A randomized controlled trial of an early-intervention, computer-based literacy program to boost phonological skills in 4- to 6-year-old children

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A randomised controlled trial of an early-intervention, computer-based literacy program to boost phonological skills in 4- to 6- -year-old children.

Background: Many school-based interventions are being delivered in the absence of evidence of effectiveness (Snowling & Hulme, 2011).

Aims: This study sought to address this oversight by evaluating the effectiveness of the commonly used the Lexia Reading Core5 intervention, with 4 to 6-year-old pupils in Northern Ireland.

Sample: A total of 126 Primary school pupils in year 1 and year 2 were screened on the Phonological Assessment Battery 2nd edition (PhAB-2). Children were recruited from the equivalent year groups to Reception and Year 1 in England & Wales, and Pre-kindergarten and Kindergarten in North America.

Methods: A total of 98 below- average pupils were randomised (T0) to either an 8-week block ($\overline{x}$ = 647.51 minutes, SD = 158.21) of daily access to Lexia Reading Core5 (n = 49) or a waiting-list control group (n = 49). Assessment of phonological skills was completed at post intervention (T1) and at 2-month follow-up (T2) for the intervention group only.

Results: Analysis of Covariance which controlled for baseline scores found that the Lexia Reading Core5 intervention group made significantly greater gains in blending, $F(1,95) = 6.50$, $p = 0.012$, partial $\eta^2 = 0.064$ (small effect size) and non-word reading, $F(1,95) = 7.20$, $p = 0.009$, partial $\eta^2 = 0.070$ (small effect size). Analysis of the 2-month follow-up of the intervention group found that all group treatment gains were maintained. However, improvements were not uniform among the intervention group with 35% failing to make progress despite access to support. *Post-hoc* analysis revealed that higher T0 phonological working memory scores predicted improvements made in phonological skills. **Conclusions:** An early-intervention, computer-based literacy program can be effective in boosting the

phonological skills of 4 to 6-year-olds, particularly if these literacy difficulties are not linked to phonological working memory deficits.

Introduction

Effective reading interventions incorporate training in letter–sound knowledge and phoneme awareness, explicit and systematic phonics instruction, and the application of these skills to the tasks of reading and spelling (Duff et al., 2014). This explicit teaching of blending, segmenting and non-word reading skills to increase efficacy and confidence in tackling unknown words is all the more essential for at-risk readers given the large body of evidence now showing the predictive value of letter-sound knowledge and some phoneme awareness in the development of 'learning to read' skills in the early stages (Snowling & Hulme, 2011).

Research indicates that the earlier an intervention occurs the greater the chance of remediation (Allen, 2011) and the higher the probability that more entrenched literacy difficulties in the future can be mitigated (Boscardin, Muthén, Francis, & Baker, 2008).

Currently, the evidence basis for computer-based literacy programs is limited (Brooks, 2013; Cheung & Slavin, 2013; Slavin, Lake, Davis, & Madden, 2011) and mixed (Archer et al., 2014, Campuzano Dynarski, Agodini, & Rall, 2009). This is even more evident in studies of technology-based literacy interventions for children under eight years of age (Lankshear & Knobel, 2003; Shannon, Styers, Wilkerson & Peery, 2015), which the current study is seeking to address.

Evidence for the effectiveness of computer-based literacy programs currently used in UK schools comes predominantly from single sample, unpublished, pre and post studies with no control group and no randomisation (Brooks, 2013). Brooks (2016) notes the importance of considering evidence from randomised controlled studies, and an increase in evidence from studies of this type is demonstrable in his recent review of 19 studies (Brooks, 2016). Although research evidence is stronger in the United States, arising from a greater number of controlled studies and randomised trials, findings are ambiguous. One study program benefits of using a computer-based literacy program on letter identification, word attack skills and

passage comprehension skills for first but not second graders (Chambers et al., 2011), one found benefits on spelling but not basic literacy skills (Blachowicz et al., 2009) and another on the reading comprehension of low-achieving pupils using a blended approach to instruction (Schechter et al., 2015).

