Evaluation of Early Reading Intervention Knowledge (ERIK)

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Evaluation of Early Reading Intervention Knowledge (ERIK)

Executive summary

This report presents an evaluation of the Early Reading Intervention Knowledge (ERIK), a reading intervention protocol intended to target reading difficulties in the primary school. ERIK comprises three parallel pathways; one that teaches phonological knowledge and skills relevant to reading (the phonological path), one that teaches phonic knowledge and skills (the orthographic path) and one that teaches oral language knowledge and skills relevant to text comprehension.

The population comprised 1072 students in their second to sixth years of schooling. The data used in the evaluation was collected by schools in the course of their implementation of ERIK. It included students' reading accuracy, comprehension and rate assessed using the Neale Analysis of Reading Ability (Neale, 1999) both prior to and post intervention. Their raw score performance in these three domains of reading were combined to compile a reading profile. A raw score below the 25th percentile at each year level was assumed to indicate 'at risk' reading. This permitted the identification of eight reading profiles: those at risk

1. in all domains of reading (Profile 1)
2. in accuracy + comprehension (Profile 2)
3. in accuracy +rate (Profile 3)
4. in comprehension +rate (Profile 4)
5. in accuracy only (Profile 5)
6. in comprehension only (Profile 6)
7. in rate only (Profile 7)
8. in none of the domains (Profile 8); they scored above the 25th percentile in the three domains.

The evaluation data also included performance in a number of areas necessary for successful early literacy learning. This was used to compile a literacy learning profile for each student. This comprised their

1. their phonological and phonemic skills and phonological short term memory,
2. their ability to make verbal analogies,
3. their ability to learn an orthographic code and to display visual symbolic and orthographic processing,
4. their ability to match spoken and written words and to use read pseudo words,
5. their listening comprehension and
6. their RAN of letters and digits.

Students were allocated to an intervention based on criteria that combined the Neale reading scores and their literacy learning profile. As a result, interventions differed in the number of students involved and therefore the number of examples of each reading profile. Many conditions had less than ten participants.

The reading profile is used as the unit for analysis of the efficacy of interventions. Profiles differed in their reading accuracy, comprehension and rate raw scores prior to intervention.

The evaluation uses differences in pre- and post-intervention scores in repeated measures ANOVA design. The between subject effects were the reading profiles (8), the intervention pathways (3), the number of years of schooling (5), and aspects of the delivery (the total number

of lessons[1] and the number of lessons per week). Cohen's *d* effect size is used to describe differences in mean post and pre-intervention scores.

The three intervention paths improved accuracy and comprehension for all reading profile groups that were eligible for evaluations. Effect sizes usually exceeded 1.0 for the interventions that, on average comprised between 60 and 70 teaching sessions for approximately 20 weeks. This is an approximately 80% likelihood that any student post intervention will have made significant gain.

The effect sizes for comprehension in the phonological intervention draw attention to the influence of phonological processes on comprehension and the need to target difficulties in these areas.

The orthographic intervention had the greatest impact on accuracy for students in their third year of school. It fits with the research that shows the effectiveness of teaching phonics for reading underachievers.

The oral language intervention contributed to improvement in both accuracy and comprehension across the years of schooling, with higher gains for comprehension for students who were under only in comprehension. Interventions that target oral language teaching are frequently overlooked in provision for reading underachievers.

At most year levels the three interventions didn't differ in their improvement efficacy for accuracy or comprehension. Differences did emerge at third year level, with the phonological and orthographic interventions leading to lowest and highest improvements in accuracy respectively.

Rate was more resistant to improvement, particularly at the older levels. For student cohorts who underachieved in rate at the 2nd and 3rd years of schooling, rate improved in the phonological and orthographic interventions. It did not show the level of gain for the older cohorts.

The improvement was not always sufficient to achieve a score above the 'at risk' criterion. The oral language intervention had the highest portion of students moving above the at risk criterion in accuracy and comprehension. Students entering this intervention had higher pre reading accuracy and comprehension scores than the other two interventions.

The relationship between improvement in reading accuracy and either the total number of lessons or the number of sessions each week is not simple or directly. Cohorts eligible for analysis were those students who were at risk in all three areas of reading or those at risk in accuracy and comprehension. For the second year of schooling, neither the total number of teaching sessions nor their weekly frequency influenced reading accuracy for either profile. A more complex relationship is suggested for the older year levels; the combination of the total number of teaching sessions and their weekly frequency influenced improvement in accuracy and comprehension. As well, the intervention pathway that was selected also influenced the total number of lessons and their weekly frequency that led to accuracy improvement.

Based on this evaluation, a number of recommendations are tendered:

1. that procedures for identifying particular literacy learning profiles be improved in their reliability and validity.

2. that an enhanced set of identification tools and intervention placement procedures are

[1] The total number of lessons each student had was grouped into decades and had values of from 1 to 12.

developed and validated.

3. that the connection between the phonological and orthographic pathways be clarified.

4. that reading fluency and rate be taught explicitly.

5. that the learning framework that underpins the three pathways be made more explicit.

6. that a more explicit focus be on building each student's identity as a literacy user and their awareness that reading can work for them.

7. that a more explicit focus be on the format for the intervention and its links with the classroom.

8. that clearer indicators of when to cease a student's involvement in a pathway and when to transfer between pathways.

9. that ERIK is modified to suit the needs of older primary students.

10. that the intervention pathways be modified to include an explicit focus on reading comprehension and the multiple ways in which a reader can show what they understand about a text.

11. that the reading progress of students post ERIK involvement be monitored for at least three years.

Evaluation of Early Reading Intervention Knowledge (ERIK)

1. Context and issue

Reading ability is a complex process requiring the integration and automatization of several areas of knowledge. The 'Simple View of Reading' and the subsequent modifications to this model (Gough & Tunmer, 1986; Tunmer & Greaney, 2010) provides a perspective on this; both aspects of letter sound knowledge and oral language knowledge are necessary. Letter sound knowledge can be divided further into phonological or phonemic knowledge and orthographic or visual symbolic knowledge. Bell, McCallum and Cox (Bell, McCallum, & Cox, 2003), for example, identified a range of psycholinguistic and cognitive influences on the reading achievement of elementary and middle school children; auditory processing and phonological awareness skills, short-term auditory and visual memory, rapid automatized naming and visual processing speed.

Studies have shown repeatedly that reading difficulties may be due to multiple causes, in one or more of these areas. The double-deficit hypothesis of dyslexia attributes reading disability to deficits in either or both of processing phonological information and naming speed (Katzir, Kim, Wolf, Morris, & Lovett, 2008); Wolf et al., 2002). As well, deficits in these areas of knowledge are not restricted to dyslexic readers (Badian, 1997). Badian compared the double-deficit profiles of dyslexic readers and underachieving reading comprehenders who had comparatively low verbal reasoning scores. Of the dyslexic readers, 50 % had a phonological, naming and orthographic deficit, 18 % had a phonological processing and naming speed deficit, 18 % had a naming speed and orthographic skill deficit. Of the underachieving comprehenders, 23 % had a phonological processing and naming speed deficit and 18 % had a naming speed deficit.

Cluster analysis procedures extend the double-deficit hypothesis of dyslexia. Morris and colleagues (Morris et al., 1998) identified seven subtypes of dyslexia based on combinations of phonology, short term visual memory, naming rate, spatial reasoning, word meaning, and oral language: (a) a phonology, visual memory and rate deficit; (b) a phonology, visual memory and spatial deficit; (c) a phonology, visual memory and lexical deficit; (d) a phonology and rate deficit; (e) a rate deficit; (f) a global language deficit; and (g) a global deficit.

Comprehensive reading intervention program needs to target skills in these areas. Following an extensive review of the literacy intervention research up to the mid-1990s, the National Reading Panel (NICD, 2000) identified key features of successful literacy interventions. Although its findings attracted initial criticism for the more conservative criteria adopted for study inclusion and data interpretation (for example, see Cunningham, 2001), its findings are seen as relevant to the implementation of research-based reading instruction (Shanahan, 2003).

Meta-analyses of interventions for students who have reading disabilities also assist in identifying what works in effective teaching. However, their relevance is limited in the following ways. In selecting studies, the few meta-analyses in this area have used criteria that don't apply directly here. First, they have selected studies that use randomized controlled trials and second, they have focused particularly on dyslexia-associated difficulties with reading and spelling skills.

The first criterion doesn't apply in the present evaluation; students were allocated to a particular intervention based on their reading profile; they were not allocated randomly to an intervention. Schools usually don't allocate students randomly to interventions. Rather, they allocate based on the perceived learning needs of the student.

The second criterion was also comparatively restrictive for the present evaluation. Not all of the students involved in this evaluation had difficulty only in word reading accuracy. Some had

difficulty in comprehension.

A comprehensive review of 49 randomized controlled interventions is provided by Galuschka, Ise, Krick and Schulte-Körne (2014). The comparisons included interventions targeting reading fluency (3), phonemic awareness (3), reading comprehension (3), phonics (29), auditory processing (3), medical treatments (3) and visual (4 interventions with coloured filters). Of them, phonics interventions yielded significant improvement. An earlier meta-analysis, also by Ise and colleagues (Ise, Engel & Schulte-Koerne, 2012) showed that effective interventions for dyslexia for German-speaking children that focused on reading and spelling were more effective than programs that targeted auditory and visual processing or speed of processing. Alexander and Slinger-Constant, (2004) distinguished between interventions for preventing reading difficulties in at-risk younger children and for assisting older, reading-disabled students. They note that while appropriate instruction can assist at-risk younger readers to read both accurately and fluently, interventions for older reading-disabled children have been less effective in improving reading accuracy.

Of interest to the present evaluation are the studies relating to reading comprehension training. In the meta-analyses, this has included interventions that teach students to abstract information from a text summarize it and link it with what they know. This is a more complex process than linking letters with sounds. The procedures that readers learn to use for linking letter clusters with sound patterns are less ambiguous or open to personal interpretation than the procedures for linking ideas mentioned in a text with what an individual already knows. It is not surprising that the comprehension studies show lower effect sizes that the phonic interventions.

It is recommended that reading intervention be founded on the causes of the particular learning difficulty (Snowling & Hulme, 2011) and use the phonological versus 'higher level' language processing distinction. Higher order language difficulties are associated with the semantics (such as vocabulary) and the conventions (morphology and syntax) of language.

An issue that is relevant to the development of intervention programs that has not been resolved is whether the multiple causes of reading underachievement are independent knowledge sources and can be targeted separately in teaching. Vukovic and Siegel (2006) note that for some readers with dyslexia, naming speed is correlated with phonological processing. As well, the influence of phonological processing and naming rate depends on the age or developmental level of the students, the information they are required to name (for example, pictures versus letters and digits) and characteristics of the dyslexia and how it is identified. The evidence suggests deficit in naming speed for readers with dyslexia does not persist and that its influence diminishes with development.

This leads to the possibility that the knowledge profiles that characterize early literacy acquisition may not be relevant to literacy learning in the middle or later years of primary education. For successful reading development, rapid naming or phonological awareness may be necessary in the early phases but not as significance as the reader builds a more complex literacy symbolic system.

The Early Reading Intervention Knowledge (ERIK) is a reading intervention protocol intended target to reading difficulties. It applies the outcomes of the research project Enhancing Reading Intervention for 'At Risk' Students, funded by an ARC Strategic Partnerships with Industry - Research and Training grant and a subsequent Literacy and Numeracy Innovative Projects Initiative grant between 2000 and 2004 (Munro, 2006). ERIK comprises three parallel pathways; one that teaches phonological knowledge and skills relevant to text reading (the phonological path), one that teaches relevant orthographic knowledge and skills and one that teaches oral language knowledge and skills relevant to text comprehension. Each student, on the basis of her/his 'literacy learning readiness profile', was allocated to one of the intervention pathways. Earlier research (Munro, 2006) reports its efficacy for students in grade 2.

An aim of the present research is to investigate the efficacy of ERIK during classroom based implementation for students across the middle primary years. Classroom interventions can be influenced by a range of extraneous variables that are usually controlled in laboratory investigations of interventions. Many laboratory validated interventions have lower efficacy in classrooms. The effectiveness of well-designed laboratory interventions is often 'diffused in the field', with the decrease in classroom effectiveness due to both teacher and student factors (Hulleman & Cordray, 2009). Ann Brown (Brown, 1992) also notes the some of the theoretical and methodological issues implicated in transferring interventions to classroom contexts and the challenges they provide for the design of investigations.

The present study examines the efficacy of ERIK in enhancing the reading outcomes of middle years primary school students in regular classroom contexts who are at risk of literacy learning difficulties and who differ in their reading profiles. Regular classroom implementation can vary in the total number of teaching sessions implemented, their frequency each week and teacher skill in allocating students to intervention pathways. It investigates the influence of these variables on ERIK efficacy.

2. Method

2.1 Participants

The participants were students in grades 1 to 5 from Catholic schools in Victoria. They were selected by their teachers for inclusion in one of the ERIK intervention on the basis that they had displayed at risk reading ability. This was established as follows.

Each student's reading accuracy; comprehension and rates were assessed using the Neale Analysis of Reading Ability (Neale, 1999) by teachers trained to implement ERIK. Their performance in the three domains of reading were combined to compile a reading profile. The cohorts at each grade level were grouped into 'at risk' and 'regular' using their Neale Analysis raw scores for accuracy, comprehension and rate using the cut-off points shown in Table 1. These cut-offs matched the 25th percentile performance in each domain of reading at each year level.

Table 1

The cut-off accuracy, comprehension and rate raw scores on the Neale Analysis for at risk reading at each year level.

YOS	accuracy	comprehension	rate
2	<15	<6	<22
3	<33	<11	<37
4	<41	<15	<51
5	<47	<18	<57
6	<57	<21	<65

This permitted the identification of the following reading profiles: those who underperformed

9. in all domains of reading (Profile 1)
10. in accuracy + comprehension (Profile 2)
11. in accuracy +rate (Profile 3)
12. in comprehension +rate (Profile 4)
13. in accuracy only (Profile 5)
14. in comprehension only (Profile 6)

15. in rate only (Profile 7)
16. in none of the domains (Profile 8); they scored above the 25th percentile in the three domains.

2.2 The interventions

ERIK comprises three parallel pathways; the phonological path, the orthographic path and skills and the oral language path (Munro, 2006). The three paths have a similar learning structure and each comprises a maximum of 60 teaching sessions.

The words taught in each session for the phonological and orthographic paths and the comprehending strategies to be taught for the oral language path were specified.

In each intervention pathway, every fifth session was a review session. This session included the re-administration of measures of prose and isolated word reading (prose reading comprehension and accuracy, word reading accuracy and orthographic knowledge for text similar to those used on intervention teaching) described earlier and students' reading self-efficacy.

The characteristics of the three intervention pathways[2] are as follows.

1. ***Phonological awareness pathway.*** Each session teaches a particular spoken onset and/or rime unit by developing various phonological and phonemic skills (rhyming, blending and segmenting) and using these to read and spell words and to read prose.

2. ***Orthographic processing pathway.*** Each session teaches a particular letter cluster unit, either a written rime or a written onset for one syllable words. It teaches word reading skills (segmenting and blending to read written words) and using these in reading and writing activities.

3. ***Oral language pathway.*** Each session teaches a comprehending strategy first in oral language contexts and then applied to reading. The strategies are taught in the following sequence: inferring the topic of the text and questions it might answer; visualizing sentences and paraphrasing sentences.

Each session in the three pathways comprises the following types of learning activities: students

1. recall what they learnt in the preceding session by re-reading text from the previous session.

2. learn pathway- specific skills (rhyming, sound blending and spoken word segmenting skills in the phonological pathway, segmenting and blending written words using phonic strategies in the orthographic pathway and application of comprehension strategies in the comprehension pathway).

3. read and write target words.

4. read relevant prose.

5. review explicitly what has been learnt in the session.

2.3 Allocation to an ERIK pathway

[2] In tables and figures in this report, the abbreviations 'phon', 'orth' and 'lang' are used to refer to the phonological, orthographic and oral language interventions respectively.

Students were allocated to one of the phonological, orthographic, or oral language intervention pathways and received a number of teaching sessions each week for several weeks using the criteria shown in Table 2.

Table 2

The criteria used to allocate students to one of the ERIK interventions

Criterion score range	Intervention
Year 1 (post RR) and Year 2	
Below 16th %ile in accuracy & comprehension or below 25th %ile in accuracy & low in the phonological tasks	Phonological
Between 15-25th %ile in accuracy and low in both the phonological and orthographic tasks (if not an ESL student)	Orthographic
Below 25th %ile in accuracy & low in orthographic tasks or below 25%ile in comprehension	Oral language
Year 3 and Year 4	
Below 15th %ile in accuracy and low on the phonological tasks or an ESL student or below 15th %ile in both accuracy and comprehension	Phonological
Slow processing speed, decoding and reading rate, poor RAN, & average scores on phonological tasks or below the 15th %ile in accuracy and low orthographic score	Orthographic
Below 15th %ile in comprehension but not in accuracy	Oral language

While most students remained in the first intervention to which they were allocated, a small portion, based on their progress, moved from the phonological to the orthographic pathway and others from the orthographic to the comprehension pathway. The number of students at each year level comprising each profile in each intervention is shown in Table 3.

Table 3

The number of students comprising each profile in each intervention at each year level

Years of schooling	Phonological	Orthographic	Language	Phonological + orthographic	Orthographic + language
Second year of schooling					
under on all measures	24	4		6	
under on accuracy + comprehension	17	13	3	2	
under on accuracy +rate	6				
under on accuracy	3				
under on comprehension +rate	1			1	
under on comprehension	1	2	10		
under on rate	1	4	2	3	
above on all	11	7	19	4	
Total	64	30	34	16	
Third year of schooling					
under on all measures	100	45	35	13	5
under on accuracy + comprehension	29	25	26	4	1
under on accuracy +rate	6	10	3		
under on accuracy	3	7	4		

under on comprehension +rate	2		6		
under on comprehension	1		15	1	
under on rate	2	4	5		
above on all	1	4	11		1
Total	144	95	105	18	7
	Fourth year of schooling				
under on all measures	47	51	37	10	4
under on accuracy + comprehension	3	19	20		3
under on accuracy +rate	5	4	9	1	
under on accuracy	4	6	1	1	
under on comprehension +rate			8		
under on comprehension		2	13		
under on rate		2	3		
above on all	4	4	3	1	
Total	63	88	94	13	7
	Fifth year of schooling				
under on all measures	12	22	10		4
under on accuracy + comprehension	10	12	5		4
under on accuracy +rate	2	3	3		2
under on accuracy	1	1	2		2
under on comprehension +rate			2		1
under on comprehension	1		3		1
under on rate		2	1		
above on all		1	4		
Total	26	41	30		15
	Sixth year of schooling				
under on all measures	3	5	3		
under on accuracy + comprehension		1	2		
under on accuracy +rate					
under on accuracy					
under on comprehension +rate		1	1		
under on comprehension	1	1	1		
under on rate					
above on all					
Total	4	8	7		

The means of distribution of students to intervention pathways shows a trend with years of schooling. In the earlier years, a greater portion was allocated to the phonological intervention. With increase in the years of schooling, a higher portion was allocated to the orthographic and comprehension pathways.

2.4 Assessment of literacy learning profile

In addition to each student's reading profile, a literacy learning profile was compiled for each student. This comprised their performance in a number of areas necessary for successful early literacy learning;

1. their phonological and phonemic skills and phonological short term memory,

2. their ability to make verbal analogies,
3. their ability to learn an orthographic code and to display visual symbolic and orthographic processing,
4. their ability to match spoken and written words and to use read pseudo words,
5. their listening comprehension and
6. their RAN of letters and digits.

The specific tasks used are described in Munro (2006).

2.5 Procedures.

Qualified primary school teachers were trained to administer the various tasks in the participants' schools over several sessions. The training included explicit task moderation procedures. Participant selection decisions and result interpretations were made by the writer with other members of the research team.

3. The design of the evaluation

3.1 The centrality of the reading profile in this evaluation.

The concept of the reading profile is an important one for this evaluation. A student's reading performance and their capacity to learn more about reading is assumed to be a synthesis of their knowledge and skill in the three domains of reading. In this report the efficacy of ERIK is investigated in terms of these profiles.

Evidence to support this synthesis is shown in the association between the three domains at the pre-assessment phase. The Pearson correlation procedure was used to assess the extent of correlation between the three domains. These are shown for the cohort as a whole, for the group who was underachieving in the three domains and the group who were above the 25th percentile in the three domains. The Pearson correlations ((2-tailed) coefficients between Neale Accuracy, Comprehension and Rate raw scores pre intervention are shown in Table 4.

Table 4

The correlations (Pearson, 2-tailed) coefficients between Neale Accuracy, Comprehension and Rate raw scores pre intervention

	Comprehension			Rate		
	All n=1072	profile 1 n=442	profile 8 n=75	All n=1018	profile 1 n=442	profile 8 n=75
Accuracy	.58**[3]	.77**	.46**	.56**	.67**	.65**
Comprehension				.281**	.55**	.29*

**. Correlation is significant at the 0.01 level (2-tailed).

The three domains are correlated significantly. The stronger correlations for the cohort that underachieved in all three domains is consistent with these students being less able to use parts

[3] Throughout this report the symbols * and ** are used to denote a statistic that is significant at the 0.05 and 0.01 levels respectively.

of each domain automatically. The data support the approach used here, that we focus on the synthesis of the three domains through the use of the students' reading profiles.

3.2 The centrality of the Simple View of Reading.

The Simple View of Reading was used to underpin the development of the intervention pathways. It was seen as important early to examine whether the data collected was aligned with this model.

The measure of decoding was the Neale accuracy raw score pre teaching and the measure of oral language was verbal analogies. The product of these two skills was correlated with Neale comprehension raw score pre teaching. The value of the correlations (Pearson, 2-tailed) for the various reading profiles is shown in Table 5.

Table 5
The correlation between comprehension and accuracy x verbal analogy score for each profile.

The domain/s of underachievement[4]	Correlation value, probability level and n
in all domains of reading	0.42** p = .000, n = 377
in accuracy + comprehension	0.44** p =.000, n =174
in accuracy +rate	0.50** p =.001, n = 39
in comprehension +rate	0.24 p =.192, n =32
in accuracy only	0.47 p =.057, n =17
in comprehension only	0.52** p =.002, n =33
in rate only	0.36 p =.132. n = 19
in none of the domains	0.37* p =.013, n =44

The correlations show that the student data are consistent with the main causes of underachievement in reading comprehension predicted by the Simple View of Reading. This theory accounted for between 20 and 25 % of the variance in reading comprehension for the profiles covering 91 % of the cohort.

3.3 The comparison of the pre- and post-teaching outcomes.

The design focuses on examining differences in the distribution of student reading scores pre-and post-teaching for both accuracy and comprehension and the factors that influence these differences. This comparison is an example of a repeated measures design.

The evaluation uses a general linear modelling repeated measures ANOVA design to investigate how the various factors affected the change in Neale reading raw score. The comparison of pre- and post-reading raw score was the within subjects factor. The between subject effects were the reading profiles (8), the intervention pathways (3), the number of years of schooling (5), and aspects of the delivery (the total number of lessons[5] and the number of lessons per week). Of the entire cohort only 9 students had complete sets of data. The number of lessons per week had the smallest number of cases and this variable was omitted from the analysis of the influences

[4] Throughout this paper the abbreviations 'acc' and 'comp' are used in tables and figures to refer to accuracy and comprehension respectively.

[5] The total number of lessons each student had was grouped into decades and had values of from 1 to 12.

Adherence to the assumptions of normality, linearity, homogeneity of variances and regression gradients and reliability of the covariate metric were checked prior to application to each year level. Versions of this design were used to examine particular questions. These are described in the following section.

3.4 The evaluation procedures used.

Improvement in accuracy, comprehension and rate was examined separately, using the following procedures the three domains of reading:

1. The main and interaction affects for the entire cohort were examined using analysis of variance for repeated measures, with Neale reading comprehension pre-and post-intervention as the within subject factor and the intervention pathway, reading profile, total number of lessons and frequency of lessons per week at each year of schooling the between subject main factors.

   Any conditions in the following evaluation for which Wilks' Lambda for the three interventions was not significant and for which Mauchly's Test of Sphericity was significant are noted.

2. The improvement for each learning profile in each intervention at each year of schooling were compared using general linear modeling, with the pre- and post-reading accuracy scores the within-subject factors, analysis of gain scores and effect sizes (Cohen's d). Some of the profiles for each intervention comprised less than 20 students[6]. In these cases the general linear modelling was not used. As well, effect sizes are not reported for samples of less than ten. The trends in pre- to post-intervention scores with reading profile are shown diagrammatically for profiles that have more than two participants. The mean gain in accuracy at each year level was calculated and used as to identify gains that were higher and lower than average.

3. The effects of the total number of lessons and the lesson frequency per week for each intervention and at each year level were analyzed.

4. The efficacy of the three interventions, in terms of the gain each delivered at each year level was examined using analysis of covariance with pre-intervention reading comprehension score the covariate. Univariate between-groups analysis of covariance procedures compared the three interventions in terms of the gain in reading accuracy and the extent to which the reading profiles differed in improvement. The independent variables were the intervention used and reading profiles with reading accuracy pre teaching the covariate

5. The difference between those who made the highest and lowest gains in accuracy at each year level were linked with the various components of their literacy learning profiles using Oneway ANOVA of each component with levels of the gain in accuracy.

Three comments about these procedures are appropriate. The first relates to how the effectiveness of each intervention is examined. The question of how to investigate with validity the effect of an intervention has attracted much dialogue over the last 5 decades. Knapp and

[6] The t-test for paired samples was reported for profiles having more than 2 students. While this statistic retains its robustness for small samples sizes, it is acknowledged that the power of the outcome in these cases is restricted and the data for the small samples need to be interpreted cautiously.

Schafer (2009) provide a useful review and recommendations for comparing pre- and post-intervention outcomes. The two procedures used most often are the analysis of gain scores and analysis of pre and post scores using repeated measures variance-covariance. The two procedures produce different results that cannot be compared directly. Both are used here to provide confirmatory analysis of the trends examined in this evaluation.

The second relates to the use of effect size measures. The Cohen's *d* effect size is used to compare mean post and pre-intervention scores. Cohen (1977) recommended that care be taken in interpreting them in a blanket way such as 0.2 being a small effect size , 0.5 being medium) and 0.8 being large (the "canned effect sizes" (Baguley, 2009, p. 613). In particular, Baguley notes that factors like the quality of the study, the uncertainty of the estimate and results from previous investigations be used to decide an interpretation.

To assist in interpreting Cohen's d; various other statistics have been calculated:

1. Cohen's (1977) U3 as the proportion of the post-teaching cohort who are above the mean of the pre-teaching group;
2. Reiser and Faraggi's (1999) overlapping coefficient; proportion (%) of the groups that overlap;
3. Probability of superiority (Ruscio & Mullen, 2012); the % likelihood that a person selected randomly post intervention will have a higher score than at pre intervention.

To assist in interpretation of Cohen's d effect sizes, the values of these statistics that match various Cohen's d values are shown in Table 6.

Table 6
The statistics values that match various Cohen's d values.

Cohen's *d*	Cohen's U3 (%)	proportion (%) of the groups that overlap	probability of superiority
.2	58	92	56
.3	62	88	58
.4	66	84	61
.5	69	80	64
.6	73	76	66
.7	76	73	69
.8	79	69	71
1.0	84	62	76
1.2	89	55	80
1.4	92	48	84
1.5	95	42	87
2.0	96	37	90
2.5	98	32	92
3.0	99.9	13	98

This review compares students' accuracy scores pre and post the teaching. This is a repeated measures design. The two distributions are not independent; a student who achieves in the top range pre teaching is likely to achieve in the top range post teaching. Calculation of Cohen's d requires computation of a measure of the combined or pooled standard deviation for the two distributions. This can be done in two ways; one that assumes the two distributions are independent and one that takes account of the fact that they are correlated. The first uses the original standard deviations for the two means and the second uses the paired t-test value that

takes account of the correlation between the two scores and will be larger than a between groups t-test. An ES calculated using the paired t-test value will be larger than the ES calculated using the original standard deviations of the scores.

Psychometricians differ in their recommendations. Some (for example, Rosenthal,1991) use the paired t-test value to calculate while others (for example, Dunlop, Cortina, Vaslow, & Burke, 1996) treat the two distributions as unrelated and use their initial standard deviations. They believe that if the pooled standard deviation is corrected for the amount of correlation between the measures, then the ES index overestimate the actual ES. This evaluation follows Dunlop, et.al. 1996) recommendation and use the original standard deviations to compute the ES rather than the paired t-test value. It errs on the side of conservative ES estimates.

Third, some of the reading profile cohorts of reading profiles at some of the year levels had very few students. This limited the range of statistical procedures that could be used for that year level.

4. Improvement in Neale accuracy raw scores

4.1 The literacy learning profiles of students entering each intervention pathway.

The mean performance of students at risk of accuracy reading difficulties (that is, having an accuracy reading score at less than the 25th percentile) on each of the literacy readiness tasks was calculated. The cohorts entering the three pathways generally did not differ in their literacy learning profiles. Exceptions were as follows:

For students in their third year,

1. the oral language pathway has higher letters sound decoding scores and higher orthographic processing scores than the phonological group.
2. the orthographic pathway had higher verbal analogies scores than the phonological pathway cohort.

For the students in the fifth year of schooling, the orthographic pathway had higher scores than the final logical pathway in RAN for both letters and names.

These data suggest that the three cohorts of at risk students entering each ERIK pathway generally did not differ in their literacy learning profiles. This report examines the factors that influenced improvement in each domain of reading during intervention. The effects of the following variables were examined: reading profile, intervention path, years of schooling and number of teaching sessions each week.

4.2 Trends across the cohort as a whole for improvement in accuracy

Patterns in how reading profile, intervention path and years of schooling affect reading accuracy for the cohort as a whole are shown in Table 7.

