ABSTRACT

Purpose: This study investigated the effectiveness of Fast ForWord (a suite of computer-based intervention programmes) on the language and literacy skills of academically struggling students from Western Australia who used the programmes within the school setting. Study Design: The design of this study was a randomized control trial with a comparison group. Two Australian-normed standardized tests were used to evaluate outcomes. Participants: Study participants were students who were identified by classroom teachers as having difficulties in language, literacy, auditory processing, attention, and/or behaviour. All participants were between 5 and 14 years old and attended one of four primary schools in the Perth metropolitan area in Western Australia. Participants were randomly assigned to immediate or delayed treatment conditions. Half of the participants participated in Fast ForWord between February and April or between May and July of 2006, while the other half served as a comparison group. Materials & Implementation: Following staff training on the Fast ForWord programmes, students used the Fast ForWord Language, Fast ForWord Middle & High School, and/or ForWord Language to Reading programmes, over a total period of 7 to 11 weeks. Before and after Fast ForWord participation, student skills were evaluated with a test battery comprising the Clinical Evaluation of Language Fundamentals-4th Edition-Australian Standardized Edition (CELF-4) and the Queensland University Inventory of Literacy (QUIL). Results: On average, Western Australian students with academic difficulties who participated in Fast ForWord made significantly better gains on a battery of language and literacy tests than the comparison group who received standard curriculum alone. On average, students who participated in Fast ForWord improved from the 12th percentile to the 25th percentile in Literacy skills, from the 12th percentile to the 21st percentile in Receptive Language skills, and from the 10th to the 18th percentile in Expressive Language skills.

Keywords: Western Australia, elementary school, primary school, experimental study, randomized control trial (RCT), Fast ForWord Language, Fast ForWord Middle & High School, Fast ForWord Language to Reading, Clinical Evaluation of Language Fundamentals-4th Edition (CELF-4)-Australian Standardized Edition, Queensland University Inventory of Literacy (QUIL).

INTRODUCTION

Educators worldwide face similar challenges in helping struggling students to develop the core language and literacy skills they need to succeed in the classroom. Consequently, there has been widespread interest in the growing body of research about a new intervention approach. This approach uses computer-based intervention programmes to combine an optimal learning environment with a focus on early reading and cognitive skills.

Early laboratory tests found that this approach resulted in dramatic improvements in the auditory processing and language skills of school children with specific language impairment (Merzenich et al, 1996; Tallal et al., 1996) and children experiencing academic reading failure (Miller et al., 1999).

Further research on this intervention approach has demonstrated benefits for a wide range of student populations, including students with language and reading difficulties, learning disabilities, or auditory processing disorders. These studies have been conducted in the United States as well as Germany, India, the United Kingdom, and Singapore (Scientific Learning 1999, 2006a-d).

The current study was conducted to investigate whether this approach to intervention would be effective for improving the language and literacy skills of students with academic difficulties in Western Australia. A randomized control trial design was used to compare students who participated in the intervention programmes with students who remained in their standard school curriculum. At their primary school sites, students participated in the following computer-based intervention programmes: Fast ForWord Language, Fast ForWord Middle & High School, and Fast ForWord Language to Reading.

METHOD

Participants

The participants were 144 students attending four public primary schools (government funded schools with optional fees) in Western Australia. These schools were located in the Perth metropolitan area and represented a range of socioeconomic conditions.
Teachers at each of the four schools selected 36 students whom they considered to have difficulties with language, literacy, auditory processing, attention, and/or behaviour, to participate in the study. The participant group comprised 43 female and 101 male students, ranging in age from 5 to 14 years, with a median age of 9 years.

Students were randomly assigned to one of two groups, with 72 students in each group. Group 1 participated in the intervention programmes between February and April or May and July of 2006. Group 2 served as the control group during the initial intervention period, and remained in their schools’ standard curricula during this time. Group 2 students participated in the intervention programmes during a later school term (between May and July or July and September 2006).

Fast ForWord participation was scheduled during class time for most students, generally in place of their language-arts lesson. A few students participated before school and during recess and/or lunch breaks.

All Fast ForWord sessions were monitored by trained parent volunteers, under the supervision of the school’s Fast ForWord Coordinator. Sonic Hearing, a private clinical practice with expertise in the Fast ForWord programmes, provided training for the parent monitors and support for the Fast ForWord Coordinator at each school.