Similarly varied findings emerged for studies involving the Lexia computer-based reading skills program both in the United States and in the UK. In the United States, matched control studies demonstrated Lexia's efficacy for all pre-schoolers but only kindergarten children with difficulties (Macaruso & Rodman, 2011), improvements in phonological awareness particularly amongst children with low pre-test scores (Macaruso and Walker, 2008) and in both the letter-sound correspondence and word recognition of low-achieving pupils (Macaruso, Hook, & McCabe, 2006) .In the UK, a quasi-experimental, controlled study involving 106 children found that Lexia was successful in improving standardised scores in reading for up to 66% of the intervention group (McMurray, 2013).

Given the variability in research findings and the evidence of effectiveness on computer-based interventions on some, but not all variables, this study also sought to explore the different variables that accounted for success in phonological skills. Prior research, predominantly with older children, identified working memory (McMurray, 2012), gender (Rutter et al., 2004), and language proficiency (Yeung & Chan, 2013) as mediating factors in literacy difficulties and intervention response and this study sought to explore if these variables were also relevant for younger populations too.

In summary, many questions still remain regarding the effectiveness of computer-assisted literacy interventions. Given the variability in findings, the use of a randomised controlled trial (RCT) is an important contribution to the literature (Snowling & Hulme, 2011). This study is, to the authors' knowledge, the first participant-level, RCT of Lexia with Year 1 and 2 pupils conducted to date.

The first research question sought to test whether the intervention group would show statistically significant improvements in blending, phoneme segmentation and non-word reading at T1 when compared to the control group. The second research question sought to examine if gains made on the intervention were uniform across all participants and if not, to determine the factors that would predict participant progress.

Method

Trial design

This was a parallel-group, randomised controlled trial with a no-treatment, wait-list control group. The study ran from December 2014 to June 2015. Every child who met eligibility criteria agreed to participate in the study (see Figure 1) and were randomised to either the Experimental group (8 weeks of daily 20- to30- min sessions of the intervention) or a Wait-List Control group (standard classroom teaching in line with the statutory Northern Irish curriculum and supplemented with both synthetic and linguistic phonics programs). Children were assessed individually pre-intervention (T0), post-intervention (T1) and at 2-month follow-up (T2) (intervention group only). Ethical approval was given by the School of Psychology Research Ethics Committee at Queen's University, Belfast and written parental consent and verbal pupil assent was provided for all participants.

Participants and setting

The study took place in two town-based primary schools in Northern Ireland. Schools were chosen based on their ability to provide pupils with access to a multi-computer information and communications technology (or ICT) suite and their focus on raising whole-school literacy levels in their school development plan. School A had a registered pupil population of 250, 46% of whom were eligible for free school meals. School B had a registered population of 547, 44% of whom were eligible for free school meals. The study was run in conjunction with the Educational Psychology Service and the School of Psychology and was overseen by a qualified Educational and Child Psychologist with research experience as lead investigator in school-based randomised controlled trials in the past. In keeping with previous research which showed the benefit for staff training and support on the efficacy of computer-based interventions (Archer et al., 2014), pre-intervention set-up and product introductory tutorials and on-going technical support were provided to both schools by LexiaUK Ltd.

Participant details are listed in Table 1. 126 children were screened to identify those with the weakest reading skills. Inclusion criteria for the study were (1) being in a mainstream Year 1 or Year 2 class, (2) having a standard score of 90 or less on any of the four subtests of the four Phonological Assessment Battery (PhAB-2) subtests assessed (low average to below average range). In Northern Ireland, the compulsory school age is 4. Therefore children in Years 1 & 2 there are within the same age-range as those in Reception & Y1 in England & Wales, and in Pre-kindergarten and Kindergarten in North America. Exclusion criterion was having scores of zero on all four subtests (due to concerns about floor effects). The 14 excluded pupils were then offered a more intensive, separate program of literacy support. To keep the trial naturalistic, children with English as an Additional Language or pupils on the school's SEN register were not excluded. Of the 126 children screened, 98 met inclusion criteria and all were invited to participate in the RCT study. All agreed and provided parental consent. The pupils ranged in age from 4 to 6 ($\overline{x}$ = 63 months, SD = 9.5).