Table 7
The main and interaction effects on accuracy for the entire cohort

Source	df	Mean Square	F	Partial Eta Squared
Within subject effects				
Change in accuracy	1	7430.689	198.22**	.199
Change in accuracy * intervention	5	22.919	.611	.003
Change in accuracy * years of schooling	6	144.862	3.86**	.019
Change in accuracy * reading profile	7	77.253	2.06*	.018
Change in accuracy * intervention * years of schooling	14	44.049	1.175	.017
Change in accuracy * intervention * reading profile	27	36.088	.963	.032
Change in accuracy * years of schooling * reading profile	24	61.467	1.64*	.047
Change in accuracy * intervention * years of schooling * reading profile	33	32.687	.872	.035

Error(factor1)	955	38.85		
Between subject effects				
Intercept	1	388235.51	3100.07**	.796
intervention	4	180.41	1.44	.007
years of schooling	4	8899.47	71.06**	.263
Reading profile	7	4011.95	32.03**	.220
intervention * years of schooling	12	79.41	.63	.009
intervention * reading profile	27	84.75	.67	.022
years of schooling * reading profile	24	219.92	1.75*	.050
intervention * YOS * reading profile	33	122.51	.978	.039
Error	796	125.23		

The ANOVA showed that reading accuracy improved (F (1, 955) = 198.22, p = .000) and this improvement was influenced by the number of years of schooling (F (4, 796) = 71.06, p = .00) and reading profile (F (1, 796) = 32.03, p = .000). Students in different years of schooling improved to different extents (F (4, 380) = 3.86, p = .00).

Second, the intervention pathways did not differ in their influence on the improvement (F (2, 796) = 1.44, p = .348). The rate of improvement did not differ across the interventions (F (2, 995) = 0.61, p = .22) and the interventions had a similar influence regardless of the number of years of schooling (F (14, 995) = 1.17, p = .18).

Third, students' reading profiles influenced their level improvement in accuracy (F (7, 796) = 32.03, p = .00) and this interaction changed with years of schooling (F (19, 380) = 1.71, p = .03). The extent of improvement for different reading profiles was not influenced by the intervention pathway selected (F (11, 955) = .963, p = .31). Students with different reading profiles improved at much the same rate regardless of the intervention (F (27, 796) = .67, p = .47). The rate of improvement did vary for the different reading profiles (F (7, 955) = 2.06, p =.01).

The number of years of schooling affected the accuracy improvement pattern for each reading profile (F (24, 796) = 1.75, p = .02) and students with different profiles at different year levels showed different accuracy improvement patterns (F (24, 955) = 1.64, p =.03).

The analysis shows that reading accuracy improved during the intervention and both the students' reading profiles and the number of years of schooling influenced this. The intervention pathway selected for students did not influence the improvement in accuracy and its interaction with other effects wasn't significant. As well interaction effects showed that students at different grade levels had different patterns in the change in accuracy. Similarly, students with different reading profiles showed different reading improvement patterns.

This section investigates further the nature of these influences; how the intervention path, the years of schooling and reading profile affected reading accuracy at each year level. It will research the influence of the three pathways for interventions that comprise cohorts of more than 20 students.

4.3 The progress of each reading profile through each intervention pathway

This section examines the progress of each reading profile through each intervention pathway at each year level and whether one of the intervention pathways was more beneficial for improving

reading accuracy, both for the cohort as a whole at each year level and for each reading profile. The analysis investigates the difference between mean pre- and post-reading accuracy scores first for each intervention across all reading profiles and then for each profile having that intervention.

4.4 Pre-intervention differences.

Prior to analyzing the gains in accuracy score, it is useful to examine the extent to which the various reading profiles differed in pre-intervention accuracy. The means and standard deviation for each profile are shown each grade level entering each intervention pathway in the following section and in Figure 1. Differences at each grade level were investigated using Oneway ANOVA procedures.

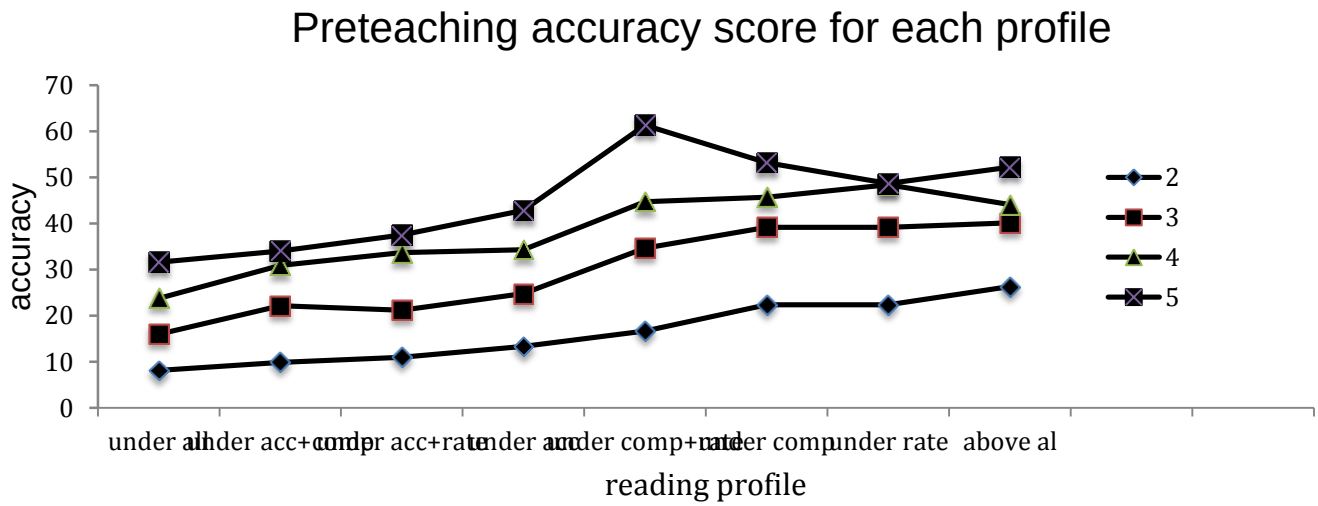


Figure 1
Trend in mean reading accuracy for each reading profile at each year of schooling.

Inspection of the mean reading accuracy for the various profiles for each intervention at each year level shows that it is lowest for the profiles in which students underachieved on all measures of reading (profile 1) and in which the students underachieved in comprehension and accuracy. It was highest for the cohorts in which students underachieved only in rate and in which they didn't underachieve on any measures. This difference was significant for all interventions from years 2 to 5 and the post hoc comparisons showed that profiles 1 and 2 were usually significantly lower than for profiles 7 and 8, and often lower than profiles 3-6. For the six year cohort the difference in profiles was significant only for the orthographic intervention. These data support the use of the reading profiles as the unit of analysis in the evaluation of the efficacy of the ERIK intervention.

The reading accuracy scores for students entering each intervention were also compared. The mean and standard deviation for each cohort entering each intervention pathway at each grade level are shown in Table 8. Differences in means were examined using the post hoc using multiple comparisons with the Scheffe test. The differences that emerged as significant ($p < .05$) are also shown.

Table 8
Mean reading accuracy scores for students entering each intervention

			Mean differences
Phonological (1)	Orthographic (2)	Oral language (3)	

Years of school	N	Mean	Std.	N	Mean	Std.	N	Mean	Std.	(p < .05)
2	66	13.68	11.21	44	14.36	7.60	35	23.60	8.13	(3) with (2), (3) with (1)
3	144	17.222	8.00	99	20.67	8.47	105	28.27	11.20	(3) with (2), (3) with (1)
4	64	25.06	10.79	107	26.56	9.69	98	35.28	10.14	(3) with (2), (3) with (1)
5	27	32.29	10.85	50	33.38	9.86	30	43.73	9.09	(3) with (2), (3) with (1)
6	4	38.75	21.01	10	44.10	21.88	10	44.50	17.63	

These data show that the students entering the oral language intervention had a high initial reading accuracy score than those entering the phonological and orthographic interventions. This is expected, based on the teachers' use of assessment data to locate students in each intervention. This needs to be taken into account when interpreting the improvement data.

4.5 Improvement in reading accuracy for students in their second year

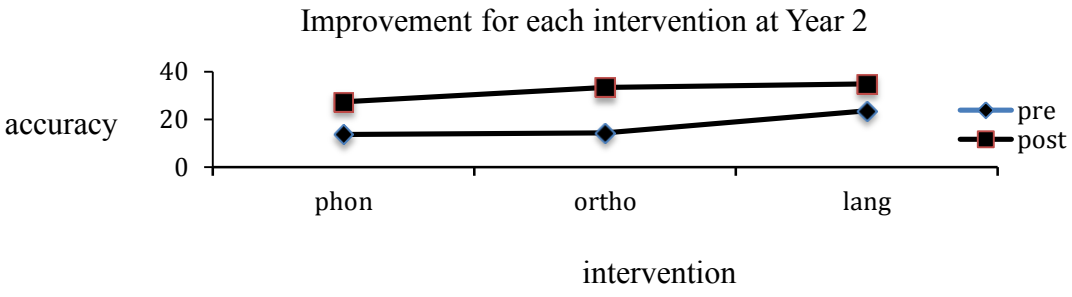
Improvement in reading accuracy for each intervention by second graders, in terms of mean scores pre- and post-teaching, their standard deviations and standard error, the F ratio for the pre- and post- difference and the effect size (Cohen's d) are shown in Table 9.

Table 9
Mean accuracy scores pre- and post-teaching, F ratio for the difference and the effect size

intervention path[7]	N	Pre			Post			F	Cohen's d
		mean	std.	st error	Mean	std.	st error		
phon	66	13.68	11.21	1.38	27.36	12.11	1.49	127.30** (1,65)	1.28
orth	30	14.36	7.60	1.14	33.36	10.08	1.52	210.54 ** (1,29)	2.15
lang	34	23.60	8.13	1.37	34.89	11.11	1.88	48.00** (1,33)	1.17

These data show that second year students in the three interventions improved in reading accuracy. Of the cohort, 51% was allocated to the phonological path, 23 % to the orthographic path and 26% to the comprehension path.

The comparative improvement in accuracy for the three interventions is shown in Figure 2.



[7] The abbreviations 'phon', 'orth' and 'lang' are used throughout this report to refer to the phonological, orthographic and oral language interventions respectively.

Figure 2
Improvement in accuracy for the three interventions.

The three interventions differed in gain score (F (2, 161) = 4.99, p = .002), with the orthographic intervention having the highest gain (M= 19.00, sd = 8.68, n= 44) and the oral language the lowest (M= 11.28, sd = 9.63, n= 35). The mean gain for the orthographic intervention was higher than for the phonological intervention (M= 13.68, sd = 9.85, n= 66), (p = .037) and for the oral language intervention (p = .005).

The effects of the intervention for each reading profile[8] in each intervention in terms of mean pre- and post-intervention scores, the extent of their difference (2-tailed t-test for paired samples) and effect size (Cohen's d) for the difference between them are shown in Table 10.

Table 10
Mean pre- and post-intervention accuracy scores for each reading profile in each intervention

Reading profile		Accuracy pre		Accuracy post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
ERIK phonological intervention							
under on all measures	24	7.91	4.07	22.71	7.11	11.83**	2.55
under on accuracy +comprehension	17	9.17	4.54	23.94	8.68	6.34**	2.13
under on accuracy +rate	6	11.00	1.78	27.50	5.09	6.43**	
under on accuracy	3	13.33	1.15	19.33	4.72	1.86	
under on comprehension +rate	1	16.00	.	27.00	.		
under on comprehension	1	15.00	.	23.00	.		
under on rate	1	26.00	.	28.00	.		
above on all	11	29.77	15.72	43.64	17.29	2.65*	.84
ERIK orthographic intervention							
under on all measures	4	7.75	5.18	27.50	4.43	5.17*	
under on accuracy +comprehension	13	10.38	4.011	33.00	9.77	7.92**	3.03
under on comprehension	3	19.50	3.53	25.50	9.19		
under on rate	4	21.50	1.91	35.25	9.47	3.54*	
above on all	7	24.87	4.94	41.29	9.50	5.41**	
ERIK language intervention							
under on accuracy +comprehension	3	11.33	2.309	28.00	10.15	3.59	
under on comprehension	10	23.70	7.48	36.90	14.25	3.72**	1.16
under on rate	2	22.00	1.414	38.50	.707	11.0	
above on all	19	26.00	7.91	35.11	10.18	4.20**	1.00

These data show that most reading profiles improved for each of the three interventions. The effect sizes for reading profiles that had more than 10 students suggest high level improvement. The lowest effect sizes were for students who were under in comprehension or above in all areas. The proportion of at risk students who displayed above 'at risk' reading accuracy performance post teaching were 85%, 100% and 100% for the phonological, orthographic and comprehension interventions respectively.

[8] Throughout this evaluation, conditions of reading profile that had 0 participants have been deleted from tabulated data.

The extent to which each profile benefitted from each intervention are shown in Figure 3.

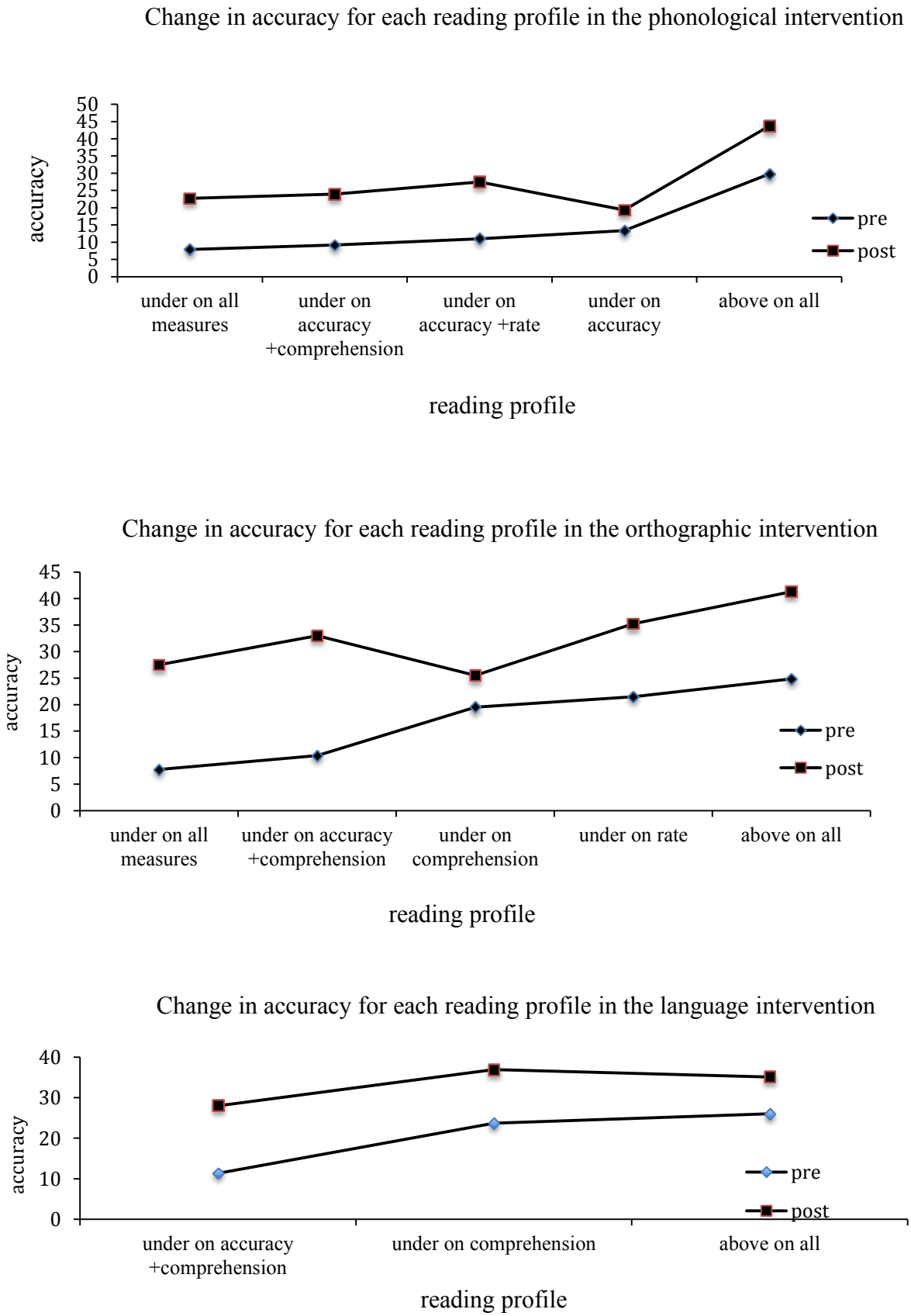


Figure 3

Improvement for each profile for each intervention.

The improvement in accuracy for each reading profile in each intervention was similar. This is shown by the trend lines being approximately parallel. Exceptions were those under in accuracy on the phonological intervention and those under in comprehension in the orthographic intervention.

Comparison of the profiles using linear modelling procedures was restricted by the small samples. Table 10 shows that the phonological and language interventions had two profiles shown that had 10 or more participants. The reading profiles made similar gains in accuracy in each context.

The mean gains for each reading profile for each intervention were used to investigate corroborative trends. These are shown in Table 11.

Table 11
The mean gains for each profile for each intervention

	phonological			orthographic			oral language		
Profile	Mean	Std	N	Mean	Std	N	Mean	Std	N
under on all	14.79	6.12	24	19.75	7.63	4			
under on accuracy + comprehension	14.76	9.60	17	22.61	10.28	13	16.67	8.02	3
under on accuracy + rate	16.50	6.28	6						
under on accuracy	6.00	5.56	3						
under on comprehension + rate	11.00	.	1				7.00	.	1
under on comprehension	8.00	.	1	6.00	5.65	2	13.20	11.21	10
under on rate	2.00	.	1	13.75	7.76	4	16.50	2.12	2
above on all	13.90	17.41	11	16.42	8.03	7	9.10	9.44	19

The gains for the different reading profiles, for those profiles that had more than 10 students, did not differ for any of the three interventions ($F(2, 63) = .63$, $p = .73$ and $F(2, 34) = .749$, $p = 0.57$ for the phonological and oral language interventions respectively.

When compared with average gains, the gains in the phonological and language interventions were below average ($M = -1.02$, $sd = 9.85$ and $M = -3.42$, $sd = 9.64$ for the phonological and language interventions respectively) and above average for the orthographic intervention ($M = 4.29$, $sd = 8.69$). The trend across the three interventions was significant ($F(2, 157) = 4.99$, $p = .002$) with the gain in the orthographic intervention higher than the gain in the phonological intervention (Scheffe mean difference = 5.32, $p = .037$).

In summary, for students in their second year of schooling, the orthographic intervention was associated with the highest gain in accuracy and oral language the lowest gain. In each intervention, those whose pre teaching reading comprehension or/and accuracy profiles were below the 25th percentile did not differ in the extent of gain made.

4.6 Students in their third year of schooling

The mean reading accuracy scores pre- and post-teaching for each intervention by third year students, standard deviations and standard error, the F ratio for the difference and the effect size (Cohen's d) are shown in Table 9 and Figure 4.

Table 9
Reading accuracy pre- and post-teaching and effect size for students in their third year of school

ERIK path	N	Pre mean	Pre sd	Pre st error	Post Mean	Post sd	Post st error	F	Cohen's d
phon	144	17.22	8.00	.667	29.90	9.81	.818	273.85 (1, 143)	1.42
orth	95	20.70	8.50	.859	34.40	11.88	1.200	216.20 (1,97)	1.32
lang	105	28.27	11.20	1.093	38.12	11.59	1.132	162.08, (1,104)	.86

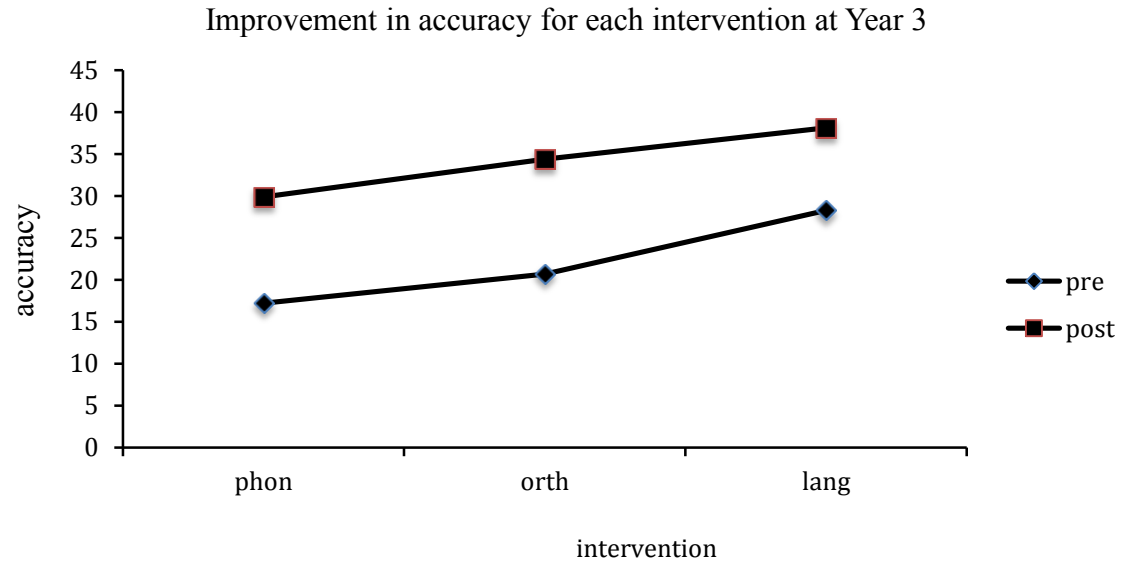


Figure 4
Improvement in accuracy for each intervention for students in their third year.

These data show that third year students in the three interventions improved in reading accuracy[9]. The phonological, orthographic and oral language intervention yielded gains of M= 12.67 (sd = 9.19), M=13.69 (sd = 9.21) and M= 9.84 (sd = 7.92) respectively. The gain for the orthographic intervention was higher than for the oral language intervention (p = .046).

The mean pre- and post-intervention scores for each reading profile in each intervention, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 13 and Figure 5.

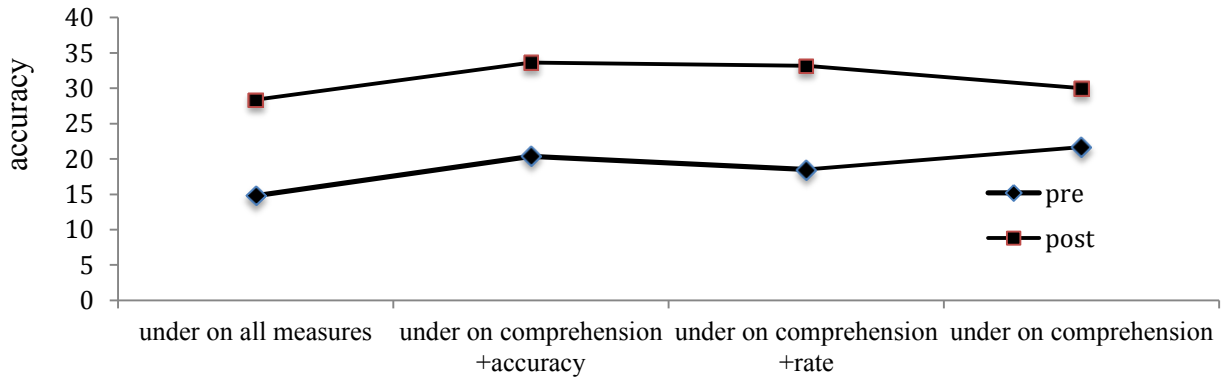
Table 13
Mean pre- and post-intervention accuracy scores for each reading profile in each intervention

Reading profile	N	Accuracy pre Mean	Accuracy pre Std	Accuracy post Mean	Accuracy post Std	t-test	Cohen's d
ERIK phonological intervention							
under on all measures	100	14.81	6.57	28.37	9.57	16.43**(1,99)	1.65
under on accuracy +comprehension	29	20.39	5.56	33.62	9.64	7.89** (1,28)	1.68
under on accuracy +rate	6	18.50	6.98	33.17	11.93	4.25** (1,5)	
under on accuracy	3	21.67	4.05	30.00	6.93		
under on comprehension +rate	2	35.50	.71	30.00	18.38		
under on comprehension	1	42.00	.	30.00	.		
under on rate	2	40.00	0	37.50	7.78		

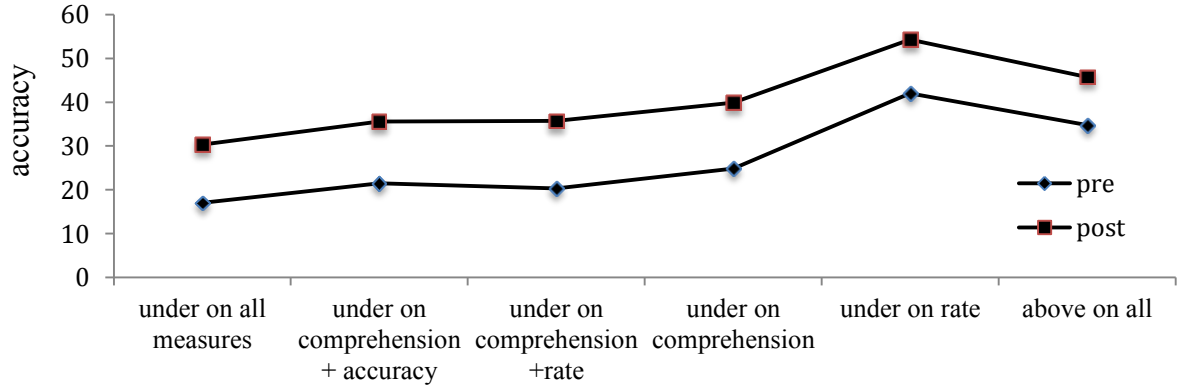
[9] The relevant ANOVA data are shown in Table C6, Appendix 4.

above on all	1	39.00	.	39.00	.		
ERIK orthographic intervention							
under on all measures	44	17.00	5.79	30.32	9.783	9.64** (1,43)	1.66
under on accuracy +comprehension	25	21.48	6.18	35.60	10.23	7.29** (1,24)	1.67
under on accuracy +rate	10	20.30	4.72	35.70	14.26	4.18** (1,9)	1.45
under on accuracy	7	24.87	3.48	39.86	8.03	4.56** (1,6)	2.42
under on rate	4	42.00	11.34	54.25	14.98	3.68*(1,3)	
above on all	4	34.75	5.85	45.75	12.31		
ERIK language intervention							
under on all measures	35	19.00	6.22	30.43	8.81	9.45** (1,34)	1.50
under on accuracy +comprehension	26	25.43	6.78	37.19	9.34	6.91** (1,25)	1.44
under on accuracy +rate	3	29.67	3.21	42.67	2.88		
under on accuracy	4	27.00	3.92	37.75	9.39		
under on comprehension +rate	6	34.33	1.97	42.83	7.84	2.69* (1, 5)	1.49
under on comprehension	15	39.13	4.56	46.27	8.71	3.89**(1, 14)	1.03
under on rate	5	36.60	2.51	40.00	7.91		.58
above on all	11	42.73	15.24	49.18	16.19	2.63* (1, 10)	.41

Change in accuracy for each reading profile for the phonological intervention



Change in accuracy for each reading profile for the orthographic intervention



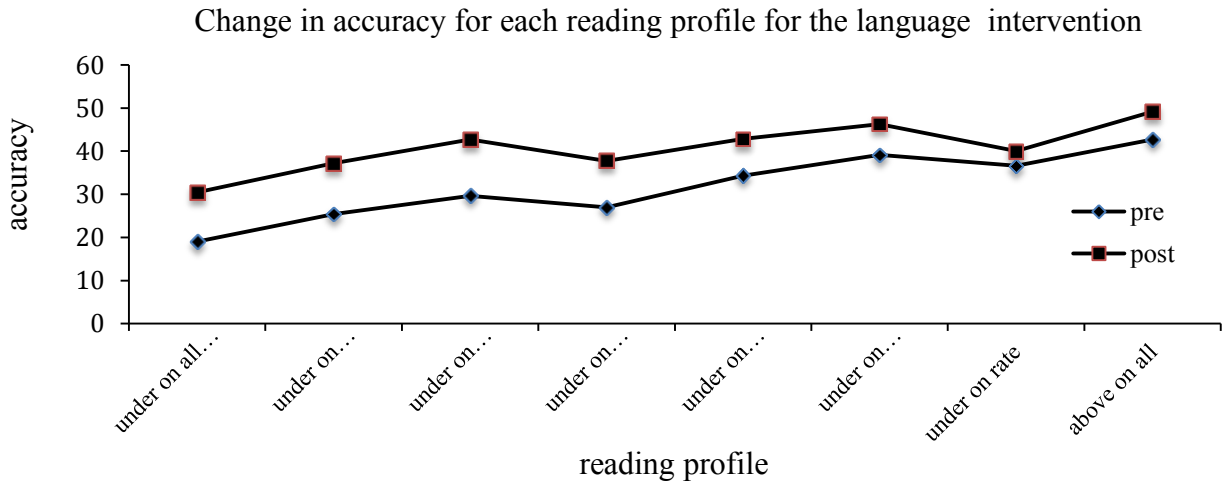


Figure 5

Improvement for each profile for each intervention.

These data show that most reading profiles improved for each of the three interventions. For profile cohorts of 10 or more participants, reading profile did not influence reading accuracy in any of the three interventions. [10] Following intervention, the proportion of at risk students who displayed above 'at risk' reading accuracy performance were 34%, 50% and 67% for the phonological, orthographic and comprehension interventions respectively.

The mean gains for each reading profile for each intervention are shown in Table 14.

