Improved Language and Literacy Skills in State Primary Schools in Western Australia

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Abstract

This study investigated the effectiveness of Fast ForWord (a suite of computer-based intervention programs) on the language and literacy skills of academically struggling students from Western Australia. Half of the participants used the program between February and April or between May and July, while the other half served as a comparison group. Before and after Fast For Word participation, the language and literacy skills of the students were evaluated. 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 the standard interventions 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.

1. 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 programs to combine an optimal learning environment with a focus on early reading and cognitive skills. The program initially builds auditory processing skills in order to strengthen skills that are necessary for reading. This treatment method is based on the link between impairments in auditory frequency modulation processing and certain learning disabilities, such as dyslexia.

A study from Bart Boets and his colleagues (2010) supports the theory that auditory processing skills are related to language and reading abilities. Their longitudinal data show that impairments in frequency modulation processing, speech perception and phonological awareness are jointly present in kindergarten children who develop dyslexia later in life. They studied three groups of Dutch-speaking children, who were initially tested in the last year of kindergarten, i.e. the year before the onset of formal reading instruction (mean age = 5 years 6 months). The children were then tested in first grade and again in third grade, by which time they had received two years and two months of reading instruction. The first group was children with dyslexia, the second group included nondyslexic children who had an increased risk of developing reading problems because of a family history of dyslexia, and the third group came from families without a history of reading disabilities. The highly predictive and concurrent correlations found in the study between auditory processing, speech perception and phonological awareness suggest a reciprocal association and support the evidence for the auditory deficit theory of dyslexia.

Numerous researchers have looked for physiological differences between proficient and struggling readers, investigating their cortical activation patterns when the students are doing a reading task. They have found that while students are performing phonological awareness tasks, there are differences in the activation patterns in the temporal region as well as the temporal-parietal region (Hoeft et al, 2007; McCrory, Mechelli, Frith & Price, 2005; Shaywitz et al, 1998,

Temple et al, 2001, Richlan, Kronbichler & Wimmer, 2009). This raised the question as to which came first, the reading difficulties and associated frustration, or the differences in cortical activation. Raschle, Zuk, & Gaab, (2012) used functional MRI to study activation patterns in kindergarten students performing phonological awareness tasks. By comparing two groups of these children, those with a family history of developmental dyslexia to those without, they found that activation patterns in the brains of children with a family history of developmental dyslexia were already altered by the time the children were in kindergarten indicating that the alterations were not due to reading difficulties.

Early laboratory tests found that this particular program's approach resulted in 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 has demonstrated benefits for a wide range of student populations, including students with language and reading difficulties, learning disabilities, auditory processing disorders, and autism (Temple et al.2003, Ho, 2004, Russo, Hornickel, Nicol, Zecker & Krause, 2010). These studies have typically been conducted in the United States (Scientific Learning 1999) although small experimental or case studies have also been conducted in Australia, Germany, India, the United Kingdom, and Singapore (Deppeler, Taranto & Bench. 2004; Scientific Learning 2006a-d). Most studies have demonstrated the importance of good implementations with reading skills improving more when students use the programs as instructed and progress through the content. One randomised controlled trial where the students used the products for an average of 28 days of the 30 days available, showed that students who used the Fast ForWord program made as much improvement as students who had 50 hours of work one-on-one with a trained, licensed speech and language therapist (Gillam et al., 2008). In another randomised controlled trial, an intent-to-treat design was used (Rouse & Krueger, 2004). Although the researchers did not find statistically significant differences between the students assigned to use the Fast ForWord program and students assigned to the comparison group, they note that students in their study had "a surprisingly difficult time completing the program," but their analyses indicated "larger effects of actually completing the program."

Improvements from the program have been shown in areas other than auditory processing and language skills. During the 2009-2010 school year, Beth Rogowsky (2010) conducted a study with year six students. The students were randomly assigned to use (or not use) the program during one of their elective periods. Students' grammar skills were tested before and after the study period. At the start of the study, there was no statistically significant difference between the scores of the students in the two groups. However, after the experimental group used the program, there was a statistically significant difference between the scores of the two groups, and there were statistically significant increases in the scores of the group that had used the program. Among the skill areas that were tested were spelling, capitalization and punctuation, linguistics, modifiers, phrases, and verb form.

Investigating a very different area, Courtney Stevens and her colleagues (2008) used event-related potentials (ERP's) to evaluate the impact of the training on the auditory attention of students with and without specific language impairments. The children, who were 6 – 8 years old, were divided into three groups: 1) language impaired children who would use the intervention, 2) typically developing children who would use the intervention, and 3) typically developing children who would not use the intervention. The children with language impairments started out with very weak auditory attention. Following the intervention, the auditory skills of both groups of children, those with language impairments, and those without, made statistically significant improvements, reaching similar levels. There was not a statistically significant change in the skills of the children who did not the intervention.

