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SPELD NZ remedial intervention for dyslexia

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Abstract

Intensive tutoring has been shown to be effective in improving the academic skills of children with reading disabilities. This study investigated the efficacy of SPELD NZs' specialist intervention. The 42 participants were aged seven years and in Year 3 in 2011. The teaching provided was one to one from qualified SPELD NZ teachers. Analyses were conducted on students' Woodcock-Johnson III (WJIII) scores post-test compared to pre-study assessment. Analyses revealed significant scores gains in both the WJIII Cognitive Abilities and Test of Achievement. Noteworthy were the large effect sizes post-remediation from the broad reading skills cluster, the word attack subscale and verbal comprehension. Less expected, however, were the large gains from measures of cognitive efficiency and processing speed. Taken together, the findings support the conclusion that SPELD NZ interventions can be most effective in lifting specific and broad achievement levels for students with dyslexia.

***Keywords**: SPELD; remediation; school intervention; specific learning disability; dyslexia.*

Introduction

Some children have great difficulty attaining fluent single word reading and, if it persists, they may have a specific reading disability (herein called dyslexia). Dyslexia is a persistent and unexplained failure to achieve accurate and/or fluent word recognition skills, despite adequate intelligence, intact senses, and proper instruction (Lyon, Shaywitz & Shaywitz, 2003). While many adults who struggle to read in childhood are eventually able to read accurately, their reading often remains slow and effortful with persistent spelling and written expression deficits.

The primary cognitive deficit in dyslexia can be traced back to deficient phonological coding (Pennington, Van Orden, Smith, Green, Haith, 1990; Snowling, 2000), which impairs the way that speech sounds are represented, stored and retrieved (Lyon et al., 2003). As dyslexia is not related to any lack of intellectual ability, there is a similar bell curve distribution of intellectual ability in the population of those with dyslexia as in the general population. It can thus be argued that the dyslexic population is one that is likely to be very responsive to appropriate remedial intervention which may also apply to the wider student population. Indeed, although dyslexia is often resistant to regular classroom instruction, intensive tutoring has been shown to be very effective in improving reading skills (Lyon, Fletcher, Fuchs & Chlabra, 2006). This is one of the propositions underlying the study reported on here.

There is not an extensive body of published Australasian research on remedial interventions which are specifically focused on dyslexia, despite dyslexia being a fairly common presenting problem in New Zealand schools. The studies in New Zealand by Tunmer et al. (e.g., Tunmer, Chapman, Greaney, Prochnow & Arrow, 2013) and in Australia by the Wheldall group at Macquarrie University (Wheldall & Madelaine, 2006) provided a useful springboard when designing this study. Among examples of programme evaluation is the work of Firth and colleagues (Firth, Frydenberg & Greaves, 2008; Firth & Frydenberg, 2011; Firth, Frydenberg & Bond, 2012; Torgesen, Alexander, Wagner, Rashotte, Voeller & Conway, 2001). These studies show that while dyslexia is increasingly recognised as a specific learning disability, far more work needs to be done researching the efficacy of interventions. A report by Graham, Bellert, Thomas and Pegg (2007) also revealed significant student gains following a basic academic skills intervention for low achieving students (not dyslexic by definition or assessment). These researchers placed 42 students in small groups receiving targeted 30-minute sessions weekly for 26 weeks. The authors conclude that remedial intervention is capable of narrowing the academic gap between students with specific learning disabilities and their average peers.

Intervention at a young age, prior to a long history of student under-achievement, appears to allow greater learning gains as well as being an appropriate timing for remedial intervention. Similarly, intervention taking place in the "safe" and familiar setting of school, at school in school hours, may act to decrease any subject anxiety, and allow any intervention to be normalised by the in-school setting. These assumptions underpinned the design of the present research and the Specific Learning Disability New Zealand (SPELD NZ) assessment and teaching programme provided the intervention.

All participants attended New Zealand State and Integrated Schools, staffed by New Zealand registered teachers, and are inspected by the Education Review Office (ERO) regularly to ensure that the instruction being given is up to an approved standard. The students in our sample were all in mainstream classes receiving instruction via the approach currently accepted as appropriate. As such, we took as a baseline that an appropriate degree of reading instruction had been received by our participants, particularly as school assessments had noted lack of progress in the children in the sample. Whilst there is debate as to whether whole language method of teaching reading is suitable for all, that discussion is outside the purview of this study.

