Linguistic skills involved in learning to spell: An Australian study

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Abstract

Being able to accurately spell in Standard English requires efficient coordination of multiple knowledge sources. Therefore, spelling is a word-formation problem solving process that can be difficult to learn. The present study uses Triple Word Form Theory as a conceptual framework to analyse Standard English spelling performance levels of Australian primary school students (N=1,198) in Years 3 to 6. Systematic linguistic error analysis and testing using a factorial multivariate analysis of variance (MANOVA) revealed significant year level differences in phonological, orthographic and morphological scores; however, the effects for gender and the interaction of year level and gender were non-significant. The results suggest that learning to spell may not proceed in developmental stages or phases and that explicit instruction in phonological, orthographic and morphological components of the language is needed in the middle and upper primary school years, and potentially beyond. The findings highlight a need for teachers to be informed of the specific linguistic skills that individual students bring to the classroom and to be able to identify instructional priorities among phonology, orthography and morphology.

Introduction

Becoming proficient in Standard English spelling is a gradual and complex endeavour (Devonshire, Morris, and Fluck 2013) which forms a crucial part of literacy learning as it can facilitate translation of ideas into meaningful written messages (Berninger et al. 1998). Students who display inadequate spelling skills may consciously devote attention to the task of spelling rather than on other resources required for composing quality texts (Graham, Harris, and Chorzempa 2002). If difficulty with spelling persists beyond the primary school years, students may avoid writing and 'develop a mindset that they cannot write', which may then lead to 'arrested writing development' (Graham and Santangelo 2014, 1704).

In order to support children's learning in spelling, there is a need to understand how their application of the spelling components manifests throughout the primary school years. Perspectives from the 1980s have postulated that children learn to spell by progressing through developmental 'stages' or 'phases' (Ehri 1985; Henderson and Beers 1980). Although stage theories of spelling development may have remained popular among many educators, a growing body of research suggests that learning to spell does not necessarily follow a linear path (Sharp, Sinatra, and Reynolds 2008; Garcia, Abbott, and Berninger 2010; Devonshire, Morris, and Fluck 2013). However, in order to support children's learning in spelling, particularly beyond the first few year years of formal schooling, there is still a need to clarify which spelling components children have a tendency to accurately demonstrate at each year level of schooling.

In addition, it is unclear what the role of gender is in the attainment of spelling, and writing more broadly. Berninger and Fuller (1992) suggest that girls outperform boys in measures of written expression and that boys display poorer orthographic skills than girls (Berninger et al. 2008). Other research has reported that girls have a tendency to write more than boys (Puranik and Al Otaiba 2012; Williams and Larkin 2013) and that gender differences in handwriting fluency exist (Adams, Simmons, and Willis 2015). On the contrary, Dunsmuir and Blatchford (2004) demonstrated in their study (n=60) that gender was not significantly related to writing attainment at seven years of age. In an Australian study, Kohnen et al. (2015) found that girls and boys (Years 1 to 7, n=629) did not differ in their performance on two spelling assessment measures.

This article reports on a cross-sectional study which sought to capture the linguistic skills involved in learning to spell across Years 3 to 6 and to determine if gender was an influential factor in spelling performance. The overall aim was to understand the ways in which children apply the components of spelling to real words at each year level so that educators can use the findings to help them plan for appropriate instruction in spelling.

Acquiring competency in spelling

Current explanations of spelling acquisition are neither sufficiently substantive nor conclusive. For several decades, a number of researchers have argued that spelling knowledge develops in sequential stages or phases (Bear and Templeton 1998; Ehri 1985; Frith 1980). Contrarily, a growing body of research supports the view that learning to spell may not follow a developmental, linear trajectory (Garcia, Abbott, and Berninger 2010; Sharp, Sinatra, and Reynolds 2008; Rittle-Johnson and Siegler 1999; Devonshire, Morris, and Fluck 2013). Recent propositions indicate that learning to spell is a process of learning to abstract, apply and interconnect phonological, orthographic and morphological knowledge from the beginning of learning to write (see, for example, Bahr 2015; Berninger, Abbott, Nagy, et al. 2010). It has also been suggested that 'orthographic awareness may not be dependent on first establishing competent phonological spelling skills' (Larkin, Williams, and Blaggan 2013, 409). Others have asserted that there is no evidence to support developmental stage theories of learning to spell (Kohnen, Nickels, and Castles 2009). The view that young students 'draw on phonology, orthography, and morphology from the beginning of spelling development', and gain increasing explicit control over these skills (Garcia, Abbott, and Berninger 2010, 88) differs from the view held by stage theorists, who claim that spelling knowledge proceeds from phonology to orthography to morphology.

Theoretical framework

Triple Word Form Theory (TWFT) presents a relatively new stance on spelling acquisition. The central tenet is that spelling competency requires efficient and autonomous coordination of phonological, orthographic and morphological word forms (Richards et al. 2006; Berninger, Abbott, Nagy, et al. 2010; Richards, Berninger, and Fayol 2009). TWFT assumes that learning to spell involves learning to store and analyse in working memory the three word forms, but that instructional priorities and approaches in spelling can influence this learning (Garcia, Abbott, and Berninger 2010). Further, Gathercole (2007) explains that while working memory continues to improve throughout childhood, a particular increase in functioning seems to occur between 10 and 12 years of age. Considering the task of spelling is known to place demands on working memory (Berninger, Abbott, Swanson, et al. 2010), it is reasonable to expect that improved efficiency and accuracy in spelling may be at least partly attributed to increases in memory functioning.

Support for TWFT has also been demonstrated in a study that utilised a linguistic analysis technique whereby spelling errors in students' (Year 1 to 9) expository and narrative writing samples were analysed and categorised to reflect any breakdowns in phonological, orthographic and/or morphological processing (Bahr et

al. 2012). In their study, Bahr et al. (2012) found evidence of spelling errors in all three word forms across all year levels, suggesting that growth in spelling may not be linear and that the development of 'a robust orthographic lexicon that coordinates phonology, orthography, and morphology' (p. 1587) follows a gradual but complex trajectory. While the findings presented by Bahr et al. (2012) are insightful, there is a need to build on their research by using other means to measure phonological, orthographic and morphological errors in spelling, and by examining the spelling patterns of other student populations. Specifically, their findings were based on an analysis of words that were freely chosen by the participants in the context of their compositional writing. Analysing such data can be problematic because participants may have avoided words that they did not know how to spell (Kohnen, Nickels, and Castles 2009). For example, if words containing complex derivational suffixes (e.g., words ending in –***ion*** or -***ious***) were not written by some of the students, it would have been impossible to determine whether or not this specific morphological feature of the spelling system was problematic for those students.

As the study presented here provides evidence of phonological, orthographic and morphological errors in the spelling of real words, a brief explanation of these linguistic word forms follows.