Based on the post-intervention group outcome means in a quasi-experimental study of Lexia in Northern Ireland (McMurray, 2012) we calculated the minimum sample size to adequately power the study to be 40 per group, at a power level of 0.80 and an alpha value of 0.05 (ClinCalc.com).

Procedure

Classroom assistants and the school SENCo were trained by the second author in the administration of the PhAB-2 (Gibbs & Bodman, 2014) in the week prior to the scheduled testing. During this training, staff were provided with video tapes of standardised administration, and were given an opportunity to administer the four subtests and have any

questions on test administration answered. The importance of consistency was stressed and assessors were observed administering the subtests to ensure consistency of administration across assessors.

Tests were administered over three days in December (T0), April (T1) and June (T2) in private reading rooms in each school to keep disruptions and external noise to a minimum. To ensure consistency throughout the intervention, data collection at each time period was allocated to the same assessor. The first author enrolled participants while the second author used simple randomisation to generate the allocation sequence (www.random.org) and assigned participants to the two groups. There were no changes to the methods or outcomes after trial commencement and the trial proceeded as per the protocol.

Measures

To assess phonological skills the Phonological Assessment Battery, Second Edition (PhAB-2) were used. The PhAB-2 was chosen because (a) it was recently standardised for the age range of interest (b) it measures both phonological processing (e.g. blending subtest) and phonological production (e.g. non-word Reading)(c) it provides standardised scores of Phonological Working Memory (we were interested in seeing if this variable could predict improvements made on the intervention over time) (d) it contains a standardised protocol for both test administration and scoring, detailed in the test manual (Gibbs & Bodman, 2014) . We used four subtests on the PhAB-2: Blending subtest (combining sounds to make a spoken word e.g. /k/, /æ/ , /t/ = cat), Phoneme Segmentation subtest (separating spoken words into their constituent phonemes e.g. car = /k/ + /a˞/) The retroflex ('r-coloured') version of this phoneme is provided here as in Northern Ireland the majority of regional dialects are rhotic. In addition, the Phonological Working Memory subtest (repeating a series of non-words e.g. narraf) and Non-Word Reading subtest (decoding unfamiliar strings of letters as sounds that might form a word e.g. tib) were administered also. In line with McMurray (2013) eligibility

criteria were set as having a standard score of less than 90 on any of the variables measures at T0 and improvements over time were measured using raw score changes. This was done because it was felt that raw scores were a more objective measure of change in outcomes over time than standardised scores with populations at the lowest end of the normative sample range.

In 2013, the PhAB-2 was standardised with a sample of 773 (4- to 11-year-olds) children in England, Scotland and Wales (Gibbs & Bodman, 2014). Internal consistency for the four subtests used ranged from .76 (Phonological Working Memory) to .96 (Blending). Evidence of construct validity was shown in increases of score with age and inter-correlations between the PhAB-2 Primary tests, while strong correlations of 0.721 and 0.738 were found between the test of non-word Reading and the York Assessment of Reading Comprehension and Single Word Reading Test, respectively.

