, <https://osf.io/cesgf/>.) PA and reading had moderate to strong correlations with spelling (r above .65). Age was weakly correlated with spelling and reading, and had a weak negative correlation with PA ($r = -.35$, $p = .04$). We categorised the sample into reading fluency groups using the suggested isiXhosa fluency benchmarks for children in grade 3 (Ardington et al. 2021, see Table S1). In our sample, thirty-one children (61%) were not reading at the lower fluency threshold of 20 WCPM. Seventeen children (33%) read within the fluency zone of 20-34 WCPM

which was a similar proportion found for isiXhosa learners in term 1 of grade 3 (Ardington et al. 2021). Only one child read above the upper threshold of 35 or more WCPM. The sample includes slower readers than those sampled by Ardington et al. (2021).

Table 1. Study 1: Descriptive statistics and Pearson correlations for PA, reading, spelling and age

Variable (unit/ maximum score)	1. Age (years)	2. Phon. Elision (/12)	3. Phon. Iso. (/12)	4. Syl. Elision (/12)	5. Syl. Iso. (/12)	6. PA: PCA	7. Readin g (wcpm)	8. Spellin g (/12)
Descriptive Statistics (N = 49)								
Mean	9.1	4	5.1	4.6	5.6	0	15.8	9.3
Median	9	2	5	5	6	0	16	11
SD	0.7	4.3	3.5	3.2	4.1	1	10.5	4
Min	8	0	0	0	0	-1.7	0	0
Max	10	12	12	11	12	2.2	41	12
Pearson Correlations								
2. Phon. Elision	-.35*							
3. Phon. Isolation	-.25	.50***						
4. Syl. Elision	-.22	.53***	.41**					
5. Syl. Isolation	-.03	.19	.35*	.47**				
6. PA PCA	-.29*	.76***	.76***	.82***	.64***			
7. Reading	-.19	.48**	.52***	.58***	.36*	.66***		
8. Spelling	-.21	.54***	.53***	.62***	.49***	.73***	.66***	

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Phon. – Phoneme; Iso. – Isolation, Syl. – Syllable; PA – Phonological Awareness; PCA – Principal Components Analysis; wcpm – words correct per minute;

The results of the multiple linear regression and quantile regression are presented in Table 2 below and in Figure 1 in the following section (Study 2 Results). The results were different for each estimation method. At the mean, both reading and PA were significant predictors accounting for 39.4% and 14.7% of the variance, respectively (see Linear Regression in Table 2). The confidence intervals for reading and PA overlapped with one another, indicating that the slopes may not be different from one another. The trend in the quantile regression results was that the difference in ability on spelling was larger for a participant 1 SD higher on reading (slope = 2.36), than PA (slope = 1.33) at the 10th quantile, and the trend was reversed at the 50th quantile (reading slope = 0.74, PA slope = 2.07). However, there was no difference in performance for participants at the mean or 1 SD above the mean on the predictors at the 90th quantile, possibly because the participants at the 90th quantile were at ceiling on the spelling task. A quantile comparison test indicated that the slopes did not differ across quantiles, which is confirmed also by the overlap in confidence intervals at each quantile.

Table 2. Study 1: Comparison of linear and quantile regressions of spelling on age, reading and PA

Model	Parameter	Estimate	SE	95% CI	t	p	ΔR^2
Linear Regression							
Final Model	(Intercept)	8.99	4.56	[-0.10, 17.91]	1.78	.080	
	Age	0.03	0.50	[-0.96, 1.01]	0.06	.950	0.02
	Reading	1.27	0.40	[0.57, 2.14]	2.5	.017	0.39
	PA	2.11	0.47	[1.32, 3.14]	4.1	<.001	0.15
Model	Parameter	Estimate	SE	95% CI	t	p	Goodness of Fit
Quantile Regression							
QR-10	(Intercept)	3.75	13.02	[-22.48, 29.97]	0.29	.775	0.54
	Age	0.21	1.43	[-2.68, 3.10]	0.15	.884	
	Reading	2.36	1.08	[0.19, 4.54]	2.20	.034	
	PA	1.33	1.11	[-0.91, 3.57]	1.20	.237	
QR-50	(Intercept)	9.8	6.03	[-2.35, 21.95]	1.62	.111	0.254
	Age	0.00	0.67	[-1.35, 1.35]	0.00	.999	
	Reading	0.74	0.58	[-0.44, 1.91]	1.26	.213	
	PA	2.07	0.81	[0.43, 3.70]	2.55	.014	
QR-90	(Intercept)	12	1.75	[8.48, 15.52]	6.90	<.001	0
	Age	0.00	0.19	[-0.38, 0.38]	0.00	1	
	Reading	0.00	0.22	[-0.44, 0.44]	0.00	1	
	PA	0.00	0.53	[-1.06, 1.06]	0.00	1	

Note: Linear regression: $F(3, 45) = 21.62$, $p < .001$; $N = 49$; nested models compared to calculate ΔR^2 . Quantile regression: $N = 149$; Goodness of fit provided for the model at each quantile and not per predictor. QR-10 – quantile regression at 10th quantile; QR-50 – quantile regression at 50th (median) quantile; QR-90 – quantile regression at 90th quantile.

Discussion

Our first study was exploratory, and examined to what extent PA and reading predicted spelling at the mean, and at different quantiles of spelling performance, corresponding to low, medium and high performance on spelling. With reference to the first research question, we found that at the mean (linear regression), both reading and PA were significant (unique) predictors of spelling. With reference to the second research question, the quantile regression presented evidence that the strength of the predictors may differ at different spelling ability levels, with reading ability leading to larger differences on spelling at the 10th quantile, and PA ability leading to larger differences on spelling ability at the 50th quantile. At the 90th quantile, the participants were at ceiling levels of performance in spelling. However, given the small sample size, all confidence intervals were wide, leading to the slope differences not reaching significance.

Study 1 provided evidence that both PA and reading are significant predictors of real word spelling in this sample, but there was insufficient precision to address whether these relationships do differ by spelling ability level.