Table 14
Gains for each reading profile for each intervention for students in the third year of school

	Phonological			Orthographic			oral language		
Reading profile	Mean	SD	N	Mean	SD	N	Mean	SD	N
under on all	13.56	8.24	100	13.31	9.15	44	11.42	7.15	35
under on accuracy + comprehension	13.24	9.03	29	14.12	9.67	25	11.76	8.68	26
under on accuracy + rate	14.66	8.45	6	15.40	11.64	10	13.00	6.08	3
under on accuracy	8.33	10.40	3	15.00	8.69	7	10.75	5.90	4
under on comprehension + rate	-5.50	19.09	2				8.50	7.73	6
under on comprehension	-12.00	.	1	6.00	5.65	2	7.13	7.09	15
under on rate	-2.50	7.77	2	12.25	6.65	4	3.40	9.86	5
above on all	.00	.	1	11.00	11.31	4	6.45	8.12	11

The gains for the different reading profiles, for those profile categories that had more than 10 students, did not differ for any intervention; ($F(2, 127) = .99$, $p = .18$, $F(5, 95) = .19$, $p = 0.96$ and $F(4, 97) = .1.59$, $p = 0.14$ for the phonological, orthographic and oral language interventions respectively. The eight profiles did not differ from the pooled average improvement across the interventions ($F(7, 137) = 1.68$, $p = .12$); they all made similar progress.

[10] The general linear modeling data are shown in Tables C 7-9, Appendix 4).

When compared with average gains for two years of schooling, the gains in the language intervention was below average (M= -2.19, sd = 7.92) and above average for phonological and the orthographic interventions (M= .63, sd = 9.19 and M= 1.65, sd = 9.21 respectively). The trend across the three interventions was significant (F (2, 368) = 2.90, p =.02) with the gain in the orthographic intervention higher than the gain in the language intervention (Scheffe mean difference = 3.86, p = .046).

4.7 Students in their fourth year of schooling

The mean reading accuracy scores pre- and post-teaching for each intervention by fourth graders, their standard deviations and standard error, the F ratio for the pre- and post- difference and the effect size (Cohen's d) are shown in Table 15 and Figure 6.

Table 15
Accuracy pre- and post-teaching and effect size for students in their fourth year of school

ERIK		Pre			Post			F	Cohen's d
path	N	mean	sd	st error	mean	sd	st error		
phon	64	25.06	10.79	1.38	35.55	10.86	1.49	95.44** (1,63)	.97
orth	88	26.56	9.69	1.14	38.07	11.54	1.52	287.43** (1,43)	1.05
lang	98	35.28	10.14	1.37	47.17	12.54	1.88	182.28** (1,34)	1.05

These data show that fourth year students in the three interventions improved in accuracy.

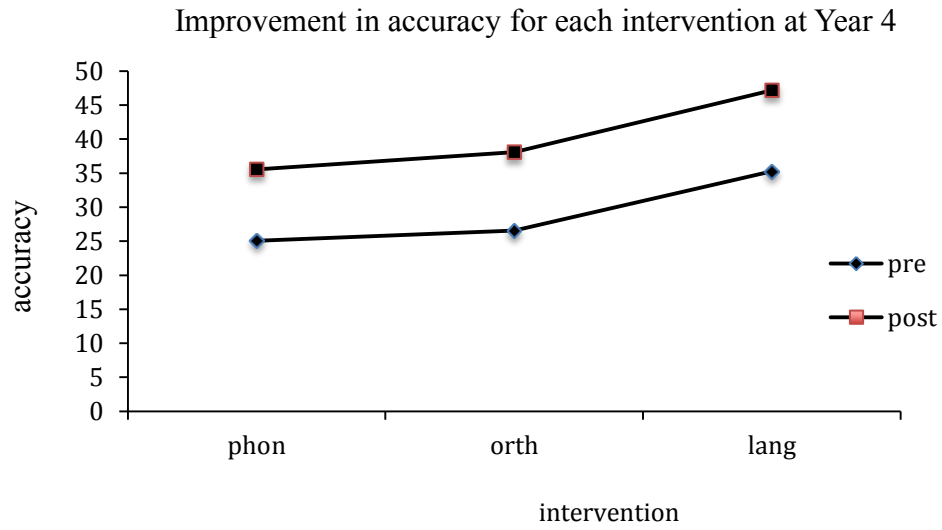


Figure 6
Improvement in accuracy for each intervention for students in their fourth year of schooling.

The three interventions differed in gain score (F (2, 161) = 4.99, p = .002). The orthographic intervention had the highest gain (M=19.00, sd = 8.68, n= 44) and the oral language the lowest (M=11.28, sd = 9.63, n= 35). The mean gain for the orthographic intervention was higher than for the phonological intervention (M= 13.68, sd = 9.85, n= 66), (Scheffe mean = 5.31, p = .037) and for the oral language intervention (p = .005).

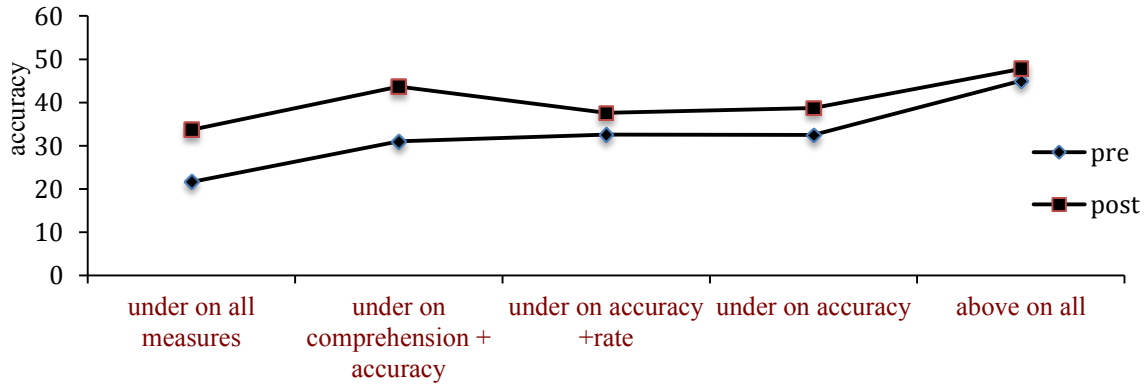
The mean pre- and post-intervention scores for each reading profile in each intervention, the difference between them (2-tailed t-test for paired samples) and the effect size are shown in Table 16.

Table 16

Mean pre- and post-intervention accuracy scores for each reading profile in each intervention

Reading profile		Accuracy pre		Accuracy post		t-test	Cohen's
	N	Mean	SD	Mean	SD		d
ERIK phonological intervention							
under on all measures	47	21.63	9.74	33.72	11.06	10.33**	1.16
under on accuracy +comprehension	3	31.00	2.64	43.67	14.74	1.49	1.20
under on accuracy +rate	5	32.60	5.72	37.60	7.57	.938	.75
under on accuracy	4	32.50	3.87	38.75	2.06	6.06**	2.02
above on all	4	45.00	2.00	47.75	1.708	1.53	1.48
ERIK orthographic intervention							
under on all measures	51	22.23	8.87	34.55	11.06	11.56**	1.23
under on accuracy +comprehension	19	29.68	6.25	44.63	8.27	14.76**	2.04
under on accuracy +rate	4	31.25	2.21	43.00	5.77	5.40*	2.69
under on accuracy	6	34.50	3.98	43.83	7.16	2.39	1.61
under on comprehension	2	46.00	5.65	57.50	4.95	23.00*	2.17
under on rate	2	44.50	3.53	54.50	6.36	1.42	1.94
above on all	4	41.75	4.03	55.25	8.61	3.03	2.01
ERIK language intervention							
under on all measures	37	28.32	9.51	39.89	11.92	8.20**	1.07
under on accuracy +comprehension	20	32.65	5.19	49.50	13.10	7.106**	1.69
under on accuracy +rate	9	35.44	3.94	48.44	7.21	5.34**	2.24
under on accuracy	1	37.00	.	39.00	.		
under on comprehension +rate	8	44.75	2.60	52.63	4.34	5.07**	2.20
under on comprehension	13	45.69	5.54	56.38	11.09	4.76**	1.22
under on rate	3	51.00	11.53	57.00	10.14	1.664	.55
above on all	3	46.00	8.66	56.33	10.06	4.43**	1.10

Change in accuracy for each reading profile in the phonological intervention



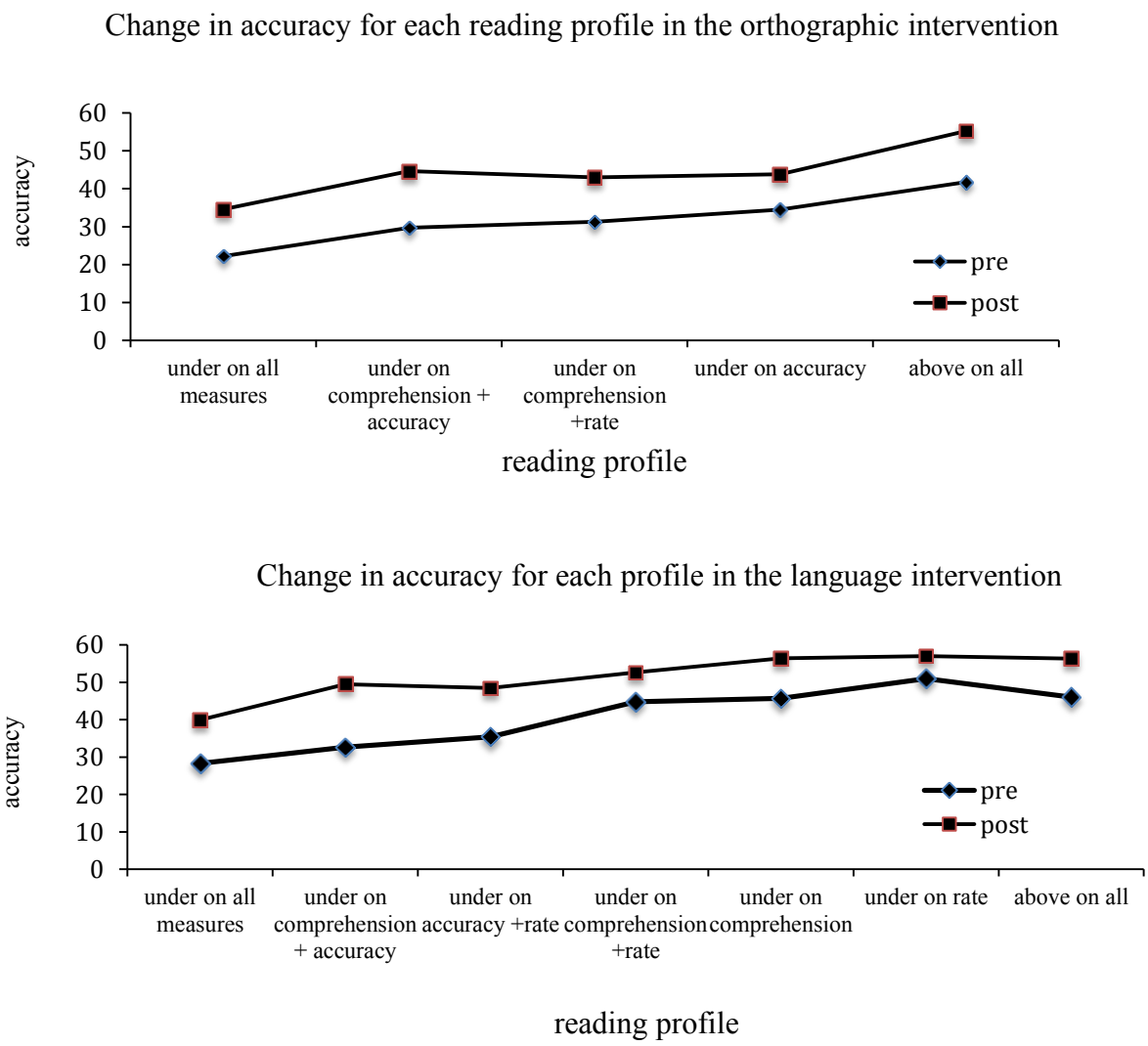


Figure 7

Improvement for each profile for each intervention.

These data show that most reading profiles improved for each of the three interventions, although the t-test for the small sample sizes should be treated with caution. When the three interventions were matched on pre teaching reading accuracy, univariate between-groups analysis of covariance showed that neither the intervention pathway, reading preference nor their interaction influenced post accuracy ($F(7, 224) = 1.24$, $p = 0.277$, $F(2, 224) = 2.39$, $p = .093$, and ($F(7, 342) = .73$, $p = .691$ for reading profile, type of intervention, and reading profile x ERIK pathway respectively).[11] Following intervention, the proportion of at risk students who displayed above 'at risk' reading accuracy performance were 30%, 45% and 77% for the phonological, orthographic and oral language interventions respectively.

The mean gains for each reading profile for each intervention are shown in Table 17.

Table 17
Gain for each reading profile in each intervention for students in the fourth year of schooling

	Phonological			orthographic			oral language		
Reading profile	Mean	Std	N	Mean	Std	N	Mean	Std	N

[11] The Tests of Between-Subjects Effects are shown in Appendix 1, Table C15.

under on all	12.08	8.018	47	12.31	7.60	51	11.56	8.57	37
under on accuracy + comprehension	12.66	14.64	3	14.94	4.41	19	16.85	10.60	20
under on accuracy + rate	5.00	11.91	5	11.75	4.34	4	13.00	7.29	9
under on accuracy	6.25	2.06	4	9.33	9.54	6	2.00	.	1
under on comprehension + rate							7.87	4.38	8
under on comprehension				11.50	.70	2	10.69	8.09	13
under on rate				10.00	9.89	2	6.00	6.24	3
above on all	2.75	3.59	4	13.50	8.88	4	10.33	4.04	3

The gain data suggests that all reading profiles that had more than 10 students showed a similar level of improvement; (F (2, 68) =.65, p = 0.70 and F 3, 67) =.1.69, p = 0.14 for the orthographic and oral language interventions respectively. As well, the interaction effect change in reading accuracy * reading profile did not achieve significance for any intervention. The eight profiles did not differ in the extent to which their progress differed from pooled average improvement across the interventions; they all made similar progress.

Similarly, the gains in the interventions did not differ did not differ from average, (F (2, 283) = 1.25, p =.29); the means for the phonological, orthographic and language interventions were M= -.68, sd = 8.58, n = 64; M= .33, sd = 7.01, n= 107; and M= .71, sd = 8.71, n= 98 respectively.

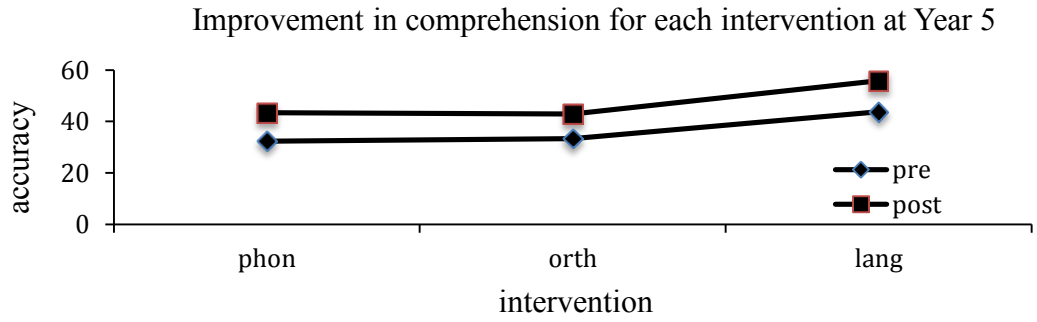
4.8 Students in their fifth year of schooling

The mean reading accuracy scores pre- and post-teaching for fifth graders in each intervention, their standard deviations and standard error, the F ratio for the pre- and post- difference and the effect size (Cohen's d) are shown in Table 18 and Figure 8.

Table 18
Reading accuracy pre- and post-teaching and effect size for students in their fifth year of school

ERIK		Pre			Post			F	Cohen's d
path	N	mean	sd	st error	mean	Sd	st error		
phon	26	32.34	11.06	1.38	43.38	13.79	1.49	127.30** (1,65)	.89
orth	50	33.38	9.86	1.40	42.86	12.59	1.78	210.54 ** (1,43)	.85
lang	30	43.73	9.09	1.37	55.83	14.23	1.88	48.00** (1,34)	1.04

Figure 8



Improvement in accuracy for each intervention for students in their fifth year.

These data show that fifth year students in the three interventions improved in accuracy. The interventions did not differ in the gain they produced (F (2, 16) = 0.55, p = .56), with mean gains for the phonological, orthographic and oral language interventions of M= 11.03 (sd = 8.42, n= 26), M= 9.48 (sd = 8.74, n= 50) and M= 12.1 (sd = 10.61, n= 30) respectively. The mean pre- and post-intervention scores for each profile in each intervention, the difference between them (2-tailed t-test for paired samples) and matching effect size are shown in Table 19 and Figure 9.

Table 19

Mean pre- and post-intervention accuracy scores for each reading profile in each intervention

Reading profile		Accuracy pre		Accuracy post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	12	31.25	8.69	40.67	13.97	3.61**	.81
under on accuracy +comprehension	10	28.40	11.13	43.30	14.46	6.49**	1.15
under on accuracy +rate	2	40.00	1.41	42.50	2.12	5.00	1.39
under on accuracy	1	43.00	.	59.00	.		
under on comprehension	1	59.00	.	63.00	.		
Orthographic intervention							
under on all measures	22	30.54	8.92	40.55	11.15	5.08**	.99
under on accuracy +comprehension	12	35.75	6.09	44.00	9.60	3.86**	1.03
under on accuracy +rate	3	36.67	3.78	40.00	2.64	1.14	1.02
under on accuracy	1	43.00	.	41.00	.		
under on rate	2	49.00	2.82	68.50	3.53	39.00**	6.10
above on all	1	51.00	.	61.00	.		
Language intervention							
under on all measures	10	37.22	5.69	48.33	8.23	4.98**	1.57
under on accuracy +comprehension	5	38.60	5.98	49.20	10.37	2.98*	1.25
under on accuracy +rate	3	38.00	4.35	46.33	4.93	2.62	1.79
under on accuracy	2	44.00	1.41	53.00	24.04	-.50	.53
under on comprehension +rate	2	59.00	14.14	87.50	7.77	1.83	2.50
under on comprehension	3	53.33	2.51	63.67	11.84	1.52	1.21
under on rate	1	48.00	.	58.00	.		
above on all	4	52.50	4.43	64.75	10.14	4.43**	1.57

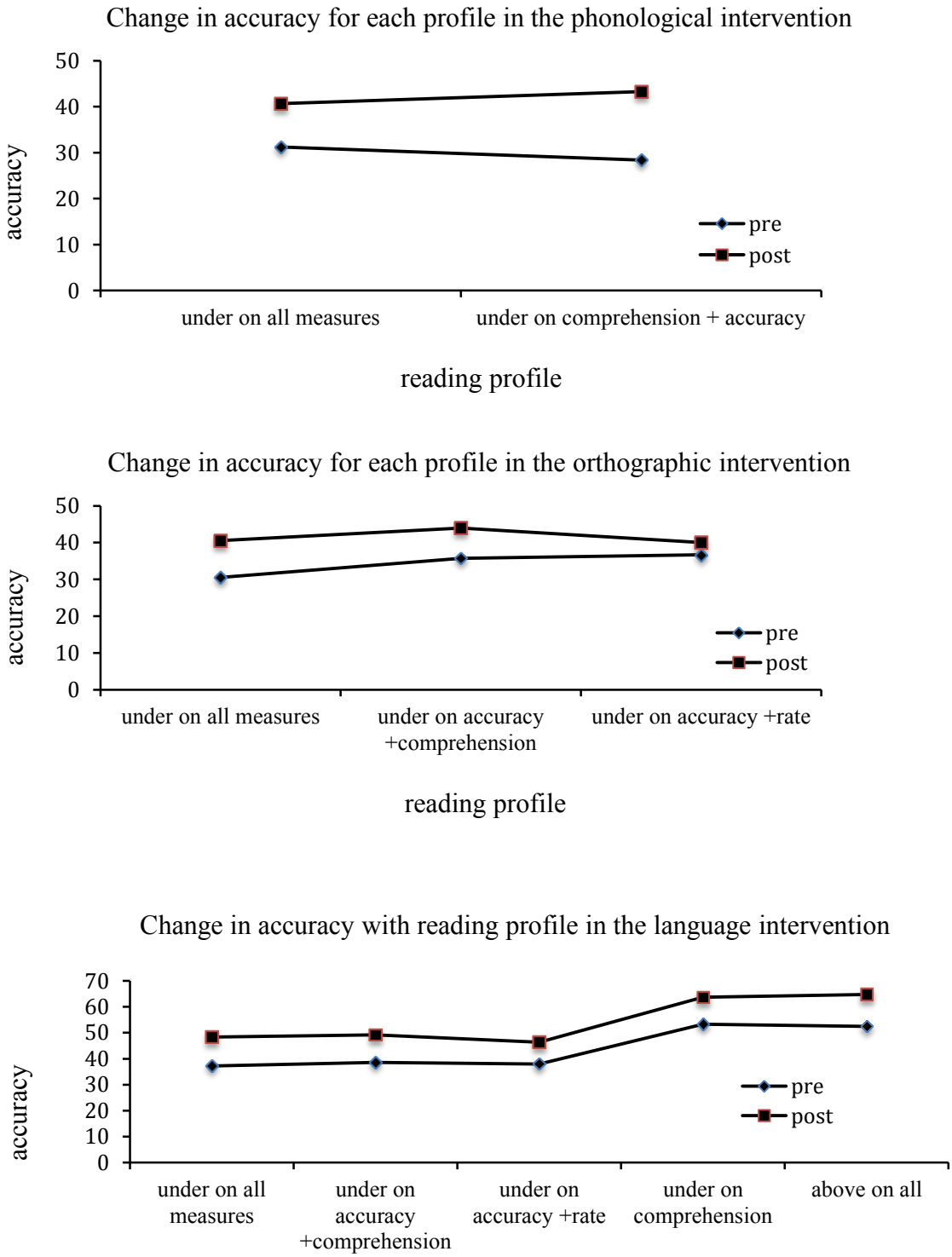


Figure 9

Improvement for each profile for each intervention.

These data show that most reading profiles improved for each intervention. When the three interventions were matched on pre teaching reading accuracy, the univariate between-groups analysis of covariance showed that neither the type of intervention, reading preference nor their interaction affected post accuracy ($F(7, 76) = 1.92$, $p = .07$, $F(2, 76) = .45$, $p = .64$ and ($F(7, 76) = .54$, $p = .84$) for reading profile, type of intervention, and reading profile x ERIK pathway

respectively). Following intervention, the proportion of at risk students who displayed above 'at risk' reading accuracy performance were 35%, 29% and 70% for the phonological, orthographic and language interventions respectively.

The mean gains for each reading profile for each intervention are shown in Table 20.

Table 20
Gains for each reading profile for each intervention for students in the fifth year of school

	Phonological			Orthographic			oral language		
Reading profile	Mean	Std	N	Mean	Std	N	Mean	Std	N
under on all	9.41	9.03	12	10.00	9.23	22	11.11	6.69	10
under on accuracy + comprehension	14.90	7.26	10	8.25	7.41	12	10.60	7.95	5
under on accuracy + rate	2.50	.707	2	3.33	5.03	3	8.33	5.50	3
under on accuracy	16.00	.	1	-2.00	.	1	9.00	25.45	2
under on comprehension + rate							28.50	21.92	2
under on comprehension	4.00	.	1	6.00	5.65	2	10.33	11.71	3
under on rate				19.50	.70	2	10.00	.	1
above on all				10.00	.	1	12.25	12.81	4

All reading profiles made similar gains in accuracy in each intervention ($F(4, 21) = 1.62$, $p = .23$, $F(5, 35) = 4.15$, $p = .005$ and $F(7, 21) = 8.73$, $p = .000$ in the phonological, orthographic and language interventions respectively. The interaction effect change in reading accuracy * reading profile was not significant for any intervention. The eight profiles did not differ in how their level of progress differed from average improvement pooled across the interventions ($F(7, 103) = 1.87$, $p = .08$); they all made roughly similar progress. When compared with average gains for five years of schooling, the gains in the three interventions ($M = .48$, $sd = 8.42$, $n=26$; $M = -1.07$, $sd = 8.74$, $n=50$; and $M = 1.55$, $sd = 10.61$, $n=30$; for phonological, orthographic and language interventions respectively) did not differ ($F(2, 117) = 0.59$, $p = .65$).

4.9 Students in their sixth year of schooling

Although the six years of schooling cohort is small (n= 19), their data are included for completeness. Improvement in accuracy for each intervention was examined using the t-test for paired samples. The mean accuracy scores pre- and post-teaching, their standard deviations and standard error and the t-value for accuracy improvement for each intervention are shown in Table 21.

Table 21
Reading accuracy pre- and post-teaching and effect size for students in their sixth year of school

ERIK		Pre			Post			t
path	N	mean	sd	st error	mean	sd	st error	
phon	4	38.75	21.01	10.50	57.00	34.28	17.14	2.11
orth	8	44.10	21.88	6.92	54.20	19.46	6.16	6.00**
lang	7	44.50	17.63	5.576	60.90	11.16	3.529	3.58**

These data show that sixth year students in the orthographic and comprehension interventions improved in reading accuracy.

The three interventions did not differ in gain score (F (2, 16) = .98, p = .39), with the scores gain M= 18.25, sd = 17.25; M= 10.1, sd = 5.32; M= 16.4, sd = 14.46 for the phonological, orthographic and oral language interventions respectively.

The mean pre- and post-intervention scores for each reading profile in each intervention and the extent of difference between them (2-tailed t-test for paired samples) are shown in Table 22. Effect sizes are not calculated because of small sample sizes.

Table 22

Mean pre- and post-intervention accuracy scores for each reading profile in each intervention

Reading profile		Accuracy pre		Accuracy post		t-test
	N	Mean	Std. D	Mean	Std. D	
Phonological intervention						
under on all measures	3	32.67	20.98	50.33	38.68	
under on comprehension	1	57.00	.	77.0	.	
Orthographic intervention						
under on all measures	5	28.40	5.02	38.80	6.57	8.92**
under on accuracy +comprehension	1	44.00	.	61.00	.	
under on accuracy +rate	1	71.00	.	73.00	.	
under on comprehension	1	91.00	.	94.00	.	
Language intervention	3	42.33	6.110	54.00	7.50	
under on all measures	2	29.00	35.35	63.50	4.95	
under on accuracy	1	57.00	.	72.00		
under on comprehension +rate	1	70.00	.	80.00		

Given the very small cohort sizes, the significance of the improvements were examined only for the reading profile that was under on all measures of reading in the orthographic intervention. The t-test for this cohort suggests improvement. Following intervention, the proportion of at risk students who displayed above 'at risk' reading accuracy performance were 50%, 50% and 65% for the phonological, orthographic and comprehension interventions respectively.

4.10 Summary of the effects of type of intervention and profile on improvement in accuracy.

The effect sizes for all reading profile groups that had more than 10 students, (that is, 25 cohorts) are shown in Table 23. All cohorts showed improved reading accuracy, with an effect size greater than .80. The orthographic intervention delivered the highest gains and the language context the lowest gains for students in their second to fourth years of school. The three interventions had similar outcomes for students in their fifth year. The difference between the orthographic and oral language interventions on accuracy improvement is not surprising, given the teaching focus of each.

Table 23

The effect sizes for all reading profile groups with more than 10 students

Reading profile	phonological	orthographic	language

	N	Cohen's d	N	Cohen's d	N	Cohen's d
Second year of schooling						
under on all measures	24	2.55				
under on accuracy +comprehension	17	2.13	13	3.03		
under on comprehension					10	1.16
above on all	11	.84			19	1.00
Third year of schooling						
under on all measures	100	1.65	44	1.66	35	1.50
under on accuracy +comprehension	29	1.68	25	1.67	26	1.44
under on comprehension					15	1.03
under on accuracy +rate			10	1.45		
above on all					11	.41
Fourth year of schooling						
under on all measures	47	1.16	51	1.23	37	1.07
under on accuracy +comprehension			19	2.04	20	1.69
under on accuracy +rate					13	1.22
Fifth year of schooling						
under on all measures	12	.81	22	.99		
under on accuracy +comprehension	10	1.15	12	1.03		

In terms of the combined effects of type of intervention and reading profile, for students in their second to fourth years of schooling, the profiles did not differ in the gains they made. Given that some profiles had a lower entry accuracy score, this may warrant further examination.

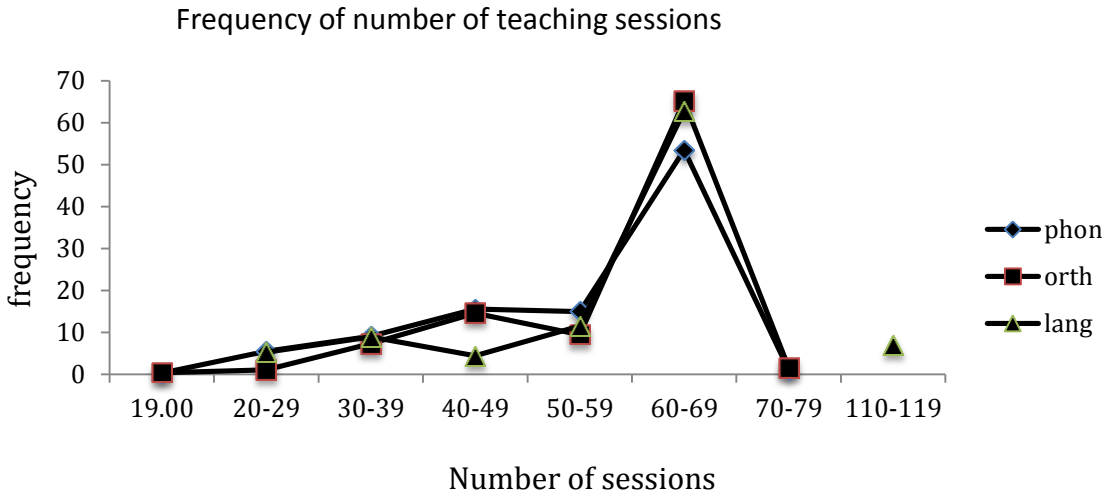
4.11 The influence of the number of lessons and their weekly frequency on accuracy improvement

The influence of the total number of lessons each student had, grouped into decades from 10 to 120 and the frequency of lessons per week on improvement in accuracy scores for each reading profile for each intervention at each year level was examined using general linear modelling procedures. The frequency of each range of lessons for each pathway is shown in Table 24.