Intervention

The intervention group received daily, individual, adult-supervised, 20-30 minute blocks of computer-based support on Lexia Reading Core5 program for 8-weeks ($\overline{x}$ = 647.51 minutes, SD = 158.21). Lexia was chosen due to its growing use in UK schools by children with literacy needs and English as an Additional Language (www.lexiauk.co.uk) and its preliminary research findings suggesting its effectiveness (Brooks, 2013, 2016). This reading skills program allows pupils to work independently in a structured, sequential manner. When pupils log-on to Lexia for the first time, they take an Auto Placement test to determine their level and then progress through graded exercises in phonological awareness, phonics, fluency, vocabulary and comprehension. However, to ensure even progress, the Lexia program blocks advancement to higher levels until a prescribed set of minimum units in all five areas are completed correctly. In addition to tracking the time an individual child spends on Lexia it also tracks the number of units each child correctly completes and flags areas of

difficulty where a pupil fails to grasp a concept or make progress despite access to additional activities to remediate this difficulty. The Lexia program targets skills in rhyming, blending and segmenting, letter-sound correspondence, ‘b’, ‘d’, ‘p’ confusable letters, short and long vowels, spelling rules, high-frequency sight words, fluency, vocabulary development, timed silent reading and listening and reading comprehension.

The Lexia online program can be supplemented with offline, teacher-led resources for individual or small group instruction. Lexia lessons consist of structured, teacher-delivered lessons which are designed to address skills based on performance on the online activities, as identified by the teacher using online reports generated by the program. Skill Builders are offline, pencil and paper activities which can be completed at the end of each online activity. These are designed to complement and extend work completed through the online Lexia program. This study examined use of the online Lexia program only.

Data Analysis

To control for baseline differences between the intervention and wait-list control group, an Analysis of Covariance (ANCOVA), controlling for baseline scores was used and partial eta squared (η^2) and Cohen’s d effect sizes were recorded.

Comparisons between the intervention group and control group were conducted at T0 (baseline testing)and T1 only. Results indicated equivalent performance at baseline testing. The control group received their intervention after T1 analysis was conducted and demonstrated the effectiveness of the intervention.

Repeated measures ANOVAs were used to measure within subject effects for the intervention group on all three variables over time from T0 to T1 and then at T2 while linear regression analysis was used to identify the demographic, procedural and baseline variables that could predict improvements in phonological skills.

Four pupils were unable to be tested at T1 and 4 pupils from the Intervention Group were unable to be tested at T2 but were included in the outcome analysis (intention-to-treat analysis. Except in the case of the participants mentioned above who were absent for T1 or T2 testing, there were no other missing values in this study. Bonferroni adjustment of significance levels was applied for all multiple comparisons ($p < 0.0167$). Statistical analyses were conducted using IBM SPSS version 22 (IBM, 2013).

Results

Baseline Characteristics

Baseline characteristics of participants in the two groups are presented in Table 1. Randomisation resulted in no significant difference on age, gender, year group, English as an Additional Language status (or EAL status) or any T0 measure.

Recruitment began in December 2014, with T1 testing in April 2015 and P2 testing in June 2015. The trial was ended after the intervention group had received one block of intervention support. Two pupils discontinued the intervention (due to difficulties using a mouse and frustration and anxiety caused by this and the other one due to poor attendance) having accessed 23 and 51 minutes respectively. However, in order not to compromise the integrity of the randomisation, the pupils' scores were still included in T1 and T2 analysis of the intervention group. Meanwhile, three pupils at T1 and four pupils from the intervention group at T2 were absent on the day of testing and their scores were included using a 'last value carried forward' method.

Prior to analysis, scatterplots were used to measure linearity and Levene's test indicated homogeneity of variance for all variables.

An ANCOVA (co-varying for baseline scores) found that the Lexia Intervention group were better able to blend sounds, $F(1,95) = 6.50$, $p = .012$, partial $\eta^2 = 0.064$ and read nonsense words, $F(1,95) = 7.20$, $p = .009$, partial $\eta^2 = .070$ than the wait-list control group after the intervention with medium effect sizes reported ($\eta^2 > .0588$) (see Table 2).

Furthermore, these gains were maintained at T2 with Repeated Measures ANOVAs (see Table 3) demonstrating an 'Intervention Over Time' effect for the Lexia group on all blending, phoneme segmentation and non-word reading respectively, $F(2,47) = 27.09$, $p < .001$, partial $\eta^2 = .535$, $F(2,47) = 30.70$, $p < .001$, partial $\eta^2 = .566$ and $F(2,47) = 22.88$, $p < .001$, partial $\eta^2 = .493$.