STUDY 2

Study 2 was conducted to determine whether the results of study 1 were replicable, and is, therefore, a confirmatory study. Based on the results of study 1, and a review of the literature, we hypothesised that we would find similar trends to study 1 in study 2¹. In study 2 we expected that both reading and PA would be positively associated with spelling for grade 3 isiXhosa learners as PA is a necessary prerequisite for the conversion of phonemes to graphemes, the primary requirement of spelling, across all alphabetically written languages (Georgiou et al. 2012). Additionally, research has attested to a relationship between spelling and reading (de Bree and van den Boer 2019; Abbot et al. 2010; Caravolas et al. 2001; Ehri 1997; Foorman et al. 1991; Ritchey 2008). In addressing the first research question, our null hypothesis (H(0)1) was that there would be no relationship between reading, PA and spelling, and the alternate hypothesis (H(1)1) was that reading and PA would be positively associated with spelling.

¹These hypotheses and how they would be tested were pre-registered before the research commenced. The pre-registration is accessible on OSF (<https://osf.io/gbqx6>) and also provides the results of the power analysis undertaken for the linear regression analysis.

Furthermore, we expected that the strength of the relationship between PA and spelling, and reading and spelling would vary with spelling ability, due to the changes that occur in the development of spelling. At early stages of spelling, reading should play a larger role, with a shift to phonemic decomposition as children become better spellers and then a shift to orthographic and morphemic spelling as children become more accurate spellers (Ellis 1994; Gentry 1982; Frith 1985).

The second null hypothesis ($H(0)2$) was that the strength of the relationship between reading and spelling, and PA and spelling, would not differ by spelling ability. We had specific alternate hypotheses for each level of spelling ability tested in our models, based on the results of study 1:

H(1)2a: Reading will have a stronger positive association with spelling, compared to PA, at the lower end of spelling ability.

H(1)2b: PA will have a stronger positive association with spelling, compared to reading, at the middle of the range of spelling ability.

H(1)2c: Reading and PA will not be associated with spelling at the higher end of spelling ability.

METHOD

We used secondary data from a collaborative literacy intervention project to perform a conceptual replication of study 1. The intervention project focuses on strengthening the isiXhosa literacy skills of children in grades 1 to 3 in five schools in low socioeconomic areas in the Eastern Cape of South Africa as well as upskilling and capacity building of teachers and literacy ambassadors (classroom assistants). Study 2 draws participants from the same population of grade 3 learners in low-income Quintile 3 township schools in the Eastern Cape. All participants attended schools in which the intervention took place i.e., there was no comparison/control group. The intervention results are not of interest to this manuscript and will not be considered further.

Study 2 differs notably from study 1 in the following ways: PA is measured using a shorter task, the data is from an intervention project, participants were assessed at the start and end of

grade 3, and the participants were sampled in 2021 which is the second year that COVID-19 impacted the quantity and quality of education in South Africa.

Participants

Two hundred participants (104 female, 96 male) were sampled from 12 classrooms (1-28 participants per classroom) and five schools (15-75 learners per school). The participants' self-reported age at the start of grade 3 was 8.5 years ($SD = 1$ year) on average. The age difference between the study 1 and study 2 participants represented a large effect, $t(247) = 3.97$, $p < .001$, $d = 0.63$, 95% CI [0.31, 0.95]. The study 1 sample reported their age later in the school year (quarter 3) than the study 2 sample (quarter 1) so this difference somewhat corresponds to the 7.5 month expected difference in average ages. Thus, in terms of school socioeconomic status and self-reported age, the participants were similar between studies.

Measures

Study 2 also included tasks of PA, ORF and spelling, with some differences addressed here.

Spelling

The spelling task administered in study 2 used eight of the 12 real words used in study 1. Four words were replaced to enhance the complexity of the task as some ceiling effects were identified with the grade 3 sample used in Daries and Probert (2020). The Cronbach's alpha internal consistency for this task was 0.86.

Reading

Reading was measured in the same way as study 1, with a new text. The story titled *Uhobe noMbovane (Ant and Dove)* was used. This reading passage was 72 words long with a mean of 5.1 words per sentence, and 7.8 letters per orthographic word.

Phonological awareness

PA was measured slightly differently in study 2 with regards to the stimuli, number of items and the way the final score was calculated. The stimuli were 12 real words on which participants were asked to perform the same operations as study 1, i.e. phoneme and syllable elision

and isolation. Because of the reduced number of items, Cronbach's alpha was lower ($\alpha = .70$). Only a total sum score was available in the dataset. The PA tasks in both studies measured the same construct so their effect on the outcome variable (spelling) can be compared, with the following caveats: Raw or z scores cannot be directly compared as the tasks are not identical, and the lower reliability of the task in study 2 and the way the final score was calculated means that the final score includes more error compared to true score than in study 1. The effect of the latter is that the relationship between PA and the outcome will be attenuated (Plonsky & Derrick 2016). We return to the effect of this difference when interpreting the results of this conceptual replication.

Procedures

The data collection procedures were the same as study 1, except that data was collected at the start and end of grade 3, whereas for study 1, data was only collected towards the end of grade 3. The dataset was missing 3.1% of data points but under listwise deletion we would lose 69 (34.5%) participants. Age and spelling at the start of grade 3 and spelling at the end of grade 3 were the variables with the most missing data. Participants who had at least one missing data point had lower start of grade 3 reading and PA scores (small effect size), and lower start of grade 3 spelling scores (medium effect size) than participants with complete data, i.e. the data was Missing at Random. Since listwise deletion would drastically reduce the sample size and bias the estimates (Woods et al. 2021), we imputed the missing data using predictive mean matching in mice (multiple imputation by chained equations) (van Buuren & Groothuis-Oudshoorn 2011). We imputed 10 datasets with 10 iterations each and saved the final model's final iteration as the dataset we worked with.

The data analysis was similar to study 1, except that we used mixed models to account for the clustering of the data at school or teacher level. We used lme4 (Bates et al. 2015), lmerTest (Kuznetsova et al. 2017), and lqmm (Geraci 2014; Geraci & Bottai 2014) to estimate these models. Using mixed models, we are able to calculate the intra-class correlation (ICC) to determine the proportion of variance in the outcome explained by the clustering variable (classroom or school). Because we can account for clustering, the standard errors associated with the fixed effects (i.e. variables of interest: age, reading and PA) are less biased than using analytic methods which do not account for the clustering (Theobald 2018).