The phonological word form

Phonological processing involves the encoding of phonemes (sounds in speech) into one or two grapheme (letter) units (Garcia, Abbott, and Berninger 2010). For example, individual phonemes may be segmented and then encoded using a corresponding letter ***r-o-b*** or letters ***m-a-sh***. However, blending and encoding a series of phonemes embedded in the medial parts of words requires greater processing skill than encoding the initial and final phonemes in words, and the demand becomes greater when words are polysyllabic (Cassady and Smith 2004; Cassady, Smith, and Putman 2008). As Berninger et al. (1998) note, 'phonological representations are more complex for polysyllabic than monosyllabic word' (p. 602). Larkin, Williams, and Blaggan (2013) argue that one's capacity to store greater amounts of phonological information in working memory can increase capacity for efficient and accurate phonological encoding. Their research demonstrated that being able to 'spell a wide range of words accurately, particularly complex and longer words' helps 'foster better phonological memory capacity and result(s) in higher non-word repetition scores' (Larkin, Williams, and Blaggan 2013, 408). Although phonology is a critical component of the spelling system, it cannot be relied upon to accurately spell all Standard English words. For example, polysyllabic words may contain phonologically regular constituents (e.g., the medial consonant graphemes, ***gn***, in the word *reco**gn**ition* are phonologically regular and require

accurate phonological blending across syllables), while other parts of the same word may require different linguistic processes (e.g., encoding the suffix, ***ion***, requires morphological processing).

The orthographic word form

Orthographic processing is also essential in spelling; however, developing heightened orthographic sensitivity is a complex process of acquiring awareness of the 'legal' (conventional) letter patterns within words (Conrad, Harris, and Williams 2013). For example, in words that are not phonologically regular such as *love*, *give*, *have* and *sieve*, orthographic regularity is evident because the convention demands that the grapheme ***v*** is never used in the final position of an English word (Elliott 1984). Instead, when the final consonant phoneme in a word is represented by the grapheme ***v***, it is always followed by the grapheme ***e***. Orthographic generalisations can also be made with many words containing vowel phonemes that may otherwise appear ambiguous or arbitrary in their spelling. For instance, the ***ou*** diphthong (in words such as *owl*, *clown*, *count* and *loud*) typically requires the graphemes ***ow*** if the diphthong is present at the end of a syllable (as in *c**ow***) or if followed by the grapheme ***l*** (as in *o**wl***), or a single ***n*** (as in *cl**own***). For most other words containing the same diphthong, the ***ou*** graphemes are typically needed instead (as in words such as ***found*** and *cl**oud***). Further, Read and Treimen (2013) explain that vowel doublets can plausibly appear in initial, medial or final positions of words, as in ***ee****l*, *s**ee**m* and *b**ee***, while consonant doublets commonly occur in the medial positions (as in the word, *pi**ll**ow*) and final positions (as in the word, *ba**ll***) but very rarely in the initial position of words (as in the word, ***ll****ama*).

The morphological word form

As the English spelling system contains morphophonemic elements (Venezky 2004), correct spelling of words requires 'sensitivity to the internal, meaning-related structure of words' (Green et al., 2003, 752) such as base words, affixes and word origins. For example, accurate spelling may require the ability to analyse vowel and consonant patterns at the end of base words (in words such as *hope* and *hop*) in order to determine whether letters need to be dropped or added for suffixes (e.g., *ho**ping*** and *ho**pping***) (Richards et al. 2006; Apel 2014). Specifically, research has shown that children's knowledge of inflected morphemes (e.g., ***-ed*** in *jumped* and ***–ies*** in *carries*) appear to be easier to learn than derivational morphemes (e.g., ***-ly*** in *quickly* and ***–ion*** in *recognition*) (Green et al., 2003). In addition, the spelling of homophones (e.g., *there* and *their*) may be a particularly problematic morphological feature, at least in the context of students' compositional writing (Bahr et al. 2012).

Current study

This study explored students' phonological, orthographic and morphological error patterns in real word spelling. The principle research questions which guided this study were as follows:

1. What are the median performance levels for students across different years on the phonological orthographic and morphological components of spelling?
2. Does performance on these spelling components differ on the basis of gender and/or year level?

Method

Employing a cross-sectional design, data were obtained at one point in time from four cohorts of students, namely a sample of students from Australian primary schools in Year 3, Year 4, Year 5 and Year 6. Hence, the cross-sectional data present a snapshot of spelling achievement from one particular point in time. This approach ensured achievement results could be compared on the basis of year level and with minimal threats to validity that could otherwise result from potential maturational effects (Mertens 2015).

Sampling

The study presents data from 1,198 students in Years 3 to 6, enrolled in public and Catholic mainstream primary schools in an Australian metropolitan area. Ethics approval was obtained from the author's university and the relevant school system authorities prior to data collection. Permission from parents was also obtained as well as students' agreement to participate. Schools were randomly selected within stratified bands (low, middle and high) based on the Index of Community Socio-educational Advantage (ICSEA) (Australian, Curriculum, Assessment and Reporting Authority (ACARA), 2013). Principals of 51 schools were contacted to seek their expressions of interest and availability for participation; however, only 13 of those school principals agreed for their schools to participate. Three participating schools were categorised as high, according to the ICSEA bands; seven as middle; and three as low. From these schools, all students in Years 3 to 6 (n=2,747) were then invited to take part and approximately 46% of those students agreed to participate. Attempts were made to collect spelling achievement data from all participating students; however, 76 students were not able to complete the spelling assessment because of student absence on the day of testing or because of classroom scheduling constraints. Table 1 presents a demographic summary for those students who completed the spelling assessment.

Table 1 Descriptive statistics for students by year level, gender and age

Demographics	Year 3	Year 4	Year 5	Year 6
Males (*n*)	158	136	122	99
Females (*n*)	165	187	159	172
Age (Months)				
M (*SD*)	99 (4.2)	120 (4.8)	131 (4.1)	144 (4.2)
Min-Max	89-114	103-150	116-148	133-157

Spelling achievement data

The Components of Spelling Test (CoST) (Daffern, Mackenzie, and Hemmings 2015) was used to measure application of the phonological, orthographic and morphological components of Standard English spelling. This measure was chosen because it offers a valid and reliable means to capture specific spelling errors that students may make in real words. Strong internal consistency results have been reported for the CoST, with Cronbach's alphas ranging from .78 to .94 (Daffern, Mackenzie, and Hemmings 2015). The CoST comprises 15 constructs and 101 individual items across three subscales: i) Phonological Component (comprising 31 items); ii) Orthographic Component (comprising 29 items), and iii) Morphological Component (comprising 41 items). Administration of the CoST required the researcher to dictate 70 words to the participating students, with each word presented in the context of a sentence. Students' written responses were then collected and analysed in terms of pre-defined linguistic features, with each linguistic error being categorised into one of the three subscales of the CoST.

Analysis of spelling performance

To capture student's performance of real word spelling across the middle and upper primary school years, descriptive profiles of median CoST scores across Years 3 to 6 were determined. Medians, as opposed to means, were used as the distributions were anticipated to be asymmetrical, and medians are typically used to provide performance norms. A factorial multivariate analysis of variance (MANOVA) was also conducted to test the significance of group differences (Tabachnick and Fidell 2001) relating to year level and gender in the three dependent variables (that is, the CoST subscales). Prior to conducting a factorial MANOVA, Pearson correlations between all of the dependent variables were obtained in order to test the assumption underpinning MANOVA that the dependent variables would be correlated with each other in the moderate range (Colman and Pulford 2008). The MANOVA model was analysed for main effects of year level and gender, their interactions, repeated contrasts for year level and simple differences for gender.

Results

Median performance levels as measured by the CoST

Results of the CoST demonstrate an increase in the median levels across the phonological, orthographic and morphological subscale scores of the CoST from Years 3 to 6, albeit to varying degrees (Figure 1). Interestingly, although minimal growth in the phonological subscale score was observed between Year 3 and Year 5, a considerable increase was evident between Year 5 and Year 6. The results also indicate that the orthographic subscale score steadily increased between Year 3 and Year 6; however, there was a substantial increase in the morphological subscale score, particularly between Year 5 and Year 6.