Inspection of the data of the intervention group at T1 testing indicated that the gains made by the intervention group as a whole were not evenly distributed and that 35% of the intervention group (17/49) made no improvements on two out of the three outcome variables.

Regression analysis (see Table 4) indicated that phonological working memory scores successfully predicted improvements in blending scores in the Lexia group ($p = .001$). Meanwhile, the intervention was shown to be equally successful for boys and girls, pupils from School A or School B, pupils who had English as a first or as an additional language or pupils that spent a large or small amount of time on the intervention.

Discussion

Interpretation

This RCT supports the findings of previous quasi-controlled studies, which found that Lexia can be effective in helping reading delayed children (Macaruso et al., 2006) and children with literacy difficulties linked to phonological deficits (McMurray, 2013). It adds to the growing evidence basis for the effectiveness of both early-intervention (Hatcher et al., 2006; Macaruso and Walker, 2008; Schwartz, 2005;) and computer-based literacy programs (McMurray, 2013, Shannon et al., 2015). However, unlike previous studies, this study tested the effectiveness of a phonics-based computer-based literacy program with children in their first and second year of school, using an RCT, which makes these findings an important addition to the field of early-intervention, literacy support programmes.

Secondly, while the intervention was shown to improve blending and non-word reading skills, it was less effective for phoneme segmentation skills. This is in line with previous research which found that the kindergarten Lexia group made greater progress than the control group on reading accuracy but not on phoneme segmentation (Macaruso & Walker, 2008). One hypothesised explanation for this lack of evidence is visual channel overload (Sakar & Ercetin, 2005). Visual channel overload occurs when verbal, auditory and visual information obtained from a text becomes too much for a person's working memory to process. Although all of the subtests in this study were administered orally, phoneme segmentation was the only subtest which contained both aural and visual input.

Thirdly, although nearly twi-thirds of the intervention group found the Lexia intervention to be beneficial, 35% of this group failed to make progress despite access to this intensive phonics-based intervention. This finding of a significant minority of children whose literacy difficulties are persistent despite remediation was also found in both the McMurray (2013) and Hatcher et al. (2006) studies and offers further evidence for the obstructive role of

working memory deficits in early literacy acquisition (Alloway et al., 2005; McMurray, 2013). It also demonstrates the importance of a multi-modal literacy intervention where ICT is supplemented by the mediation of a skilled adult (Brooks, 2013) who can remediate pupil-specific literacy problems identified by the ICT program.

Finally, the finding that time spent on the program was not a significant predictor of outcome is in line with the finding of McMurray (2013). McMurray (2013) also found that time spent on Lexia did not significantly contribute to the amount of variance in final reading scores. Instead, the findings of the present study and those of McMurray (2013) indicate that children's progress on the Lexia program contributed to the amount of variance in final reading scores, as indicated in McMurray's study by level and in the present study by score. The present authors postulate that a ceiling period of time can be reached within a session and once this is reached a pupil cannot make more progress within a session. This suggestion is strengthened by the views of the children in McMurray's (2013) study who note that they reach a point where they become 'stuck' on a Level. The authors also postulate that the optimal period of time spent on the program is likely to be developmentally appropriate and in line with a child's attention span, and individual differences.

Limitations

This current study had some important limitations. Firstly, it used a wait-list control design which meant that only within-treatment effects were available at T2. This decision was taken because the authors felt an ethical responsibility to provide literacy support to the wait-list control group identified with literacy difficulties as soon as we possibly could. Given the restricted time-frame of the study and the restricted access to individual user licences from Lexia for the duration of the study, the only available time to provide the wait-list group with support was after the intervention group had received their 8-week block.