RESULTS

The descriptive statistics and correlations among the variables are presented in Table 3. Visualisations of the spread of the raw data, and assumptions of the linear regression, are presented in the OSF project (<https://osf.io/cesgf/>). On average, the ORF of the group was low at the start of grade 3 ($M = 12.7$, $SD = 13.6$), and had improved by the end of grade 3 ($M = 30.7$, $SD = 19$). There was a large effect size difference in the reading abilities of study 2 participants at the end of grade 3 compared to study 1, $t(247) = -5.29$, $p < .001$, $d = -0.84$, 95% CI $[-1.16, -0.52]$. There were more learners at or above the threshold of 20 WCPM in study 2 (70%) than in study 1 (37%) at the same point in the academic year. There was no difference for spelling between the studies at the same point in the academic year, $t(247) = 0.94$, $p = .348$, $d = 0.15$, 95% CI $[-0.16, 0.46]$. The PA scores could not be compared directly because of the different way the construct was measured in each study. The correlations among variables was moderate to strong, which was similar to study 1. The correlation between PA, and reading and spelling was slightly lower than in study 1, probably due to the lower reliability of the PA task in study 2. As in study 1, age was negatively and weakly correlated with PA at the end of grade 3. Additionally, the same negative correlation was found for spelling at the end of grade 3 in study 2.

Table 3 Study 2: Descriptive statistics, effect size difference (Cohen's d) to study 1 and Pearson correlations for PA, reading, spelling and age

Variable (unit/ maximum score)	T1: Start of Grade 3				T2: End of Grade 3		
	1. Age (years)	2. Reading (wcpm)	3. PA (/12)	4. Spelling (/12)	5. Reading (wcpm)	6. PA (/12)	7. Spelling (/12)
Descriptive Statistics (N = 200)							
Mean	8.5	12.7	5.5	5.3	30.7	8.7	8.7
Median	8	9	5	5	31.5	10	11
SD	1	13.6	3	4.3	19	3	4
Min	6	0	0	0	0	0	0
Max	12	70	12	12	72	12	12
Difference to Study 1							
t	4.0	1.5	-	5.6	-5.3	-	0.9
P	<.001	.138	-	<.001	<.001	-	.348
Cohen's d	0.63	0.2	-	0.9	-0.8	-	0.2
[95% CI]	[0.31, 0.95]	[-0.1, 0.6]		[0.6, 1.2]	[-1.2, -0.5]		[-0.2, 0.5]
Pearson Correlations							
2. T1 Reading	-0.18*						
3. T1 PA	-0.08	0.52***					
4. T1 Spelling	-0.12	0.78***	0.53***				
5. T2 Reading	-0.13	0.69***	0.46***	0.66***			
6. T2 PA	-0.21**	0.40***	0.43***	0.46***	0.54***		
7. T2 Spelling	-0.21**	0.55***	0.54***	0.67***	0.60***	0.61***	-

Note: * p < .05, ** p < .01, *** p < .001; PA tasks not directly comparable between study 1 and study 2

The results of the linear mixed model and linear quantile models are presented in Table 4 and Figure 1. First, the intra-class correlation (ICC) was examined to determine whether school or teacher random effects should be included in the model. The ICC for school level was .161 for start of grade 3 and .025 for end of grade 3, and for teacher level the ICC was .084 at the start of grade 3 and .032 at the end of grade 3. We decided to use school random effects for start of grade 3 and teacher random effects for end of grade 3 because these levels affected the spelling outcome the most. We then fitted maximal models with varying intercepts, varying intercepts and slopes (uncorrelated) and varying intercepts and slopes (correlated). Only the varying intercepts models converged and were used for further analysis. In the final step, we determined the fixed effects by comparing a null model (only the cluster predictor) to successive models adding age, then reading, then PA. For both timepoints, the model fit improved with the addition of each fixed effect. Thus, we report the models using varying intercepts for school (start of grade 3) and teacher (end of grade 3) with all three predictors, in Table 4.

The linear mixed model, which estimated the mean, found that at both the start and end of grade 3, reading and PA were significant predictors of spelling. The 95% CI for reading at the end of grade 3 (beta = 1.47, [0.9, 2.0]) overlapped with the estimate in study 1 (beta = 1.27, [0.57, 2.14]). The 95% CI for PA for study 2 (beta = 1.71, [1.2, 2.2]) and study 1 (beta = 2.11, [1.32, 3.14]) also overlapped, despite the change in measurement. As expected, the width of the 95%CI was smaller in study 2 because of the larger sample. The 95% CIs of the start of grade 3 estimates (reading beta = 2.97, [2.5, 3.5], PA beta = 0.76, [0.4, 1.2]) did not overlap with those at the end of grade 3 for either study 1 or 2; the reading estimate was much larger, and the PA estimate much smaller.

The linear mixed quantile regression results indicated that participants who had 1 SD higher ability in reading and PA had a similar increment in spelling score compared to participants at mean of these variables at the 10th and 50th quantiles at the end of grade 3 (Table 4). At the 90th quantile, neither were significant, replicating what was found in study 1. The clustering at teacher level accounted for a large proportion of the variance at the 90th quantile (ICC = .294)

compared to the other quantiles ($ICC = .016$ 10th, $ICC_{50th} = .023$). The start of grade 3 results established reading as a significant predictor at all three tested quantiles. Participants with 1 SD higher on reading had higher scores on spelling than those at the mean at each quantile, with a slightly smaller difference at the 10th quantile. Participants who differed by 1 SD on PA only had higher scores on spelling at the 50th quantile. The school that a participant was in had the largest effect at the 10th quantile ($ICC = .093$), than the other two quantiles ($ICC_{50th} = .008$, $ICC_{90th} = .014$).