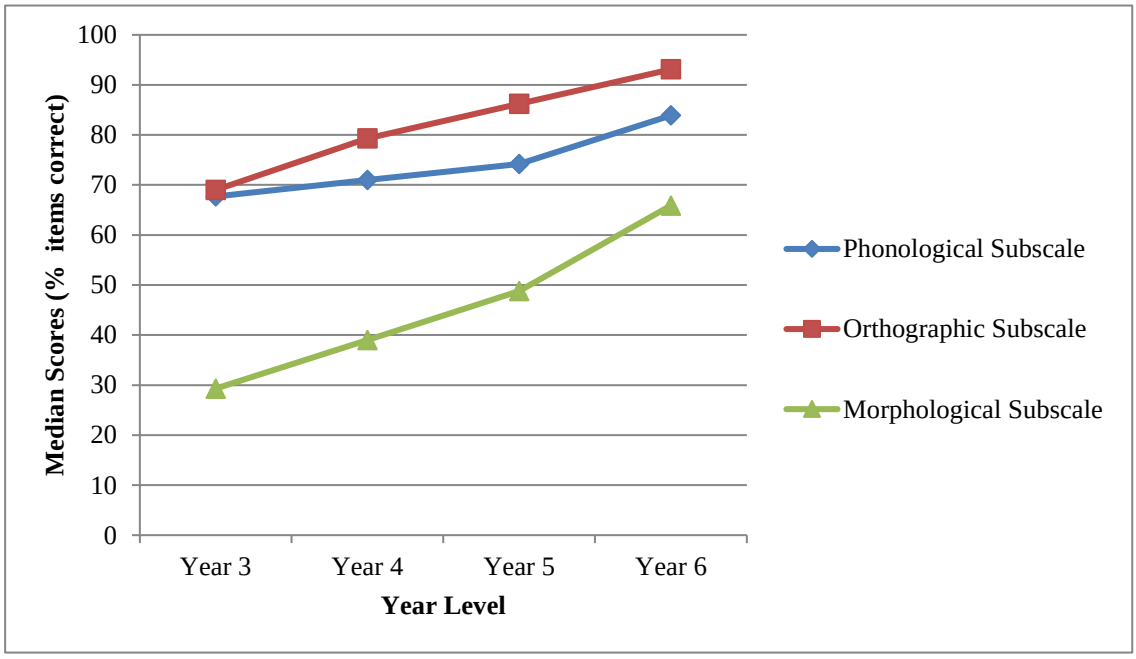

Figure 1 Median scores on the CoST subscales (Years 3 to 6, *n*=1,198)

In the phonological subscale, while there was noticeable improvement in the 50th percentile between Year 5 and Year 6, overall development was minimal across the four years in the 90th percentile (Figure 2). The results also indicate somewhat parallel transitions across the percentiles in the phonological subscale score, with the exception between the 70th and 90th percentiles, whereby the gap considerably narrowed between Year 5 and Year 6. Of particular concern, these results demonstrate that Year 6 students in the 10th percentile failed to reach scores equivalent to Year 3 students performing in the 50th percentile.

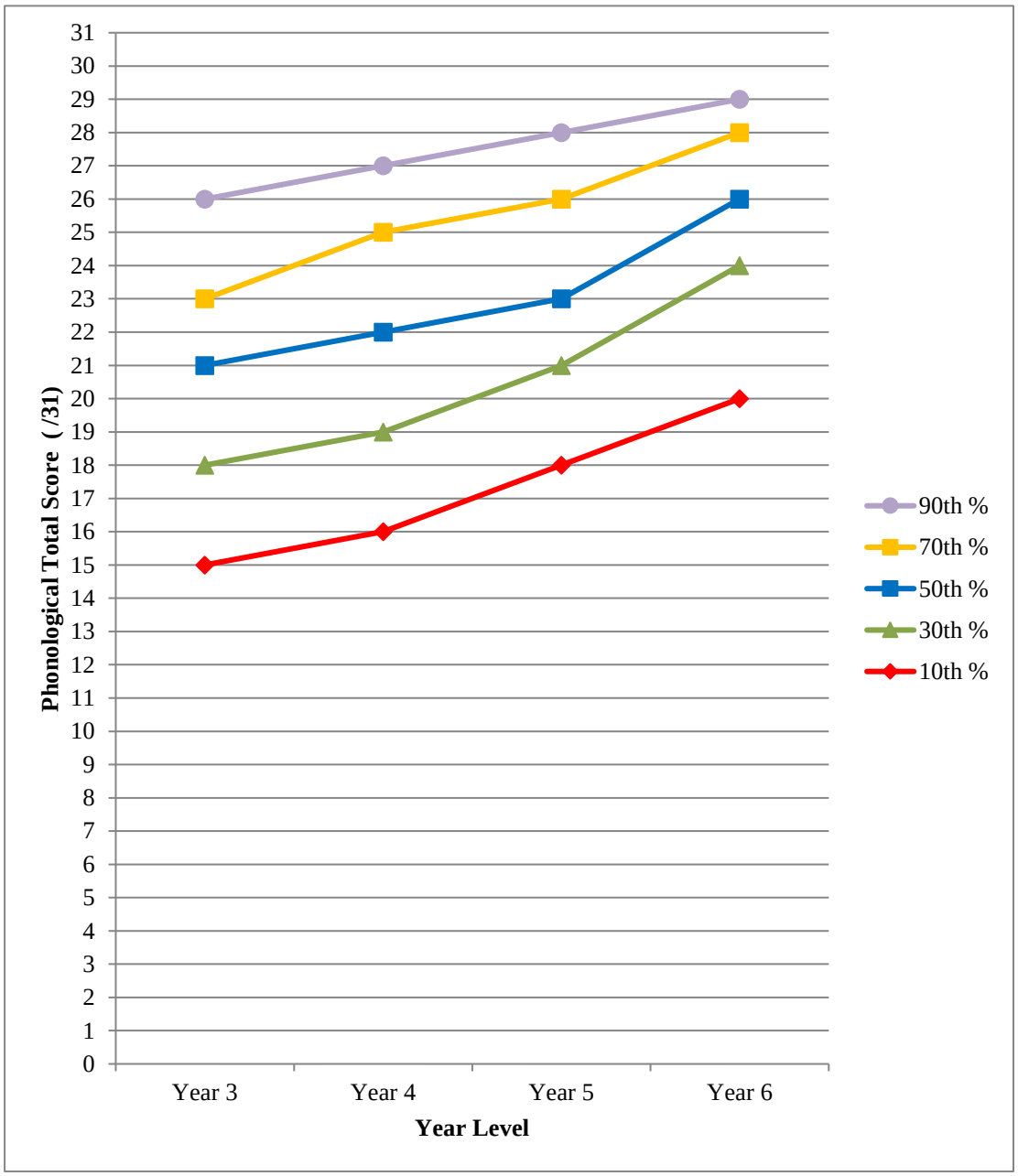

Figure 2 Median levels for the phonological subscale (Years 3 to 6, *n*=1,198)

In the orthographic subscale, minimal improvement was notable in the 90th percentile; however, ceiling was reached for this group of students by the end of Year 5 (Figure 3). It is also clear that, despite substantial incline in the subscale score in the 10th percentile over the four years, Year 6 students at the 10th percentile mirrored Year 3 students achieving at the 50th percentile. Figure 3 also shows that from Year 3 to Year 6, the gap between the 10th and 90th percentiles narrowed markedly.