The aim of the present study was to investigate the efficacy of SPELD NZs' specialist intervention and to demonstrate that local solutions are available to New Zealand schools for students with dyslexia. Importantly, there was planned collaboration with the schools that were involved. In line with SPELD NZs' intention to work with the education sector in promoting the learning of students with dyslexia, initial discussions regarding the feasibility of this study were held with the New Zealand Principals' Federation and the Resource Teachers of Learning and Behaviour (RTLB) Association. Two independent academics were then approached to undertake the data analysis (the first author) and interpret outputs (the third author). Analyses were conducted to determine students' cognitive and achievement scores post-test as compared to pre-study assessment. We hypothesised that students will demonstrate higher levels of academic achievement following participation in the SPELD NZ programme.

Methods

Participants

The 42 participants in this study were all aged seven years and in Year 3 in 2011. Despite an attempt to intentionally target of children from different ethnic backgrounds, the majority of the participants were New Zealand Europeans with nine Maori, two Pacific Island and two from Africa. Boys outnumbered girls 29 to 13, and 24 had been part of their school's Reading Recovery Programme in Year 2. The sample students were from different schools and circumstances, from decile one and decile ten schools, geographically spread from Northland to Canterbury and from both rural and city schools.

General Procedure and Materials

Identification of participants.

The Terms of Reference for this study were sent to state and integrated schools throughout New Zealand. Principals were invited to apply for students at their school to be considered for inclusion in the programme. The Terms of Reference specified that the target group was: (i) "Year two/three 2010/2011 students age seven by Dec 2010 with indicators of Specific Learning Difficulties, who have not made the expected rate of progress, despite access to quality learning opportunities in their regular classrooms and additional in-school targeted support"; and (ii) "disorder in one or more of the basic psychological learning processes that involves difficulties in understanding or using language, spoken or written. It will be reflected predominantly in difficulties in listening, thinking, speaking, reading, hand-writing, written language, spelling and/or maths."

Classroom teachers, RTLBs and Special Education Needs Co-ordinators (SENCOs) were involved in the initial identification of students experiencing difficulty with reading and writing. In New Zealand, the SENCO has responsibility for the special needs register, and for organising and recording Individual Educational Programme meetings for each student on the register. At secondary schools they are involved in applying for Special Assessment Conditions (SACS). In this study, the teachers, RTLBs and SENCOs, being familiar with the backgrounds of their students they were involved with, were instructed *not* to refer students where learning difficulties were likely to have resulted from one of the following: visual, hearing or motor impairment; low general cognitive ability; economic, cultural or environmental disadvantage. Given this approach, it is unlikely that the sample included students whose learning difficulties related to trauma, tuition, or motivation, although those factors cannot be completely ruled out.

Classroom teachers, SENCOs, and/or RTLBs were also responsible for language assessments within the schools. Participants in the present study had been assessed as experiencing reading and spelling difficulties using at least one of a variety of age-normed screening tools for reading [2] and spelling [3].

Children who were identified as likely candidates for this study were referred to SPELD NZ. Formal assessment was then carried out by accredited assessors who examined work samples and read the child history provided by classroom teachers and parents/caregivers. Importantly, they used a standardised and valid psychometric tool normed in Australia for use in Australia and New Zealand (Woodcock-Johnson III, referenced in Thompson, Tunmer & Nicholson, 1993) to ensure participants had average intelligence, average listening comprehension, poor reading comprehension and poor word reading (decoding). Given the comparatively small sample size, it was not seen as apt to analyse in terms of socio-cultural factors.

SPELD NZ intervention

A sample of 42 students was selected following the Woodcock-Johnson III assessment by SPELD NZ qualified assessors. Teaching using the particular SPELD NZ approach began in Term 1, 2011. The teaching provided was 1:1 and was from qualified SPELD NZ teachers with each student receiving 60 45-minute lessons on a twice weekly basis. SPELD NZ lessons for this study were mainly funded from donations from charitable organisations with some costs covered by schools, parents/caregivers, and SPELD teachers contributing *pro bono*.