Table 4 Study 2: Results from mixed effects models at the mean, and 0.1, 0.5 and 0.9 quantiles at the start of grade 3 (school random effects) and end of grade 3 (teacher random effects)

		T1: Start of Grade 3					T2: End of Grade 3				
Model	Parameter	Est.	95%			p	Est.	SE	95%		
			SE	CI	t				CI	t	p
Linear Mixed Model											
	ICC	.161					.032				
	(Intercept)	5.28	0.26	[4.8, 5.9]	20.3	.000	8.74	0.33	[8.1, 9.4]	26.8	.000
	Age	0.01	0.20	[-0.4, 0.4]	0.0	.970	-0.31	0.21	[-0.7, 0.1]	-1.5	.146
	Reading	2.97	0.23	[2.5, 3.5]	13.0	<.001	1.47	0.25	[0.9, 2.0]	5.8	.000
	PA	0.76	0.23	[0.4, 1.2]	3.3	.001	1.71	0.25	[1.2, 2.2]	6.7	.000
	RE (Intercept) SD	0.37		[0, 0.9]			0.84		[0, 1.4]		
	RE Residual SD	2.67		[2.4, 3.0]			2.83		[2.5, 3.1]		
Model	Parameter	Est.	95%			p	Est.	SE	95%		
			SE	CI	t				CI	t	p
Linear Mixed Quantile Model											
QR-10	ICC	.093					.016				
	(Intercept)	5.17	0.35	[4.5, 5.9]		<.001	5.44	0.84	[3.8, 7.1]		<.001
	Age	0.00	0.07	[-0.1, 0.1]		.999	-0.36	0.37	[-1.1, 0.4]		.335
	Reading	2.46	0.27	[1.9, 3.0]		<.001	2.23	0.77	[0.6, 3.9]		.006
	PA	0.00	0.13	[-0.3, 0.3]		.999	1.85	0.89	[0.04, 3.7]		.043
	RE (Intercept) SD	1.22					0.64				
	RE Residual SD	3.82					5.04				
QR-50	ICC	.008					.023				

	(Intercept)	4.96	0.27	[4.4, 5.5]	<.001	8.79	0.42	[7.8, 9.8]	<.001
	Age	0.00	0.21	[-0.4, 0.4]	0.999	-0.49	0.31	[-1.1, 0.1]	.121
	Reading	3.75	0.39	[3.0, 4.6]	<.001	1.73	0.65	[0.4, 3.0]	.010
	PA	0.78	0.21	[0.4, 1.2]	<.001	1.58	0.43	[0.8, 2.4]	<.001
	RE (Intercept) SD	0.26				0.48			
	RE Residual SD	2.80				3.07			
QR-90	ICC	.014				.294			
	(Intercept)	8.52	1.18	[6.2, 10.9]	<.001	12.00	0.63	[11.0, 13.3]	<.001
	Age	-0.14	0.49	[-1.1, 0.8]	.768	0.00	0.07	[-0.1, 0.1]	.999
	Reading	4.02	0.94	[2.1, 5.9]	<.001	0.00	0.18	[-0.3, 0.3]	.999
	PA	0.71	0.43	[-0.2, 1.6]	.103	0.00	0.15	[-0.4, 0.4]	.999
	RE (Intercept) SD	0.56				2.13			
	RE Residual SD	4.80				3.30

Figure 1. Model coefficients with 95% confidence intervals for linear and quantile regressions for study 1 (end of Grade 3) and study 2 (start and end of Grade 3)

Discussion

In the second study, we aimed to replicate the findings of study 1. We found evidence in support of our first hypothesis that reading and PA are related to spelling ability. These findings were replicated at the mean of spelling where the 95% CIs of the estimates overlapped for study 1 and study 2. We also find evidence in support of our second hypothesis. Comparing the start and end of grade 3 linear mixed model results in study 2, we found that reading was a stronger predictor of spelling at the lower ability level (i.e. start of grade 3) than at the higher spelling ability level (i.e. end of grade 3). The mixed quantile regression results partially supported H(1)2a and H(1)2c. At the lower end of spelling ability, 1 SD change in reading lead to larger gains in spelling compared to 1 SD change in PA. When spelling ability was at ceiling level, neither PA nor reading were significant predictors. We had hypothesised that PA would become a stronger predictor of spelling at the mid-range of spelling ability. Although it did reach significance at the 50th quantile at the start of grade 3, and the 10th and 50th quantiles for end of grade 3, a 1 SD change in PA compared to someone at the mean lead to an increase in spelling scores that was lower than or of similar magnitude to a 1SD difference on reading.

GENERAL DISCUSSION

In two studies, we examined the relationships between reading, PA and spelling for isiXhosa grade 3 learners. Research has confirmed the importance of both reading and PA for spelling, and in this study, we contribute to the growing body of evidence from languages other than English by using data from isiXhosa. Additionally, we included a conceptual replication of our own work to determine the replicability of our findings. After running our analyses on a small sample of participants at the end of grade 3, we sought to replicate the analyses using a sample four times larger, and assessed at both the start and end of grade 3. The participants were similar in terms of the schools they attended and their mean age extrapolated to the end of grade 3. The participants' end of grade 3 spelling scores did not differ between studies, but the study 2 participants had higher reading abilities at the end of grade 3. Thus, in most respects, the participants were similar.

These two studies indicated that in isiXhosa, reading and PA make significant unique predictions to spelling (Research Question 1). Reading was a consistent positive concurrent predictor of spelling in grade 3. This supports the findings of Nghikembua (2020), who reported a significant association between grade 1 reading and grade 2 spelling in Oshikwanyama. Further this result seems to be in line with the perspective of Bear et al. (2004) who explains that reading is the starting point of spelling in that what learners are able to read provides the basis for what they are capable of spelling. When learners read or practice reading they are recognising common letter patterns in words, mapping sounds onto letters and letter patterns which develops their orthographic representations of words necessary for spelling (Conrad 2008).