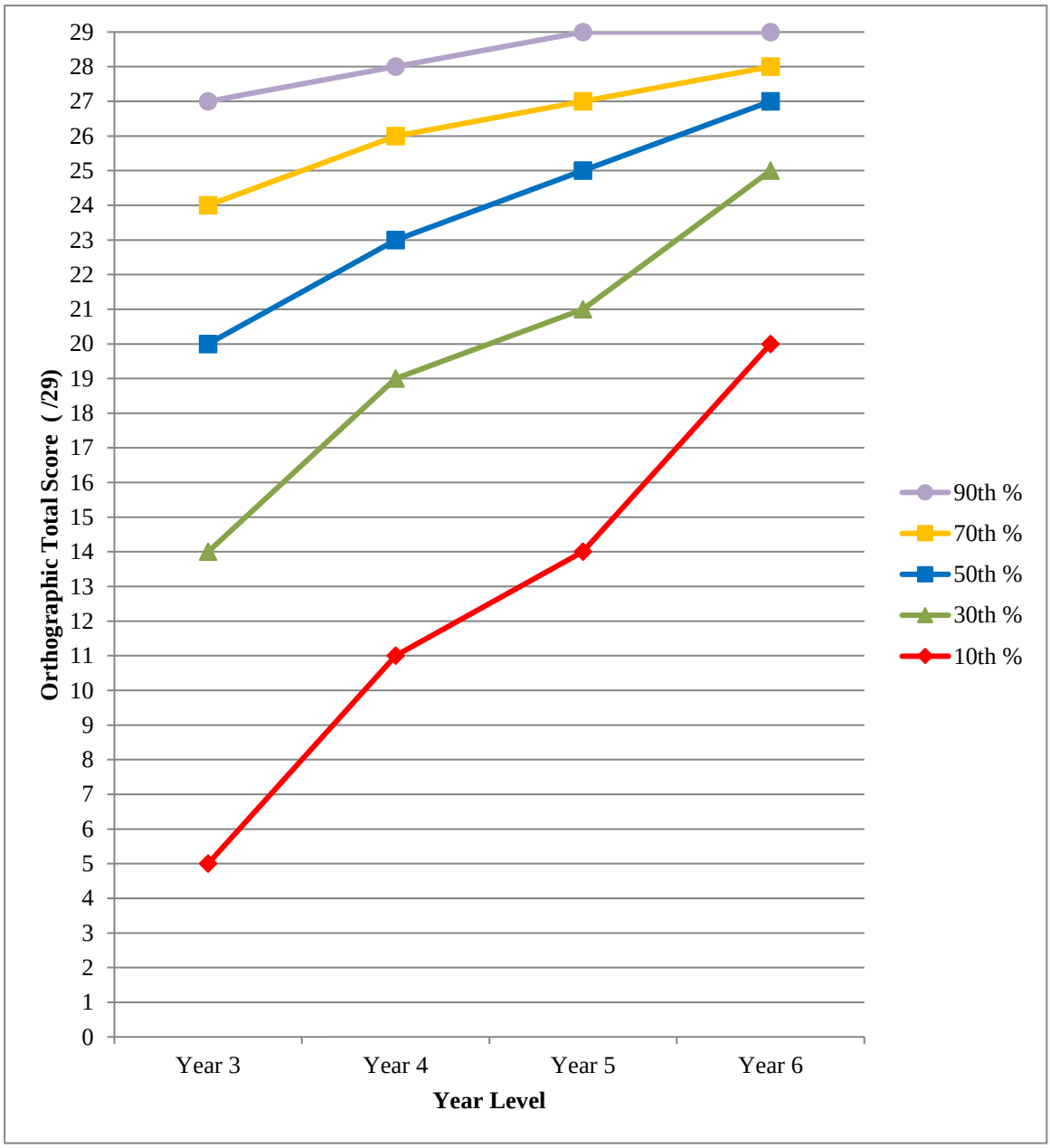

Figure 3 Median levels for the orthographic subscale (Years 3 to 6, *n*=1,198)

Relatively parallel transitions across the different median levels in the morphological subscale were observed between Year 3 and Year 5 (Figure 4); however, between Year 5 and Year 6, a distinguishable greater increase in the subscale score was evident in the 30th and 50th percentiles. Year 6 students performing at the 10th percentile have marginally exceeded Year 3 students achieving at the 50th percentile. Moreover, the gap between the 10th and 90th percentiles appeared to widen slightly as the students proceed from Year 3 to Year 6, with the lowest-achieving spellers loosing relative ground in the morphological aspects of spelling.