In accordance with the philosophy of SPELD, the teachers did not deliver a standard scripted programme. They used the WJIII assessment results to develop an individual plan for each participant. The pilot guidelines for lessons stipulated that the focus was on the following subskills: phonological awareness; phoneme/grapheme knowledge; visual and auditory processing; processing speed; and sequencing. Following the completion of 60 sessions, reassessments were carried out using the same WJIII battery of tests that were used in the initial assessment. Given the time between pre and post assessments, it was not considered that test familiarity would be a significant variable.

Assessment materials

The Woodcock-Johnson III (WJIII) Tests of Cognitive Abilities and Tests of Achievement were used to test the effectiveness of SPELD remediation. The two distinct, co-normed batteries were given to students in one session both before (November - March 2010) and after remediation (following 60 lessons in 30 weeks). The WJ111 cognitive and achievement tests each contain 20 tests, each measuring a different aspect of general cognitive and specific academic ability.

The Woodcock-Johnson III includes 31 cognitive tests that are published in two components: The Standard Battery (Tests 1-10) and the Extended Battery (Tests 11-20). An additional 11 tests are published separately as the Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities. The WJ-III COG and DS are co-normed with the Woodcock-Johnson III Tests of Achievement. The Woodcock-Johnson III Normative Update was published in 2007 and it is a recalculation of the WJ-III normative data on the basis of 2005 U.S. Census statistics (U.S. Census Bureau).

Data Analysis

SPSS 20 software was used for all analyses. Significance was considered at alpha <.05 and Bonferroni correction to the alpha level (i.e., adjusting the alpha level by dividing by the number of tests to decrease the likelihood of a Type I error) was made for pairwise comparisons.

Statistical analyses were performed on each test or cluster for the following data: Standard Scores (SS); W scores; Success Rate (SR) scores. The SS are based on mean of 100 and standard deviation (SD) of 15. The W score is centred on a value of 500, which is the average performance of 10 year olds. It has mathematical properties that make it suited for measuring an individual's progress over time. According to Woodcock (1978), the reference W is the criterion score against which the performance of a person within that group is measured and they were normed for every month of every age and grade level. SR scores refer to the students' predicted probability of success. The calculation uses the W score, and it gives an indication of expected success based on the W Difference. For example if the success rate is 75% this means that when the student originally got 50% they are now expected to get 75%. As 50% is the median difficulty level (i.e., if the W Difference was 0 the success rate is 50%), statistical significance was deemed to be reached when the mean SR score is significantly higher than 50% on a one-sample t-test.

RPI and PR descriptive statistics are also included in the text. The RPI is a measure of a person's proficiency in a skill compared with average age peers and is similar to the index used to describe visual acuity (20/20).

We first ran preliminary analyses of variance (ANOVAs) to determine if there were any ethnicity effects (27 Pakeha, 14 "Other"). Analyses on the tests of Cognitive Abilities revealed a two-way interaction on the long-term retrieval data, whereby only those in the "Other" ethnic group showed significant gains following intervention, and a main effect on Fluid reasoning scores, with Pakeha scoring higher (M=108.2) than the "Other" group (M=97.87). For the tests of Achievement data, there was an Assessment by Ethnicity interaction on the Reading Fluency scores, whereby only Pakeha students scored significantly higher after intervention. Because of the small sample sizes, ethnicity was not considered further in analyses.

Secondly, we ran ANOVAs to determine if there were any sex effects. As there were no significant sex differences in any analysis, this was not included as a variable or discussed further.

Thirdly, we considered students who had been involved in a Reading Recovery programme in their regular school. Of the 42 participants, 27 had taken Reading Recovery classes (69.2%), 12 had not and three had missing data on that measure. Unfortunately we do not have information regarding the length of Reading Recovery tuition. Analyses were conducted on the standard score data from both the tests of Cognitive Abilities (k=20) and Achievement data (k=20) prior to SPELD lessons to determine if those who had received Reading Recovery were at any testing advantage over those who had not. There were no statistically significant t-test results.

When analyses were next conducted on the SR data (following intervention), there was one phonetic-ability specific test that achieved statistical significance. Participants who had previously been involved in Reading Recovery classes had higher percent success rate scores (M = 76.38%, SD = 16.09) on the phonemic awareness broad cluster than those who did not (M = 61.33%, SD = 17.91), p<01.