The study involved an analysis of students’ scores on a battery of tests administered before and after the intervention period. All tests were administered by Speech Pathology and Occupational Therapy students who were trained in the assessment process by qualified Speech Pathologists. The test administrators were blind to the student’s group assignment.

Implementation
Lab supervisors at the schools were trained in current and established findings on the neuroscience of how phonemic awareness and the acoustic properties of speech impact rapid development of language and reading skills; the scientific background validating the efficacy of the programmes; effective implementation techniques; and monitoring student progress.

Materials
The Fast ForWord programmes are computer-based programmes that combine an optimal learning environment with a focus on early reading and cognitive skills. The programmes used in this study, (Fast ForWord Language, Fast ForWord Middle & High School, Fast ForWord Language to Reading) include five to seven exercises designed to build skills critical for reading and learning, such as auditory processing, memory, attention, and language comprehension. While there are differences between the programmes, all help develop certain critical skills as detailed in the following exercise descriptions.

*Circus Sequence¹, Sweeps², and Trog Walkers³*: Students hear a series of short, non-verbal tones. Each tone represents a different fragment of the frequency spectrum used in spoken language. Students are asked to differentiate between these tones. These exercises target working memory, sound processing speed, and sequencing skills.

*Old MacDonald’s Flying Farm¹ and Streams²*: Students hear a single syllable that is repeated several times, and then interrupted by a different syllable. Students must respond when they hear a change in the syllable. This exercise is designed to improve auditory processing, develop phoneme discrimination, and increase sustained and focused attention.

*Phoneme Identification¹, IDs², Polar Cop³, and Treasure in the Tomb³*: Students hear a target phoneme, and then must identify the identical phoneme when it is presented later. These exercises target auditory discrimination skills, increase sound processing speed, improve working memory, and help students identify a specific phoneme. Polar Cop also develops sound-letter correspondence skills. Treasure in the Tomb also develops grapheme recognition.

*Phonic Match¹, Matches², and Bug Out³*: Students choose a square on a grid and hear a sound or word. Each sound or word has a match somewhere within the grid. The goal is to find each square’s match and clear the grid. The Phonic Match exercise targets auditory word recognition and phoneme discrimination, improves working memory, and increases sound processing speed. The Bug Out! exercise targets skill with sound-letter correspondences as well as working memory.

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¹ Exercise from the Fast ForWord Language programme.
² Exercise from the Fast ForWord Middle & High School programme.
³ Exercise from the Fast ForWord Language to Reading programme.
Phonic Words¹ and Cards²: Students see two pictures representing words that differ only by the initial or final consonant (e.g., “knee” versus “me”, or “tack” versus “tag”). When students hear one of the words, they must click the picture that matches the word. This exercise is designed to increase sound processing speed, improve auditory recognition of phonemes and words, and help students gain an understanding of word meaning.

Language Comprehension Builder¹: Students listen to a sentence that depicts action and complex relational themes. Students must match a picture representation with the sentence they just heard. This exercise targets oral language and listening comprehension, understanding of syntax and morphology, and rate of auditory processing.

Block Commander¹: In Block Commander, a three-dimensional board is filled with familiar shapes that students select and manipulate. The students are asked to follow increasingly complex commands. This exercise is designed to increase listening comprehension, improve syntax, develop working memory, improve sound processing speed, and increase the ability to follow directions.

Stories² and Start-Up Stories³: Students follow increasingly complex commands, match pictures to sentences, and answer multiple-choice questions about stories that are presented aurally.

Assessments
All students who participated in the study were assessed at three time points, before and after Group 1 participated in the intervention programmes, and again, after Group 2 participated in the intervention programmes.

To allow comparisons between intervention and non-intervention conditions, only data from the first two test time points were included in these analyses. For all comparisons, Group 1 served as the experimental (FFW) group and Group 2 as the comparison/control (CNTL) group.

At each of the three assessment time points, students’ language skills were assessed with the Clinical Evaluation of Language Fundamentals – 4th Edition – Australian Standardized Edition (CELF-4; Semel, Wiig, & Secord, 2006), and their phonological awareness and spelling skills were assessed with the Queensland University Inventory of Literacy (QUIL; Dodd, Holm, Oerlemans, & McCormick, 1996). Standard scores for both of these tests are based on Australian normative samples.