PA was a consistent positive predictor of spelling at the mean of spelling across studies, which is consistent with the findings for Herero grade 2-5 learners (Vei 2003), Oshikwanyama grade 1 and grade 2 learners (Nghikembua, 2020) and isiXhosa grade 3 learners (Diemer 2015). However, its relationship to spelling differed across the spelling ability distribution (research question 2). In the quantile models, PA was significant at the mid-range of spelling ability (i.e. when the intercept corresponded to raw scores of five to ten). In the replication (study 2), PA's effect was weaker than reading. This result is similar to what de Bree and van den Boer (2019) found for transparently written Dutch. The difference in the strength of the relationship between PA and spelling at the 50th quantile in study 1 and study 2 may be due to how PA was measured in each study, and also possibly due to the study 2 participants having higher overall reading skills at the end of grade 3. Overall, these two studies provide evidence for Ellis' (1994) observation that young spellers begin with early attempts at copying whole words (which relies on reading experience) to developing degrees of mastery of the alphabetic principle by using phonetic decomposition (which relies on PA) to finally developing orthographic and morphemic spelling (which relies on orthographic and morphological awareness) (Gentry 1982; Frith 1985). The influence of PA was restricted to the middle of the range of performance. At ceiling levels of spelling performance, neither PA nor reading were significant predictors, highlighting that other skills, such as orthographic or morphological awareness, may play a role.

At the method level, we undertook a conceptual replication of Study 1. We did this to address the imprecision in our estimates due to the small sample size, a limitation of many applied linguistics research articles. Notably the measurement of PA in each study differed. The

measurement of PA in Study 2 more closely represented how PA has been measured in the past: a sum score of fewer than 15 items. When summing all items, all items are given equal weight in the PA construct. Reliability is lower in a shorter than a longer test. However, in Study 1, a principal components analysis was used on almost 50 items. In principal components analysis, items are weighted based on their contribution to the overall PA construct, thus providing a “truer” representation of the PA construct. Additionally, longer tests are more reliable. The briefer nature of the PA task included as a sum score in study 2 compared to a more detailed task converted to a principal components score in Study 1 may have led to an underestimation of the role of PA in Study 2. This is a limitation applicable across studies which use sum scores, and tasks with reliability on the lower end.

Overall, the findings of our study confirm the association found between reading and spelling ability, and PA and spelling ability in transparent orthographies using cross-sectional data. The strengths of our study included a replication aspect where similar participants were sampled at the start and end of grade 3 compared to study 1. Future studies could sample participants before they begin formal instruction and longitudinally follow their spelling development until grade 3. Longitudinal studies can best address how various predictors relate to spelling over the course of development. We did not include additional variables known to affect spelling such as orthographic or morphological awareness (Apel et al. 2012; Apel 2009), and we included only one indicator variable per construct. Future research could include multiple measures of the same construct and use a latent variable framework to better account for measurement error. Sum scores are easy to use in practice and to interpret but the sole use of sum scores could lead to an underestimation of effects. As far as possible, researchers are encouraged to share item level data, not only total summed scores, in their open access datasets which would allow these kinds of latent variable analyses. Our findings emphasize the importance of the reading-writing connection. Spelling was most related to reading ability, and PA was associated with spelling at the mid-range of performance. These results suggest that teachers should make sure children know their letter-sound correspondences, can blend these to form words, and can use these skills automatically for fluent reading which may in-turn support spelling development.

In conclusion, through the use of two studies, we found that reading was a replicable predictor of spelling for grade 3 isiXhosa learners and that PA was influential only at the mid-range of spelling performance. These findings support what has been found for other consistently written languages, adding to the growing body of knowledge of universal predictors of reading and spelling development.

REFERENCES

- Abbott, R. D., Berninger, V. W., & Fayol, M. 2010. Longitudinal relationships of levels of language in writing and between writing and reading in grades 1 to 7. *Journal of Educational Psychology*, 102(2), 281. 281–298. doi:10.1037/a0019318
- Adams, M. J. 1990. Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.
- Anthony, J. L., & Francis, D. J. 2005. Development of phonological awareness. *Current Directions in Psychological Science*, 14(5), 255-259. , 255–259. doi:10.1111/j.0963-7214.2005.00376.x
- Apel, K. 2009. The acquisition of mental orthographic representations for reading and spelling development. *Communication Disorders Quarterly*, 31, 42–52. 10.1177/1525740108325553
- Apel, K., Wilson-Fowler, E. B., Brimo, D., & Perrin, N. A. 2012. Metalinguistic contributions to reading and spelling in second and third grade students. *Reading and Writing*, 25, 1283-1305. <https://doi.org/10.1007/s11145-011-9317-8>
- Ardington, C., Wills, G., Pretorius, E., Mohohlwane, N., & Menendez, A. 2021. Benchmarking oral reading fluency in the early grades in Nguni languages. *International Journal of Educational Development*, 84, 102433. <https://doi.org/10.1016/j.ijedudev.2021.102433>
- Babayiğit, S. 2009. Reading and spelling in transparent alphabetic orthographies: Points of convergence and divergence. In C. Wood & V. Connelly (Eds.), *Contemporary perspectives on reading and spelling* (pp. 133-148). London: Routledge.
- Babayiğit, S., & Stainthorp, R. 2007. Preliterate phonological awareness and early literacy skills in Turkish. *Journal of Research in Reading*, 30(4), 394-413. <https://doi.org/10.1111/j.1467-9817.2007.00350.x>