Table 24

The frequency of each range of lessons for each pathway

range of	Phonological		Orthographic		Comprehension	
lessons	Frequency	Percent	Frequency	Percent	Frequency	Percent
10-19	1	.3	1	.4	0	
20-29	17	5.5	3	1.1	12	5.3
30-39	28	9.1	21	7.3	20	8.9
40-49	48	15.6	40	14.6	10	4.4
50-59	46	15	26	9.5	26	11.5
60-69	165	53.5	178	65.2	142	62.8
70-79	3	1.0	4	1.5		
110-119					16	7.1
	308		273		226	



These data show that the distribution of the number of lessons was similar across the three pathways, with 60-69 lessons being the most frequent for all three paths.

The mean number of lessons, the mean number of lesson per week and the mean duration for each lesson for each ERIK path is shown in Table 25.

Table 25
The total number of lessons, weekly frequency and lesson duration for each intervention.

	No. of lessons		lessons per week		Lesson duration	
	mean	sd	mean	sd	mean	sd
Phonological	52.06	11.51	3.46	.74	40.00	.00
Orthographic	55.04	9.21	3.34	.65	40.00	.00
Language	57.96	19.21	3.60	.80		

These data show that the three pathways had on average between 50 and 60 lessons, three-four lessons per week of 40 minutes duration.

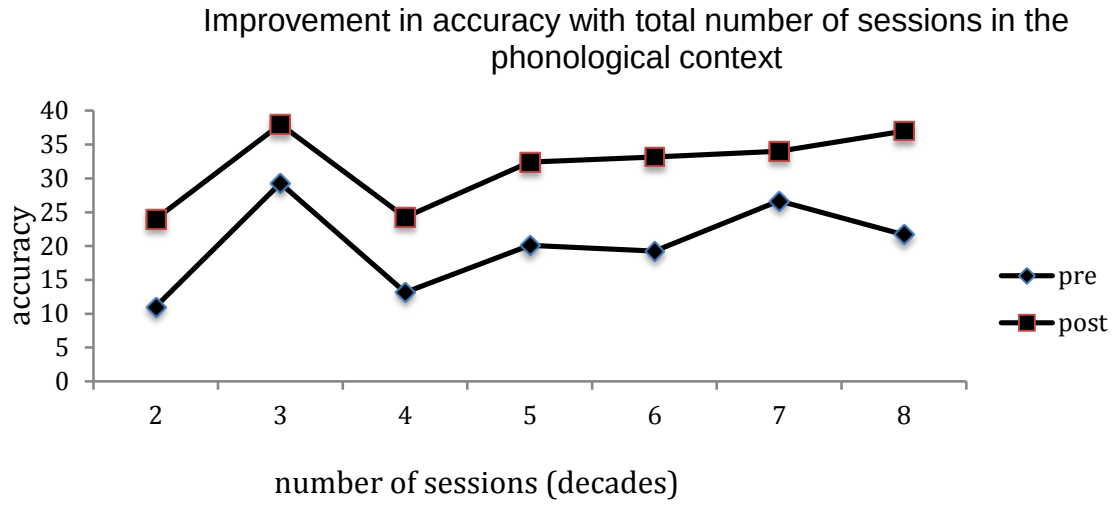
4.11.1 Effects for the cohort as a whole. The mean pre and post accuracy scores for each total number of lessons in each intervention across all year levels and profiles, the extent of difference (2-tailed t-test for paired samples) and the size of each improvement (Cohen's d) are shown in Table 26 and in Figure 10.

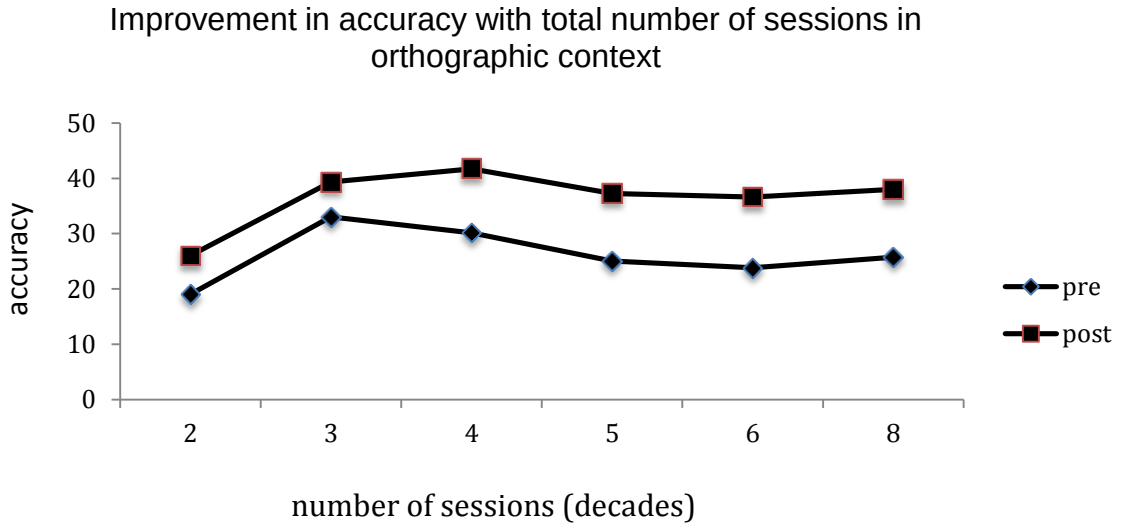
Table 26

The mean pre and post accuracy scores for each total number of lessons in each intervention

Intervention	duration	Mean	Std. Dev	N	Mean	Std. Dev	t-value	Cohen's d
Phonological	2	11.00	.	1	24.00	.		
	3	29.28	12.38	32	37.97	11.12	4.94**	0.74
	4	13.15	8.83	33	24.27	6.48	7.90**	1.44
	5	20.10	11.55	38	32.39	15.78	6.44**	0.88
	6	19.26	11.08	194	33.17	13.10	19.07**	1.14
	7	26.67	12.85	3	34.00	5.29	1.34	

	8	21.67	9.29	3	37.00	10.00	6.57*	
Orthographic	2	19.00	.	1	26.00	.		
	3	33.00	5.86	6	39.33	6.12	3.41*	
	4	30.14	10.60	21	41.71	11.62	6.24**	1.04
	5	25.02	14.48	42	37.26	13.98	7.72**	.86
	6	23.82	10.31	198	36.64	11.49	23.90**	1.17
	8	25.75	7.89	4	38.00	11.97	6.91**	1.21
Comprehension	2	20.40	12.21	5	30.20	11.03	2.85*	.84
	3	40.55	15.19	15	52.5	15.01	7.61**	.79
	4	40.93	11.91	15	59.27	14.86	7.65**	1.36
	5	32.21	10.40	19	41.00	17.06	3.84**	.62
	6	30.25	11.54	172	41.28	12.60	16.81**	.91
	12	44.50	10.10	16	54.81	14.45	3.93**	.83





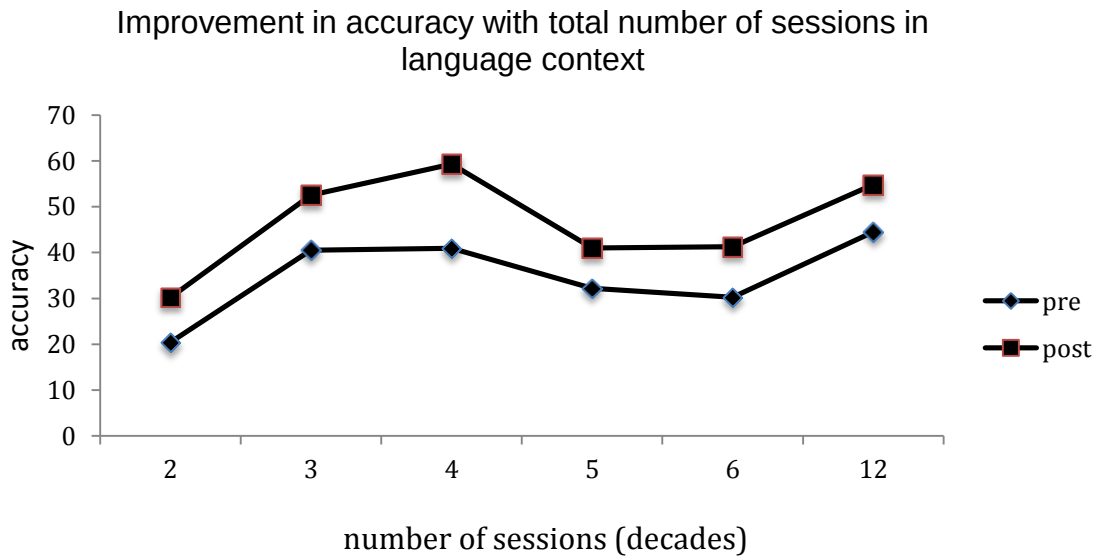


Figure 10
Trend in improvement with number of sessions in each intervention

While the effect sizes suggest that not all durations were equally effective, one might expect an increase with increase in duration. A clear pattern, however, with increase the total number of sessions does not emerge.

Further, one might expect that those students who began with lower accuracy scores received more lessons. Inspection of the data would suggest that this expectation is not supported. For the phonological intervention, those with the lower mean pre teaching accuracy scores generally did not receive the largest number of lessons.

The influence of the total number of lessons and weekly frequency on the gain in reading accuracy for the entire cohort for whom these data were available was examined using within subjects (repeated measures) ANOVA with pre- and post-reading accuracy the within-subjects factor and the duration, the number of lessons per week, each reading profile and each intervention were the between subjects factors. This analysis is shown in Table 27.

Table 27
The influence of the total number of lessons and weekly frequency on the gain in reading accuracy for each intervention

Source	df	Mean Square	F	Partial Eta Squared
Tests of Within-Subjects Effects				
gain in accuracy	1	4511.95	114.21**	.139
gain in accuracy * intervention	5	34.37	.87	.006
gain in accuracy * number of lessons	8	26.86	.68	.008
gain in accuracy * weekly frequency	3	266.75	6.75**	.028
gain in accuracy* intervention *number of lessons	9	73.55	1.86	.023
gain in accuracy * intervention* weekly frequency	6	114.00	2.88**	.024
gain in accuracy *number of lessons *weekly frequency	5	87.86	2.22*	.015

gain in accuracy * intervention * number of lessons * weekly frequency	6	201.03	5.08**	.041
Error(read)	707	39.50		
Tests of Between-Subjects Effects				
Intercept	1	157287.95	654.72**	.481
ERIK path	5	3166.83	13.18**	.085
number of lessons	8	306.07	1.27	.014
number of lessons per week	3	78.44	.33	.001
intervention * number of lessons	9	1018.8	4.24**	.051
intervention * weekly frequency	6	597.45	2.48*	.021
weekly frequency * number of lessons	5	205.41	.86	.006
intervention * number of lessons * weekly frequency	6	218.15	.91	.008
Error	707	240.23		

This analysis indicates that influence of the total number of lessons and their weekly frequency on improvement in reading accuracy is a complex relationship. First, it depends on the intervention pathway selected. However, neither the total number of lessons nor the number of lessons per week emerged as significant main effects ($F(8, 707) = 1.27$, $p = .16$) and $F(3, 707) = 0.33$, $p = .86$ respectively.

The interaction effects show this complexity. Different intervention pathways require different weekly frequencies of teaching (ERIK path * number of lessons per week ($F(6, 707) = 2.48^*$, $p = .021$) and different total durations(gain in reading accuracy * number of lessons ($F(6, 707) = 6.75^{**}$, $p = .00$), ERIK path*number of lessons ($F(9, 707) = 4.24^{**}$, $p = .00$), gain in reading accuracy * ERIK path * number of lessons per week ($F(6, 707) = 2.88^{**}$, $p = .00$), gain in reading accuracy*number of lessons*number of lessons per week ($F(6, 707) = 2.22^*$, $p = .02$) and gain in reading accuracy*ERIK path * number of lessons*number of lessons per week ($F(6, 707) = 5.08^{**}$, $p = .00$)). The remaining interaction effects did not achieve significance.

These outcomes for the cohort as a whole are somewhat surprising. They suggest that making decisions to increase reading accuracy either by simply increasing either the total number of lessons or the number of session each week may not be as effective as also taking account of the intervention pathway selected. One might expect as well that these decisions need to take account of students' learning profiles and years of schooling. The following section examines the influence of these variables for learning profiles at the various year levels.

4.11.2 The effect for each reading profile at each year level. This question of whether different reading profiles benefited from different total numbers of lessons was investigated using univariate ANOVA with reading accuracy the within subjects effect[12]. This could be examined only for those reading profiles in which students were at risk in all three areas of reading and those at risk in accuracy and comprehension. The remaining profiles each had fewer than 10 students at each year level. As well, there were insufficient students in the fifth and sixth years of schooling cohorts to permit analysis.

The pattern that emerged shows the complexity of teaching reading. While reading accuracy improved ($p < .01$), the patterns of interactions varied. For students in their second year of schooling, the analysis examined accuracy improvement for the two learning profiles. Neither

[12] Only significant effects are reported here. Violations of sphericity (Mauchly's Test) did not arise for any condition of change in reading accuracy.

the total number of teaching sessions nor their weekly frequency influenced reading accuracy for either profiles. Further, it was not influenced by the intervention chosen.

A similar main effect pattern was observed for third year students; the two factors did not, by themselves affect accuracy improvement. However, combinations of the two did have an effect. For those who underachieve in all three areas, different levels of improvement required different numbers of sessions ($F(1, 130) = 2.89$, $p < .05$). As well for those who under achieved in comprehension and accuracy, the rate of improvement in accuracy was influenced by a combination of the intervention, the total number of lessons and the number of lessons per week.

For students in the fourth year of schooling, those who underachieved in all three areas had sufficient students. Improvement in accuracy was influenced both by the intervention and its interaction with both the total number of lessons and also with the weekly frequency of teaching.

4.12 The literacy learning profiles of those students who improved.

We have already noted that the majority of reading profiles at each year level showed improvement over the course of the access to intervention. Some students achieved above the at-risk reading accuracy criterion at post teaching while others didn't.

In order to evaluate in more depth each intervention, it is useful to investigate and contrast the literacy learning characteristics of those students who did and did not show this level of improvement. Oneway analysis of variance was used to compare those who did and didn't achieve above the at risk reading accuracy criterion on each of the tasks that comprised the literacy learning profile. Mean performance on each component of literacy learning by those who did and didn't achieve the at risk reading accuracy score post intervention for students in their third to sixth years of schooling, the F ratio for each comparison and its level of significance at each year level are shown in Table 28. An analysis for students in their second year of schooling is not completed because 85%, 100% and 100% of the students achieved the at risk criterion for the phonological, orthographic and language interventions respectively.

Table 28
Each component of literacy learning for those who did / didn't achieve above at risk accuracy score post intervention

	Below criterion		Above criterion		F	P
	Mean	Std.	Mean	Std.		
	Three years of schooling					
	n=169		n=155			
Phon Awareness Segmentation 1	3.49	.88	3.51	.90	.06	.80
Phon Awareness Blending	3.74	.67	3.84	.51	2.17	.14
Phon Awareness Segmentation 2	2.17	1.52	2.52	1.52	4.13*	.04
Verbal Analogies	6.39	3.69	6.63	3.56	.36	.54
Matching Spoken and Written Words	10.52	1.33	10.79	1.82	2.24	.13
Learning an Orthographic Code	15.78	5.04	15.72	4.95	.01	.91
Phonological Short Term Memory	1.40	2.21	1.47	1.65	.10	.75
Visual Symbolic Processing	13.30	7.49	12.35	3.86	2.01	.16
Listening Comprehension	3.30	1.52	3.54	1.43	2.06	.15
Orthographic Processing of Words	10.05	2.50	10.25	2.36	.57	.44
RAN - Letters	37.54	19.61	33.86	17.45	3.15	.07

RAN - Digits	43.70	26.01	37.64	21.30	5.17*	.02
	Four years of schooling					
	n=102		n=96			
Phon Awareness Segmentation 1	3.41	.94	3.32	1.01	.40	.52
Phon Awareness Blending	3.66	.80	3.58	.81	.40	.52
Phon Awareness Segmentation 2	2.18	1.49	2.22	1.58	.03	.84
Verbal Analogies	7.51	2.84	5.95	3.99	10.13**	.002
Matching Spoken and Written Words	10.55	1.66	11.36	1.70	11.60**	.001
Learning an Orthographic Code	17.75	5.17	19.60	4.70	6.97**	.009
Phonological Short Term Memory	1.54	1.62	1.65	1.86	.18	.66
Visual Symbolic Processing	14.64	3.93	15.68	3.89	3.49	.06
Listening Comprehension	3.52	1.48	3.70	1.44	.72	.39
Orthographic Processing of Words	10.95	3.16	12.08	2.79	7.08**	.008
RAN - Letters	36.43	15.01	26.86	15.04	19.94**	.00
RAN - Digits	41.28	19.65	29.53	17.14	19.90**	.00
	Five years of schooling					
	n=64		n=41			
Phon Awareness Segmentation 1	3.59	.77	3.12	1.30	5.41*	.02
Phon Awareness Blending	3.58	.83	3.44	1.11	.53	.46
Phon Awareness Segmentation 2	2.56	1.51	1.93	1.38	4.67*	.03
Verbal Analogies	5.55	4.19	6.29	3.90	.83	.36
Matching Spoken and Written Words	10.61	2.88	11.66	.99	5.03*	.02
Learning an Orthographic Code	21.77	5.95	22.46	5.19	.38	.54
Phonological Short Term Memory	1.97	2.80	1.85	2.42	.04	.82
Visual Symbolic Processing	17.36	4.72	18.56	2.83	2.14	.14
Listening Comprehension	4.06	1.39	3.27	1.37	8.20**	.005
Orthographic Processing of Words	12.73	2.96	12.27	3.53	.53	.47
RAN - Letters	23.06	17.38	21.77	13.11	.16	.68
RAN - Digits	25.46	20.02	24.06	14.97	.14	.70
	Six years of schooling					
	n=9		n=8			
Phon Awareness Segmentation 1	3.56	.72	3.38	.51	.34	.56
Phon Awareness Blending	3.78	.44	3.38	1.18	.90	.35
Phon Awareness Segmentation 2	2.33	1.50	2.25	1.66	.01	.91
Verbal Analogies	8.56	.88	8.00	1.30	1.06	.31
Matching Spoken and Written Words	11.89	.33	11.63	.51	1.60	.22
Learning an Orthographic Code	24.11	5.96	25.00	4.59	.11	.73
Phonological Short Term Memory	1.00	1.00	.38	1.06	1.53	.23
Visual Symbolic Processing	17.89	4.40	16.88	8.00	.108	.74
Listening Comprehension	4.22	1.20	4.75	1.03	.92	.35
Orthographic Processing of Words	12.56	2.12	14.38	2.32	2.83	.11
RAN - Letters	30.44	5.65	23.44	5.47	6.69*	.02
RAN - Digits	33.11	7.16	26.26	6.43	4.25	.06

The particular literacy learning skills that differentiated between those who did and didn't cross the at risk criterion score varied between years of schooling. Most are associated with the acquisition of word reading: rapid automatized naming, either of digits, letters or both for students in the third, fourth and sixth years of schooling, simple and/or complex phonemic segmentation between the groups at the third and fifth year levels, matching spoken and written letter clusters at the fourth and fifth year levels and orthographic processing at the fourth year level. A skill more associated with reading comprehension, listening comprehension discriminated at the fifth year level.

4.13 Summary of the improvement in accuracy

In summary, given the limitations of the available data, the three interventions delivered improved reading accuracy for all reading profiles at all year levels. As noted earlier, the data illustrate the complexity of teaching reading.

First, this improvement was not always sufficient to achieve a score above the 'at risk' criterion. The proportion of the cohort at each year level who achieved above at risk reading accuracy scores varied, from a high level for students in their second year of schooling to lower levels at the higher grade levels. The comprehension intervention had the highest portion of students moving above the at risk criterion. Students entering this intervention had higher pre reading accuracy scores than the other two interventions.

Second, at most year levels the three interventions didn't differ in their improvement efficacy. Differences did emerge at third year level, with the phonological and orthographic interventions leading to lowest and highest improvements respectively.

Third, for those students who were at risk in all three areas of reading or those at risk in accuracy and comprehension (that is, profiles 1 and 2 respectively), the relationship between improvement in reading accuracy and either the total number of lessons or the number of sessions each week is not simple or directly. While for the second year of schooling neither the total number of teaching sessions nor their weekly frequency influenced reading accuracy for any of these profiles, a more complex relationship is suggested for the older year levels.

For the higher year levels the combination of the total number of teaching sessions and their weekly frequency influenced improvement in accuracy. As well, the intervention pathway that was selected also influenced the total number of lessons and their weekly frequency that led to accuracy improvement.

5. Improvement in Neale comprehension raw scores

This section unpacks the factors that influence the improvement in reading comprehension for each reading profile in each intervention at each year level. Students in each year had different numbers of teaching sessions altogether and different numbers of sessions each week. This analysis examines these effects.

5.1 Trends across the cohort as a whole for improvement in comprehension

The ANOVA showed that comprehension improved ($F(1, 380) = 125.18$, $p = .000$) and this improvement was influenced by most of the main effects. First, the number of years of schooling influenced the extent of improvement ($F(4, 380) = 17.43$, $p = .00$) and students in different years of schooling improved to different extents ($F(4, 380) = 2.48$, $p = .02$ for change in comprehension * years of schooling). The rate of improvement was affected by the weekly frequency of lesson ($F(3, 380) = 2.87$, $p = .03$)

Second, the intervention pathways did not differ in their influence on the improvement ($F(2, 380) = 1.62$, $p = .198$). The rate of improvement did not differ across the interventions ($F(2, 380) = 0.82$, $p = .32$) and the frequency of lessons each week didn't change the effectiveness of each pathway ($F(2, 380) = 0.90$, $p = .46$). However, it did vary with years of schooling ($F(8, 380) = 5.29$, $p = .00$). As well, different interventions required different total numbers of lessons to achieve the same level of improvement ($F(5, 380) = 2.73$, $p = .01$). The combination of different numbers of lessons in different interventions influenced the rate of comprehension improvement ($F(2, 380) = 10.54$, $p = .00$).

Third, the total number of lessons did influence the improvement of reading comprehension ($F(6, 380) = 2.61$, $p = .017$) and children at different years of schooling needed different total numbers of lessons to achieve the same level of improvement in comprehension ($F(12, 380) = 3.39$, $p = .00$). The total number of lessons by themselves did not increase the rate of improvement ($F(6, 380) = 2.02$, $p = .06$).

As well, the rate of comprehension improvement were influenced by the number of years of schooling and the total number of lessons ($F(12, 380) = 7.17$, $p = .000$) and students with different reading profiles needed different total numbers of lessons to achieve the same rate of improvement ($F(11, 380) = 2.19$, $p = .01$).

Fourth, varying the weekly frequency of lessons did change the level of improvement in comprehension ($F(3, 380) = 3.02$, $p = .10$) and particular combinations of the number of lessons and weekly frequency led to better improvement ($F(4, 380) = 3.79$, $p =. 01$) and to a faster rate of improvement ($F(4, 380) = 10.22$, $p =. 00$). This held across the different interventions ($F(1, 380) = .34$, $p = .55$) and also across the year levels ($F(1, 380) = 2.70$, $p = .101$).

The frequency of lessons per week had much the same effect at all year levels ($F(3, 380) = .23$, $p = .96$) and for all interventions ($F(4, 380) = .16$, $p = .95$). As well, different combinations of weekly frequency in different interventions didn't improve the rate of comprehension ($F(4, 380) = .56$, $p = .69$). Weekly frequency had a similar effect on the rate of comprehension change across the years ($F(6, 380) = .46$, $p = .84$).

Fifth, students' reading profiles influenced their level improvement in comprehension ($F(7, 380) = 23.47$, $p = .00$) and this interaction changed with years of schooling ($F(19, 380) = 5.43$, $p = .00$). As well, the extent of improvement for different reading profiles was influenced by the intervention pathway selected ($F(11, 380) = 4.01$, $p = .00$), the total number of lessons ($F(11,$

380) = 3.43, p = .00) and the weekly frequency of lessons (F (10, 380) = 2.76, p = .00). The rate of improvement didn't vary for the different reading profiles (F (7, 380) = 1.84, p =.07) but students with different profiles at different year levels showed different comprehension patterns (F (19, 419) = 1.69, p =.03). Students with different reading profiles improved at much the same rate regardless of the intervention (F (11, 380) = .96, p = .47), the weekly frequency (F (10, 380) = .71, p = .71), or the number of lessons (F (1, 380) = .23, p = .62).

In summary, the analysis shows that reading comprehension improved during the interventions and both the intervention selected, students' reading profiles and the number of years of schooling influenced this. It indicates a complex set of interactions that affect the change in comprehension. Different reading profiles showed different reading improvement patterns in different intervention pathways. As well, the years of schooling influenced the improvement.

These findings suggest that these factors affect improvement in comprehension differently from accuracy. These effects are unpacked and analysed in this section. The evaluation investigates the influence of the intervention path, the years of schooling and reading profile on reading comprehension at each year level. It will research the influence of the three pathways for interventions that comprise cohorts of more than 20 students.

5.2 The progress of each reading profile through each intervention at each year level

This analysis investigates the difference between mean pre- and post-teaching comprehension scores first for each intervention for all reading profiles and then for each profile. It uses general linear modelling with the pre- and post-teaching comprehension the within subject factors, paired t-test (2-tailed) to compare means and the effect size (Cohen's d)[13].

It also examines the question of whether one of the intervention pathways was more beneficial for improving comprehension, both for each year level cohort and for each reading profile. Univariate between-groups analysis of covariance procedures compared post teaching comprehension in the three interventions and the effect of reading profile on this. Reading comprehension pre teaching was the covariate.

5.3 The reading comprehension scores pre intervention

The reading comprehension scores for students entering each intervention were also compared using Oneway. The mean and standard deviation for each cohort before each intervention pathway at each grade level are shown in Table 28. Differences in means were examined using the post hoc multiple comparisons with the Scheffe test. The F value for the difference at each year level is also shown.

Table 28
Mean reading comprehension scores for students entering each intervention

										F (p value)
	Phonological (1)			Orthographic (2)			Oral language (3)			
Years of school	N	Mean	Std.	N	Mean	Std.	N	Mean	Std.	

[13] The general linear modeling was not used for profiles that had less than 20 students. Effect sizes are not reported for samples of less than ten.
The t-test for paired samples was reported for profiles having more than 2 students. While this statistic retains its robustness for small samples sizes, it is acknowledged that the power of the outcome in these cases is restricted and the data for the small samples need to be interpreted cautiously.

2	66	7.59	12.06	41	4.78	3.34	35	8.4	8.98	1.51 (p = .23)
3	144	6.89	6.47	90	8.22	6.17	91	7.49	3.8046	1.49 (p = .23)
4	64	13.42	14.56	100	11.13	3.70	97	11.59	4.40	1.68 (p = .19)
5	27	13.56	10.51	50	13.20	5.37	30	14.80	5.135	0.51 (p = .60)
6	4	8.75	6.99	10	15.78	4.024	10	14.60	5.56	

These data indicate that the three interventions did not differ in initial reading comprehension score for any year level.

5.4 Improvement in reading comprehension for second year students

Of the second year's cohort, 51% was allocated to the phonological path, 23 % to the orthographic path and 26% to the comprehension path. The mean reading comprehension scores pre- and post-teaching, their standard deviations and standard error, the F ratio for the difference and the effect size (Cohen's d) are shown in Table 29 and in Figure 11.