Table 1: WJIII Cognitive Abilities test Mean standard scores and W scores (standard deviation in parenthesis) pre- and post-intervention

	Standard Score pre-intervention	Standard Score post-intervention	W score pre-intervention	W score post-intervention
General intellectual ability	**95.38 (9.15)**	**99.60 (10.10)**	**482.67 (08.11)**	**492.17 (06.58)**
Verbal comprehension	**97.50 (10.33)**	**100.79 (09.02)**	**482.86 (10.24)**	**491.31 (08.64)**
Visual auditory learning	98.43 (13.03)	100.52 (13.31)	489.52 (07.41)	494.88 (07.32)
Spatial relations	100.14 (9.14)	99.71 (09.71)	493.79 (15.52)	498.10 (06.02)
Sound blending	91.07 (14.25)	98.36 (10.09)	479.88 (61.75)	500.12 (08.14)
Concept formation	88.17 (13.32)	90.46 (14.31)	483.73 (06.08)	488.39 (07.06)
Visual Matching	82.48 (12.62)	83.45 (19.55)	457.05 (60.88)	476.19 (10.89)
Numbers reversed	93.21 (11.46)	94.57 (09.80)	469.14 (18.38)	479.83 (13.76)
Analysis synthesis	91.07 (14.25)	98.36 (10.09)	479.88 (61.75)	500.12 (08.14)
Decision speed	93.46 (15.02)	98.24 (13.61)	480.83 (09.41)	488.66 (08.09)
Memory for words	97.67 (11.17)	97.10 (13.27)	481.43 (15.06)	487.48 (17.88)
Thinking ability	**97.95 (11.27)**	**103.00 (11.22)**	**491.15 (06.49)**	**498.33 (06.35)**
Cognitive efficiency	**90.08 (09.90)**	**92.50 (10.55)**	**473.33 (09.05)**	**482.33 (08.12)**
Short term memory	94.43 (10.61)	95.31 (11.08)	475.21 (12.93)	483.71 (12.39)
Processing speed	86.63 (13.42)	90.73 (13.67)	473.54 (08.56)	481.80 (09.36)
Long term retrieval	95.24 (14.06)	97.48 (13.35)	492.12 (04.69)	495.62 (04.44)
Fluid Reasoning	103.56 (12.07)	103.97 (13.86)	489.23 (10.92)	496.47 (12.43)
Phonemic awareness	**87.64 (17.60)**	**100.28 (11.32)**	**486.62 (10.03)**	**498.10 (06.12)**
Incomplete Words	92.00 (25.15)	102.57 (16.33)	486.19 (11.69)	496.05 (08.11)
Phonemic awareness 3	89.15 (20.60)	101.51 (12.76)	483.64 (09.60)	494.38 (06.09)

Table 2: Success Rate data (Mean probability of success converted to percent) for the WJIII Cognitive Abilities tests.

	Mean probability of success in percent	Mean difference (probability of success – chance performance)	Standard deviation	Effect size (Cohen's d)	t statistic (one-sample)
General intellectual ability	**71.55%**	**21.55**	**9.76**	**2.21**	**14.31***
Verbal comprehension	**70.36%**	**20.36**	**12.23**	**1.66**	**10.79***
Visual auditory learning	62.67%	12.67	13.19	0.96	6.22*
Spatial relations	55.07%	5.07	14.86	0.34	2.21
Sound blending	72.05%	22.05	20.07	1.10	7.12*
Concept formation	63.20%	13.20	9.27	1.13	9.11*
Visual Matching	70.64%	20.64	18.21	1.13	7.35*
Numbers reversed	71.98%	21.98	23.05	0.95	6.10*
Analysis synthesis	70.11%	20.11	22.81	0.88	5.72*
Decision speed	67.56%	17.56	15.64	0.84	7.19*
Memory for words	62.29%	12.29	28.65	0.43	2.78*
Thinking ability	**66.50%**	**16.50**	**12.93**	**1.27**	**8.07***
Cognitive efficiency	**92.50%**	**42.50**	**10.55**	**1.36**	**8.59***
Short term memory	67.64%	17.64	23.83	0.88	5.67*
Processing speed	71.73%	21.73	12.03	1.81	11.57*
Long term retrieval	59.21%	9.21	8.37	1.10	7.13*
Fluid Reasoning	68.77%	18.77	19.71	0.95	5.30*
Phonemic awareness	**73.36%**	**13.36**	**17.20**	**1.36**	**8.48***
Incomplete Words	57.98%	7.98	29.51	0.80	5.22*
Phonemic awareness 3	72.82%	22.82	15.52	1.47	9.06*