Clinical Evaluation of Language Fundamentals-4th Edition – Australian Standardized Edition (CELF-4): The CELF-4 is a comprehensive language test widely used to measure a student’s overall oral language ability. It includes subtests that specifically measure receptive and expressive skills in language structure (syntax and morphology) and language content (semantics).

The Queensland University Inventory of Literacy (QUIL): The QUIL is a standardized clinical assessment tool for assessing the phonological awareness skills of school age children as they pertain to literacy. Three of the ten sub-tests were administered to all students: Nonword Spelling, Phoneme Segmentation and Phoneme Manipulation. In addition, students in years 4-7 were administered the Spoonerisms subtest.

Analysis
Student achievement was reported in terms of Standard Scores. Standard Scores for the CELF-4 composites have a mean of 100 and a standard deviation of 15. Standard Scores for the QUIL have a mean of 10 and a standard deviation of 3.

Three students from Group 2 and four students from Group 1 were excluded from all analyses, either because they dropped out before the study was completed or because valid test scores could not be obtained for them. All analyses included the remaining 137 students.

A multivariate analysis of variance (MANOVA) was conducted with the results from the QUIL and the two CELF-4 composites that had no overlapping subtests – the Receptive Language Index (RLI) and the Expressive Language Index (ELI). For inclusion in the MANOVA, the standard scores from the QUIL were mathematically transformed to the scale of the CELF-4. In addition, a univariate analysis of covariance (ANCOVA) was conducted on each of the composites, in order to control for chance variability in pre-test scores. A p-value of 0.05 was used as the criterion for identifying statistical significance.

RESULTS
Participation Level
Research conducted by Scientific Learning shows a relationship between programme use and the benefits received from the intervention. Programme use is composed of content completed, days of use, and adherence to the chosen protocol (attendance level and participation level). Programme use was similar for both groups of participants, so the usage data reported here includes all study participants whose assessment data was included in the analysis.
Participants used the 50-Minute Fast ForWord Language protocol, or the 48-Minute Fast ForWord Middle & High School and the 50-Minute Fast ForWord Language to Reading protocol. These protocols call for participants to use each programme for 48 or 50 minutes per day, 5 days a week for 8 to 12 weeks.

Table 1 shows detailed usage information, and figures 1-3 show the average daily progress through exercises of each programme, for all participants who used that programme. The final day shown is determined by the maximum number of days that at least two-thirds of the students who used that programme were still using it. For students who used the programme fewer than the number of days shown, percent complete is maintained at the level achieved on their final day of programme use.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Number of Students</th>
<th>Days Participated</th>
<th>Calendar Days</th>
<th>Percent Complete</th>
<th>Participation Level</th>
<th>Attendance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast ForWord Language</td>
<td>54</td>
<td>29</td>
<td>42</td>
<td>63%</td>
<td>100%</td>
<td>93%</td>
</tr>
<tr>
<td>Fast ForWord Middle &amp; High School</td>
<td>80</td>
<td>24</td>
<td>35</td>
<td>70%</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>Fast ForWord Language to Reading</td>
<td>130</td>
<td>18</td>
<td>27</td>
<td>47%</td>
<td>99%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Table 1. Usage data showing the number of students who used each Fast ForWord programme along with group averages for the number of days participated, the number of calendar days between start and finish, the percentage of programme completed, the participation level, and the attendance level.
### Assessment Results

Assessment data from before and after the intervention period indicated that both groups started out below the average range on most measures, and made progress toward or into the average range (Table 2). Despite random assignment to treatment conditions, there was a trend towards higher pre-test scores in the comparison group. This apparent difference between the two groups was not statistically significant.

To determine whether the two groups showed differential improvement over the study period, a repeated measures multivariate analysis of variance (MANOVA) was conducted, with treatment condition (group) as the between-group factor and assessment time point (time) as the repeated measures factor. The analysis included the composite score from the QUIL and both the Receptive Language Index and the Expressive Language Index from the CELF-4.