Table 29
Improvement in reading comprehension for each intervention by second graders

intervention		Pre			Post			F	Cohen's d
	N	Mean	std.	st err	mean	std.	st error		
phon	66	7.59	12.06	1.49	13.41	12.97	1.60	59.09** (1, 65)	.47
orth	44	4.59	3.31	.50	11.91	4.57	.69	107.16 ** (1, 43)	1.86
lang	35	8.22	7.89	1.34	16.86	9.23	1.56	50.91** (1, 34)	1.01

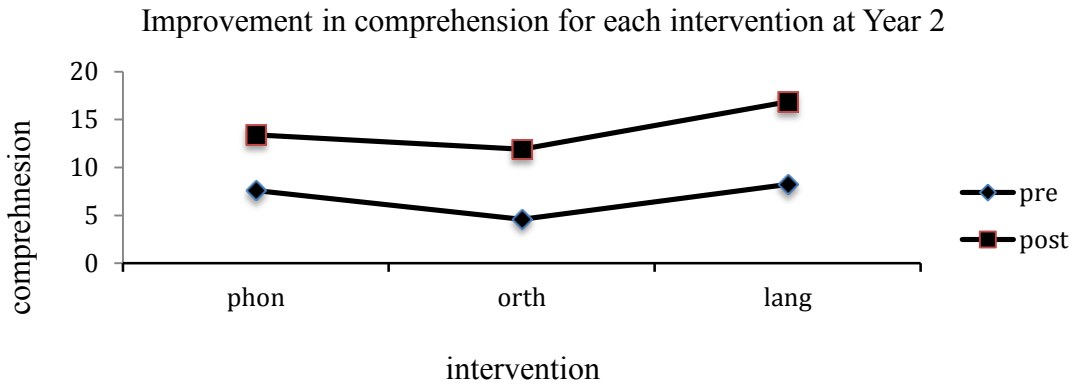


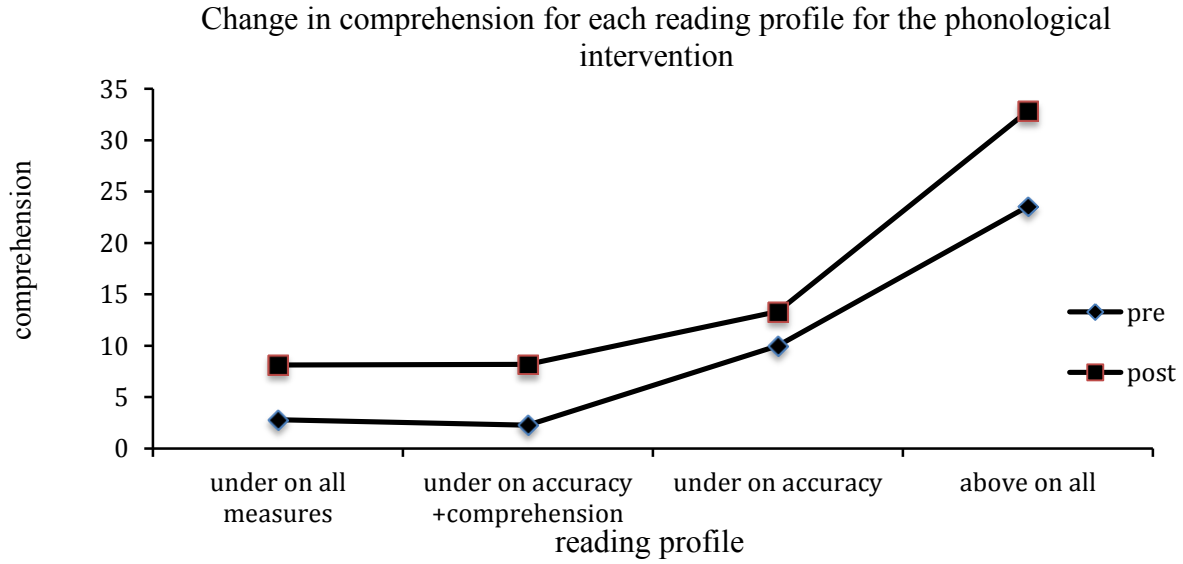
Figure 11
Trend in improvement in reading comprehension for each intervention

These data show that second year students in the three interventions improved in reading comprehension. The effect sizes show that improvement was highest in the orthographic intervention and least in the phonological intervention. This is consistent with enhanced word reading ability assisting students to comprehend the text they are reading more effectively.

The mean pre- and post-intervention scores for each reading profile in each intervention were compared to examine their progress. These data, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 30 and in Figure 12.

Table 30
The pre- and post-teaching comprehension scores for each reading profile in each intervention

Reading profile		Comprehension pre		Comprehension post		t-test	Cohen's d
	N	Mean	SD	Mean	SD		
Phonological intervention							
under on all measures	24	2.79	1.21	8.13	4.00	6.18**	1.81
under on accuracy +comprehension	17	2.29	1.40	8.18	4.26	6.29**	1.86
under on accuracy	3	10.00	2.64	13.33	7.77	1.000	
under on comprehension +rate	1	3.00		7.00			
under on comprehension	1	4.00		11.00			
under on rate	1	8.00		10.00			
above on all	11	23.55	21.23	32.82	20.16	2.58*	.45
Orthographic intervention							
under on all measures	4	1.50	1.29	10.75	3.50	4.59*	
under on accuracy +comprehension	13	1.84	1.35	10.54	5.01	7.24**	2.37
under on comprehension	2	3.00	.00	8.00	2.82	2.50	
under on rate	4	9.75	1.25	13.50	3.41	2.61	
above on all	7	8.28	2.28	13.86	4.29	3.01*	
Comprehension intervention							
under on accuracy +comprehension	3	1.67	1.52	10.00	7.00	2.362	
under on comprehension	10	3.90	1.44	15.50	4.74	8.43**	3.31
under on rate		8.00	1.41	15.00	5.67	1.40	
above on all	19	11.73	9.23	19.26	11.13	3.85**	.74



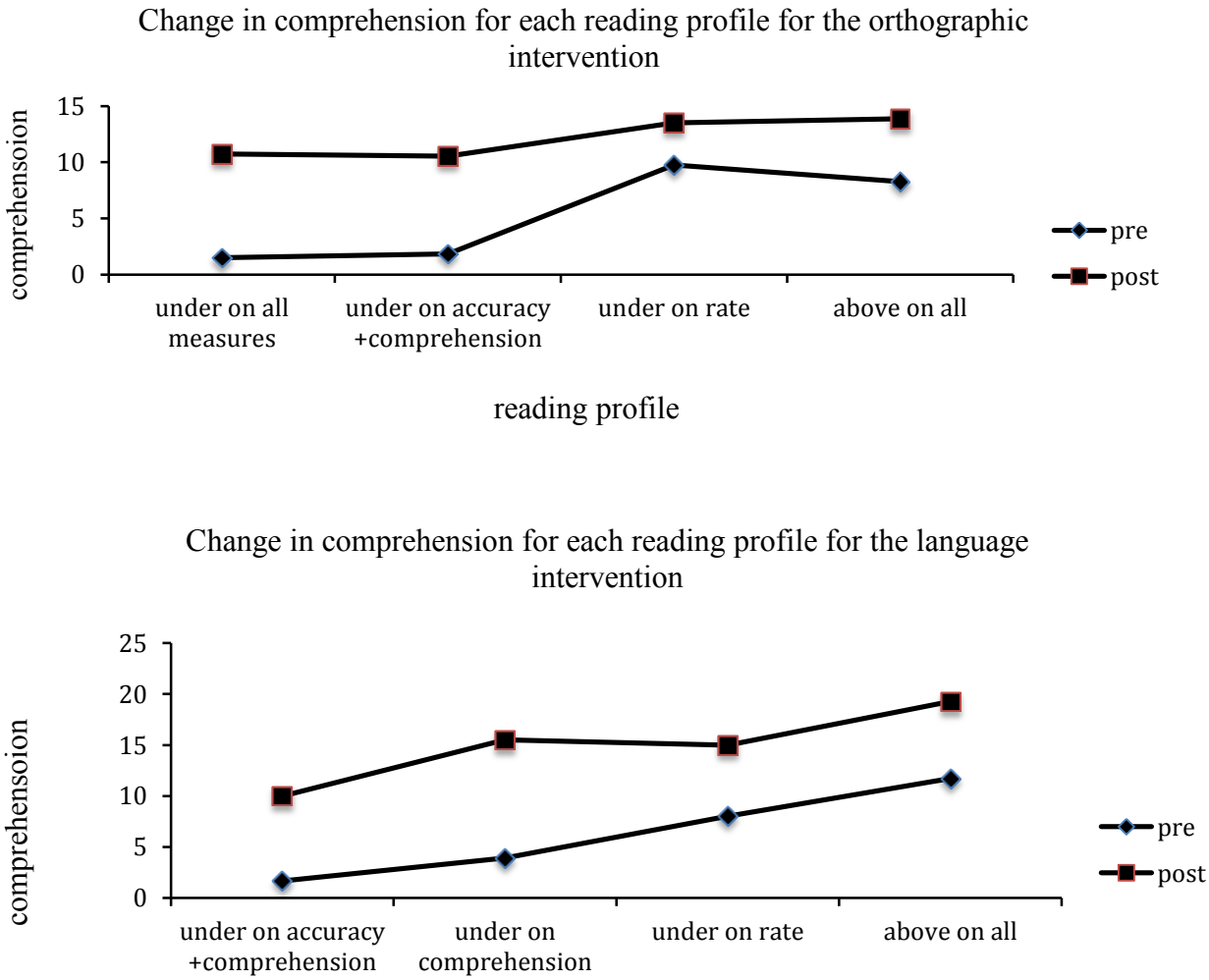


Figure 12.
The trend in comprehension gains for each reading profile in each intervention

These data show that most reading profiles improved for each of the three interventions. The proportion of at risk students who moved to be not 'at risk' were 82%, 94% and 97% for the phonological, orthographic and comprehension interventions respectively. Comparison of the effect sizes support this. Those whose pre-teaching profile including being 'under in comprehension' showed the highest effect sizes.

The three interventions were compared in terms of the extent to which each improved comprehension using univariate between-groups analysis of covariance. Matched on pre teaching comprehension, the three interventions did not differ in their effectiveness in improving comprehension ((F (7, 121) = 0. 90, p =.51; (F (2, 110) =0.38, p = 0.77 and (F (8, 110) =1.01, p = 0.44 for reading profile, intervention and reading profile x intervention respectively).

5.5 Students in their third year of schooling

Improvement in reading comprehension for each intervention by third graders was examined using within-subject linear modelling procedures. The mean reading comprehension scores pre-

and post-teaching, their standard deviations and standard error, the F ratio for the pre- and post-difference and the effect size are shown in Table 31 and Figure 13.

Table 31
Improvement in reading comprehension for each intervention by third graders

		Pre			Post			F	Cohen's d
intervention	N	mean	std	st err	Mean	std.	st err		
Phon	144	6.89	6.48	.54	13.22	7.62	.64	304.11** (1,143)	.90
Orth	98	8.62	6.37	.64	16.86	15.25	1.54	37.63** (1,97)	.76
Lang	105	9.55	8.07	.79	17.03	13.02	1.28	76.86** (1,104)	.71

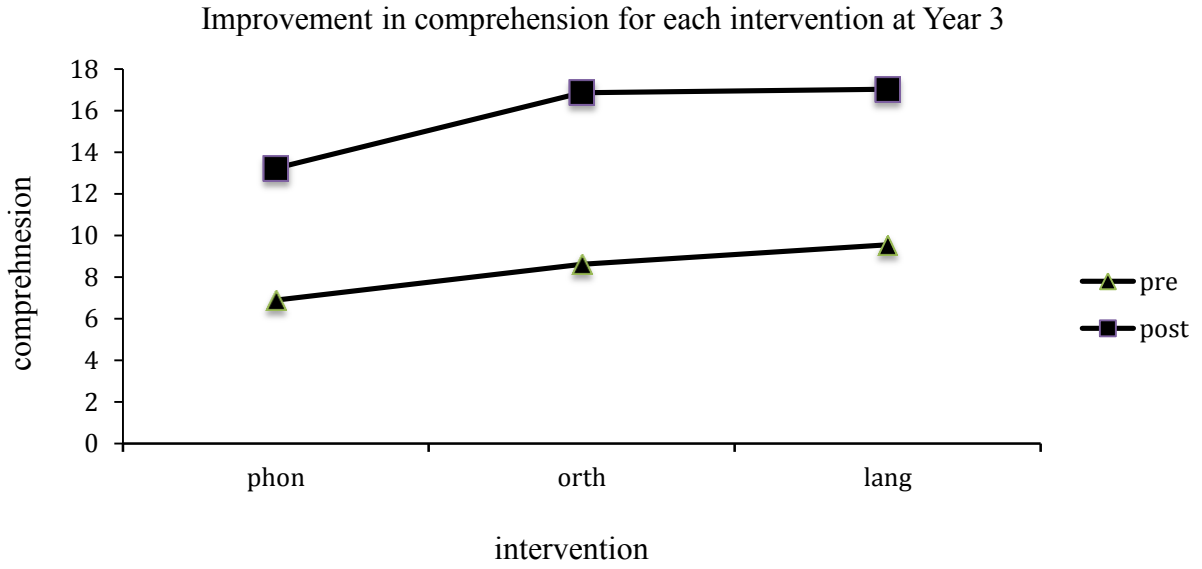


Figure 13
Trend in improvement in reading comprehension for each intervention

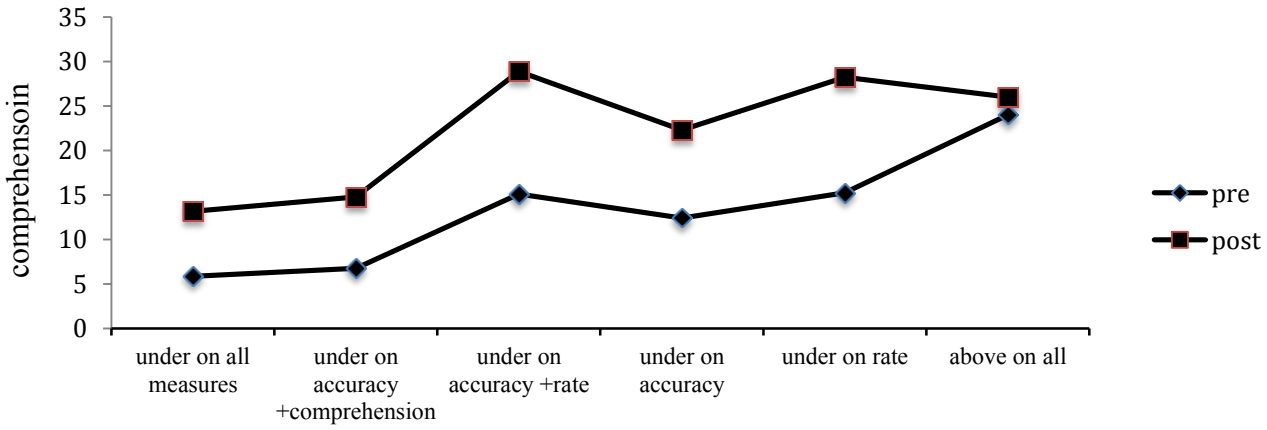
These data show that third year students in the three interventions improved in comprehension. The effect sizes show comparatively uniform improvement. Following intervention, the proportion of at risk students who displayed above 'at risk' comprehension performance were 59%, 61% and 78% for the phonological, orthographic and language interventions respectively.

The progress of each reading profile through each intervention was examined by comparing their mean pre- and post-intervention scores. These, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 32 and in Figure 14.

Table 32
Pre and post intervention comprehension for each reading profile in each intervention

Reading profile		Comprehension pre		Comprehension post		t-test	Cohen's d
	N	Mean	Std	Mean	Std		
ERIK phonological intervention							
under on all measures	100	5.19	2.61	11.48	4.32	16.89**	1.76
under on accuracy +comprehension	29	6.44	2.21	12.93	4.97	7.19**	1.69

under on accuracy +rate	6	16.50	6.34	23.50	10.62	3.24*	
under on accuracy	3	15.33	5.85	23.00	20.78	.88	
under on comprehension +rate	2	3.50	4.94	9.50	4.95		
under on comprehension	1	7.00		18.00			
under on rate	2	43.00	5.69	44.00	7.071		
above on all	1	41.00		46.00	.		
ERIK orthographic intervention							
under on all measures	44	5.87	2.51	13.18	12.29	3.98**	.82
under on accuracy +comprehension	25	6.76	2.49	14.80	11.32	3.34**	.98
under on accuracy +rate	10	15.10	4.61	28.90	26.84	1.91	.72
under on accuracy	7	12.42	2.30	22.29	16.29	1.81	
under on rate	4	15.25	2.63	28.25	16.82	1.81	
above on all	4	24.00	19.51	26.00	14.72	.700	
ERIK comprehension intervention							
under on all measures	35	5.89	2.77	11.91	4.6939	7.86**	1.56
under on accuracy +comprehension	26	6.08	2.88	12.50	4.45	7.05**	1.71
under on accuracy +rate	3	14.67	2.88	19.33	.58	3.50	
under on accuracy	4	13.00	1.41	16.75	5.85	1.67	
under on comprehension +rate	6	6.83	2.32	15.50	6.29	2.90*	
under on comprehension	15	8.13	1.81	15.67	3.54	6.70**	2.68
under on rate	5	28.60	15.03	33.40	19.66	-.52	
above on all	11	21.55	9.64	38.73	25.21	3.21**	.90



reading profile

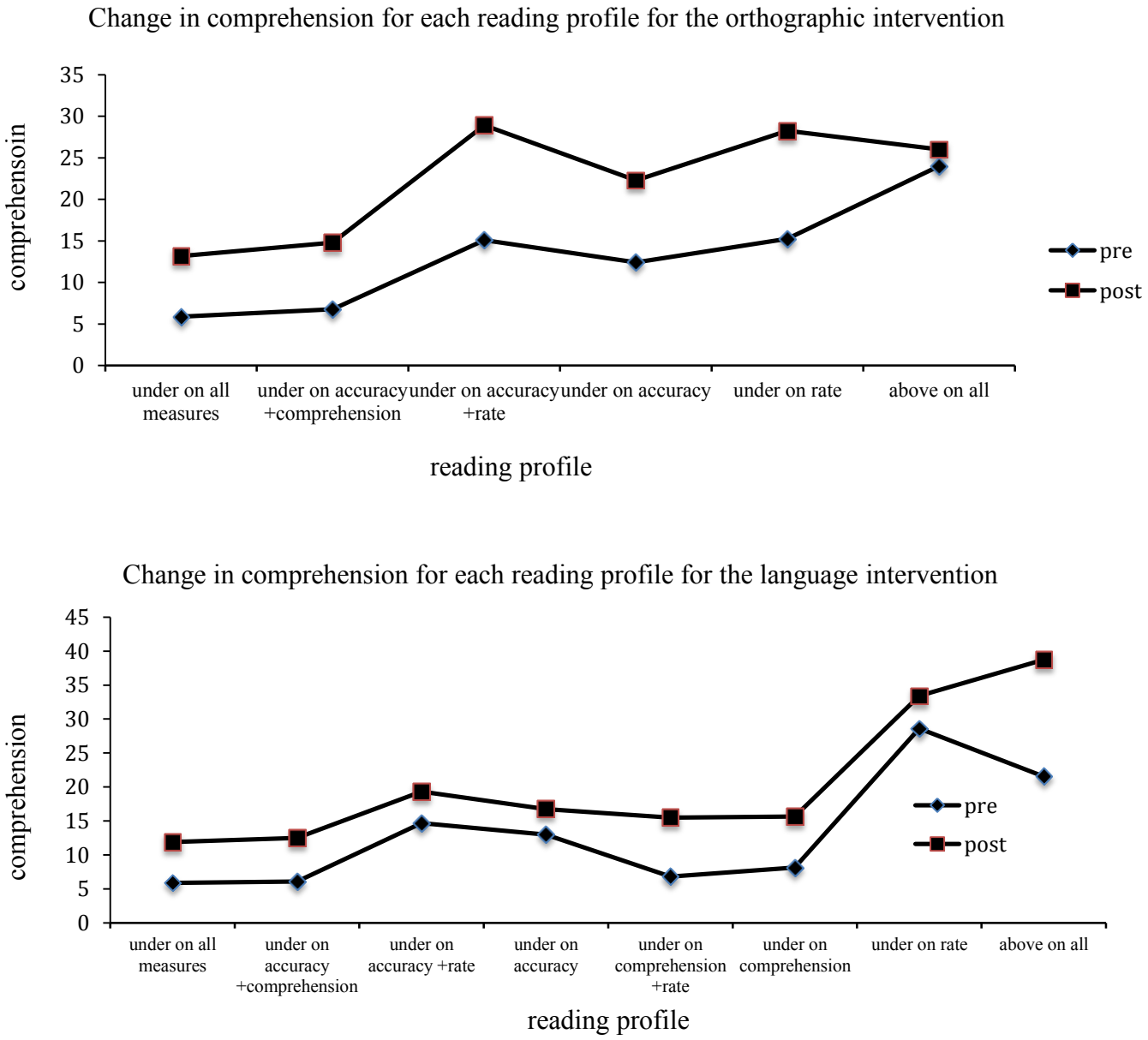


Figure 14.
The trend in comprehension gains for each reading profile in each intervention

Reading profile influenced comprehension in the three interventions (F (1, 127) = 45.42, p = .001, F (2, 77) = 6.84, p = .001 and F (3, 85) = 18.80, p = .001 in the phonological, orthographic and language interventions respectively. The interaction effect change in reading comprehension * reading profile was significant only for the language intervention (F (7, 97) = 2.62, p = .02).

Profiles that included underachievement in comprehension at pre-teaching improved. The comparative effect sizes show that the effectiveness of the oral language intervention for improving comprehension emerges at this year level. The phonological and orthographic interventions assisted students who underachieved as well in accuracy to access the text, with the phonological intervention having the greater effect.

5.6 Students in their fourth year of schooling

Improvement in comprehension scores in each intervention for fourth year students was examined using within-subject linear modelling procedures. Their mean scores pre- and post-teaching, standard deviations and standard error, the F ratio for the difference and the effect size (Cohen's d) are shown in Table 33 and in Figure 15.

Table 33
Improvement in reading comprehension for each intervention by fourth graders

		Pre			Post			F	Cohen's d
intervention	N	mean	std.	st error	mean	std.	st error		
Phon	64	13.42	14.56	1.82	19.03	12.86	1.61	57.85	.40
Orth	107	11.04	4.06	.39	18.36	8.46	.81	81.95	1.10
Lang	98	11.69	4.48	.453	21.70	11.75	1.187	77.54	1.13

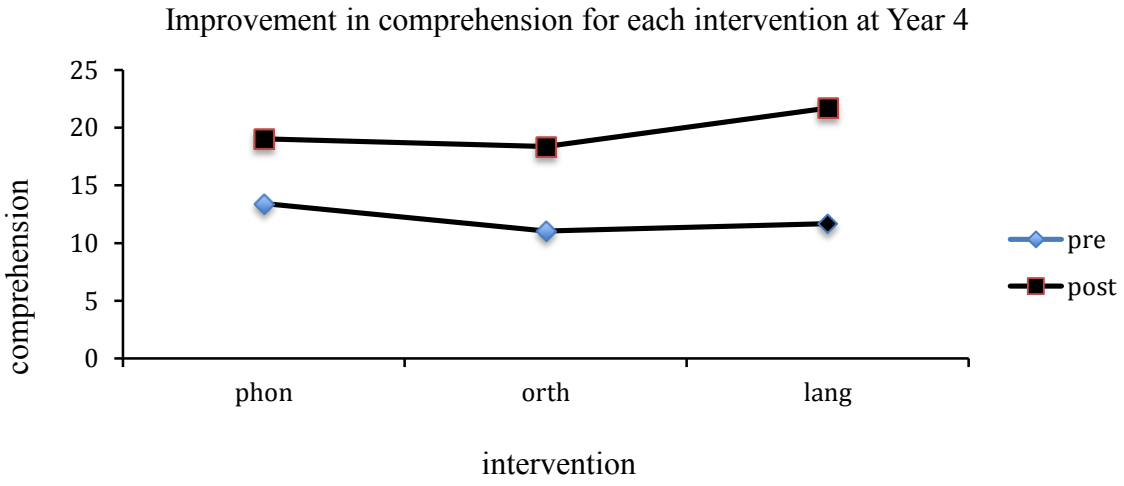


Figure 15
Trend in improvement in reading comprehension for each intervention

These data show that while fourth year students in the three interventions improved in reading comprehension, the improvement was greatest for the orthographic and oral language contexts. Following intervention, the proportion of at risk students who displayed above 'at risk' comprehension post the teaching were 51%, 68% and 72% for the phonological, orthographic and comprehension interventions respectively.

The trend noted for students in their third year has strengthened here; reading comprehension is improved by oral language teaching in the middle primary years. As well, the orthographic teaching assisted students to access the written text.

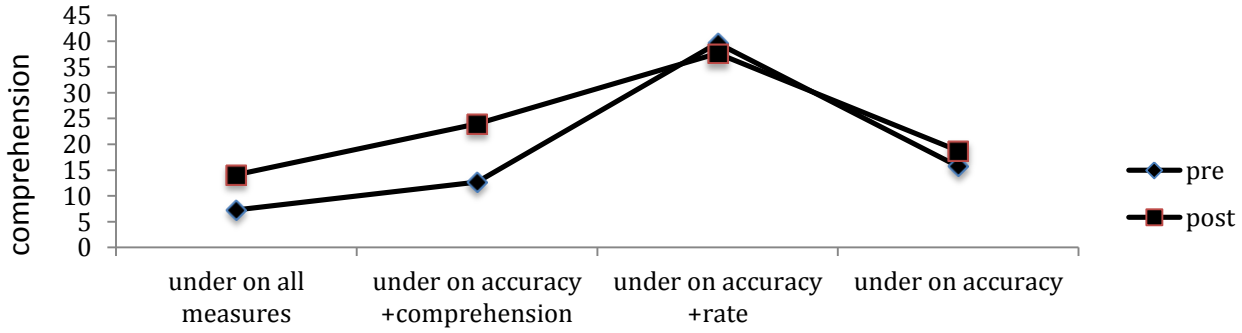
The progress of each reading profile through each intervention was examined by comparing their mean pre- and post-intervention scores. These, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 34 and in Figure 16.

Table 34
Pre- and post-comprehension intervention scores for students in the fourth year of schooling

Reading profile		Comprehension pre		Comprehension post		t-test	Cohen's d
	N	Mean	Std. D	Mean	Std. D		

Phonological intervention							
under on all measures	47	7.31	3.47	14.11	5.83	9.34**	1.42
under on accuracy +comprehension	3	12.66	1.15	24.00	8.54	2.31	
under on accuracy +rate	5	39.60	20.45	37.60	16.56	.63	
under on accuracy	4	15.75	.95	18.75	2.63	2.03	
above on all	4	51.75	3.86	52.75	2.21	-.37	
Orthographic intervention							
under on all measures	51	9.23	3.10	17.96	10.65	5.81**	1.11
under on accuracy +comprehension	19	10.26	2.90	18.21	4.04	10.98**	2.26
under on accuracy +rate	4	16.50	1.00	21.75	3.59	2.92	
under on accuracy	6	17.66	3.32	20.00	5.86	.72	
under on comprehension	2	10.50	.707	25.50	4.95	5.00	
under on rate	2	18.50	2.12	21.50	7.78	.42	
above on all	4	16.50	1.91	27.25	8.65	2.75	
Language intervention							
under on all measures	37	9.10	3.35	18.38	9.84	5.91**	1.26
under on accuracy +comprehension	20	10.75	2.82	24.85	17.76	3.76**	1.11
under on accuracy +rate	9	16.66	1.65	21.89	3.88	3.81**	
under on accuracy	1	18.00		21.00			
under on comprehension +rate	8	11.62	1.9226	24.13	12.77	2.66*	
under on comprehension	13	11.53	2.36	20.77	6.11	4.85**	2.00
under on rate	3	21.33	4.725	26.33	3.51	1.73	
above on all	3	21.00	3.00	23.33	2.51	1.32	

Change in comprehension for each reading profile for the phonological intervention



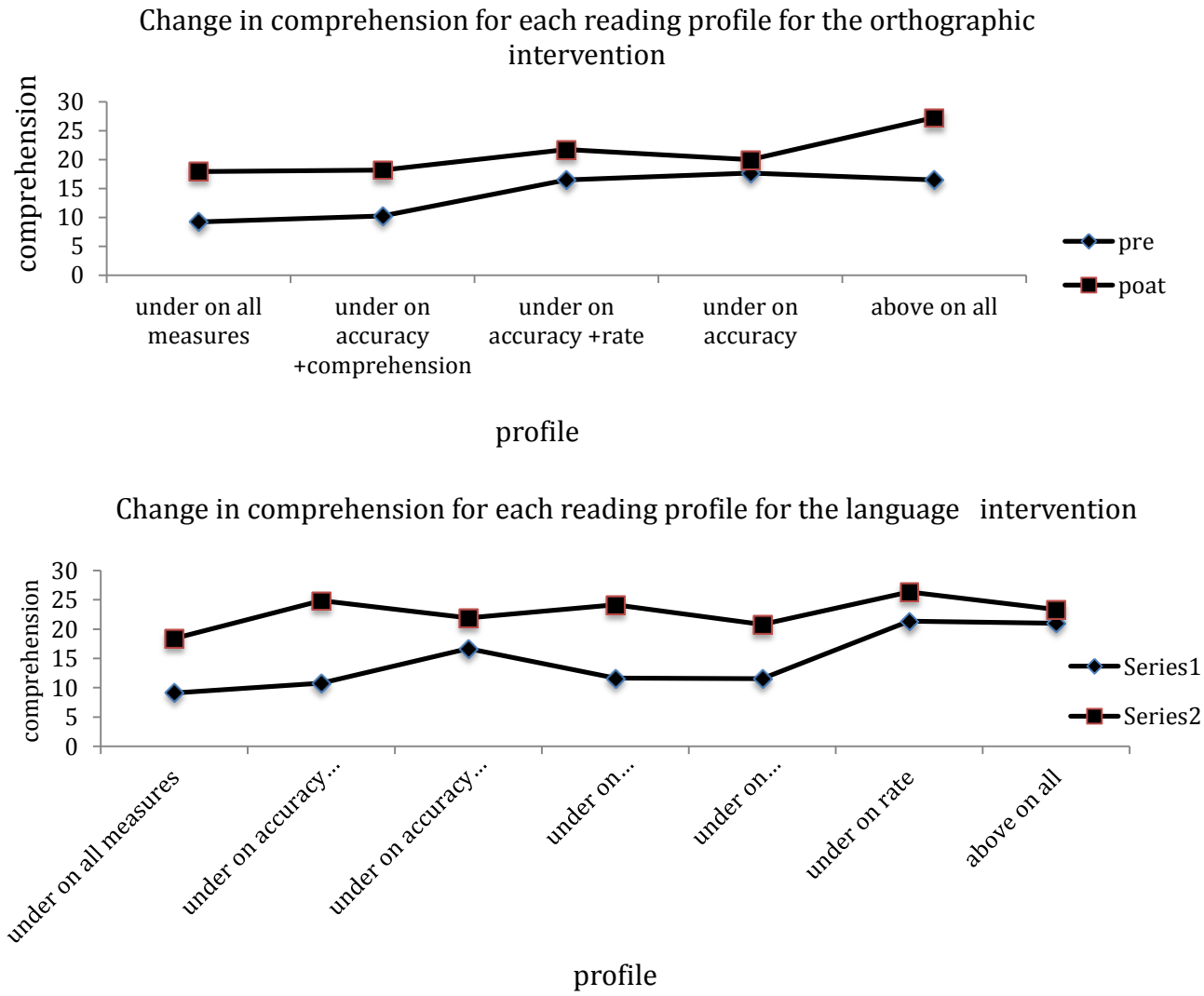


Figure 16.
The trend in comprehension gains for each reading profile in each intervention

These data show that while most reading profiles improved in each intervention, reading profile did influence the extent of comprehension in the three interventions ($F(4, 58) = 61.28$, $p = .001$, $F(6, 81) = 3.62$, $p = .003$ and $F(7, 86) = 2.47$, $p = .023$ in the phonological, orthographic and language interventions respectively. Comparison of the effect sizes shows that those students whose profile included being under in accuracy and/ or comprehension made larger gains.