Results

WJIII Cognitive Abilities

Table 1 contains SS and W score means and standard deviations pre- and post-intervention for the main clusters and sub-clusters of the WJIII Cognitive Abilities tests. Table 2 contains the Success Rate (SR) data from the each of the Cognitive Ability clusters.

The first cluster is **General Intellectual Ability** (GIA), which consists of the following sub-skills: verbal comprehension; visual-auditory learning; spatial relations; sound blending; concept formation; visual matching; numbers reversed; analysis-synthesis; decision speed; and memory for words. GIA scores following the intervention were significantly higher (SS Mean = 99.6, 10.10 SD; W Mean = 492.17, 6.58 SD; RPI Mean = 87.31, 9.33 SD; PR Mean = 49.62, 21.88 SD) than scores at the first assessment (SS Mean = 95.38, 9.15 SD; W Mean = 482.67, 8.11 SD; RPI Mean = 83.9, 10.26 SD; PR Mean = 39.52, 19.90 SD) according to paired t tests on the SS data ($t(41) = 4.36$, $p<.001$) and the W score data, $t(41) = 10.45$, $p<.001$. The W score difference is particularly noteworthy, as the 10 point increase indicates that the GIA tasks that were accomplished with 50% success during the first assessment were performed with 75% following the remediation. As shown in Table 2, the SR data showed that the overall GIA effect was moderate and significant (d=2.21). Within this cluster, the largest effect was the Verbal Comprehension subscale.

Verbal Ability scores following intervention were also significantly higher than the scores at the first assessment according to analyses on the SS data ($t(41) = 4.36$, $p<.001$) and the W score data, $t(41) = 3.20$, $p=.003$.

Thinking ability scores were significantly higher following intervention (SS Mean = 103.00, 11.21 SD; W Mean = 498.33, 6.35 SD; RPI Mean = 89.80, 7.15 SD; PR Mean = 56.45, 23.17 SD) than they were at the first assessment (SS Mean = 97.95, 11.27 SD; W Mean = 491.15, 6.50 SD; RPI Mean = 86.82, 7.25 SD; PR Mean = 44.85, 24.83 SD) according to analyses on the SS data ($t(39) = 4.66$, $p<.001$) and the W score data, $t(39) = 11.50$, $p<.001$.

Cognitive efficiency scores were slightly higher following intervention than at the first assessment. Only the W score data showed a significant effect, $t(38) = 7.56$, $p<001$.

Analyses were conducted on the clinical cluster of **Phonemic awareness.** Phonemic awareness scores were significantly higher following intervention (SS Mean = 100.28, 11.32 SD; W Mean = 498.1, 8.89 SD; RPI Mean = 88.18, 8.76 SD; PR Mean = 52.53, 23.42 SD) than at the first assessment (SS Mean = 87.64, 17.59 SD ; W Mean = 486.62, 10.03 SD; RPI Mean = 75.69, 17.51 SD; PR Mean = 29.42, 28.49 SD) according to analyses on the SS data ($t(38) = 4.56$, $p<.001$) and the W score data, $t(38) = 7.29$, $p<.001$.

Table 3: WJIII Achievement test Mean Standard Scores and W scores (standard deviation in parentheses) pre- and post-intervention.