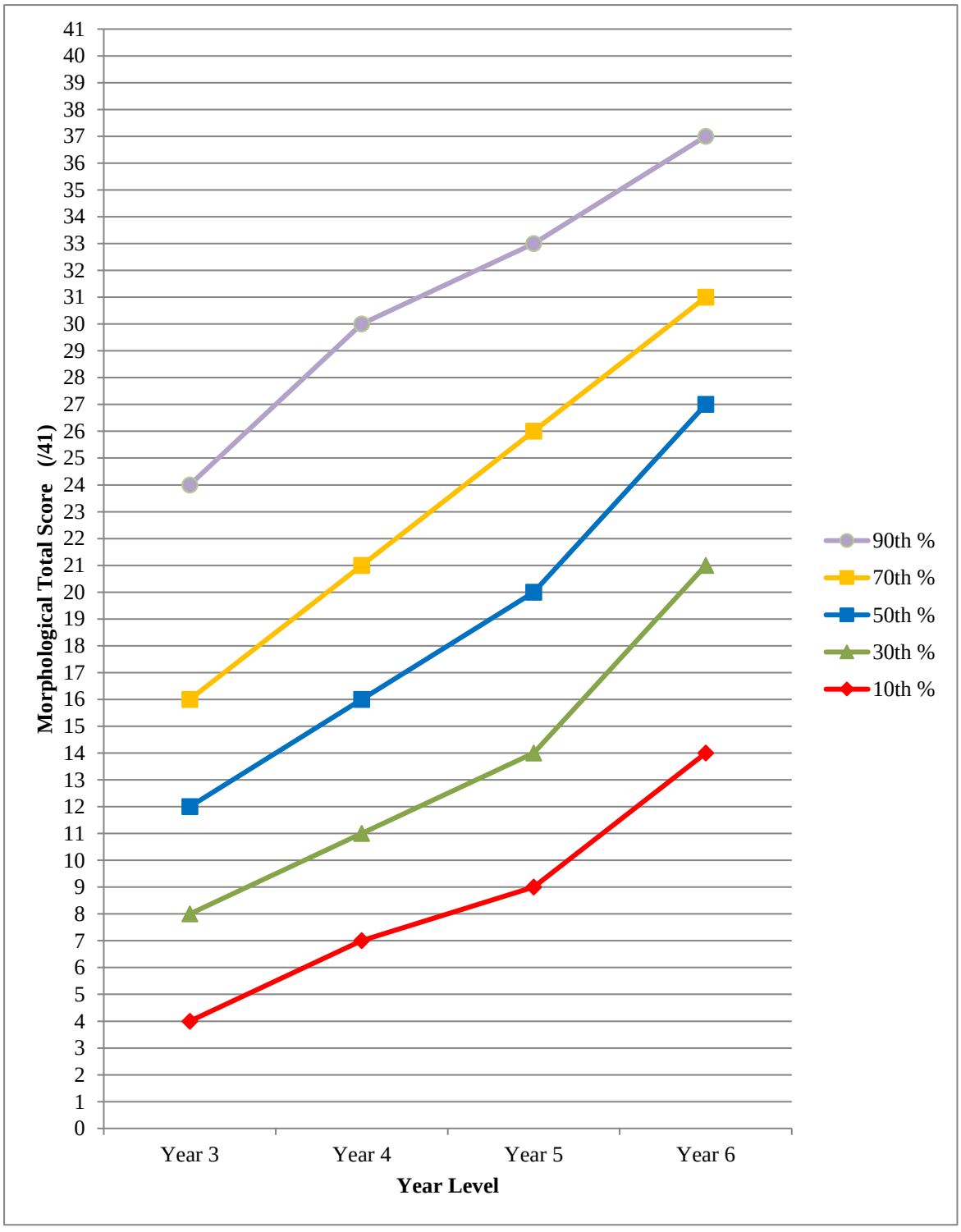

Figure 4 Median levels for the morphological subscale (Years 3 to 6, *n*=1,198)

Across the three subscale scores, the phonological and morphological subscale scores did not reach ceiling, even for the Year 6 students at the 90th percentile. By contrast, the orthographic subscale score did reach ceiling as early as Year 5, but only for students above the 90th percentile.

Phonological sub-skills in spelling

In examining specific phonological features of spelling for students in the 50th percentile, ceiling was observed in the students' application of three of the four phonological sub-skills of the CoST. These involved the encoding of initial and final consonants, short vowels and consonant digraphs. Although these students appear to have mastered three specific phonological skills by the end of Year 3 (and possibly earlier), the capacity for students to accurately blend phonologically regular medial parts of complex polysyllabic words (e.g., ***agnosti*** in *di**agnosti**cian*) seems to have continued refining throughout the middle and upper primary school years, and potentially beyond (Figure 5).

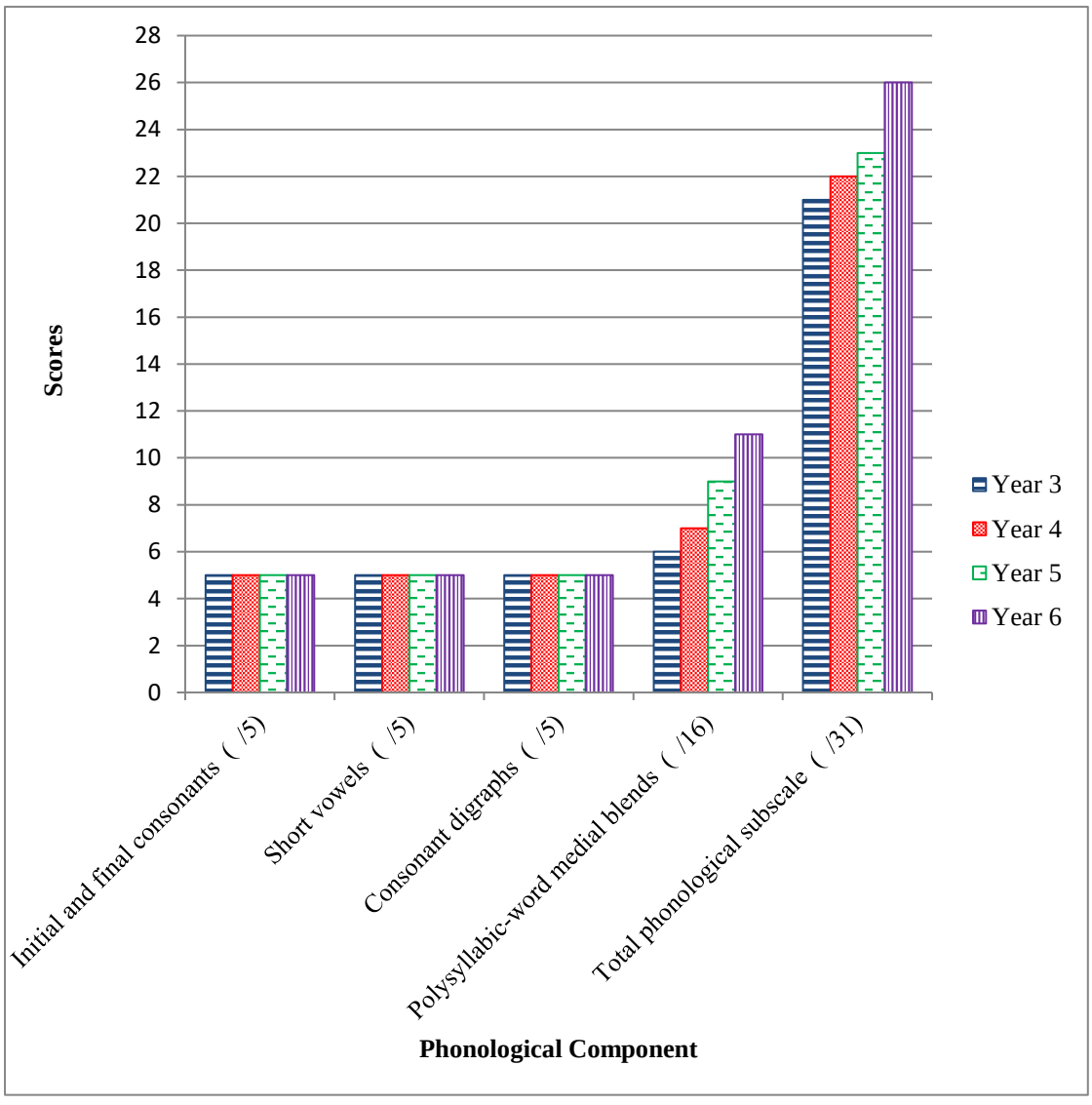

Figure 5 Scores for phonological component measures for students in the 50th percentile

Orthographic sub-skills in spelling

With regard to orthographic spelling features, the results show that by the time students in the 50th percentile completed Year 4 schooling they were able to accurately represent syllable juncture consonants (Figure 6). The results also suggest that the spelling of syllable juncture consonants (e.g., ***bb*** in *ni**bb**le*) may be the easiest of the five orthographic sub-skills. Correct application of ambiguous vowels, such as ***l*** influenced diphthongs (e.g., ***oi*** in *b**oi**l*), was notable between Year 4 and Year 5, while correct representation of complex consonant patterns (e.g., ***tch*** in *scra**tch**es*) appeared to have a longer and later developmental span (between Year 4 and Year 6). As can be seen in Figure 6, unaccented final syllables (e.g., ***el*** in *tunn**el***) and common long vowel patterns (e.g., ***ai*** in *b**ai**t*) were the most challenging orthographic sub-skills for students in the 50th percentile, as neither of these scores reached ceiling by the time students completed Year 6.