As well, the advantageous effect of oral language teaching for comprehension improvement was again shown, both for those cohorts for whom effect sizes could be calculated and those for which the sample sizes were under 10 participants. In these cases the t-test values show the effectiveness of the intervention[14].

5.7 Students in their fifth year of schooling

Improvement in comprehension scores in each intervention for fifth year students was examined using within-subject linear modelling procedures. Their mean scores pre- and post-teaching,

[14] While the t-test is sufficiently robust to apply to small cohorts, these data should be interpreted with caution.

standard deviations and standard error, the F ratio for the difference and the effect size (Cohen's d) are shown in Table 35 and in Figure 17.

Table 35
Improvement in reading comprehension for each intervention by fifth graders

		Pre			Post			F	Cohen's d
intervention	N	mean	std	st error	mean	std.	st error		
phon	26	13.53	10.72	2.10	20.69	11.30	2.21	48.25	.65
orth	50	13.20	5.38	.76	20.22	7.22	1.02	80.65	1.10
lang	30	14.80	5.13	.94	23.97	5.96	1.09	56.48	1.65

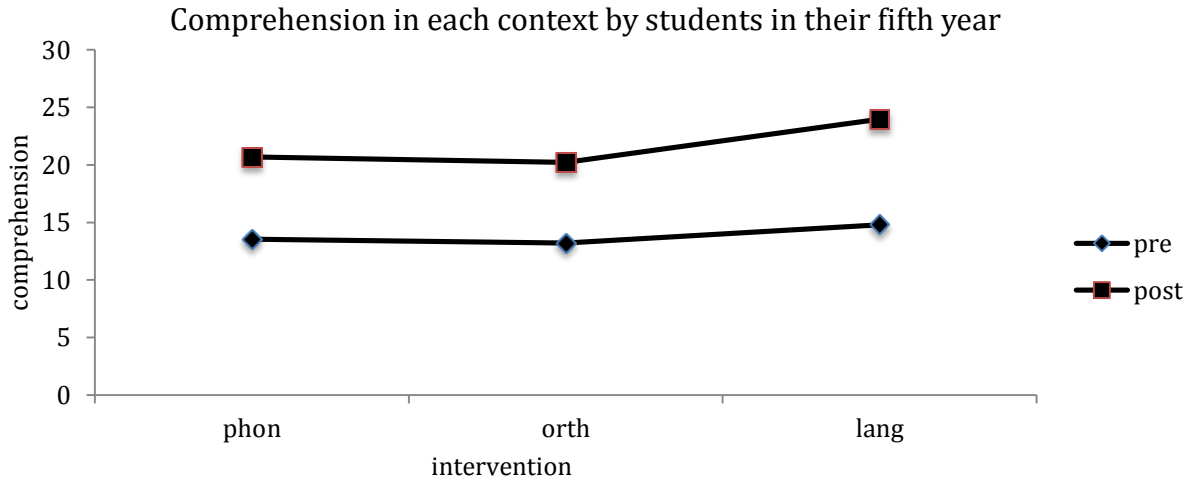


Figure 17

Trend in improvement in reading comprehension for each intervention

These data show that fifth year students in the three interventions improved in comprehension. Following intervention, the proportion of at risk students who achieved above 'at risk' reading comprehension performance were 53%, 58% and 80% for the phonological, orthographic and comprehension interventions respectively. Comparison of the effect sizes shows this was greatest for the oral language intervention. This continues and extends the developmental trend noted for students in the third and fourth years of schooling.

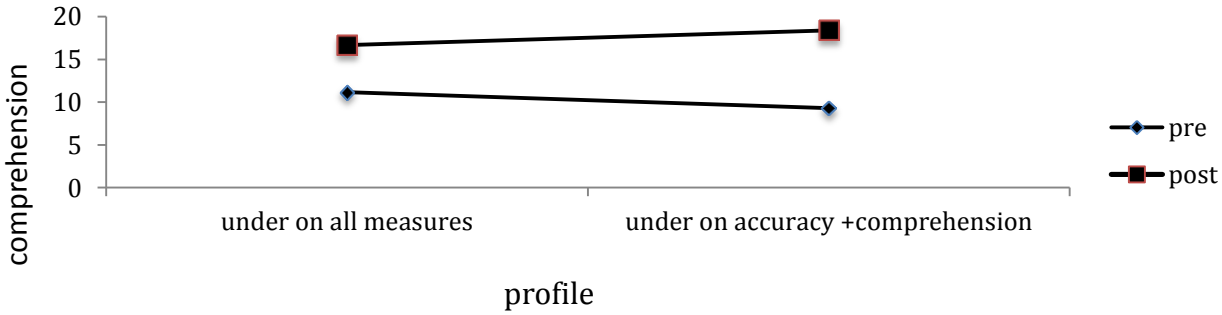
The effects of the intervention for each reading profile in each intervention were examined using mean pre- and post-intervention scores for each reading profile in each intervention, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 34 and in Figure 17.

Table 34
Pre- and post-intervention comprehension scores for each intervention and reading profile

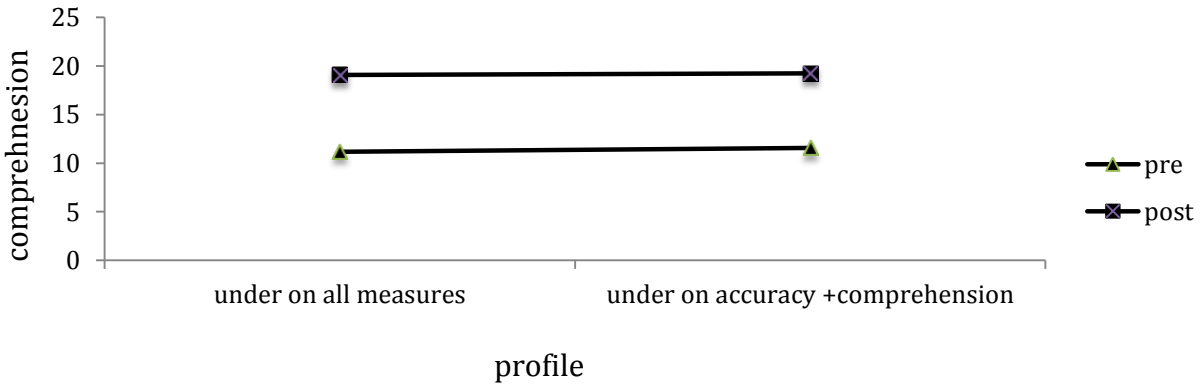
Reading profile		Comprehension pre		Comprehension post		t-test	Cohen's d
	N	Mean	Std. D	Mean	Std. D		
Phonological intervention							
under on all measures	12	11.16	2.51	16.67	4.33	6.11**	1.56

under on accuracy +comprehension	10	9.300	2.21	18.40	7.21	4.10**	1.71
under on accuracy +rate	2	48.00	9.89	53.00	12.72	2.50	
under on accuracy	1	19.00		24.00			
under on comprehension	1	10.00		24.00			
Orthographic intervention							
under on all measures	22	11.18	3.39	19.09	4.87	7.44**	1.89
under on accuracy +comprehension	12	11.58	2.64	19.25	6.35	4.49**	1.58
under on accuracy +rate	3	19.00	1.00	20.67	4.04	-.95	
under on accuracy	1	18.00		18.00			
under on rate	2	23.00	4.24	39.00	1.41	8.00	
above on all	1	25.00		27.00			
Language intervention							
under on all measures	10	13.55	1.33	22.44	4.18	6.02**	2.87
under on accuracy +comprehension	5	12.40	3.57	22.20	8.49	3.06*	
under on accuracy +rate	3	19.00	.00	23.33	3.21	2.33	
under on accuracy	2	20.50	3.53	25.00	11.31	.43	
under on comprehension +rate	2	8.0	5.66	23.00	1.41	3.00	
under on comprehension	3						
under on rate	1	21.00		29.00			
above on all	4	21.25	2.50	28.25	8.26	1.47	

Change in comprehension for each reading profile for the phonological intervention



Change in comprehension for each reading profile for the orthographic intervention



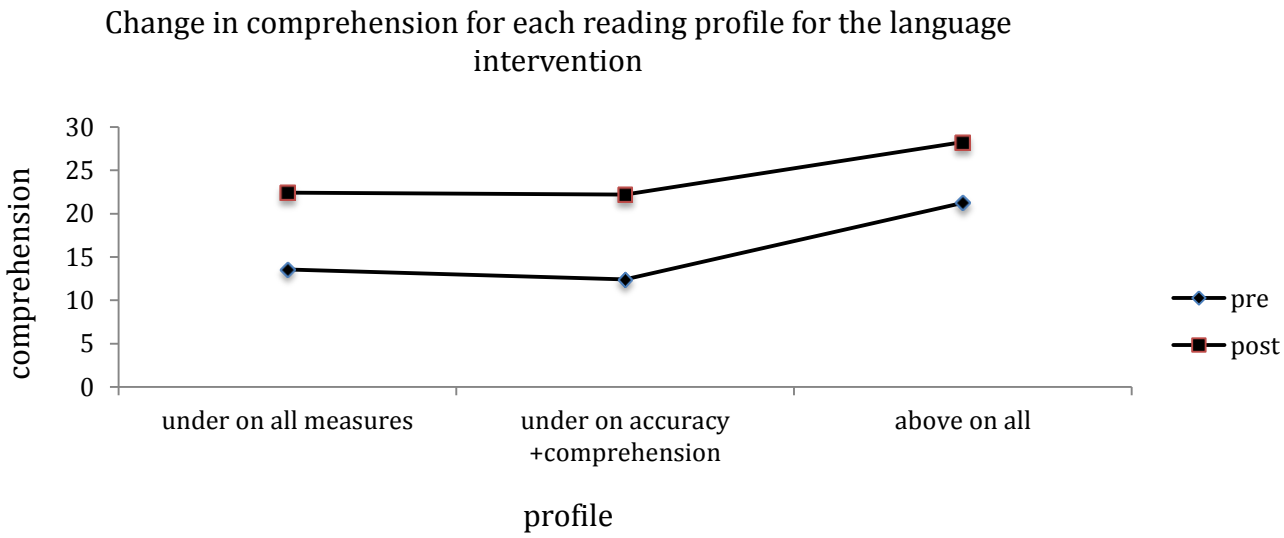


Figure 12.
The trend in comprehension gains for each reading profile in each intervention

Reading profile influenced comprehension in the phonological and orthographic interventions (F (1, 21) = 33.79, p = .000 and F (1, 34) = 9.88, p = .000 respectively. In all three interventions, the effect sizes and t-test showed improvement for those under in comprehension and accuracy.

5.8 Students in their sixth year of schooling

The six years of schooling cohort is very small (n= 19) and is included for completeness. The mean reading comprehension scores pre- and post-teaching for each intervention, their standard deviations and standard error and the t-value for comprehension improvement for each intervention profile are shown in Table 37

Table 37
Improvement in reading comprehension for each intervention by sixth graders

		Pre			Post			T	Cohen's d
intervention	N	mean	std.	st error	mean	std.	st error		
Phon	4	8.75	6.99	3.50	34.00	25.85	12.93	3.35 p = .164	
Orth	10	15.50	3.89	1.23	22.50	8.00	2.53	11.85 p =. .007	1.12
Lang	10	14.60	5.56	1.75	25.40	5.97	1.88	51.56 p =. .000	1.87

These data show that sixth year students in the orthographic and language interventions improved in reading comprehension. They continue the development trend noted for the earlier year levels; the oral language teaching is most effective for improving comprehension when the students have the necessary orthographic knowledge and skills.

The progress of each reading profile through each intervention was examined by comparing their mean pre- and post-intervention scores. These, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 38.

Table 38
Pre- and post-intervention comprehension scores for each intervention and reading profile

Reading profile		Comprehension pre		Comprehension post		t-test	Cohen's d
	N	Mean	SD	Mean	SD		
ERIK phonological intervention							
under on all measures	3	6.00	5.29	33.67	31.66	1.44	1.22
under on comprehension	1	17.00		35.00			
ERIK orthographic intervention							
under on all measures	5	12.60	2.88	15.60	3.84	1.15	.88
under on comprehension + accuracy	1	18.00		31.00			
under on comprehension +rate	1	21.00		31.00			
under on comprehension	1	15.00		32.00			
ERIK language intervention	3	12.33	1.52	22.67	5.50	4.30*	2.56
under on all measures	2	12.50	10.60	29.50	3.53	3.40	2.15
under on accuracy	1	21.00		31.00			
under on comprehension +rate	1	70.00	.	80.00			

Given the very small cohort sizes, the significance of the improvements were examined only for the reading profile that was under on all measures of reading in the orthographic intervention. The t-test for this cohort suggests improvement. Following intervention, the proportion of at risk students who displayed above 'at risk' reading comprehension performance were 50%, 50% and 65% for the phonological, orthographic and comprehension interventions respectively.

5.9 Summary of improvement in reading comprehension

In summary, reading comprehension improved in all interventions. A developmental trend emerged. In the early years the three interventions contributed to improvement. With increase in the number of years of schooling, the oral language intervention became increasingly influential in improving comprehension. As well, the orthographic intervention continued to deliver gains that were higher than for the phonological intervention. This is not surprising. Teaching letter cluster and word analysis skills explicitly is likely to increase students' ability to identify words in the text. The effect sizes for each intervention at each year level and the number of students in each cohort are shown in Table 38.

Table 38
Effect size for each intervention at each year level

Years of schooling	Phonological		orthographic		oral language	
	N	Cohen's d	N	Cohen's d	N	Cohen's d
2	66	.47	44	1.86	35	1.01
3	144	.90	98	.76	105	.71
4	64	.40	107	1.10	98	1.13
5	26	.65	50	1.10	30	1.65
6			10	1.12	10	1.87

It is also useful to review the reading comprehension progress of each reading profile. The effect sizes for all reading profile groups that had more than 10 students in each intervention at

each year level are shown in Table 39. It should be noted that the interpretation of reading profile is restricted because there is sufficient data only for some of the profiles.

Table 39
Effect sizes for reading profile groups with n>9 in each intervention at each year level

Reading profile	phonological		orthographic		Language	
	N	Cohen's d	N	Cohen's d	N	Cohen's d
Second year of schooling						
under on all measures	24	1.81				
under on accuracy +comprehension	17	1.86	13	2.37		
under on comprehension					10	3.31
above on all					19	.74
Third year of schooling						
under on all measures	100	1.76	44	.82	35	1.56
under on accuracy +comprehension	29	1.69	25	.98	26	1.71
under on comprehension					15	2.68
under on accuracy +rate			10	.72		
above on all						
Fourth year of schooling						
under on all measures	47	1.42	51	1.11	37	1.26
under on accuracy +comprehension			19	2.26	20	1.11
under on comprehension					13	2.00
Fifth year of schooling						
under on all measures	12	1.56	22	1.89	10	2.87
under on accuracy +comprehension	10	1.71	12	1.58		

The cohorts for which data were available were those that constituted lowest reading achievement. Across the year levels the three interventions facilitated comprehension improvement. These cohorts included students who were 'under' in both comprehension and accuracy and it is not surprising that such profiles would benefit both from orthographic and the language interventions.

5.10 The influence of the number of lessons and their weekly frequency on comprehension improvement

Key issues for teachers and schools are the total number of teaching sessions students need to improve their comprehension and the ideal frequency of teaching sessions. The total number of teaching sessions is the length of the intervention and for convenience are grouped into decades from 10 to 120. These variables were shown, in an earlier section to influence reading comprehension for the cohort as a whole. This section examines these issues. The frequency of each range of lessons for each intervention is shown in Table 40 and Figure 13.

Table 40
The frequency of the total number of lessons and lessons per week for each intervention

range of	Phonological	Orthographic	Comprehension

lessons	Frequency	Percent	Frequency	Percent	Frequency	Percent
10-19	1	.3	1	.4	0	
20-29	17	5.5	3	1.1	12	5.3
30-39	28	9.1	21	7.3	20	8.9
40-49	48	15.6	40	14.6	10	4.4
50-59	46	15	26	9.5	26	11.5
60-69	165	53.5	178	65.2	142	62.8
70-79	3	1.0	4	1.5		
110-119					16	7.1
total	308		273		226	

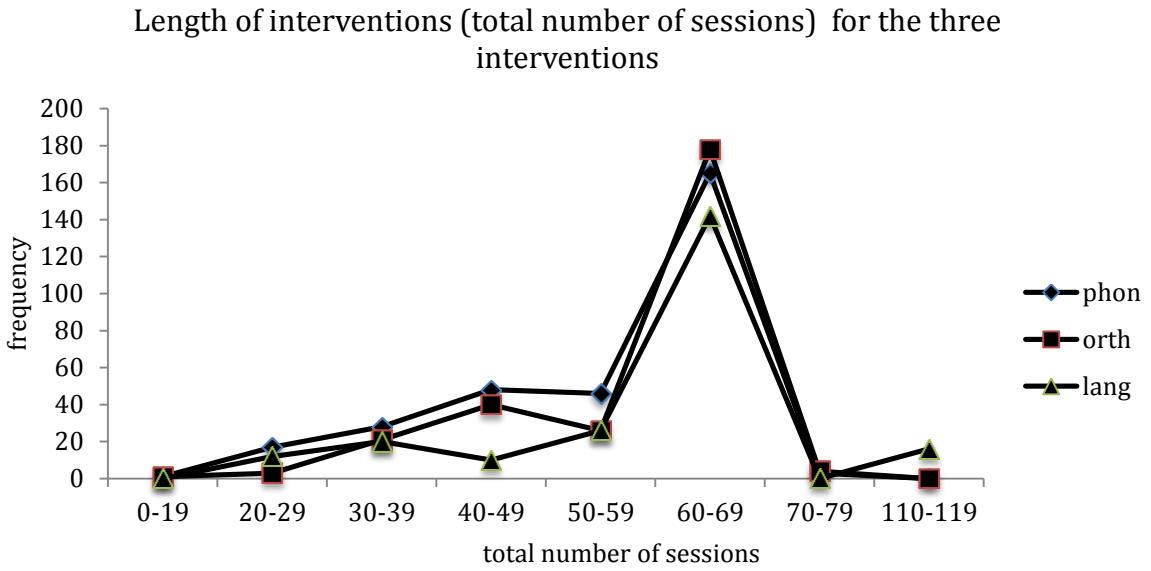


Figure 13
The frequency of each range of lessons for each intervention.

These data show that the distribution of the number of lessons was similar across the three pathways, with 60-69 lessons being the most frequent for all three paths.

The mean number of lessons, the mean number of lesson per week and the mean duration for each lesson for each ERIK path is shown in Table 41.

Table 41
The mean number of lessons, the weekly frequency and the mean duration

	Phonological			Orthographic			Comprehension		
	No. of lessons	lessons per week	Lesson Duration	No. of lessons	lessons per week	Lesson Duration	No. of lessons	lessons per week	Lesson Duration
Mean	52.06	3.46	40.00	55.04	3.34	40.00	57.96	3.60	
Std. Dev	11.515	.743	.000	9.214	.645	.000	19.214	.802	

These data show that the three pathways had on average between 50 and 60 lessons, three-four lessons per week of 40 minutes duration.

5.10.1 Effects for the cohort as a whole.

The influence of the number of lessons, their weekly frequency and the intervention path on the gain in comprehension for the entire cohort was examined using general linear modelling with pre- and post-comprehension the within-subjects factor. This analysis is shown in Table 42.

Table 42
The influence of the number of lessons and intervention on the gain in reading comprehension

Source	df	Mean Square	F	Partial Eta Squared
Tests of Within-Subjects Effects				
gain in reading comprehension	1	4511.95	114.21**	.139
gain in reading comprehension * intervention	5	34.37	.870	.006
gain in reading comprehension * number of lessons	8	26.86	.680	.008
gain in reading comprehension * weekly frequency	3	266.75	6.75**	.028
gain in reading comprehension * intervention * number of lessons	9	73.55	1.862	.023
gain in reading comprehension * intervention * weekly frequency	6	114.00	2.88**	.024
gain in reading comprehension * number of lessons * weekly frequency	5	87.86	2.22*	.015
gain in reading comprehension * intervention * number of lessons * weekly frequency	6	201.03	5.08**	.041
Error(read)	707	39.50		
Tests of Between-Subjects Effects				
Intercept	1	157287.95	654.72**	.481
Intervention	5	3166.83	13.18**	.085
number of lessons	8	306.07	1.274	.014
weekly frequency	3	78.44	.327	.001
intervention * number of lessons	9	1018.86	4.24**	.051
intervention * weekly frequency	6	597.458	2.48*	.021
weekly frequency * number of lessons	5	205.408	.855	.006
intervention * number of lessons * weekly frequency	6	218.125	.908	.008
Error	707	240.236		

This analysis shows that influence of the total number of lessons and their weekly frequency on improvement in reading comprehension is a complex relationship. First, it depends on the intervention pathway selected. However, neither the total number of lessons nor the number of lessons per week had significant effect by itself.

The interaction effects also show this complexity. Different intervention pathways require different weekly frequencies and different total durations. The remaining interaction effects did not achieve significance.

These outcomes for the cohort as a whole are somewhat surprising. They suggest that making decisions to increase reading comprehension either by simply increasing either the total number of lessons or the number of session each week may not be as effective as also taking account of

the intervention pathway selected. One might expect as well that these decisions need to take account of students' learning profiles and years of schooling.

The mean pre and post comprehension intervention scores for number of lessons influence in each intervention across all year levels and profiles were compared using the t-test for paired samples and are shown with the t-value (2-tailed) for the comparison and the size of each improvement (Cohen's d) in Table 43 and in Figure 14.

Table 43

The pre and post intervention scores for each number of lessons in each intervention

Teaching condition	duration	Mean	Std. Dev	N	Mean	Std. Dev	t-value	Cohen's d
Phonological	2	2.00	.	1	10.00	.		
	3	22.62	19.61	32	27.84	17.35	5.67	.28
	4	4.51	3.27	33	9.15	4.01	10.16	1.27
	5	12.34	13.08	38	19.55	14.72	5.14	.52
	6	7.03	6.46	194	14.09	9.00	13.53	.90
	7	8.67	5.03	3	18.33	4.04	8.04*	2.12
	8	7.00	2.6	3	14.00	6.92	2.78	1.34
Orthographic	2	5.000	.	1	8.00	.		
	3	13.00	5.44	6	20.00	5.17	4.86	1.32
	4	11.39	7.10	21	21.65	14.38	3.19	.90
	5	11.42	8.99	42	17.33	11.99	4.54	.56
	6	9.26	4.63	202	15.35	6.29	17.40	1.10
	8	10.67	3.32	6	16.50	1.04	3.90*	2.37
Language	2	5.400	3.36	5	11.00	6.96	2.09	1.02
	3	11.10	3.81	20	19.70	4.46	11.28	2.07
	4	12.87	5.30	15	25.33	7.37	9.19	1.94
	5	12.89	9.76	19	21.16	13.38	3.58	.71
	6	10.33	7.23	172	18.59	11.00	13.95	.89
	12	18.12	6.09	16	25.31	4.06	3.79	1.39

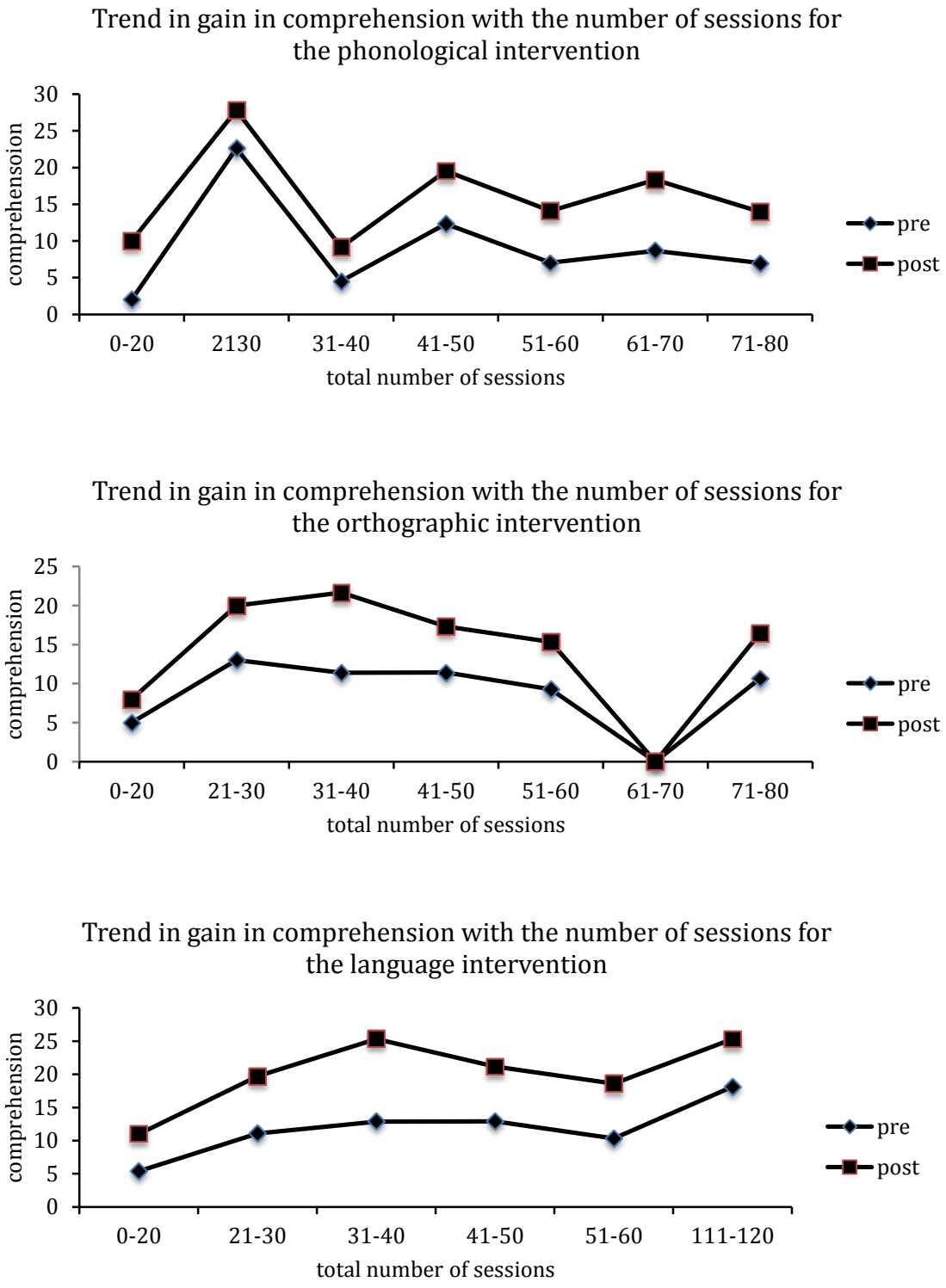


Figure 14
Trend in mean pre and post comprehension for the number of lessons in each intervention.

The effect sizes and t-tests suggest that gain in comprehension did not increase with increase in duration. The most frequently used number of sessions had an effect size of between .89 to 1.1. Those students who began with lower comprehension scores did not receive more lessons.

5.10.2 The effects for each reading profile on the total number of sessions.

Across the years of schooling, this analysis was usually possible only for those reading profiles in which students were at risk in all three areas of reading or at risk in comprehension and

comprehension (that is, profiles 1 and 2 respectively) in the second to fourth years of schooling[15]. The emerging pattern shows the complexity of teaching reading. While reading comprehension improved ($p < .01$), the patterns of interactions varied.

For students in their second year of schooling, the analysis examined comprehension improvement for learning profiles 1, 2 and 8. Neither the total number of teaching sessions nor their weekly frequency influenced comprehension for any of these profiles. Further, it was not influenced by the intervention.

For third year students, profiles 1 and 2 had sufficient students for this analysis. Again neither of the main effects of the total number of teaching sessions nor the frequency influenced change in comprehension. However, various interactions achieved significance. For both profiles, changes in reading x number of lessons are merged as significant. For profile 2, weekly frequency and the total number of lessons had a combined effect on comprehension. As well, this varied with the intervention. For students in the fourth year of schooling, only profile 1 had sufficient students. The pattern was similar to that observed for profile 2 for third year students; both the total number of lessons and the weekly frequency of teaching combined with the intervention pathway to influence improvement in reading comprehension.

Together these findings show that the total number of sessions and the teaching frequency is linked with the approach to teaching. For those who underachieve in all three areas, different levels of improvement required different numbers of sessions. As well for those who under achieved in comprehension and comprehension, the intervention pathway and the number of lessons per week also exerted an influence.

5.11 The literacy learning profiles of those students who improved.

We have already noted that the majority of reading profiles at each year level showed improvement over the course of the access to intervention. Some students achieved above the at-risk comprehension criterion while others didn't. In other words, each intervention pathway interacted differentially in leading to enhanced reading comprehension outcomes.