	Standard Score pre-intervention	Standard Score post-intervention	W score pre-intervention	W score post-intervention
Broad Reading Cluster	84.40 (13.62)	86.78 (12.78)	425.21 (27.76)	468.32 (15.41)
Letter-Word Identification	86.83 (12.58)	86.54 (11.75)	482.86 (10.24)	449.45 (27.26)
Reading Fluency	84.93 (11.52)	90.41 (10.27)	468.75 (7.48)	477.66 (8.33)
Passage Comprehension	89.12 (10.88)	92.79 (11.02)	453.69 (18.50)	472.45 (16.31)
Basic Reading Skills Cluster	88.60 (12.75)	89.75 (10.28)	438.13 (25.33)	462.30 (20.14)
Word Attack (non-words)	92.88 (12.11)	95.60 (7.54)	451.50 (26.01)	475.24 (14.31)
Phoneme grapheme Knowledge Cluster	95.71 (11.31)	96.38 (7.42)	469.63 (16.34)	483.71 (9.52)
Spelling of Sounds (non-words)	97.67 (16.44)	98.90 (9.72)	483.57 (15.56)	492.14 (6.23)
Sound awareness	96.05 (16.75)	103.68 (13.28)	474.13 (13.06)	487.55 (9.52)
Oral Language Extended Cluster	109.05 (10.43)	109.00 (8.67)	490.69 (6.88)	496.17 (6.04)
Story Recall	105.05 (8.04)	106.19 (8.40)	496.12 (3.46)	498.60 (3.73)
Understanding Directions	101.71 (9.21)	100.86 (8.48)	485.24 (6.58)	490.36 (6.09)
Picture Vocabulary	104.31 (9.14)	103.71 (9.06)	489.26 (10.57)	494.38 (9.86)
Oral comprehension	112.57 (11.80)	113.63 (9.66)	492.40 (12.59)	501.59 (10.66)
Listening Comprehension Cluster	109.76 (14.06)	110.12 (8.39)	488.79 (8.51)	495.93 (6.98)
Oral Expression Cluster	105.74 (9.77)	105.81 (9.22)	492.45 (6.59)	496.62 (6.19)
Spelling	90.81 (8.81)	89.14 (8.26)	451.86 (12.58)	465.14 (13.18)

Table 4: Success Rate data (Mean probability of success in percent) for the WJIII Achievement tests.

	Mean probability of success in percent	Mean difference (probability of success – chance performance)	Standard deviation	Effect size (Cohen's d)	t statistic (one-sample)
Broad Reading Cluster	83.30%	33.30	15.99	2.08	13.16*
Letter-Word Identification	86.24%	36.24	18.18	2.09	12.92*
Reading Fluency	70.15%	20.15	16.24	1.24	7.85*
Passage Comprehension	82.57%	32.57	17.81	1.83	11.85*
Basic Reading Skills Cluster	87.37%	37.37	11.69	1.63	10.32*
Word Attack (non-words)	84.81%	34.81	9.27	2.58	16.73*
Phoneme grapheme Knowledge Cluster	75.63%	25.63	17.12	1.50	9.58*
Spelling of Sounds (non-words)	66.00%	16.00	14.87	0.81	6.89*
Sound awareness	75.74%	25.74	17.45	1.48	9.10*
Oral Language Extended Cluster	63.78%	13.78	8.91	0.91	5.84*
Story Recall	56.57%	6.57	9.91	0.41	2.63
Understanding Directions	62.57%	12.57	12.61	0.72	4.65*
Picture Vocabulary	62.02%	12.02	15.11	0.61	3.96*
Oral comprehension	69.59%	19.59	17.87	0.85	5.43*
Listening Comprehension Cluster	66.93%	16.93	12.54	0.93	5.98*
Oral Expression Cluster	60.60%	10.60	10.00	0.68	4.41*
Spelling	72.99%	22.99	20.57	1.09	7.01*

WJIII Achievement tests

Table 3 contains SS and W score means and standard deviations pre- and post-intervention for the main clusters and sub-clusters of the WJIII Achievement tests. Table 4 contains the SR data from the each of the Achievement test clusters.

The **Broad Reading** Cluster scores were significantly higher following intervention (SS Mean = 87.18, 12.36 SD; W Mean = 468.92, 15.10 SD; RPI Mean = 57.99, 30.48 SD; PR Mean = 28.01, 22.76 SD) than at the first assessment (SS Mean = 84.40, 13.62 SD; W Mean = 451.80, 20.93 SD; RPI Mean = 52.93, 29.22 SD; PR Mean = 23.09, 19.78 SD), according to analyses on the SS data ($t(39) = 2.60$, $p < .013$) and the W score data, $t(39) = 6.26$, $p < .001$. Importantly, the W score 17-point increase indicates that the reading tasks that were accomplished with 50% success on the first assessment was performance with 84% success following intervention.