- Bates, D., Mächler, M., Bolker, B., & Walker, S. 2015. Fitting Linear Mixed-Effects Models Using {lme4}. *Journal of Statistical Software*, 67(1), 1–48.
<https://doi.org/10.18637/jss.v067.i01>
- Bear, D.R., Invernizzi, M., Templeton, S., & Johnston, F. 2004. Words their way. Upper Saddle River, NJ: Merrill Prentice Hall.
- Bosman, A., Vonk, W., & van Zwam, M. 2006. Spelling consistency affects reading in young Dutch readers with and without dyslexia. *Annals of Dyslexia*, 56, 271–300.
<https://doi.org/10.1007/s11881-006-0012-4>
- Bourassa, D. C., & Treiman, R. 2010. Linguistic foundations of spelling development. In *The Routledge International Handbook of English, Language and Literacy Teaching* (pp. 206–216). Routledge.
- Bryant, P.E., MacLean, M., Bradley, L. L., & Crossland, J. 1990. Rhyme and Alliteration, Phoneme Detection, and Learning to Read. *Developmental Psychology*, 26, (3), 429–438.
- Caravolas, M., Hulme, C., & Snowling, M. J. 2001. The foundations of spelling ability: Evidence from a 3-year longitudinal study. *Journal of Memory and Language*, 45(4), 751–774.
doi:10.1006/jmla.2000.2785
- Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavský, M., Onochie-Quintanilla, E., et al. 2012. Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological Science*, 23, 678–686.
<https://doi.org/10.1177/0956797611434536>
- Caravolas, M., Volín, J., & Hulme, C. 2005. Phoneme awareness is a key component of alphabetic literacy skills in consistent and inconsistent orthographies: Evidence from Czech and English children. *Journal of Experimental Child Psychology*, 92, 107–139.
<https://doi.org/10.1016/j.jecp.2005.04.003>
- Caravolas, M. 2004. Spelling development in alphabetic writing systems. *European Psychologist*, 9(1), 3–14. <https://doi.org/10.1027/1016-9040.9.1.3>
- Chard, D. J., & Dickson, S. V. 1999. Phonological awareness: Instructional and assessment guidelines. *Intervention in school and clinic*, 34(5), 261–270.
<https://doi.org/10.1177/105345129903400502>
- Conrad, N. J. 2008. From reading to spelling and spelling to reading. *Journal of Educational Psychology*, 100(4), 869–878. doi:10.1037/a0012544

- Daries, M. A., & Probert, T. N. 2020. A linguistic analysis of spelling errors in grade 3 isiXhosa home-language learners. *Reading & Writing*, 11(1). e1-e10. doi:10.4102/rw.v11i1.265
- de Bree, E., & van den Boer, M. 2019. Knowing what we don't know: Cognitive correlates of early spelling of different target types. *Reading & Writing*, 32(8). 2125-2148. doi:10.1007/s11145-019-09936-9
- De Vos, M., Van der Merwe, K. & Van der Mescht, C. 2015. A linguistic research programme for reading in African languages to underpin CAPS. *Journal for Language Teaching*, 48(2), 148–177. <https://doi.org/10.4314/jlt.v48i2.7>
- Desimoni, M., Scalisi, T. G., & Orsolini, M. 2012. Predictive and concurrent relations between literacy skills in grades 1 and 3: A longitudinal study of Italian children. *Learning and Instruction*, 22, 340– 353. <https://doi.org/10.1016/j.learninstruc.2012.02.002>
- Diemer, M.N. 2015. The contributions of phonological awareness and naming speed to the reading fluency, accuracy, comprehension and spelling of Grade 3 isiXhosa readers. unpublished MA dissertation, Rhodes University, Grahamstown.
- Diemer, M., van der Merwe, K., & de Vos, M. 2015. The development of phonological awareness literacy measures for isiXhosa. *Southern African Linguistics and Applied Language Studies*, 33(3), 325-34. <https://doi.org/10.2989/16073614.2015.1108769>
- Ehri, L. C. 1987. Learning to spell and read words. *Journal of Reading Behaviour*, 19, 5-31.
- Ehri, L. C. 1997. Learning to read and learning to spell are one and the same, almost. In C. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory and practice* (pp. 237–269). Mahwah, NJ: Erlbaum.
- Ehri, L. C. 2005. Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading*, 9, 167–188. https://doi.org/10.1207/s1532799xssr0902_4
- Ellis, N. C. 1994. Longitudinal studies of spelling development. In G. D. A. Brown & N. C. Ellis (Eds.), *Hand- book of spelling: Theory, process and intervention* (pp. 155–190). Chichester, UK: Wiley.
- Foorman, B. R., Francis, D. J., Novy, D. M., & Liberman, D. 1991. How letter-sound instruction mediates progress in first-grade reading and spelling. *Journal of Educational Psychology*, 83(4), 456-469. doi:10.1037/0022-0663.83.4.456

- Frith, U. 1985. Beneath the surface of developmental dyslexia. In K. Patterson, J. Marshall & M. Coltheart (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading*, (pp. 301–330). London: Erlbaum.
- Fuchs, L.S., Fuchs, D., Hosp, M.K. & Jenkins, J.R. 2001. Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading*, 5(3), 239–256. https://doi.org/10.1207/S1532799XSSR0503_3
- Furnes, B., & Samuelsson, S. 2009. Preschool cognitive and language skills predicting kindergarten and grade 1 reading and spelling: A cross-linguistic comparison. *Journal of Research in Reading*, 32, 275–292.
- Gentry, J. R. 1982. Analysis of developmental spelling skills in GNYS AT WRK. *The Reading Teacher*, 36, 192–200.
- Gentry, J. R. 2004. The science of spelling: The explicit specifics that make great readers and writers (and spellers!). Portsmouth, New Hampshire: Heinemann.
- Georgiou, G. K., Torppa, M., Manolitsis, G., Lyytinen, H., & Parrila, R. 2012. Longitudinal predictors of reading and spelling across languages varying in orthographic consistency. *Reading and Writing: An Interdisciplinary Journal*, 25, 321–346. <https://doi.org/10.1007/s11145-010-9271-x>.
- Georgiou, G. K., Torppa, M., Landerl, K., Desrochers, A., Manolitsis, G., de Jong, P. F., & Parrila, R. 2020. Reading and Spelling Development Across Languages Varying in Orthographic Consistency: Do Their Paths Cross? *Child Development*, 91(2), e266–e279. <https://doi.org/10.1111/cdev.13218>
- Geraci, M. 2014. Linear quantile mixed models: The lqmm package for laplace quantile regression. *Journal of Statistical Software*, 57(13), 1–29. <https://doi.org/10.18637/jss.v057.i13>
- Geraci, M., & Bottai, M. 2014. Linear quantile mixed models. *Statistics and Computing*, 24(3), 461–479. <https://doi.org/10.1007/s11222-013-9381-9>
- Harrison, G., Goegan, L. D., Jalbert, R., McManus, K., Sinclair, K., & Spurling, J. 2016. Predictors of spelling and writing skills in first- and second-language learners. *Reading and Writing: An Interdisciplinary Journal*, 29, 69–89. <https://doi.org/10.1007/s11145-015-9580-1>.