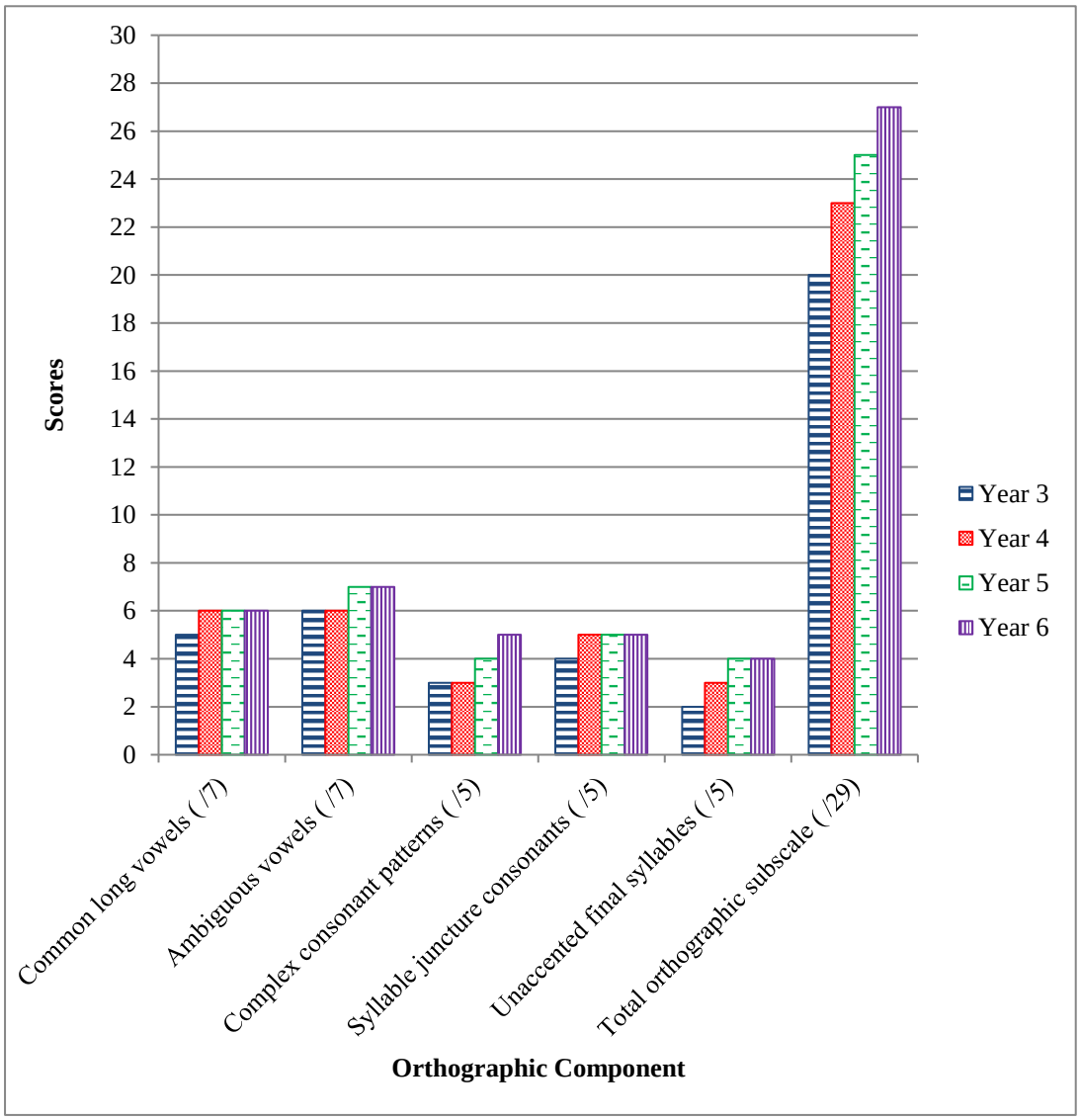

Figure 6 Scores for orthographic component measures for students in the 50th percentile

Morphological sub-skills in spelling

Although the morphological subscale (total) score did not reach ceiling at any year level, nor at any percentile level, it is worth noting that the inflected suffix sub-skill score did reach ceiling, and this was evident at the 50th percentile level in Year 5 (Figure 7). The results clearly demonstrate that students at the 50th percentile completed Year 6 (the final year of primary schooling in Australia) without having completely mastered five of the six morphological sub-skills. Specifically, results show that inflected suffixes (e.g., ***ed*** in *smudg**ed***) were easier for students to grasp than derivational suffixes (e.g., ***ion*** in *opposit**ion***). Additionally, the homophone sub-skill was the least developed score at the 50th percentile (e.g., ***serial/cereal***), closely followed by morpheme juncture schwas (e.g., ***o*** in *opp**o**sition*) and assimilated prefixes (e.g., ***opp*** in ***opp**osition*), as shown in Figure 7.

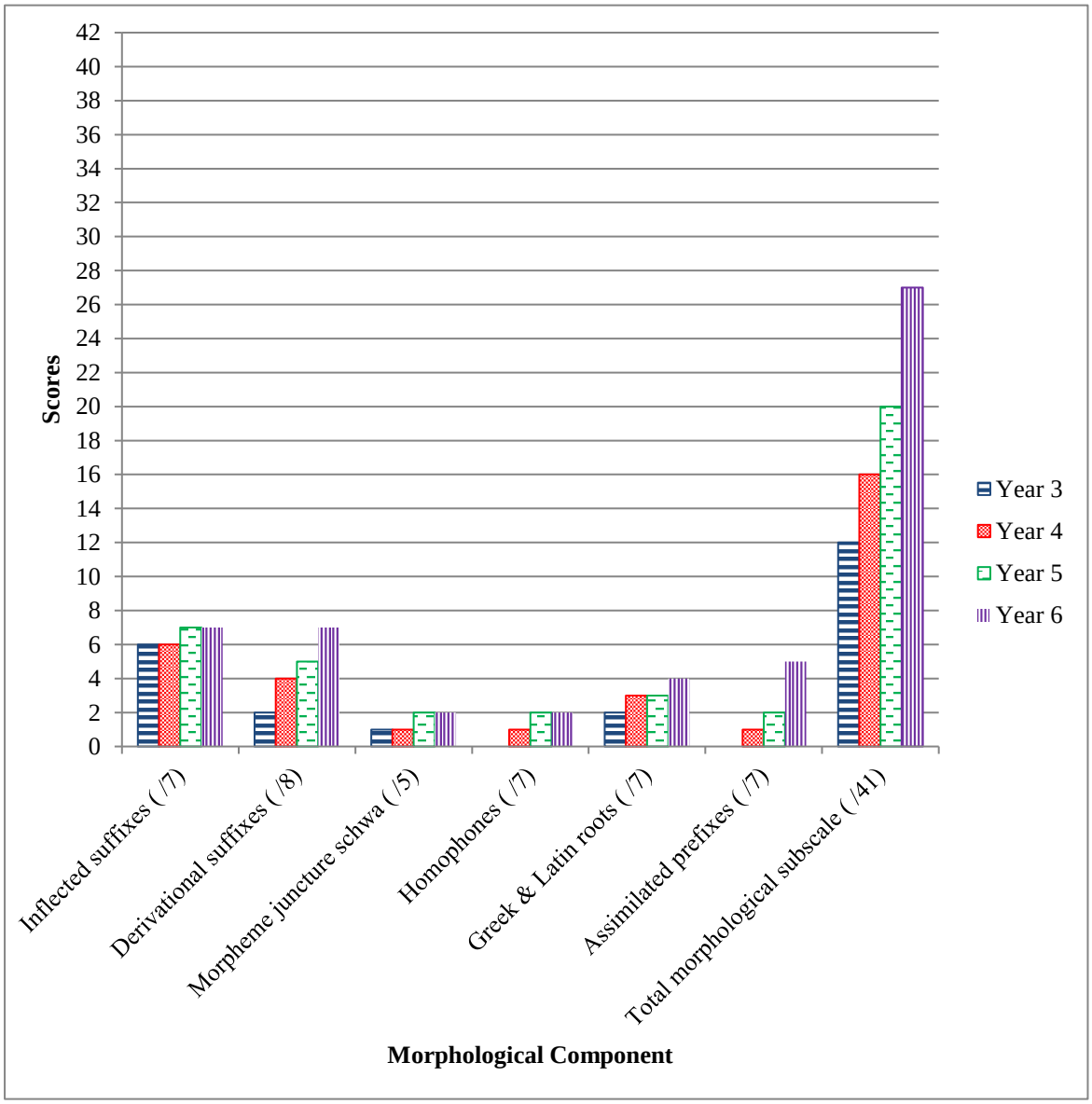

Figure 7 Scores for morphological component measures for students in the 50th percentile