The MANOVA (Table 3) revealed a significant difference by time. There was also a significant interaction between time and group, indicating that the students who used Fast ForWord programmes made significantly greater gains on the test battery than the comparison group.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>n</th>
<th>Before Mean</th>
<th>SE</th>
<th>After Mean</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELF-4: Receptive Language Index</td>
<td>FFW</td>
<td>68</td>
<td>81.8</td>
<td>1.6</td>
<td>88.1</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>CNTL</td>
<td>69</td>
<td>84.7</td>
<td>1.6</td>
<td>88.4</td>
<td>1.7</td>
</tr>
<tr>
<td>CELF-4: Expressive Language Index</td>
<td>FFW</td>
<td>68</td>
<td>81.3</td>
<td>1.6</td>
<td>85.9</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>CNTL</td>
<td>69</td>
<td>83.4</td>
<td>1.5</td>
<td>85.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Queensland University Inventory of Literacy</td>
<td>FFW</td>
<td>68</td>
<td>6.49</td>
<td>0.22</td>
<td>7.90</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>CNTL</td>
<td>69</td>
<td>7.08</td>
<td>0.24</td>
<td>7.93</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Table 2. Performance of 137 primary school students on a battery of clinical tests before and after the 68 students randomly assigned to Group 1 (FFW) used Fast ForWord Language, Fast ForWord Middle & High School, and/or Fast ForWord Language to Reading.

![Figure 4](https://example.com/figure4.png)

Figure 4. Students who used Fast ForWord programmes (FFW) showed significantly greater improvements than a comparison group (CNTL) on a test battery including the Receptive Language Index and Expressive Language Index of the CELF-4. Results from 137 students are shown.

<table>
<thead>
<tr>
<th>Literacy Skills</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNTL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Figure 5](https://example.com/figure5.png)

Figure 5. Students who used Fast ForWord programmes (FFW) showed significantly greater improvements than a comparison group (CNTL) on a test battery including the QUIL. Results from 137 students are shown.
Students were randomly assigned to the experimental and comparison groups. Therefore, it was statistically appropriate to perform further analyses to determine what the outcome would have been if the two groups had started out with the same scores at pre-test. These analyses were done on each of the composite scores discussed above. Each score was statistically adjusted by conducting a univariate analysis of covariance (ANCOVA) with group as the fixed factor and pre-test score as the covariate (table 4).

<table>
<thead>
<tr>
<th>Measure</th>
<th>FFW</th>
<th>CNTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CELF-4: Receptive Language Index</td>
<td>68</td>
<td>89.0</td>
</tr>
<tr>
<td>CELF-4: Expressive Language Index</td>
<td>68</td>
<td>86.7</td>
</tr>
<tr>
<td>Queensland University Inventory of Literacy</td>
<td>68</td>
<td>8.19</td>
</tr>
</tbody>
</table>

Table 4. Estimated post-test scores, controlling for pre-test score, for 137 primary school students on a battery of clinical tests before and after the 68 students randomly assigned to the FFW group used Fast ForWord Language, Fast ForWord Language to Reading, and/or Fast ForWord Middle & High School.

**DISCUSSION**

Four primary schools in Western Australia participated in a randomized control trial with a comparison group, involving 144 students identified as having difficulties in language, literacy, auditory processing, attention, and/or behaviour. The students were randomly assigned either to use Fast ForWord programmes or to remain in their school’s standard curriculum for one school term. Overall, the Fast ForWord group made significant gains in receptive language, expressive language, and literacy skills, and significantly outperformed their peers who remained in the standard curriculum.

In addition to making these quantitative gains, teachers and parents reported that the students who participated in Fast ForWord showed improved self-esteem, greater willingness to attend school, increased attention and focus in the classroom environment, and better academic performance.

Future research should evaluate the effectiveness of Fast ForWord products for other populations. For example, a study is currently underway to evaluate the impact of Fast ForWord in older students and young adults.

**CONCLUSION**

Strong cognitive and linguistic skills provide a critical foundation for building reading and writing skills. The computer-based Fast ForWord intervention programmes build these skills through the development of auditory processing, memory, attention, and sequencing skills, and by exercising early reading skills such as phonological awareness, vocabulary, and listening comprehension.

This study conducted in Western Australia demonstrated that primary school students identified by their teachers as having learning difficulties made significantly greater gains in language and literacy skills after Fast ForWord participation than students who received standard school curriculum alone.

These results confirm and extend the findings of prior studies conducted in the United States, Germany, the United Kingdom, and Singapore, with diverse student populations. Collectively, this body of research supports the use of the Fast ForWord programmes to strengthen students’ foundational cognitive, linguistic, and early reading skills, allowing students to benefit more from the classroom curriculum.

**Notes:**

†Preliminary results from a very small pilot study suggest that Fast ForWord product use yields a different pattern of results for secondary school students. We plan to add to these data and publish the findings in a future manuscript.

**REFERENCES**