Analyses were conducted on the **Word Attack** cluster. This requires students to read nonsense words (e.g., plurp, fronkett) aloud to test phonetic word attack skills. These scores were higher following intervention than at the first assessment. Only the W score data was significant, $t(41) = 7.89$, $p < .001$. The 24-point increase in word attack W scores is particularly noteworthy, as it indicates that non-words that were read with 50% success at the first assessment were performed with almost 94% success at the second assessment following intervention.

As shown in the Table 4, all SR tests were statistically significant and the largest effect sizes included the Broad Reading Cluster (d=2.08), the Word Attack sub-cluster (d=2.58) and the Letter-Word identification sub-cluster (d=2.08).

Discussion

Analysis of the data indicated very substantial gains for the 42 students in the sample following SPELD NZ remediation described above. All Cognitive Abilities tests showed significant improvement after remediation according to the analysis of the Success Rate data, with the largest effect shown with the Verbal Comprehension subscale. As expected, based on the SPELD philosophy of intensive phonics remediation (including phoneme/grapheme knowledge), Phonemic Awareness subscale scores also showed large effects. Of interest also were high scores in areas such as cognitive efficiency (effect size 1.36) and processing speed (1.81), which are explicitly addressed in SPELD training. Taken together, the average effect size from the cognitive tests (1.55) is noteworthy and testament to the ability of the brain to be modified, presumably via strengthened neural connectivity, following even a relatively brief (60-session) exposure to an enriched environment in the form of SPELD intervention.

The Achievement test results were also all statistically significant following remediation, with particular successful improvement in both Word Attack and Letter-Word identification skills. Success Rate data from the Achievement tests were also all statistically significant, with the largest effects of remediation being with Broad Reading skills, the Word Attack skills and Letter-Word identification. Importantly, Word Attack skills showed a 24-point increase in W scores, indicating that non-words that were read with 50% success at the first assessment were performed with almost 94% success at the second assessment. That such significant gain occurred in the measures involving phonological processing is noteworthy.

Studies have shown that teaching the principles of phonological awareness to children can raise scores on multiple measures of reading ability and is the most effective approach of remediation with individuals with dyslexia (Rayner, Foorman, Perfetti & Seidenberg, 2001; Swanson, 1999; Torgesen et al., 2001).

In addition, we found that participants who had previously been involved in Reading Recovery classes (69.2% of the sample) had higher percent success rate scores on the phonemic awareness broad cluster than those who did not. That such a high proportion of the sample had been involved in the Reading Recovery programme may suggest that students with dyslexia are not best provided via that approach. It is unclear why phonological skills were enhanced in those who had both Reading Recovery and SPELD NZ tuition despite having the same standard scores on the test prior to the intervention. It is likely, however, that SPELD NZ lessons provided a needed additive effect, perhaps even reminding students of their previously taught phonic skills. To read and write well, a person needs orthographic knowledge as well as phonological awareness, which is the ability to understand sound structures and detect phonemes.

It is noteworthy that, in New Zealand, dyslexia was only formally recognised by the Ministry of Education in 2007. The report by Tunmer and Greaney (2010) contributed much to this discussion. In essence they noted four key components making up a definition of dyslexia: (i) the presence of persistent learning and literacy difficulties; (ii) students are otherwise developing in a typical manner; (iii) there has been some experience of data based literacy teaching and intervention; and (iv) the difficulty is due to some impairment in the phonological domains of language and literacy. This is a practical working definition that could be applied in all likelihood to the students in this sample.

What is missing, however, is another central aspect of the debate referred to above. That is, what is the cause or causes of the "impairment" mentioned in Tunmer and Greaney's fourth key point? For many in the field this is a fundamental question to which the answer is still being clarified. Most modern definitions of dyslexia include a statement to the effect that it involves individual differences in neurological processing.

With the advent of Functional Magnetic Resonance Imaging (fMRI), neuroscientists have found that skilled reading depends on a left-lateralised network of inferior frontal, temporoparietal, and occipitotemporal cortical areas, and activation of this network is positively correlated with real word and pseudoword reading ability (Cohen & Dehaene, 2004; Pugh, 2006; Rumsey, Horwitz, Donohue, Nacem & Andreason, 1997; Richlan, 2012; Turkeltaub, Gareau, Flowers, Zeffiro & Eden, 2003). Studies with individuals with dyslexia have almost universally found an impaired left hemisphere posterior network during language tasks (McCrory, 2004; Peterson & Pennington, 2012; Shaywitz & Shaywitz, 2005), while right posterior overactivity may be an important biological marker of dyslexia (Waldie, Haigh, Badzakova-Trajkov, Buckley & Kirk, 2013).