Correlations among the components of spelling

Pearson correlations between the dependent variables were also obtained in order to test the MANOVA assumption that three spelling components would be at least moderately correlated with each other (Colman and Pulford 2008). As can be seen in Table 2, a strong pattern of correlations was observed among the dependent variables, suggesting the appropriateness of a MANOVA. The relationships among the subscales also suggest that phonological, orthographic and morphological skills may develop concurrently, rather than one after the other.

Table 2 Pearson correlations, means, and standard deviations associated with the CoST subscales (*n* =1,198)

CoST Subscales	1	2	3	*M*	*SD*
1 Phonological	--			22.48	4.58
2 Orthographic	.773**	--		21.81	6.92
3 Morphological	.809**	.784**	--	18.86	9.76

Year level and gender differences in spelling performance

Table 3 summarises the CoST subscale mean scores and standard deviations (expressed as percentages) across the year groups, for males and females. A preliminary inspection of these results suggested that there was an overall increase in scores from Year 3 to Year 6; however, differences between males and females were not obvious.

Table 3 Means and standard deviations for CoST subscales (Years 3 to 6) by gender

Year Level	Gender	N	Phonological Subscale (%)		Orthographic Subscale (%)		Morphological Subscale (%)	
			M	*SD*	*M*	*SD*	*M*	*SD*
3	Male	158	66.78	14.40	63.47	27.67	32.76	19.31
	Female	165	65.42	14.35	62.38	27.29	31.44	18.13
4	Male	136	69.40	15.95	72.92	23.36	41.77	22.54
	Female	187	70.28	13.85	73.58	22.56	42.14	20.68
5	Male	122	75.20	13.53	79.65	20.40	51.24	22.96
	Female	159	74.32	13.94	79.42	20.46	49.16	22.70
6	Male	99	80.16	12.96	87.39	14.41	62.21	23.19
	Female	172	81.06	12.13	87.71	14.51	63.54	20.00

As shown in Table 4, the results of the MANOVA indicated that year level had a significant main effect, Pillais' Trace = .229, $F(9,3570)=32.73$, $p< .001$. The multivariate effect size was estimated at .076,

implying that 7.6% of the variance in the dependent variables was accounted for by year level. The effects for gender and the interaction of year level and gender were non-significant.

Table 4 Main effects of year level, gender, and their interactions in the CoST subscales

	F	*df*	*Pillai's Trace*	*Significance*	*Partial Eta²*
Year Level	32.732	9,3570	.229	.000	.076
Gender	.085	3,1188	.000	.968	.000
Year Level x Gender	.316	9,3570	.002	.970	.001

Subsequent testing using repeated contrasts found that at each year level contrast, that is Year 3 vs Year 4, Year 4 vs Year 5, and Year 5 vs Year 6, there was a significant difference ($p < .001$) on each of the three spelling components, as indicated in Table 7. The significance level was adopted using a Bonferroni adjustment of .05/9 (.006). No significant differences were found for gender using the same contrasts.

Table 5 Year level contrasts in the CoST subscales

CoST Subscales	Repeated Contrasts	Year 3 v Year 4	Year 4 v Year 5	Year 5 v Year 6
Phonological Subscale	Contrast Estimate	-1.24	-1.45	-1.81
	Significance	.000	.000	.000
	95% Confidence Interval			
	Lower Bound	-1.90	-2.14	-2.55
	Upper Bound	- .57	- .76	-1.08
Orthographic Subscale	Contrast Estimate	-2.99	-1.82	-2.33
	Significance	.000	.001	.000
	95% Confidence Interval			
	Lower Bound	-3.99	-2.86	-3.42
	Upper Bound	-1.10	- .78	-1.23
Morphological Subscale	Contrast Estimate	-4.04	-3.38	-5.20
	Significance	.000	.000	.000
	95% Confidence Interval			
	Lower Bound	-5.38	-4.78	-6.67
	Upper Bound	-2.70	-1.99	-3.72

Discussion

In this study, concurrent increases in the performance levels across the phonological, orthographic and morphological subscale scores of the CoST from Year 3 to Year 6 were found, albeit to varying degrees. While change in phonological, orthographic and morphological knowledge differed significantly on the basis of year

level, gender differences were not significant. The findings support non-linear explanations of spelling acquisition; however, as they are based on cross-sectional data, some degree of caution is needed in this interpretation.

An important theoretical contribution of this study is that it strengthens TWFT and its assumption that learning to spell 'depends on developing awareness of phonological, orthographic, and morphological word forms … and coordinating them' (Richards, Berninger, and Fayol 2009, 332). It seems that orthographic spelling skills may not be dependent on first acquiring competency in phonology. Although the results show that some aspects of morphological spelling appear particularly difficult to master, they suggest that accurate phonological and orthographic spelling representations are not prerequisites for learning aspects of morphological spelling. This finding is broadly consistent with non-linear models of spelling development (Devonshire, Morris, and Fluck 2013; see, for example, Berninger, Abbott, Nagy, et al. 2010), and it negates assumptions associated with stage and phase theories of spelling development (see, for example, Bear and Templeton 1998). Indeed, as Read and Treiman (2013) justifiably assert, 'theories that attempt to identify discrete stages during the development of spelling … are problematic' (p. 209).

Even though the absence of significant gender differences in spelling resonates with findings from another recent Australian study (Kohnen et al. 2015), this finding could be due to sampling bias caused by students belonging to the sample being self-selected. Only 46 percent of the children agreed to take part in the study and, as Table 1 shows, the ratio of boys in the sample continually diminishes from Grade 3 to Grade 6. According to Puranik and Al Otaiba (2012), girls 'are more inclined to engage in literacy related activities and have more favourable attitudes toward reading and language than boys' (p. 1527). Therefore, it is plausible to hypothesise that some boys refrained from participating in the study because of a growing awareness of their weaknesses in spelling.

Another important finding is the substantial increase in performance levels observed between Year 5 and Year 6 in the morphological and phonological components of spelling. There are three plausible explanations for this: a) changes in memory functioning; b) changes to instructional priorities; and c) accumulation of lexical exposure and oral vocabulary. What follows is an elaboration of each, including implications for instruction.