In order to evaluate in more depth each intervention, it is useful to investigate and contrast the literacy learning characteristics of those students who did and did not show this level of improvement. Oneway analysis of variance was used to compare those who did and didn't achieve above the at risk reading comprehension criterion on each of the tasks that comprised the literacy learning profile. Mean performance on each component of literacy learning by those who did and didn't achieve the at risk reading comprehension score post intervention for students in their third to sixth years of schooling, the F ratio for each comparison and its level of significance at each year level are shown in Table 44. An analysis for students in their second year of schooling is not completed because 85%, 100% and 100% of the students achieved the at risk criterion for the phonological, orthographic and comprehension interventions respectively.

Table 44
Mean performance on each component of literacy learning by those who did and didn't achieve the at risk comprehension score post intervention

	Below criterion	Above criterion	F	P

[15] The remaining profiles (3-8) each had fewer than 10 students. As well, there were insufficient students in the fifth and sixth years of schooling cohorts to permit analysis.

	Mean	Std.	Mean	Std.		
Three years of schooling						
	n=169		n=155			
Phon Awareness Segmentation 1	3.49	.88	3.51	.90	.06	.80
Phon Awareness Blending	3.74	.67	3.84	.51	2.17	.14
Phon Awareness Segmentation 2	2.17	1.52	2.52	1.52	4.13*	.04
Verbal Analogies	6.39	3.69	6.63	3.56	.36	.54
Matching Spoken and Written Words	10.52	1.33	10.79	1.82	2.24	.13
Learning an Orthographic Code	15.78	5.04	15.72	4.95	.01	.91
Phonological Short Term Memory	1.40	2.21	1.47	1.65	.10	.75
Visual Symbolic Processing	13.30	7.49	12.35	3.86	2.01	.16
Listening Comprehension	3.30	1.52	3.54	1.43	2.06	.15
Orthographic Processing of Words	10.05	2.50	10.25	2.36	.57	.44
RAN – Letters	37.54	19.61	33.86	17.45	3.15	.07
RAN – Digits	43.70	26.01	37.64	21.30	5.17*	.02
Four years of schooling						
	n=102		n=96			
Phon Awareness Segmentation 1	3.41	.94	3.32	1.01	.40	.52
Phon Awareness Blending	3.66	.80	3.58	.81	.40	.52
Phon Awareness Segmentation 2	2.18	1.49	2.22	1.58	.03	.84
Verbal Analogies	7.51	2.84	5.95	3.99	10.13**	.002
Matching Spoken and Written Words	10.55	1.66	11.36	1.70	11.60**	.001
Learning an Orthographic Code	17.75	5.17	19.60	4.70	6.97**	.009
Phonological Short Term Memory	1.54	1.62	1.65	1.86	.18	.66
Visual Symbolic Processing	14.64	3.93	15.68	3.89	3.49	.06
Listening Comprehension	3.52	1.48	3.70	1.44	.72	.39
Orthographic Processing of Words	10.95	3.16	12.08	2.79	7.08**	.008
RAN – Letters	36.43	15.01	26.86	15.04	19.94**	.000
RAN – Digits	41.28	19.65	29.53	17.14	19.90**	.000
Five years of schooling						
	n=64		n=41			
Phon Awareness Segmentation 1	3.59	.77	3.12	1.30	5.41*	.02
Phon Awareness Blending	3.58	.83	3.44	1.11	.53	.46
Phon Awareness Segmentation 2	2.56	1.51	1.93	1.38	4.67*	.03
Verbal Analogies	5.55	4.19	6.29	3.90	.83	.36
Matching Spoken and Written Words	10.61	2.88	11.66	.99	5.03*	.02
Learning an Orthographic Code	21.77	5.95	22.46	5.19	.38	.54
Phonological Short Term Memory	1.97	2.80	1.85	2.42	.04	.82
Visual Symbolic Processing	17.36	4.72	18.56	2.83	2.14	.14
Listening Comprehension	4.06	1.39	3.27	1.37	8.20**	.005
Orthographic Processing of Words	12.73	2.96	12.27	3.53	.53	.47
RAN – Letters	23.06	17.38	21.77	13.11	.16	.68
RAN – Digits	25.46	20.02	24.06	14.97	.14	.70
Six years of schooling						
	n=9		n=8			

Phon Awareness Segmentation 1	3.56	.72	3.38	.51	.34	.56
Phon Awareness Blending	3.78	.44	3.38	1.18	.90	.35
Phon Awareness Segmentation 2	2.33	1.50	2.25	1.66	.01	.91
Verbal Analogies	8.56	.88	8.00	1.30	1.06	.31
Matching Spoken and Written Words	11.89	.33	11.63	.51	1.60	.22
Learning an Orthographic Code	24.11	5.96	25.00	4.59	.11	.73
Phonological Short Term Memory	1.00	1.00	.38	1.06	1.53	.23
Visual Symbolic Processing	17.89	4.40	16.88	8.00	.108	.74
Listening Comprehension	4.22	1.20	4.75	1.03	.92	.35
Orthographic Processing of Words	12.56	2.12	14.38	2.32	2.83	.11
RAN - Letters	30.44	5.65	23.44	5.47	6.69*	.02
RAN – Digits	33.11	7.16	26.26	6.43	4.25	.06

The particular literacy learning skills that differentiated between those who did and didn't cross the at risk criterion score varied between years of schooling. Most are associated with the acquisition of word reading: rapid automatized naming, either of digits, letters or both for students in the third, fourth and sixth years of schooling, simple and/or complex phonemic segmentation between the groups at the third and fifth year levels, matching spoken and written letter clusters at the fourth and fifth year levels and orthographic processing at the fourth year level. A skill more associated with reading comprehension, listening comprehension discriminated at the fifth year level.

5.13 Summary

In summary, given the limitations of the available data, the three interventions delivered improved reading comprehension for all reading profiles at all year levels. As noted earlier, the data illustrate the complexity of teaching reading.

First, this improvement was not always sufficient to achieve a score above the 'at risk' criterion. The proportion of the cohort at each year level who achieved above at risk comprehension scores varied, from a high level for students in their second year of schooling to lower levels at the higher grade levels. The language intervention had the highest portion of students moving above the at risk criterion. Students entering this intervention had higher pre reading comprehension scores than the other two interventions.

Second, at most year levels the three interventions didn't differ in their improvement efficacy. Differences did emerge at third year level, with the phonological and orthographic interventions leading to lowest and highest improvements respectively.

Third, for those students who were at risk in comprehension and accuracy (that is, profiles 1 and 2), the relationship between improvement in reading comprehension and either the total number of lessons or the number of sessions each week is not simple or direct. While for the second year of schooling neither the total number of teaching sessions nor their weekly frequency influenced reading comprehension for any of these profiles, a more complex relationship is suggested for the older year levels. For the higher year levels the combination of the total number of teaching sessions and their weekly frequency influenced improvement in comprehension. As well, the intervention pathway that was selected also influenced the total number of lessons and their weekly frequency that led to comprehension improvement.

6. Improvement in Neale rate raw scores

This section unpacks the factors that influence the improvement in reading rate for each reading profile in each intervention at each year level. It examines initially the link between rate, comprehension and accuracy. The correlation between these variables (Pearson correlation, 2-tailed) for each profile across the various interventions are shown in Table 45.

Table 45
The correlation between reading rate, comprehension and accuracy for each profile

Profile		Accuracy		Comprehension	
	Rate	pre correlation	post correlation	pre correlation	post correlation
Under on all	pre (n = 442)	.67**	.50**	.55**	.23**
	post (n = 438)	.41**	.36**	.38**	.15**
under on acc	pre (n = 199)	.59**	.42**	.59**	.36**
+comp	post (n = 197)	.37**	.31**	.35**	.11
under on	pre (n = 54)	.64**	.53**	.15	.08
accuracy +rate	post (n = 54)	.52**	.66**	.23	.44**
under on	pre (n = 35)	.59**	.45**	.62**	.32
accuracy	post (n = 35)	.51**	.29	36*	-.05
under on comp	pre (n = 24)	.72**	.72**	.78**	.38
+rate	post (n = 23)	.69**	.72**	.65**	.43*
under on	pre (n = 53)	.62**	.52**	.63**	.40**
comprehension	post (n = 53)	.61**	.48**	.44**	.37*
under on rate	pre (n = 24)	.67**	.57**	.46*	.37*
	post (n = 23)	.54**	.47*	.05	-.03
above on all	pre (n = 53)	.66*	.38**	.28*	.31**
	post (n = 53)	.31**	.31**	.12	.13

Prior to intervention, rate was correlated with both accuracy and comprehension, with values ranging between .62 to .72 for accuracy and between .15 to .78 for comprehension. They are consistent with the proposition that, for most profiles, rate is associated with accuracy or comprehension. The lowest correlations were for between rate and comprehension for the profiles under on accuracy and rate, and those above on all measures. This pattern of correlations justifies the evaluation of the extent to which the interventions support improvement in rate.

6.1 Trends across the cohort as a whole for improvement in accuracy

Students in each year had different numbers of teaching sessions altogether and different numbers of sessions each week. This analysis examines these effects. It uses analysis of variance for repeated measures, with Neale reading rate pre-and post-intervention.

Reading rate overall was not influenced by the intervention to which students were exposed. However, there were particular conditions where it did have an effect. First, the number of years of schooling influenced the extent of improvement. Students' rate improved with the number of years of schooling they'd had.

Second, students' reading profile influenced the level of improvement. Generally, across all year levels and interventions, reading profiles that included underachievement in rate pre teaching made lower gains in rate than those that did not include it. The effect varied across interventions and year level. Third, the total number of lessons students had didn't directly influence improvement in reading rate, for any of the reading profiles in any of the interventions.

The pattern of interactions suggest a complex relationship between reading rate and other aspects of reading. This section examines the influence of the intervention path, the years of schooling and reading profile on reading rate at each year level. It will research the influence of the three pathways for interventions that comprise cohorts of more than 10 students.

6.2 Progress of each reading profile through each intervention pathway at each year level

The effects of the intervention for each reading profile in each intervention were examined using mean pre- and post-intervention scores for each reading profile in each intervention. The extent of their difference is assessed using the t-test for correlated samples (two tailed) and the effect size (Cohen's d). In some conditions the post intervention rate mean was lower than the matching pre intervention score.

6.3 Students in their second year of schooling

The mean reading rate scores pre- and post-teaching for students in their second year of schooling, the t-test for the difference in means (paired t-test, 2-tailed) and the effect size (Cohen's d) are shown in Table 46 and in Figure 17.

Table 46
Improvement in reading rate for each intervention by students in their second year of schooling

		Pre		Post		F	Cohen's d
intervention	N	mean	std	mean	std.		
Phon	65	29.29	19.77	39.13	21.42	4.31**	0.47
Orth	29	29.38	13.35	29.79	15.94	.138	0.02
Lang	35	41.57	16.66	46.97	19.18	2.40*	0.30

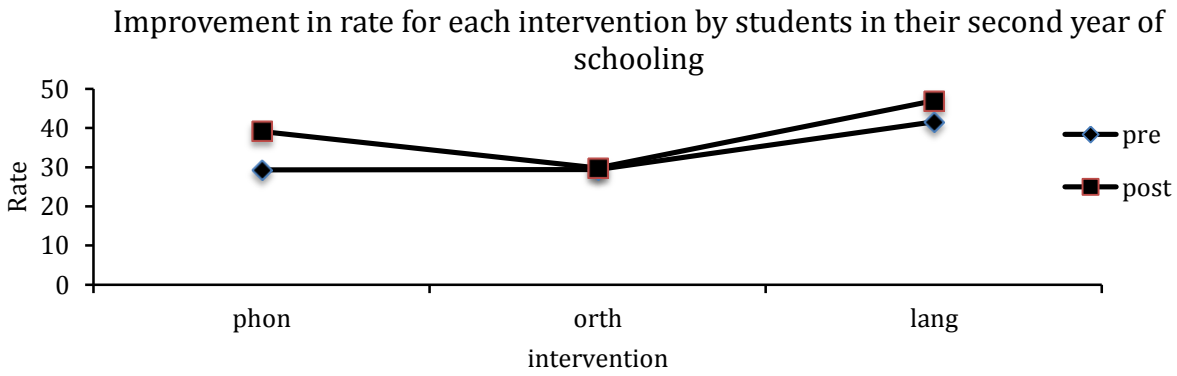


Figure 17
Trend in improvement in reading comprehension for each intervention

These data show that rate improved in the phonological and language interventions. The effect sizes show the improvement was low to moderate. The reading profiles that benefited most

from the teaching were identified by comparing the mean pre- and post-intervention scores for each reading profile in each intervention. These and the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 47[16].

Table 47
The pre- and post-intervention rate scores for each reading profile in each intervention.

Reading profile		Rate pre		Rate post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	24	14.08	5.50	33.54	19.25	4.68**	1.37
under on accuracy +comprehension	17	37.59	12.16	37.65	20.19	.01	0.00
under on accuracy +rate	6	16.33	3.14	27.07	10.34	2.99*	1.40
under on accuracy	3	39.33	18.58	47.33	14.57	.42	
under on comprehension +rate	1	19.00		41.00			
under on comprehension	1	32.00		40.00			
under on rate	1	20.00		22.00			
above on all	11	48.64	17.71	54.18	23.61	.75	0.26
Orthographic intervention							
under on all measures	4	14.50	5.57	20.00	6.97	1.72	
under on accuracy +comprehension	12	34.25	10.26	27.50	17.89	1.13	-0.46
under on comprehension	2	35.00	18.38	45.50	6.36	.60	
under on rate	4	14.50	5.000	20.75	6.29	1.69	
above on all	7	36.43	11.94	40.00	14.71	.99	
Language intervention							
under on all measures							
under on accuracy +comprehension	3	48.33	20.27	52.00	20.88	.25	
under on comprehension +rate	1	20.00		43.00	1		
under on comprehension	10	42.30	14.69	47.70	19.76	1.10	0.31
under on rate	2	18.00	2.828	20.00	4.243	.40	
above on all	19	43.74	16.43	48.84	18.99	2.03	0.28

These data show that the lowest achieving cohort, those students under on all measures of reading and those under only in rate in the phonological intervention improved their rate.

5.4 Students in their third year of schooling

The mean reading rate scores pre- and post-teaching for students in their second year of schooling, the t-test for the difference in means (paired t-test, 2-tailed) and the effect size (Cohen's d) are shown in Table 48 and in Figure 18.

Table 48
Improvement in reading rate for each intervention by students in their second year of schooling

	Pre	Post	F	Cohen's d

[16] The trends are not shown in figures because most profiles in each intervention have less than 10 students and the pre- and post-interventions do not differ ($p<.05$).

intervention	N	mean	Std	mean	std.		
Phon	142	28.18	15.25	35.81	17.17	5.74**	0.46
Orth	93	31.98	17.38	39.02	15.94	3.41 **	0.42
Lang	105	41.69	20.45	42.85	19.54	.68	0.05

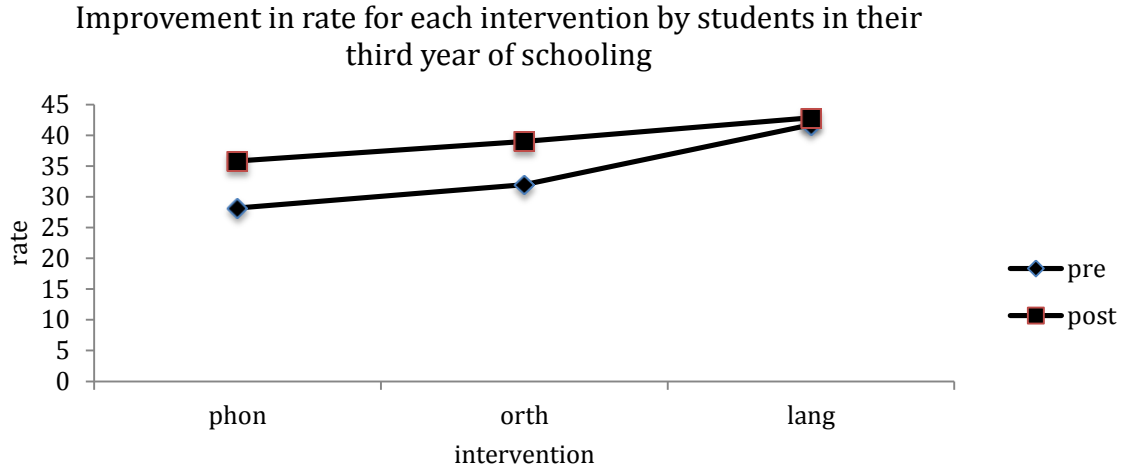


Figure 18
The mean reading rate scores pre- and post-teaching for students in their third year of schooling

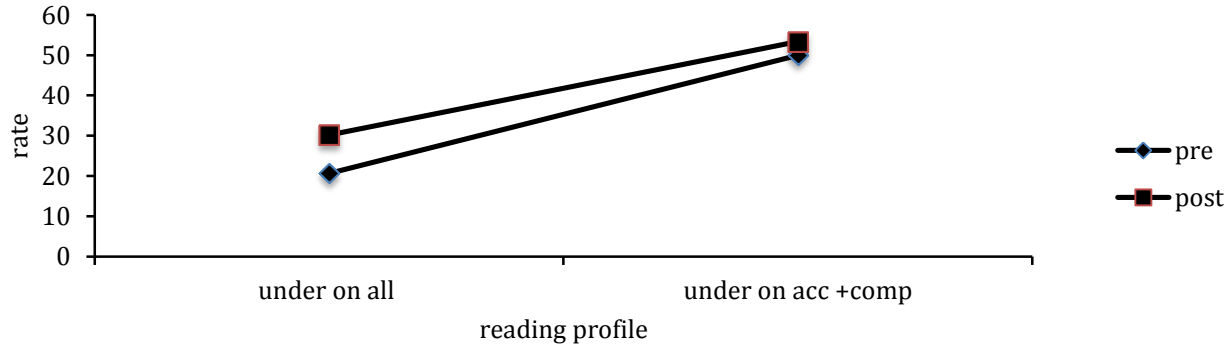
These data show that rate improved in the phonological and orthographic interventions. Again the effect sizes show the improvement was low to moderate. The reading profiles that benefited most from the teaching were identified by comparing the mean pre- and post-intervention scores for each reading profile in each intervention. These and the extent of difference between them (2-tailed t-test for paired samples) and matching effect size are shown in Table 49 and Figure 19.

Table 49
The mean pre- and post-intervention scores for each reading profile in each intervention.

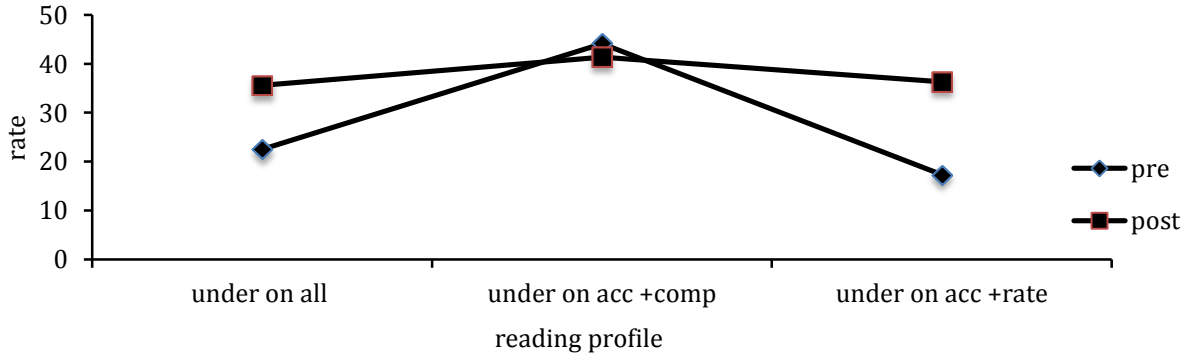
Reading profile		Rate pre		Rate post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	99	20.68	7.432	30.21	11.31	7.94**	0.46
under on accuracy +comprehension	29	49.97	12.72	53.36	21.51	.76	0.19
under on accuracy +rate	6	27.50	7.232	32.83	11.19	.95	
under on accuracy	3	52.33	14.64	45.00	19.00	.41	
under on comprehension +rate	1	21.00		17.00			
under on comprehension	1	41.00		72.00			
under on rate	2	32.00	1.414	33.50	12.02	.16	
above on all	1	57.00		59.00			
Orthographic intervention							
under on all measures	43	22.47	8.919	35.58	14.73	7.03**	1.07
under on accuracy +comprehension	24	44.13	8.347	41.33	13.84	.815	-0.25
under on accuracy +rate	10	17.30	7.196	36.30	18.54	3.40**	1.35
under on accuracy	7	45.57	6.803	44.00	17.29	-.241	
under on comprehension +rate							

under on comprehension							
under on rate	4	21.00	9.487	53.75	22.07	2.25	
above on all	4	67.50	11.26	35.75	7.80	3.51	
Language intervention							
under on all measures	35	22.44	8.668	30.86	13.65	4.24**	0.73
under on accuracy +comprehension	26	55.15	13.57	48.08	21.96	1.755	-0.38
under on accuracy +rate	3	33.67	3.215	41.33	5.686	1.95	
under on accuracy	4	61.25	22.02	51.50	15.67	1.06	
under on comprehension +rate	6	26.83	6.824	42.17	15.07	3.59*	
under on comprehension	15	57.00	17.93	56.07	17.87	.180	-0.05
under on rate	5	30.80	4.438	32.40	18.27	.25	
above on all	11	58.36	14.77	53.00	17.93	1.75	-0.32

Change in rate for each reading profile for the phonological intervention



Change in rate for each reading profile for the orthographic intervention



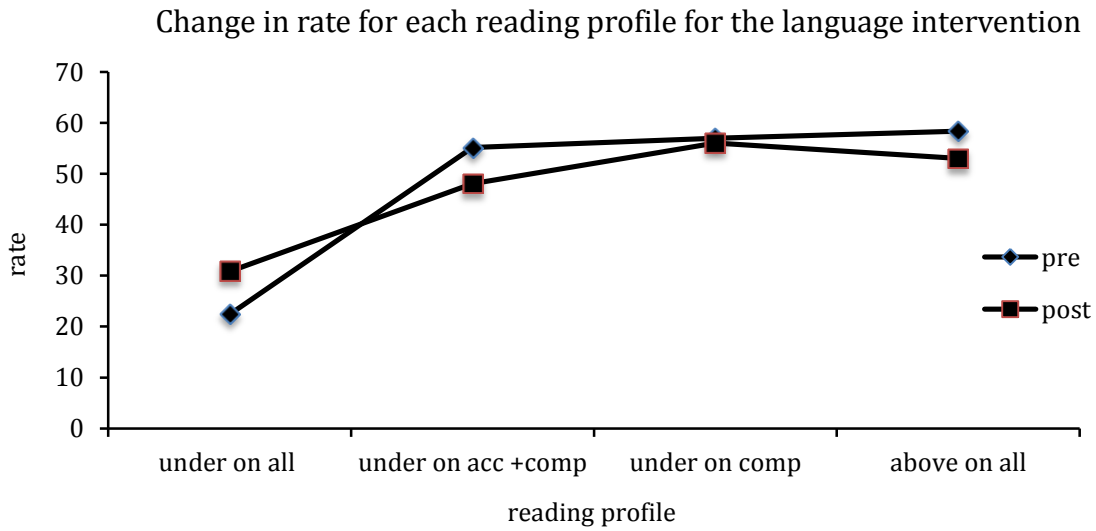


Figure 19
The mean pre- and post-intervention scores for each reading profile in each intervention.

Rate improvement was restricted to particular reading profiles. It improved for the lowest achieving profile, that is, those under in all areas in the three interventions and also for students under in rate and accuracy in the orthographic intervention. The effect sizes were high.

6.5 Students in their fourth year of schooling

The mean reading rate scores pre- and post-teaching for students in their second year of schooling, the t-test for the difference in means (paired t-test, 2-tailed) and the effect size (Cohen's d) are shown in Table 50 and in Figure 20.

Table 50
Improvement in reading rate for each intervention by students in their fourth year of schooling

		Pre		Post		t-test	Cohen's d
intervention	N	mean	std	mean	std.		
Phon	63	35.98	18.30	37.83	15.45	1.01	0.10
Orth	88	43.13	18.13	44.06	18.19	0.44	0.05
Lang	96	49.15	22.58	51.15	18.96	1.01	0.09

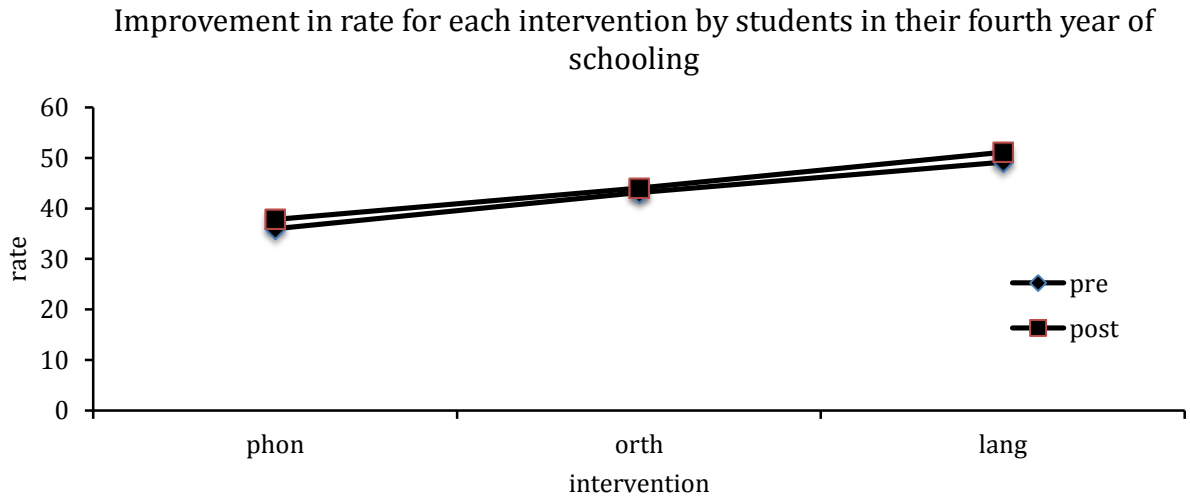


Figure 20
The mean reading rate scores pre- and post-teaching for each intervention for students in their fourth year of schooling

These data show that rate did not improve in any of the interventions. The extent to which particular profiles improved was examined by comparing their mean pre- and post-intervention scores. These, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 51.

Table 51
The mean pre- and post-intervention scores for each reading profile in each intervention.

Reading profile		Rate pre		Rate post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	47	30.21	14.15	34.62	15.39	2.29*	0.29
under on accuracy +comprehension	3	77.00	5.568	50.33	11.15	-6.78*	
under on accuracy +rate	5	28.80	4.868	37.20	9.230	1.51	
under on accuracy	4	63.75	5.560	50.25	14.08	2.81	
above on all	4	54.25	2.062	54.50	3.416	.225	
Orthographic intervention							
under on all measures	51	32.18	11.74	39.00	17.59	3.39**	0.45
under on accuracy +comprehension	19	63.76	12.34	55.05	19.28	1.41	-0.53
under on accuracy +rate	4	37.00	11.136	42.25	14.080	1.09	
under on accuracy	6	55.00	3.847	52.83	13.586	.39	
under on comprehension	2	59.00	4.243	48.50	.707	4.20	
under on rate	2	42.00	4.243	50.50	23.335	.43	
above on all	4	65.75	15.305	39.50	9.950	2.64	
Language intervention							
under on all measures	37	33.49	13.080	39.22	17.748	2.25*	0.37
under on accuracy +comprehension	20	68.70	11.328	60.45	16.997	1.47	-0.57
under on accuracy +rate	9	35.22	11.211	50.11	7.639	5.42**	
under on accuracy	1	71.00		63.00			
under on comprehension +rate	8	39.25	8.631	48.75	7.226	-2.52*	

under on comprehension	13	65.23	11.322	61.77	16.599	.737	-0.24
under on rate	3	40.00	5.292	64.00	8.544	3.024	
above on all	3	61.33	6.658	53.67	1.155	2.266	

The data show that rate improvement was restricted to particular reading profiles. It improved for the lowest achieving profile, that is those under in all areas in the three interventions and also, in the language intervention, for students under in rate and accuracy and in rate and comprehension. The effect sizes show that the gains were low to moderate.

6.6 Students in their fifth year of schooling

The mean reading rate scores pre- and post-teaching for students in their second year of schooling, the t-test for the difference in means (paired t-test, 2-tailed) and the effect size (Cohen's d) are shown in Table 52 and in Figure 21.