The restricted time-frame for the study also limited the length of time available for follow-up. While the authors accept a 2-month timeframe falls short of the 6- to 24- month follow-up of other literacy intervention studies (Duff et al., 2014), we felt that it was better to include a follow-up test at least equivalent to the length of time of the intervention in order to monitor progress or fall-back.

Thirdly, participants did not access the adult-mediated support using the scripted lesson plans (Lexia Lessons) and practice worksheets (Skill Builders) generated by the Lexia program to help pupils who had not grasped a literacy concept being taught electronically. This was an omission, which occurred due to timetable limitations, but which could be planned for in future research through an examination of the use of these supplementary resources in conjunction with the online program. Importantly, the role of the teacher must be stressed in critically evaluating the most effective use of any such resources at an individual pupil level. This may be particularly important given the growing evidence of the impact of adult-mediation in determining the success of computer-based programs (Brooks, 2013; Savage et al., 2010). Whilst the present results are positive in terms of the efficacy of the progam for the majority of participating children, it may be noted that the expertise and critical professional judgement of the class teacher is likely to be a crucial factor in its most effective deployment.

Generalisability

Despite the limitations above, the study had many important strengths. Firstly, it sought to subject well-intentioned educational practices to vigorous evaluation (Duff et al., 2014) using practitioner-led evidence-based research. The study adopted the most rigorous research method available (Snowling & Hulme, 2011), something sorely lacking in the field of literacy interventions (Brooks, 2013, Snowling & Hulme, 2011). To improve the external validity of the study, children with English as an Additional Language and pupils on the SEN

register were also included. The study sought to target literacy difficulties as early as possible, something that research has identified as both achievable (Hatcher et al., 2006) and cost-beneficial (Allen, 2011).

With recent cuts in school budgets, pupils are now less likely to access within school literacy support, placing an even greater strain on external literacy support services, lengthening waiting lists and further delaying access to much needed assistance. Although not a panacea for all literacy difficulties, computer-based interventions can provide a strategic opportunity for children to access early-intervention, intensive, phonics-based support in a format that children report to be enjoyable and motivating (McMurray, 2012). If literacy difficulties are caused by underlying phonological deficits in the absence of significant working memory deficits, access to computer-based support could just provide the literacy boost some children need to catch-up with peers and access class-based literacy instruction. This prevents difficulties becoming entrenched and offers a quick and early solution allowing classroom literacy learning to continue.

Future research is needed to examine which components of the Lexia Reading Core5 program are most successful in boosting phonological and letter-sound knowledge, the impact of additional adult mediation on progress made on the program, the impact of Lexia on subsequent reading and spelling skills of participants and whether progress in phonological skills is sustained by children engaging with this computer based intervention over a longer period of time.

Conclusion

This RCT demonstrated that a computer-based, early intervention literacy program boosted the phonological skills of children, resulting in significantly higher performance on blending and non-word reading tasks as compared with the control group. Furthermore, these gains in performance were maintained by the intervention group when assessed again at 2-month

follow-up. However, *post-hoc* analysis showed that effect sizes were small and that gains made by the intervention group were not spread evenly across participants with approximately 35% of the intervention group failing to make significant gains despite access to the intervention. Future research should investigate the cognitive factors impacting on the performance of children who are not seen to make progress on such interventions. In considering why this may be the case, it may be noted that multiple regression analysis conducted for this research indicated that pre-intervention phonological working memory scores were a key predictor of gains made within the intervention group. The findings overall show promising initial results from a randomised controlled trial of a computer-based literacy intervention for young children.

However, it also demonstrates that while a majority of children involved will make progress, there are significant minorities of children who do not make gains on this type of program, which has been reported elsewhere in the literature (McMurray, 2012; Hatcher et al., 2006).

Finally, in deciding whether or not to utilise such a program with a pupil, practitioners may wish to consider phonological working memory scores when deciding on the specific literacy support package offered to struggling pupils, as pre-intervention phonological working memory scores were seen to be a key predictor of gains made in reading skills within the intervention group.