- Howie, S., Combrinck, C., Roux, K., Tshele, M., Mokoena, G. & McLeod Palane, N., 2017, PIRLS 2016 progress in international reading literacy study 2016: South African children's reading literacy achievement, Centre for Evaluation and Assessment, Pretoria, Retrieved March, 1, 2021, from <http://www.sajce.co.za>.
- Hulme, C. & Snowling, M.J. 2015. Learning to read: What we know and what we need to understand better. *Child Development Perspectives*, 1(7), 1–5. [10.1111/cdep.12005](https://doi.org/10.1111/cdep.12005)
- James, E., Currie, N. K., Tong, S. X., & Cain, K. 2021. The relations between morphological awareness and reading comprehension in beginner readers to young adolescents. *Journal of Research in Reading*, 44(1), 110–130. <https://doi.org/10.1111/1467-9817.12316>
- Keuning, J., & Verhoeven, L. 2008. Spelling development throughout the elementary grades: The Dutch case. *Learning and Individual Differences*, 18(4), 459-470. <https://doi.org/10.1016/j.lindif.2007.12.001>
- Kim, Y. S., Apel, K., & Al Otaiba, S. 2013. The relation of linguistic awareness and vocabulary to word reading and spelling for first-grade students participating in response to intervention. *Language, Speech, and Hearing Services in Schools*, 44, 337–347. [https://doi.org/10.1044/0161-1461\(2013/12-0013\)](https://doi.org/10.1044/0161-1461(2013/12-0013)).
- Koenker, R. 2021. quantreg: Quantile Regression. R package version 5.86. <https://CRAN.R-project.org/package=quantreg>
- Koenker, R., & Machado, J. A. F. 1999. Quantile regression, inference processes and goodness of fit. *Journal of the American Statistical Association*, 94(448), 1296–1310.
- Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. 2017. {lmerTest} Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, 82(13), 1–26. <https://doi.org/10.18637/jss.v082.i13>
- Landerl, K., & Wimmer, H. 2008. Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology*, 100, 150–161. <https://doi.org/10.1037/0022-0663.100.1.150>.
- Lekgoko, O., & Winskel, H. 2008. Learning to read Setswana and English: Cross-language transference of letter knowledge, phonological awareness and word reading skills. *Perspectives in Education*, 26(4), 57-73. <https://hdl.handle.net/10520/EJC87497>

- Leppänen, U., Aunola, K., Niemi, P., & Nurmi, J.E. 2008. Letter knowledge predicts Grade 4 reading fluency and reading comprehension. *Learning and Instruction*, 18, 548–564.
<https://doi.org/10.1016/j.learninstruc.2007.11.004>
- Lerkkanen, M., Rasku-Puttonen, H., Aunola, K., & Nurmi, J. 2004. The developmental dynamics of literacy skills during the first grade. *Educational Psychology*, 24, 793–810.
<https://doi.org/10.1080/0144341042000271782>
- Lervåg, A., & Hulme, C. 2010. Predicting the growth of early spelling skills: Are there heterogeneous developmental trajectories? *Scientific Studies of Reading*, 14, 485–513.
<https://doi.org/10.1080/10888431003623488>
- Makaure, Z. P. 2021. The contribution of phonological processing skills to early literacy development in northern Sotho-English bilingual children: a longitudinal investigation (Doctoral dissertation).
- Malda, M., Nel, C., & Van de Vijver, F. J. 2014. The road to reading for South African learners: The role of orthographic depth. *Learning and Individual Differences*, 30, 34–45.
<https://doi.org/10.1016/j.lindif.2013.11.008>
- Marsden, E., Morgan-Short, K., Thompson, S., & Abugaber, D. 2018. Replication in Second Language Research: Narrative and Systematic Reviews and Recommendations for the Field. *Language Learning*, 68(2), 321–391. <https://doi.org/10.1111/lang.12286>
- McIlraith, A. L., & Language and Reading Research Consortium. 2018. Predicting word reading ability: a quantile regression study. *Journal of Research in Reading*, 41(1), 79–96.
<https://doi.org/10.1111/1467-9817.12089>
- Melby-Lervåg, M., Lyster, S.-A. H., & Hulme, C. 2012. Phonological skills and their role in learning to read: A meta-analytic review. *Psychological Bulletin*, 138, 322–352. doi: 10.1037/a0026744
- Moats, L. C. 2010. *Speech to print: Language essentials for teachers*. Baltimore, MD: Brookes.
- Moll, K., Ramus, F., Bartling, J., Bruder, J., Kunze, S., Neuhoff, N., ... & Landerl, K. 2014. Cognitive mechanisms underlying reading and spelling development in five European orthographies. *Learning and instruction*, 29, 65–77.
<https://doi.org/10.1016/j.learninstruc.2013.09.003>
- Mpiti, T. 2012. *The nature of spelling errors of Grade three isiXhosa background learners in English First Additional Language*. Doctoral dissertation, University of Fort Hare.