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

2. Material and Methods

2.1. Subjects

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. Study participants were students who were identified by classroom teachers as having difficulties in language, literacy, auditory processing, attention, and/or behaviour. 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.

Participants were randomly assigned to immediate or delayed treatment conditions, with 72 students in each group. Group 1 participated in the intervention programs between February and April or May and July. During the initial intervention period, Group 2 served as the control group and remained in their schools' standard intervention curricula including any reading recovery programs, extra classroom assistance, or small group work with an educational assistant. Group 2 students participated in the intervention programs during a later school term (between May and July or July and September 2006). Participation had no impact on private services that the students in either group may have been receiving (a minority of students were receiving private tutoring and/or speech pathology services.)

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 Learning, a private clinical practice with expertise in the Fast ForWord programs, provided training for the parent coaches and support for the Fast ForWord Coordinator at each school.

2.2. Study Design

The design of this study was a randomised control trial with a comparison group. Two Australian-normed standardised tests were used to evaluate outcomes. 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 qualified Speech Pathologists as well as 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 and were not involved in the implementation of the treatment.

2.3. Implementation

Fast ForWord Coordinators and parent volunteers at each of the schools were trained in effective implementation techniques including motivation and intervention strategies and methods for monitoring student progress. Following staff training on the Fast ForWord programs, students used the Fast ForWord Language, Fast ForWord Middle & High School, and/or ForWord Language to Reading programs, over a total period of 7 to 11 weeks.

The Fast ForWord programs are computer-based programs that use neuroscience-based principles to create an optimal learning environment with a focus on early reading and cognitive skills. The programs used in this study, (Fast ForWord Language, Fast ForWord Middle & High School, Fast ForWord Language to Reading) each include five to seven exercises designed to build skills critical for reading and learning, such as auditory processing, memory, attention, and language comprehension. The Fast ForWord Language and Fast For Word Middle & High School programs differ primarily in their interface with Fast ForWord Language directed towards younger students (year four and under) while Fast ForWord Middle & High School is directed towards older students. Both focus on developing oral language and listening skills. The Fast ForWord Language to Reading program picks up where the other two leave off, continuing to build more complex oral language skills, but also incorporating sound-symbol correspondence.

2.4. Assessments

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

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 Standardised 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.

The Clinical Evaluation of Language Fundamentals 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) is a standardised 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.

3. Results

3.1. 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 test scores could not be obtained. 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.

3.2. Participation Level

Program use is composed of content completed, days of use, and adherence to the chosen protocol (attendance level and participation level). Program use was similar for both groups

of participants.

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 program for 48 or 50 minutes per day, 5 days a week for 8 to 12 weeks. Table 1 shows detailed usage information for all participants who used the program.

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

Program	Number of students	Days participated	Calendar days	Percent complete	Participation level	Attendance level
Fast ForWord Language	27	35	51	66%	100%	94%
Fast ForWord Middle & High School	38	28	41	70%	100%	93%
Fast ForWord Language to Reading	61	15	19	42%	99%	95%
Total	68	43	60	--	100%	94%

3.3. 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, Figure 1, Figure 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.

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.*

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

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 statistically significant interaction between time and group, indicating that the group of students who used Fast ForWord programs made significantly greater gains on the test battery than the students in the comparison group.

Table 3. *A MANOVA showed that students who used Fast ForWord programs made significantly greater gains on a test battery comprising the CELF-4 ELI and RLI and the QUIL *p<0.05.*

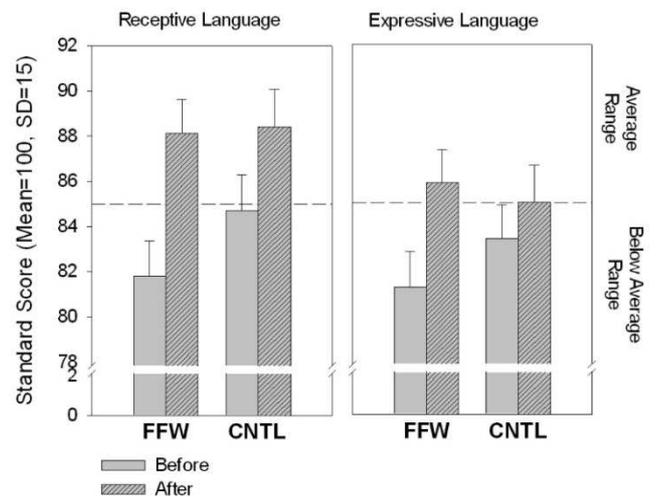| MANOVA		
	dF	F
time	100	81.30*
time x group	100	7.62*