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Key Points

- Lexia is an effective early-intervention program for literacy difficulties for children with low average to below average phonological skills
- The intervention group made statistically significant improvements in blending and non-word reading when compared to the control group
- Approximately 35% of the intervention group failed to make progress despite access to an intensive, literacy intervention
- Phonological working memory predicted gains made in blending by the intervention group

TABLES AND FIGURES

Table 1 Descriptive data for the intervention and wait-list control group in the study

	Lexia Group (n=49)	**Wait-List Group (n=49)**	**F-value or Chi-Square**	**p-value[a]**
Number of Boys (n,%)	26 (53%)	21 (43%)	1.022	0.312
Number of Year 1 children (n,%)	23 (47%)	25 (51)	0.163	0.686
Number of EAL children (n,%))	16 (33%)	18 (37%)	0.180	0.671
Age of Participants ($\bar{x}$, SD)	62.78 (10.75)	63.76 (8.17)	0.258	0.613
T0 Blending Scores ($\bar{x}$, SD)	4.45 (5.87)	4.61 (6.24)	0.018	0.894
T0 Segmentation Scores ($\bar{x}$, SD)	4.00 (4.18)	3.12 (3.87)	1.163	0.284
T0 NW Reading Scores ($\bar{x}$, SD)	2.18 (4.68)	2.27 (4.38)	0.008	0.929

[a] One-way ANOVAs (confidence interval: 95%) measured baseline differences of continuous variables and Chi-Square tests measured baseline differences for categorical variables

471 **Table 2** Analysis of covariance for blending, segmentation and non-word reading at T1

Variable	Intervention (n=49) Mean (SD)			Control (n=49) Mean (SD)			Value F (1,95)	p	Effect size (η^2) (Cohen's d*)
	T0	T1	Diff	T0	T1	Diff			
Blending	4.45 (5.87)	9.18 (6.51)	4.74 (4.78)	4.61 (6.24)	7.02 (6.68)	2.41 (4.38)	6.50	0.012	0.064 (d=0.36)
Phoneme Segmentation	4.00 (4.18)	5.61 (4.49)	1.61 (3.46)	3.12 (3.87)	3.78 (4.01)	0.65 (3.78)	3.467	0.066	0.035 (d=0.23)
Non-Word Reading	2.18 (4.68)	5.63 (6.73)	3.45 (4.82)	2.27 (4.38)	3.57 (5.57)	1.31 (2.82)	7.20	0.009	0.070 (d=0.35)

472 ***Cohen's d was calculated using the difference in gains scores divided by the pooled**

473 **post-test standard deviations**

474 **Table 3** Descriptive data for intervention group on blending, segmentation and NW reading

475 at T0, T1, T2

N		Variable	Mean	SD		Variable	Mean	SD		Variable	Mean	SD
49		BlendT0	4.45	5.87		SegT0	4.00	4.18		NWRT0	2.18	4.68
49		BlendT1	9.18	6.51		SegT1	5.61	4.49		NWRT1	5.63	6.73
49		BlendT2	10.9	6.65		SegT2	7.53	4.04		NWRT2	7.55	6.93

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478 **Table 4** Regression analysis for intervention group on difference in blending scores at T1

Coefficients							
	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-7.361	5.594		-1.316	0.196	-18.659	3.937
Age	-0.021	0.77	-0.048	-0.277	0.783	-0.177	0.134
School	0.531	1.518	0.056	0.350	0.728	-2.535	3.597
Gender	1.539	1.352	0.162	1.138	0.262	-1.191	4.269
EngOrEAL	1.752	1.553	0.174	1.128	0.266	-1.385	4.888
Class	-1.165	1.773	-0.123	-0.657	0.515	-4.745	2.416
Time	0.007	0.005	0.219	1.436	0.159	-0.003	0.016
Phonological WM Score, T0	0.578	0.163	0.479	3.554	0.001	0.249	0.906

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481 **Figure 1** Consort Diagram Showing Flow of Participants through the trial

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