Improvement in reading rate for each intervention by students in their second year of schooling

		Pre		Post		F	Cohen's d
intervention	N	mean	Std	mean	std.		
Phon	26	52.81	18.36	52.08	18.19	.23	-0.03
Orth	42	51.21	20.19	48.95	23.79	.64	-0.10
Lang	30	57.90	18.46	61.83	14.65	.95	0.23

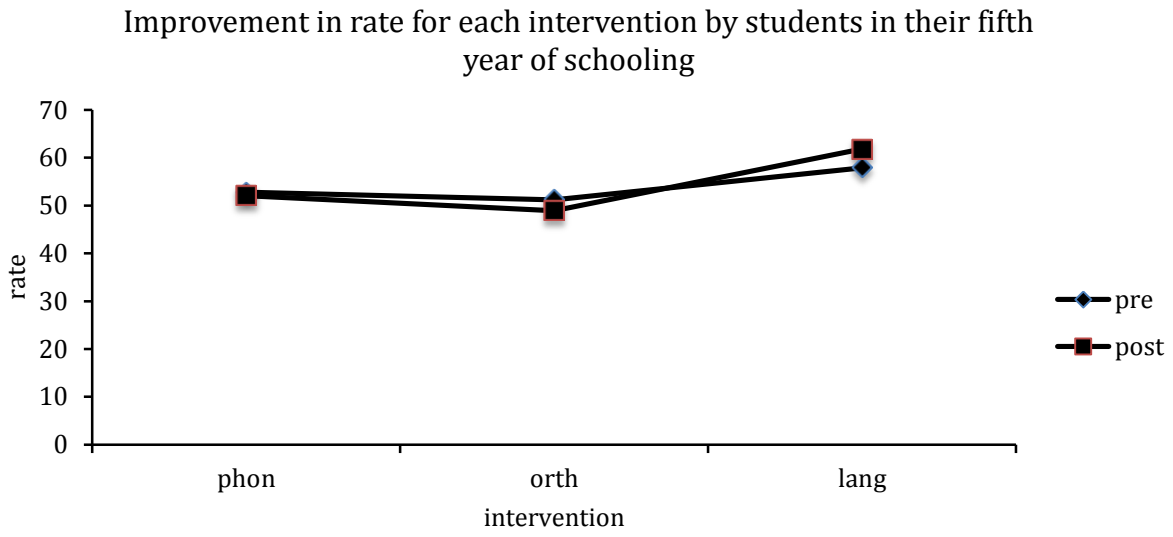


Figure 21
The mean reading rate scores pre- and post-teaching for each intervention for students in their fifth year of schooling

These data show the now familiar pattern that rate did not improve in any of the interventions. The extent to which particular profiles improved was examined by comparing their mean pre- and post-intervention scores. These, the extent of difference between them (2-tailed t-test for paired samples) and measure of effect size are shown in Table 53.

Table 53
The mean pre- and post-intervention scores for each reading profile in each intervention.

Reading profile		Rate pre		Rate post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	12	39.00	9.293	47.58	16.211	2.22*	0.64
under on accuracy +comprehension	10	68.20	8.904	53.40	17.386	-3.67**	-1.07
under on accuracy +rate	2	34.50	4.950	41.00	1.414	1.44	
under on accuracy	1	66.00		74.00			
under on comprehension	1	88.00		93.00			
Orthographic intervention							
under on all measures	22	40.41	12.473	46.50	24.832	1.34	0.31
under on accuracy +comprehension	12	74.75	12.592	54.00	19.320	-3.91**	-1.27
under on accuracy +rate	3	36.33	3.215	41.33	9.018	.97	
under on accuracy	1	75.00		54.00			
under on rate	2	43.50	4.950	36.00	.000	-2.14	
above on all	1	70.00		114.00			
Language intervention							
under on all measures	9	44.22	9.391	58.89	14.155	2.67*	
under on accuracy +comprehension	5	77.80	10.986	53.20	16.208	-3.49*	
under on accuracy +rate	3	38.00	2.000	58.00	9.849	3.28	
under on accuracy	2	71.00	1.414	63.50	10.607	-1.15	
under on comprehension +rate	2	46.50	3.536	67.00	1.414	13.67*	
under on comprehension	3	65.00	9.165	84.00	3.464	2.65	
under on rate	1	44.00		60.00			
above on all	4	63.50	5.066	63.50	19.807		

The data show that rate improvement was restricted to particular reading profiles. It improved for the lowest achieving profile, that is, those under in all areas in the phonological and language interventions and also, in the language intervention, for students under in rate and comprehension. Where the number in a cohort permitted, the effect sizes show that the gains were low to moderate. Reading rate decreased over the intervention for several cohorts. It is possible that the interventions taught some students at this year level to 'slow down' while reading and to allocate attention to comprehension processes.

6.7 Students in their sixth year of schooling

The mean reading rate scores pre- and post-teaching for students in their sixth year of schooling and the t-test for the difference in means (paired t-test, 2-tailed) are shown in Table 54. The effect size hasn't been calculated because of the small numbers.

Table 54
Improvement in reading rate for each intervention by students in their sixth year of schooling

		Pre		Post		t-test
intervention	N	mean	std	mean	std.	
Phon	4	53.25	22.47	46.25	37.55	.92
Orth	8	55.00	20.87	59.00	26.93	.95
Lang	8	71.25	18.78	68.75	11.85	.33

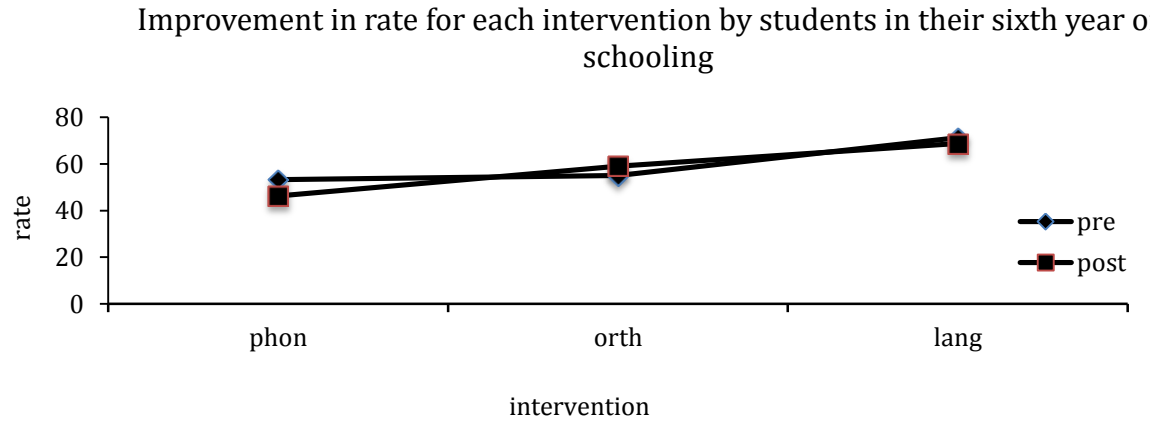


Figure 21
Mean reading rate pre- and post-intervention for students in their sixth year of schooling

Given the small number of participants, these data are at best indicative of trends. Again, rate did not improve in any of the interventions. The extent to which particular profiles improved was examined by comparing their mean pre- and post-intervention scores. These and the extent of difference between them (2-tailed t-test for paired samples) are shown in Table 53.

Table 53
Pre- and post-intervention rate scores for each intervention and reading profile

Reading profile		Rate pre		Rate post		t-test	Cohen's
	N	Mean	Std. D	Mean	Std. D		d
Phonological intervention							
under on all measures	3	44.00	15.620	30.33	24.379	2.609	
under on comprehension	1	81.00		94.00			
Orthographic intervention							
under on all measures	5	42.40	9.127	40.40	10.407	.773	
under on accuracy +comprehension	1	86.00		93.00			
under on comprehension +rate	1	56.00		86.00			
under on comprehension	1	86.00		91.00			
Language intervention							
under on all measures	3	56.00	5.568	61.00	7.000	.96	
under on accuracy +comprehension	2	79.00	5.657	74.50	17.678	.-52	
under on comprehension +rate	1	64.00		80.00			
under on comprehension	1	70.00		79.00			

6.8 Summary of improvement in rate

Rate was less susceptible to improvement than accuracy or comprehension by the three interventions. Improvement occurred for particular reading profiles in specific interventions. The effect sizes for the improvement were generally low to moderate.

The effect sizes for all reading profile groups that had more than 10 students in each intervention at each year level are shown in Table 54. It should be noted that the interpretation of reading profile is restricted because there is sufficient data only for some profiles.

Table 54
Effect sizes for reading profile groups with n>9 in each intervention at each year level

Reading profile	phonological		orthographic		Language	
	N	Cohen's d	N	Cohen's d	N	Cohen's d
Second year of schooling						
under on all measures	24	1.37				
under on accuracy +comprehension	17	0.00	13	-0.46		
under on comprehension					10	0.31
above on all	11	0.26			19	0.28
Third year of schooling						
under on all measures	100	0.46	44	1.07	35	0.73
under on accuracy +comprehension	29	0.19	25	-0.25	26	-0.38
under on comprehension					15	-.05
under on accuracy +rate			10	1.35		
above on all					11	-0.32
Fourth year of schooling						
under on all measures	47	0.29	51	0.45	37	0.37
under on accuracy +comprehension			19	-0.53	20	-0.57
under on comprehension					13	-0.24
Fifth year of schooling						
under on all measures	12	0.64	22	0.31		
under on accuracy +comprehension	10	-1.07	12	-1.27		

The cohorts for which data were available were those who had lowest reading achievement pre intervention. Across the year levels the three interventions facilitated rate improvement. The reading profile most likely to show improvement was the lowest achieving cohort, those students under on all measures of reading. The improvement was shown in all interventions for students in the third and fourth years of schooling. Students in their second year showed improvement in reading rate in the phonological intervention.

Other profiles that showed improvement included being under on rate. For students in the third year of schooling, the under in accuracy + rate profile improved in the orthographic intervention and the under in comprehension + rate profile improved in the language intervention. For students in the fourth year of schooling, the under in accuracy + rate profile and the under in comprehension + rate profile improved in the language intervention. For students in the fifth year of schooling, the under in comprehension + rate profile improved in the language intervention. The pattern here suggests that each intervention, intended to target a particular aspect of reading, improved that aspect and also the rate.

It was also noted that reading rate decreased over the intervention for several cohorts. It is possible that the interventions taught some students at this year level to 'slow down' while reading and to allocate attention to comprehension processes.

7. Effect of Reading Recovery on gains

It should be said at the outset that this evaluation does not assume that ERIK and Reading Recovery are equivalent reading interventions. Rather, it recognizes that they differ both in what they assume about how reading is learnt and how it is taught. The two interventions differ in the skills they teach and the extent to which the skills are taught explicitly.

Of the cohort, 231 students were reported to have had Reading Recovery earlier and 355 students hadn't. Those students who had been exposed to Reading Recovery had been judged by their teachers to require further assistance. This section compares the use of ERIK with both groups.

The number and portion of students recorded as having and not having reading recovery at each year level are shown in Table 55. Approximately 20% of the cohort at each year level was recorded as having had Reading Recovery earlier.

Table 55.
Number and portion of students having had and not had Reading Recovery

	Didn't have Reading Recovery		Had Reading Recovery	
	Frequency	Percent	Frequency	Percent
2	56	34.8	29	18.0
3	157	41.9	93	24.8
4	79	27.3	61	21.1
5	33	27.0	20	16.4
6	2	8.3	7	29.2

The mean comparative pre-intervention data for the two cohorts and the extent of difference between the two cohorts (t-test for independent sample, two-tailed) are shown in Table 56.

Table 56
Pre-intervention data for the two cohorts.

Aspect of reading	Didn't have Reading Recovery		Had Reading Recovery		t-test
	Mean	sd	mean	Sd	
accuracy pre	26.57	13.33	21.84	11.09	4.47**
comprehension pre	10.65	9.96	7.96	5.71	3.71**

These data show that the cohort that had been exposed to Reading Recovery prior to exposure to ERIK began with lower reading comprehension and accuracy scores than the cohort that had not had Reading Recovery. For these students, Reading Recovery had not led to sustained gains in reading. The accuracy and comprehension post intervention scores and their gain are shown in Table 57.

Table 57
The accuracy and comprehension post intervention scores and their gains.

	Not RR		RR		t-test
	mean	std	mean	Std	
Accuracy post	38.98	13.07	33.34	12.61	5.05**

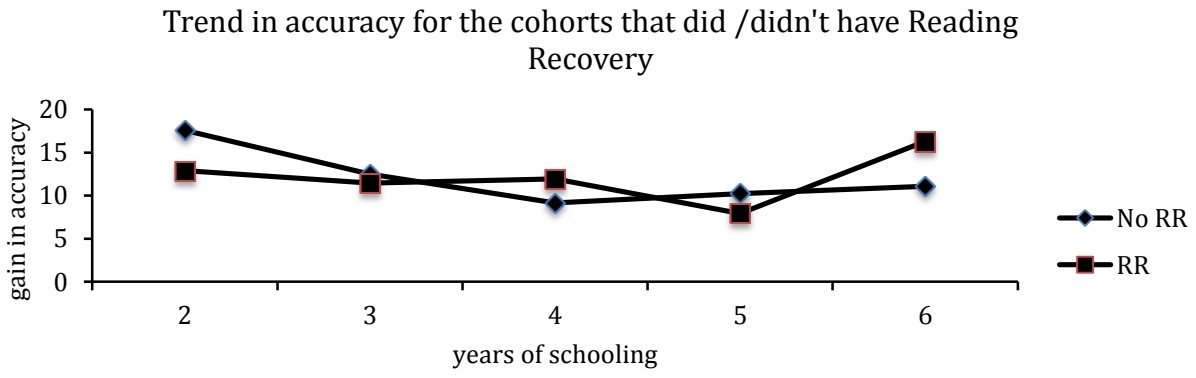
Comprehension post	18.20	12.13	13.74	7.29	4.89**
Gain in accuracy	12.33	8.92	11.75	7.99	.78
Gain in comprehension	7.49	7.67	5.81	4.73	2.90**

These data show that the cohort that had been exposed to Reading Recovery intervention prior to ERIK had lower reading comprehension and accuracy scores post ERIK intervention than the cohort that had not had the Reading Recovery intervention. Similarly, the group that had not had Reading Recovery had larger gains in comprehension but not in reading accuracy.

The comparative gains in comprehension and accuracy at each year level in Table 58 show the effectiveness of ERIK for these students. The means are compared using the t-test for independent samples (two-tailed), with equality of means equal variances not assumed.

Table 58
Gains in comprehension and accuracy.

	gain	Didn't have Reading Recovery			Had Reading Recovery			t-test	p
		N	Mean	Std. D	N	Mean	Std. D		
2	acc	56	17.58	10.25	29	12.89	8.22	2.28*	.02
	comp	56	7.00	5.62	29	5.58	3.83	1.36	.18
3	acc	157	12.50	8.73	92	11.45	7.42	1.00	.31
	comp	157	8.42	9.82	92	5.55	4.77	3.08**	.009
4	acc	79	9.15	6.14	61	11.93	7.03	2.45*	.01
	comp	79	5.70	4.39	61	6.18	4.69	-.60	.54
5	acc	33	10.24	9.92	19	7.94	6.16	1.41	1.02
	comp	33	7.72	5.63	19	5.42	3.51	1.81	.07
6	acc	10	11.10	6.22	7	16.28	17.60	-.74	.48
	comp	10	10.70	4.32	7	6.28	8.63	1.24	.24



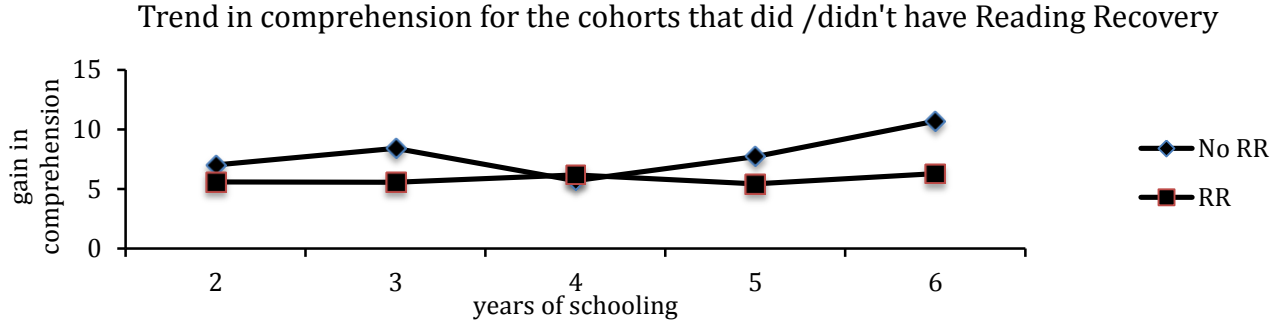


Figure
Trend in accuracy and comprehension for the cohorts that did /didn't have Reading Recovery

These data show that the group that had received Reading Recovery earlier made similar gains to their peers who hadn't had this exposure. Differences emerged only for accuracy for students in their second and fourth years of schooling and for comprehension for students in their third year.

It is possible that the differences between the reading outcomes prior to intervention for the two cohorts may have been linked with aspects of students' literacy learning profiles. The extent of these differences for each aspect are shown in Table 59, with the t-test for independent samples used to compare the matching means.

Table 59
Differences between aspects of students' literacy learning profiles for those who had and didn't have Reading Recovery.

Aspect of literacy	Didn't have Reading Recovery		Had Reading Recovery		t-test	
	Mean N = 308	Sd	Mean N = 213	Sd.	t value	P
Phon awareness segmentation 1	3.43	1.00	3.38	.99	.506	.613
Phon awareness blending	3.61	.89	3.77	.63	2.28*	.023
Phon awareness segmentation 2	2.22	1.56	2.31	1.46	.65	.513
Verbal analogies	7.42	2.82	7.54	2.64	.51	.604
Matching spoken and written words	10.60	2.15	10.68	1.69	.46	.640
Learning an orthographic code	17.44	5.95	16.19	5.12	2.48*	.013
Phonological short term memory	1.37	1.75	1.48	1.56	.75	.450
Visual symbolic processing	13.91	4.71	14.07	7.16	.30	.759
Listening comprehension	3.56	1.47	3.52	1.51	.28	.776
Orthographic processing of words	10.84	2.94	10.12	2.82	2.79**	.005
RAN – Letters	36.98	17.55	40.22	13.58	2.26*	.024
RAN – Digits	41.08	20.58	46.45	19.75	2.93**	.003

The students who had previously had Reading Recovery had lower capacity to learn phonic patterns; they were less able to learn an orthographic code and had longer RAN. These are not skills usually targeted explicitly by Reading Recovery. On the other hand, these students had higher phonological segmentation skills.

We noted earlier that the students involved in ERIK who had had Reading Recovery had not benefitted from it sufficiently to be seen as successful readers. They made gains following their exposure to ERIK. There are no data that show that the gains they made here are retained.

It is inevitable that the possibility of ERIK replacing or complementing Reading Recovery will be raised. There is simply insufficient data relating to either intervention to respond to this possibility.

8. Discussion of findings

In summary, the evaluation shows the effectiveness of the ERIK interventions. The effect sizes for accuracy, comprehension and rate for all reading profile groups that had 10 or more students in each intervention at each year level are shown in Table 60.

Table 60

The effect sizes for all reading profile groups that had more than 10 students

Reading profile	phonological			orthographic			language		
	acc	comp	rate	acc	comp	rate	Acc	Comp	Rate
			Second year of schooling						
under on all measures	2.55	1.81	1.37						
under on acc +comp	2.13	1.86	0.00	3.03	2.37	-0.46			
under on comp							1.16	3.31	0.31
above on all	.84		0.26				1.00	.74	0.28
			Third year of schooling						
under on all measures	1.65	1.76	0.46	1.66	.82	1.07	1.50	1.56	0.73
under on acc +comp	1.68	1.69	0.19	1.67	.98	-0.25	1.44	1.71	-0.38
under on comp							1.03	2.68	-.05
under on acc+rate				1.45	.72	1.35			
above on all							.41	.90	-0.32
			Fourth year of schooling						
under on all measures	1.16	1.42	0.29	1.23	1.11	0.45	1.07	1.26	0.37
under on acc +comp				2.04	2.26	-0.53	1.69	1.11	-0.57
under on comp							1.22	2.00	-0.24
			Fifth year of schooling						
under on all measures	.81	1.56	0.64	.99	1.89	0.31		2.87	
under on acc +comp	1.15	1.71	-1.07	1.03	1.58	-1.27			

Perhaps not surprisingly, the cohorts that had sufficient numbers comprised the lowest achieving readers in their 2nd to 5th years of schooling. For these cohorts, the three interventions improved accuracy and comprehension[17]. Effect sizes that exceed 1.0 for interventions that comprise, on average, between 60 and 70 teaching sessions for approximately 20 weeks are usually interpreted, using the data in Table 5, as impressive (Ruscio & Mullen, 2012). There is 78% likelihood that any student post intervention will have made significant gain.

Rate was more resistant to improvement, particularly at the older levels. For student cohorts who underachieved in rate at the 2nd and 3rd years of schooling, rate improved in the phonological and orthographic interventions. The older cohorts did not show this level of gain. This is consistent with phonological and orthographic factors contributing to lower outcomes for the younger students pre intervention. The outcome is not surprising: the interventions did not target improvement in rate directly.

The phonological intervention contributed to improvement in both accuracy and comprehension across the years of schooling. The effect sizes for comprehension are reasonably consistent

[17] Effect sizes are compared using the data in Table 5 and the interpretations suggested by Ruscio & Mullen (2012).

across the years of schooling. They show the influence of phonological processes on comprehension and the need to target difficulties in these areas. The effect sizes for accuracy generally decreased across the years. This could be associated with developmental differences in the cognitive processes needed to deliver accuracy versus comprehension outcomes. The span of cognitive processes for accuracy is more narrow than for comprehension.

The orthographic intervention also contributed to improved accuracy and comprehension across the years, with approximately similar effect sizes. It suggests that some underachievers have difficulty comprehending text because they cannot read the words accurately or efficiently. This intervention had the greatest impact on improvement in accuracy for students in their third year of schooling. This finding is consistent with the wealth of research that shows the effectiveness of teaching in phonics for reading underachievers.

The oral language intervention also improved accuracy and comprehension across the years of schooling. For cohorts where students were under only in comprehension, the gain for comprehension was much higher than for accuracy. The rationale for including this intervention pathway was discussed in Section 1 and linked with the Simple View of Reading in Section 3.2 and research that examined the multiple causes of reading difficulties. Interventions that target oral language teaching are frequently overlooked in provision for reading underachievers.

At most year levels the three interventions didn't differ in their improvement efficacy for accuracy. Differences did emerge at third year level, with the phonological and orthographic interventions leading to lowest and highest improvements in accuracy respectively.

The improvement was not always sufficient to achieve a score above the 'at risk' criterion. The proportion of the cohort at each year level who achieved above at risk reading accuracy or comprehension scores varied, from a high level for students in their second year of schooling to lower levels at the higher grade levels. The oral language intervention had the highest portion of students moving above the at risk criterion in accuracy. Students entering this intervention had higher pre reading accuracy and comprehension scores than the other two interventions.

The relationship between improvement in reading accuracy and either the total number of lessons or the number of sessions each week is not simple or directly. It is examined for those students who were at risk in all three areas of reading or those at risk in accuracy and comprehension (that is, profiles 1 and 2 respectively). While for the second year of schooling neither the total number of teaching sessions nor their weekly frequency influenced reading accuracy for either profile, a more complex relationship is suggested for the older year levels; the combination of the total number of teaching sessions and their weekly frequency influenced improvement in accuracy or comprehension. As well, the intervention pathway that was selected also influenced the total number of lessons and their weekly frequency that led to accuracy improvement.

It is reasonable to ask: Why don't the results show a more explicit preferential improvement for particular domains of reading? The data show an impressive effect size but it is not sensitive to particular areas of literacy learning need. They show that accuracy teaching leads to improved comprehension and oral language teaching leads to improve accuracy.

This is neither surprising nor a cause for concern. Reading is a complex process comprising several interacting systems of knowledge. We noted in Table 4 the correlation between accuracy and comprehension particularly for underachievers. Able readers are more likely to have automatized word reading accuracy and so its effect is decreased. This allows processes such as vocabulary come into play.

8. Recommendations for the future

The recommended implications made here are made against the backdrop of the purpose of this evaluation. One of the strengths of this evaluation is that it is an analysis of a school based implementation "warts and all". Like all authentic implementations in schools, it needed to respond to and take account of a range of factors that don't arise in laboratory studies. In this evaluation of ERIK, the main purpose was the provision of literacy interventions for underachieving students. It was not to evaluate the efficacy of the interventions.

This purpose makes the evaluation all the more relevant to schools. Most empirical evaluations of literacy interventions do not transfer easily to classroom contexts. This is due in part to the fact that the range of controls imposed in a research study, for example, a 'double blind randomized' allocation of students to interventions is not how educators operate in classrooms. With limited resources, including learning time, teachers allocate students to teaching regimes based on was perceived to most appropriate to the student at that time. Allocations by teachers are usually not random.

As well, the design of the evaluation needed to respond to all of the unexpected issues that arise in the real world of classrooms. A plethora of issues can interact with a student's literacy learning at any point, ranging from their self-efficacy as a reader to the time of the day and where they are located when engaging in literacy learning and the time the teacher had to prepare for the lesson. These factors are rarely considered in educational evaluations. In the real world of the classroom they impact on the quality of a student's learning outcomes.

The recommendations tendered as a result of the evaluation are as follows:

1. It is recommended that the procedures for identifying particular literacy learning profiles be improved in their reliability and validity. The literacy learning profile tasks that we used have been normed up to grade 2. I recommend that these be supplemented with vocabulary tasks, improved listening comprehension tasks, paraphrasing and summarizing tasks and word reading tasks.

   As well, I recommend that the tasks be extended in their content to at least a grade 6 level. A more elaborated and differentiated set of tasks that assess the factors that influence literacy learning from the first to the seventh years of schooling may lead to more comprehensive literacy learning profiles that more accurately predict reading outcomes. It should also be remembered that it is often necessary to teach these predictors of reading ability because they provide the infrastructure for literacy learning.

2. I recommend an enhanced set of validated set of identification tools and intervention placement procedures. There is probably a need to improve the assessment procedures that identify reading profiles and allocate students to each pathway. This may allow sharper discrimination between the interventions and also 'streamline' progress through it. With the data that we have now collected, we've now got a better idea of what to identify and useful cut-offs.

3. I recommend that the connection between the phonological and orthographic pathways be clarified. The two interventions target reading accuracy and, less directly, rate, fluency and comprehension. The orthographic pathway was seen as appropriate for students who had already acquired better phonological skills.

   Since ERIK was first developed, the need for an explicit phonological teaching unit has

been recognized and Phonological Early reading Intervention (PERI) was introduced. I believe that both the phonological and orthographic pathways are necessary but they could be integrated into one pathway and with multiple entry points. There is also a need to extend both pathways to take account for more complex words (2-4 syllable words) and more complex letter patterns, for example, the schwa in multi-syllabic words and morphographic patterns.

4. I recommend implementing teaching that targets reading fluency and rate. These qualities of reading are linked with increased automaticity of aspects of the reading process and is an important component of successful reading. Successful reading comprehension is linked with the achievement of automaticity for component processes such as word reading and meaning retrieval.

   This could be developed either in its own intervention pathway or as part of other interventions, for example, as part of reading aloud in each intervention. It would include teaching an awareness of prosody and activities that target automaticity. A regular finding was that underachieving students at several year levels were less able to complete rapid automatized naming effectively. These types of activities, with repeated reading activities, could assist here.

5. I recommend making more explicit the learning framework that underpins the three pathways. Key aspects of this, across the three interventions, are: (1) stimulating students' existing knowledge and skills; (2) scaffolding students to store new knowledge and skills in memory; (3) guiding students to identify how they went about learning; (4) to link positive emotion with the progress made; and (5) how to move gradually from using particular literacy strategies when scaffolded to towards independent use. An original purpose of having every fifth session as a review activity was to facilitate this learning.

   When these learning functions are implemented explicitly, students progress faster. A number of short videos that show the teaching framework being implemented could be made. These could be used for professional learning.

6. I recommend a more explicit focus on building each student's identity as a literacy user and their awareness that reading can work for them. Students who have reading difficulty often have a negative identity as a reader and low self-efficacy. A positive identity as a reader and an positive self-efficacy are more likely to motivate reading in the future.

7. I recommend a clearer more explicit focus on the format for the intervention and its links with the classroom. The small group intervention is valuable. What is not clear at present is the link between the ERIK interventions and the student's regular classroom. I would recommend a 'response to intervention' model, with gradual transfer back to the classroom and the capacity to gradually embed classroom texts in the ERIK program.

   I'd also recommend a more seamless link with regular teaching. The classroom teacher can be involved in ongoing data monitoring for ERIK students. Linked with this is the possibility of classroom teachers monitoring the reading of the students who have been in the ERIK intervention.

   It is recommended that the three current interventions be organizing into a modified response to intervention model that allows transfer back to the regular classroom and a

more seamless link between the intervention and the regular classroom. Classroom texts can be used in the small group teaching sessions.

8. Clearer indicators of when to cease a student's involvement in a pathway are recommended. There needs to be more clarity on when to discontinue a student or when to switch to another pathway. The post intervention data suggest that some students, having completed ERIK involvement, did not achieve above at risk criterion performance. We need clear indicators of when to cease as student's involvement. I would recommend that this decision be based on their capacity to perform. Over an extended period, I would recommend that this be based on a student's ability to read and comprehend independently particular types of texts and words.

   This was a second original purpose of doing every fifth session as a review activity. Not only was it intended to review what had been learnt but also to assess a student's progress. I would recommend including in each review session short assessment tasks that do this. A possible criterion could be the student's ability to read and comprehend independently appropriate text over a period. Suppose a student in the third year of schooling read independently and comprehended typical grade level text and showed word reading accuracy and efficiency over four successive review sessions. These tasks could now be delivered on line in much the same way as On Demand Testing.

   A related issue is the indicator for transferring between interventions. Again, the post intervention data are such that some students would be more likely to benefit from involvement in more than one pathway. It is reasonable to expect that teachers and schools could make better use of the interventions if they had clear guidance on when and how to make this transfer.

9. It is recommended that ERIK be modified to suit the needs of older primary students. The review has shown that the intervention pathways work well with older primary students. Its efficacy and engagement with students could be improved by using texts that are more appropriate for this age range in terms of topics, genres and purposes.

10. It is recommended that the intervention pathways be modified to include an explicit focus on reading comprehension and the multiple ways in which a reader can show what they understand about a text. In particular, the pathways could have an increased focus on inferential and evaluative comprehension type teaching. It has been reported anecdotally that involvement in ERIK does not enhance NAPLAN outcomes. This could be in part because the ERIK program doesn't teach explicitly many of the types of skills required for NAPLAN type tasks. This could be included in adaptations for older students.

11. It is recommended that the reading progress of students post ERIK involvement be monitored for at least three years. The long term retention of these data would assist in identifying ERIK's efficacy and the extent to which students can transfer what they have learnt.

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