Both the fMRI findings and the Tunmer and Greaney (2010) points above are germane to this present study and are likely to underpin future research in this area. That SPELD NZ specialist remedial intervention was shown to be effective may further confirm recognition of dyslexia in this country.

Summary, limitations and conclusions

Members of SPELD NZ designed and implemented a pilot research study into the outcomes of a remedial intervention programme using SPELD NZ assessors, teachers, and methods. The results of this study are very promising, indicating significant gains as a result of the remedial intervention provided by SPELD NZ. However, this study was designed as a pilot: a first if significant step to investigate and demonstrate what aspects of remedial intervention had the most effect. Despite the positive outcomes resulting from this intervention, as a pilot a number of matters and variables need further clarification and consideration in future studies.

Firstly, the lack of a control group needs to be addressed and this is the greatest limitation of the present study. It would have been ideal to have included an age- and SES-matched control group of reading-impaired children. These would have been assessed with the WJIII battery on two occasions (at similar time points as the experimental group), but would not have received SPELD NZ tuition. Including a control group would have allowed the authors to assess potential positive effects of remediation that may have occurred simply due to maturation or to repeated testing. These potential threats to the internal validity of our study need to be addressed in future research. Secondly, we did not have information regarding how long participants had been in reading recovery prior to participating in our study. Thirdly, further investigation with a larger sample group would be worthwhile.

Amongst matters to be further investigated or developed in a larger sample are ethnicity (i.e., the need to have larger samples of non-Pakeha), socio-economic status, the effect of the number of school changes prior to participation, the effect of one to one teacher time as compared to the intervention itself, and relationship factors between teacher, assessor, and student. Long term retrieval or the persistence of the learning gains made by these subjects would also repay future research. All these need further examination, and given the significant advances made by students, this is clearly merited.

Implementing these improvements would address whether or not significant differential results are reflected according to the ethnicity of the subjects. Similarly the effects of interventions on the fluid reasoning abilities of the subjects requires further work, as does the effect on reading fluency. The scope of this study was not such that examination of these matters was viable, although the improved reading results achieved might imply better reading fluency.

In addition, because many statistical analyses were conducted, there is a possibility of Type I errors (false positives) and, as such, the results should be treated with caution and replication of the study is warranted. Bonferroni adjustments, however, were used to reduce this problem of Type I errors.

In sum, the data gave support to the conclusion that SPELD NZ interventions can be most effective in lifting achievement levels for students with dyslexia. Such improvements can flow on to other aspects of their lives, and can give greater success in the key competencies of the New Zealand Curriculum. That the statistical analyses, and substantial average effect-size from all measures, show such satisfactory results for SPELD NZ intervention also has wider implications for students. Reading success leads to increased confidence, and this is exemplified by many of the comments received at the end of the pilot research programme. Typical (unedited) comments by students at the end of the intervention included: "I feel better on the inside now"; "will happily write now"; "massive improvements in behaviour and attitude"; "confidence has improved"; "He feels much happier to attempt to read words for himself"; "He feels proud when he achieves things for himself." Taken together, these results indicate that the intervention carried out with this sample produced significant gains for the students.

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[2] Reading tests include: Burt Word Recognition Test – 2007 NZ revised; a Running Record, http://www.readinga-z.com/guided/runrecord.html; the **Dyslexia Early Screening Test - Second Edition, by Fawcett & Nicholson, 2004**; the *Aston index*, by Newton & Thomson, 1976; the *Lucid - Cognitive Profiling System*, by Dunoon, 1996.

[3] Spelling tests include: the *Schonell Essential Spelling Test* by Schonell, 1932; *Peters Diagnostic and Remedial Spelling Test*, 1970, both available via the NZ Ministry of Education tool selector webpage, http://toolselector.tki.org.nz/Assessment-areas/English/%28sub_area%29/87.

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