Fig. 1. *Students who used Fast ForWord programs (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.*
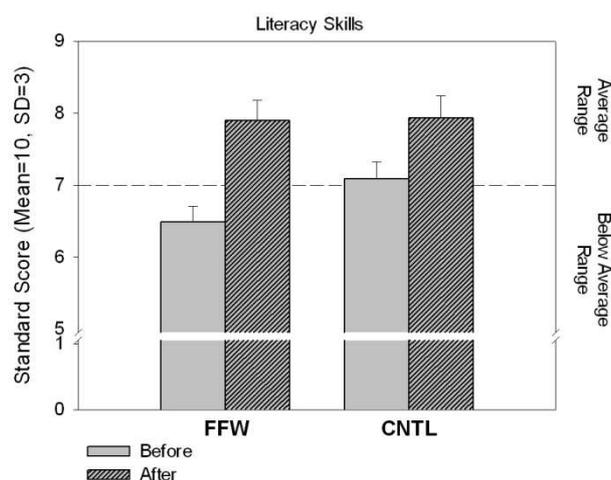
***Fig. 2.** Students who used Fast ForWord programs (FFW) showed significantly greater improvements than a comparison group (CNTL) on a test battery including the QUIL. Results from 137 students are shown.*

4. Discussion

Four primary schools in Western Australia participated in a randomised 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 programs 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.

These results demonstrate that the Fast ForWord Programs can be effectively implemented in Australian schools and can improve the language and reading skills of children in Australia.

Strong cognitive and linguistic skills provide a critical foundation for building reading and writing skills. The computer-based Fast ForWord intervention programs 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 programs to strengthen students' foundational cognitive, linguistic, and early reading skills, allowing students to benefit more from the classroom curriculum.

Since this study was done, there are new protocols and revisions that increase the intensity of the products. The revisions include additional content, improved movement through the content based on student performance (allowing the students to complete the products, with the additional content, more quickly), enhanced motivational feedback for participants and more engaging graphics, and additional protocols allowing schools to select the protocol that fits best into the students' day.

Results from various studies have shown that students' early reading skills improve more with additional products completed (Scientific Learning, 2012). The students in this study completed one product and part of a second. A future study would look at the impact of the students used the products across two terms, allowing them to complete more content.

Acknowledgements

References

[1] Boets, B., Vandermosten, M., Poelmans, H., Luts, H., Wouters, J., Ghesquiere, P. (2010). Preschool impairments in auditory processing and speech perception uniquely predict future reading problems. Research in Developmental Disabilities, 32, 560-570.

[2] Deppeler, J.M., Taranto, A.M., Bench, J. (2004). Language and auditory processing changes following Fast ForWord. The Australian and New Zealand Journal of Audiology, 26(2)94-109.

[3] Dodd, B., Holm, A., Oerlemans, M. & McCormick, M. (1996). Queensland University Inventory of Literacy. Brisbane: Dept of Speech Pathology & Audiology, UQ.

[4] Dodd, B., Holm, A., Oerlemans, M., & McCormick, M., (1996). Queensland University Inventory of Literacy. University of Queensland, Australia: Department of Speech P athology and Audiology.

[5] Gillam, R. B., Frome Loeb, D., Hoffman, L. M., Bohman, T., Gamplin, C. A., Thibodeau, L., Widen, J., Brandel, J., & Friel-Patti, S. (2008). The efficacy of Fast ForWord Language intervention in school-age children with language impairment: A randomized controlled trial. Journal of Speech, Language, and Hearing Research, 51, 97-119.

[6] Ho, C. (2004) An examination of Fast ForWord Language intervention for children with poor reading skills. Unpublished honours thesis, School of Psychology, University of Western Australia.

[7] Hoeft, F., Meyler, A., Glover, G.H., Kobayashi, N., Mazaika, P., Jo, B., Ueno, T., Reiss, A.L., Whitfield-Gabrieli, S., Keller, T.A., Adam Just, M., Gabrieli, J. D. E. (2007). Prediction of children's reading skills using behavioural, functional, and structural neuroimaging measures. Behavioral Neuroscience 121, 602-13.

[8]   McCrory, E.J., Mechelli, A., Frith, U., Price, C. J. (2005). More than words: A common neural basis for reading and naming deficits in developmental dyslexia. Brain, 128, 261-7.