First, in light of Gathercole's (2007) research on working memory, it could be that growth in cognitive functioning plays a crucial role in students' readiness to process complex words when spelling. The notable

increase in performance levels between Year 5 and Year 6 could reflect a developmental change in students' readiness to accurately encode morphologically complex words, but also to accurately blend the phonologically regular medial phonemes in polysyllabic words. The findings align with Gathercole's (2007) assertion that 'as the efficiency of processing increases with age, more of this resource is available to support storage, leading to improvements in task scores' (p. 235). Indeed, Larkin, Williams, and Blaggan (2013) suggest that increased accuracy of complex and polysyllabic words could be the result of changes that occur in working memory, while others posit that shorter words 'seem less demanding in terms of cognitive resources associated with short-term memory' (Ruberto, Daigle, and Ammar 2016, 662). In this study, improved performance in medial phoneme blending of polysyllabic words was observed at each year level, but particularly between Year 5 and Year 6, and this is consistent with research demonstrating that medial phoneme blending requires greater skill than phonological encoding of initial and final phonemes in words (Cassady, Smith, and Putman 2008).

Second, the marked increase in performance levels between Year 5 and Year 6 could be the result of changes to instructional priorities during these upper primary school years. It is possible that morphological instruction has dominated in Year 5 and Year 6, considering morphology is more prominent in the Australian Curriculum: English (ACARA 2014) across the upper primary years. Additionally, instructional programs which are either phonics driven or broadly informed by stage theories are popular among many Australian schools. Therefore, it is possible that morphology has not been adequately taught in the lower and middle primary school years.

The third plausible explanation for the observed increases in performance levels, particularly in the upper primary years, may be related to students' cumulative experience with increasingly complex words and a subsequent increase in vocabulary knowledge. With potential expansion of vocabulary acquisition over time, a reliance on effortful, strategic encoding may diminish. Indeed, as Richards, Berninger, and Fayol (2009) explain, an 'autonomous orthographic lexicon' can become established when 'durable, multifaceted … representations can be directly and … automatically accessed' (Richards, Berninger, and Fayol 2009, 328). Hence, it is reasonable to advocate the importance of contextualising instruction in spelling with meaningful, relevant and increasingly sophisticated vocabulary.

Another important finding is the presence of substantial differences in performance across all three subscales for students in the lower percentiles compared with students in the higher percentiles. This finding suggests that a single mainstream class potentially constitutes enormous variability in performance among

students. It also highlights the need for early intervention for low-achieving spellers. Of note, a comparison of the percentiles within each of the three spelling components is indicative of a particularly concerning trend in the trajectory for very low-achieving students. Critically low performance levels were found among students in the 10th percentile, even as they approached the final months of primary schooling. For example, Year 6 students performing in the 10th percentile of the phonological subscale failed to reach the equivalent level of those Year 3 students in the 50th percentile. Clearly, provisions for targeted intervention in spelling are needed well before low-progress students commence Year 3 schooling.

In addition, it seems that there is scope for improvement in the phonological processing of polysyllabic words beyond the primary school years, even for high-achieving spellers. These results reveal the need for explicit instruction in highly specific aspects of spelling beyond the primary school years, while other aspects of spelling may potentially require considerably less or no instructional attention for some students. For example, the study revealed that ceiling was reached in the orthographic subscale score for Year 5 students in the 90th percentile. This result suggests that orthographic knowledge is a constrained skill, and that engaging in learning tasks predominantly designed to improve orthographic encoding may not necessarily be effective in improving spelling performance for some students. In other words, when students obtain heightened sensitivity to the legal orthographic patterns inherent in Standard English spelling, no further orthographic knowledge can be gained through instruction in orthographic awareness. This does not necessarily mean that spelling mastery has been reached. Rather, the results suggest that phonological and morphological spelling representations may require further development instead. For instance, in the morphological component, only one of the six morphological sub-skills reached ceiling, namely inflected suffixes. Importantly, the apparent difficulty across most of the morphological sub-skills suggests that substantial morphological learning is also needed beyond Year 6, even for students performing in the 90th percentile.

While the teaching of inflected suffixes in the early years of formal schooling is a reasonable proposition (Apel et al. 2013), the evidence from this study shows that derivational suffixes are indeed more difficult to master, suggesting that they may need to be taught after inflected suffixes have been taught. This is consistent with other research demonstrating that inflected suffixes are acquired before derivational suffixes (see, for example, Deacon et al. 2014). Derivational knowledge is an important aspect of morphological instruction as it provides students with fundamental understanding of nominalization. Instruction in nominalisation can coincide with instruction in the generalisations associated with derivational suffixes.

Specifically, teaching nominalisation involves teaching students how to transform a verb or an adjective to a noun (e.g., *propose* to *proposition*) and helping them to understand the function of derived suffixes. In turn, an understanding of the foundation of nominalisation enables students to develop word consciousness and a potentially more concise and sophisticated writing style.

This study also revealed that the homophone sub-skill was the least developed morphological aspect of spelling. During and prior to data collection, the Australian Curriculum for English referred to homophones in Year 4 only (ACARA 2014). Therefore, the teaching of homophones may have occurred most prominently in Year 4. This may partly explain the minimal increase observed in the homophone sub-skill. Considering the abundance of homophones in the English lexicon, homophones should be comprehensively taught across multiple year levels, rather than being exclusive to Year 4.

While Bahr (2015) justifiably asserts that explicit instruction in spelling "should continue through the upper grades" (p. 201), the results of the present study suggest that explicit instruction may need to continue beyond the upper primary school years and into secondary school. In the absence of appropriate instruction in spelling, it is possible that persisting difficulties with spelling may lead to difficulties across other disciplines of learning, such as reading (Ellis and Cataldo 1990).

Limitations and future directions

The generalisability of these findings is limited to mainstream schools across one metropolitan area in Australia. However, it needs to be noted that the average ICSEA for the participating schools in the study was only marginally above the national mean. Further, as all students were able to opt out of the present study, it is possible that some potentially low-achieving spellers may have been less inclined to agree to participate in the first instance. More males than females in the study were identified in the bottom third across all spelling components, and while the effects for gender and the interaction of year level and gender were not found to be statistically significant, a degree of caution is needed in drawing this conclusion. Replication of this study using other student populations is therefore recommended. Utilising the CoST in combination with other measures of spelling performance (including non-word spelling measures) in future cross-sectional, longitudinal and/or experimental designs may also provide critical insights needed for developments in curriculum, instruction and assessment regimes specific to spelling.

Concluding remarks

This study explored the achievements of real word spelling among girls and boys in Years 3 to 6. Year level differences were found in the phonological, orthographic and morphological components of spelling. This study adds to the growing body of evidence suggesting mastery in spelling does not proceed in successive stages or phases. Rather, it seems that phonological, orthographic and morphological components can be learned simultaneously. While the study also suggests that there may be enormous variability in spelling performance within a given classroom, children still have much to learn about spelling when they complete primary schooling, even if they are comparatively high-performing spellers.

An educational implication of this study is that concurrent and explicit teaching of spelling through phonology, orthography and morphology is needed from the early years of schooling, but that instruction may also be needed beyond the primary school years. In addition, educators should seek to triangulate multiple forms of spelling assessment in order to gain a comprehensive understanding of what the instructional priorities are for individual students in a given class. While children require targeted instruction in spelling, coupled with specific and ongoing feedback, it demands pedagogical content knowledge on the educator's part. As noted by Westwood (2013, 21), 'most primary school teachers in Australia lack any real depth of linguistic and metalinguistic knowledge – because this type of information is rarely included in teacher education courses'. Westwood (2013, 21) goes on to say that 'teachers' own lack of confidence in teaching morphological principles (and with teaching spelling in general), often causes them to rely on the use of commercially published spelling programs', which tend to emphasise aspects of phonology only. Perhaps there is a need to address pre-service teacher education and in-service teacher professional learning with regard to the teaching and learning of spelling.

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