- Nghikembua, T. N. 2020. Learning to Read and Spell in Oshikwanyama Language Precursors , Dynamics and Teacher Knowledge of Early Literacy Instruction [University of Jyväskylä]. <http://urn.fi/URN:ISBN:978-951-39-8385-7>
- Öney, B., & Durgunoglu, A.Y. 1997. Beginning to read in Turkish: A phonologically transparent orthography. *Applied Psycholinguistics*, 18, 1–15. doi:10.1017/S014271640000984X
- Perfetti, C. A. 1997. The psycholinguistics of spelling and reading. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to Spell: Research, Theory, and Practice Across Languages* (pp. 21–38). Mahwah: Lawrence Erlbaum Associates Publishers.
- Petscher, Y., & Logan, J. A. R. 2014. Quantile Regression in the Study of Developmental Sciences. *Child Development*, 85(3), 861–881. <https://doi.org/10.1111/cdev.12190>
- Pretorius, E. & Mokhwesana, M. 2009. Putting reading in Northern Sotho on track in the early years: Changing resources, expectations and practices in a High Poverty School. *South African Journal of African Languages*, 1, 54–73. <https://doi.org/10.1080/02572117.2009.10587317>
- Probert, T. 2016. A comparative study of syllables and morphemes as literacy processing units in word recognition: IsiXhosa and Setswana. unpublished MA dissertation, Rhodes University, Grahamstown.
- R Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.
- Ravid, D. D. 2012. The Psycholinguistics of Spelling: Phonology and Beyond. In *Spelling Morphology* (pp. 21-39). Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-0588-8_2
- Revelle, W. 2021. psych: Procedures for Personality and Psychological Research, Northwestern University, Evanston, Illinois, USA, <https://CRAN.R-project.org/package=psych> Version = 2.1.6,.
- Ritchey, K. 2008. The building blocks of writing: Learning to write letters and spell words. *Reading and Writing: An Interdisciplinary Journal*, 21, 27–47. <https://doi.org/10.1007/s11145-007-9063-0>
- Santoro L. E., Coyne M. D., Simmons D. C. 2006. The reading-spelling connection: Developing and evaluating a beginning spelling intervention for children at risk of reading disability.

- Learning Disabilities Research and Practice*, 21(2):122–133. doi: 10.1111/j.1540-5826.2006.00212.x.
- Schaefer, M., Probert, T., & Rees, S. 2020. The roles of phonological awareness, rapid automatised naming and morphological awareness in isiXhosa. *Per Linguam*, 36(1), 90-111. <https://doi.org/10.5785/36-1-878>.
- Schlagal, R. C. 1989. Constancy and change in spelling development. *Reading Psychology: An International Quarterly*, 10(3), 207-232. <https://doi.org/10.1080/0270271890100302>
- Smythe, I., Everatt, J., Al-Menaye, N., He, X., Capellini, S., Gyarmathy, E., et al. 2008. Predictors of word-level literacy amongst Grade 3 children in five diverse languages. *Dyslexia*, 14, 170–187. <https://doi.org/10.1002/dys.369>
- Spaull, N. 2013. South Africa’s education crisis: The quality of education in South Africa 1994-2011. Johannesburg: Centre for Development and Enterprise, 21(1), 1-65. Retrieved March 12, 2021, from <http://www.section27.org.za/wp-content/uploads/2013/10/Spaull-2013-CDE-report-South-Africas-Education-Crisis.pdf>
- Spaull, N., Pretorius, E. & Mohohlwane, N. 2020. Investigating the comprehension iceberg: Developing empirical benchmarks for early-grade reading in agglutinating African languages. *South African Journal of Childhood Education*, 10(1), e1–e14. <https://doi.org/10.4102/sajce.v10i1.773>
- Stahl, S. A., & Murray, B. A. 1994. Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology*, 86(2), 221.
- Templeton, S. 2004. Instructional approaches to spelling. In E. R. Silliman & L.C. Wilkinson (Eds.), *Language and literacy learning in schools* (pp. 273-291). New York, NY: The Guilford Press.
- Theobald, E. 2018. Students are rarely independent: When, why, and how to use random effects in discipline-based education research. *CBE Life Sciences Education*, 17(3), 1–12. <https://doi.org/10.1187/cbe.17-12-0280>
- Treiman, R. 1991. Children’s spelling errors on syllable-initial consonant clusters. *Journal of Educational Psychology*, 83, 346-360.
- van Buuren, S., & Groothuis-Oudshoorn, K. 2011. {mice}: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, 45(3), 1–67. <https://www.jstatsoft.org/v45/i03/>

- van der Berg, S., Spaull, N., Wills, G., Gustafsson, M., & Kotzé, J. 2016. Identifying binding constraints in education. Retrieved May 10, 2021, from SSRN 2906945.
- Veber Nielsen, A.-M., & Juul, H. 2016. Predictors of early versus later spelling development in Danish. *Reading and Writing: An Interdisciplinary Journal*, 29, 245–266.
<https://doi.org/10.1007/s11145-015-9591-y>
- Veii, K. 2003. Cognitive and linguistic predictors of literacy in Namibian Herero- English bilingual school children [University of Surrey].
<https://core.ac.uk/download/pdf/40107776.pdf>
- Weiser, B., & Mathes, P. 2011. Using encoding instruction to improve the reading and spelling performances of elementary students at risk for literacy difficulties: A best-evidence synthesis. *Review of Educational Research*, 81(2), 170-200.
<https://doi.org/10.3102/0034654310396719>
- Wilsenach, C. 2013. Phonological skills as predictor of reading success: An investigation of emergent bilingual Northern Sotho/English learners. *Per Linguam: a Journal of Language Learning = Per Linguam: Tydskrif vir Taalaanleer*, 29(2), 17-32.
<https://hdl.handle.net/10520/EJC146853>
- Wilsenach, C. 2019. Phonological awareness and reading in Northern Sotho – understanding the contribution of phonemes and syllables in grade 3 reading attainment. *South African Journal of Childhood Education*, 9(1), e1-e10. doi:10.4102/sajce.v9i1.647
- Wilsenach, C. 2015. Receptive vocabulary and early literacy skills in emergent bilingual Northern Sotho-English children. *Reading & Writing* 6(1), 11. <https://doi.org/10.4102/rw.v6i1.77>
- Woods, A. D., Davis-Kean, P., Halvorson, M. A., King, K. M., Logan, J. A. R., Xu, M., Gerasimova, D., Vasilev, M. R., Bainter, S., Clay, J. M., Van Dusen, B., Moreau, D., Joyal-Desmarais, K., Cruz, R. A., Brown, D. M. Y., Schmidt, K., Nissen, J., Uzdavines, A., & Elsherif, M. M. 2021. *Best Practices for Addressing Missing Data through Multiple Imputation*. <https://doi.org/10.31234/osf.io/uaezh>
- Zarić, J., Hasselhorn, M., & Nagler, T. 2020. Orthographic knowledge predicts reading and spelling skills over and above general intelligence and phonological awareness. *European Journal of Psychology of Education*, 36(1), 21-43. <https://doi.org/10.1007/s10212-020-00464-7>