[9]   Merzenich, M. M., Jenkins, W. M., Johnston, P, Schreiner, C. E., Miller, S. L., & Tallal, P. (1996). Temporal processing deficits of language-learning impaired children ameliorated by training. Science, 271, 77-80.

[10]   Miller, S. L., Merzenich, M. M., Tallal, P., DeVivo, K., Linn, N., Pycha, A., Peterson, B. E., Jenkins, W. M. (1999). Fast ForWord Training in Children with Low Reading Performance, Nederlandse Vereniging voor Lopopedie en Foniatrie: 1999 Jaarcongres Auditieve Vaardigheden en Spraak-taal. (Proceedings of the 1999 Dutch National Speech-Language Association Meeting).

[11]   Raschle, N. M., Zuk, J., Gaab, N. (2012). Functional characteristics of developmental dyslexia in left-hemispheric posterior brain regions predate reading onset. Proceedings of the National Academy of Sciences, 109, 2156-2161.

[12]   Richlan, F., Kronbichler, M., Wimmer, H. (2009). Functional abnormalities in the dyslexic brain: A quantitative meta-analysis of neuroimaging studies. Human Brain Mapping 30, 3299-3308.

[13]   Rogowsky, B. A. (2010). The Impact of Fast ForWord on Sixth Grade Students' Use of Standard Edited American English. Doctor of Education dissertation, Wilkes University.

[14]   Rouse, C. E. & Krueger, A. B. (2004). Putting computerized instruction to the test: a randomized evaluation of a "scientifically based" reading program. Economics of Education Review, 23, 323-338.

[15]   Russo, N. M., Hornickel, H., Nicol, T., Zecker, S., Kraus, N. (2010). Biological changes in auditory function following training in children with autism spectrum disorders. Behavioral and Brain Functions, 6, 1-8.

[16]   Scientific Learning Corporation. (1999). National field trial results: Results of Fast ForWord training for children with language and reading problems. Berkeley, CA: Scientific Learning Corporation.

[17]   Scientific Learning Corporation. (2006a). Improved English Language and Perceptual Skills by German Secondary School Students who used Fast ForWord Products, MAPS for Learning: Educator Reports, 10(4): 1-6.

[18]   Scientific Learning Corporation. (2006b). Improved Cognitive Skills Accelerate English Language and Reading Development in Bilingual English Speaking Students in India who used Fast ForWord® Products, MAPS for Learning: Educator Reports, 10(17)1-6.

[19]   Scientific Learning Corporation. (2006c). Improved Auditory Processing by Students in the United Kingdom who used Fast ForWord® Products, MAPS for Learning: Educator Reports, 10(11): 1-6.

[20]   Scientific Learning Corporation. (2006d). Improved Reading Skills and Behavior in Primary School Students who Used Fast ForWord® Language at a Singapore Public School. MAPS for Learning: Educator Reports, 10(5):1-6.

[21]   Scientific Learning Corporation. (2012). Improved Reading Skills by Students in the Chamberlain School District who used Fast ForWord Products: 2008-2011. Scientific Learning: Research Reports, 16(5):1-5.

[22]   Semel, E., Wiig, E. H., & Secord, W. A. (2006). Clinical Evaluation of Language Fundamentals: Fourth Edition. San Antonio, TX: Harcourt Assessment, Inc.

[23]   Shaywitz, S.E., Shaywitz, B.A., Pugh, K.R., Fulbright, R.K., Constable, R.T., Mencl, W.E., Shankweiler, D.P., Liberman, A.M., Skudlarski, P., Fletcher, J.M. (1998). Functional disruption in the organization of the brain for reading in dyslexia. Proc Natl Acad Sci USA 95: 2636-2641.

[24]   Stevens, C., Fanning, J., Coch, D., Sanders, L., & H Neville (2008). Neural mechanisms of selective auditory attention are enhanced by computerized training: Electrophysiological evidence from language-impaired and typically developing children. Brain Research, 1205, 55-69.

[25]   Temple, E., Deutsch, G.K., Poldrack, R.A., Miller, S.L., Tallal, P., Merzenich, M.M., & Gabrieli, J.D.E. (2003). Neural deficits in children with dyslexia ameliorated by behavioural remediation: Evidence from functional MRI. Proceedings of the National Academy of Sciences, 100, 2860-65.

[26]   Tallal, P., Miller, S. L., Bedi, G., Byma, G., Wang, X., Nagarajan, S. S., Schreiner, C., Jenkins, W. M., Merzenich, M. M. (1996). Language comprehension in language-learning impaired children improved with acoustically modified speech. Science, 271, 81-84.