Improved Auditory Discrimination and Early Reading Skills Accelerate English Language Development in Students in Kolkata, India who used Fast ForWord® Products

MAPS for Learning: Educator Reports, 12(16):1-5

ABSTRACT

Purpose: This study investigated the effects of the Fast ForWord products on the auditory discrimination and phonological processing skills of bilingual speaking students. **Study Design:** The design of this study was a case study using standardized assessments normed in the United States. **Participants:** Study participants were students attending a school in Kolkata, India. **Materials & Implementation:** The Fast ForWord product was implemented at St. Mary's Orphanage and Day School as part of the educational curriculum. Before and after Fast ForWord participation, students had their auditory discrimination and phonological processing skills evaluated with standardized tests. **Results:** On average, students significantly improved their skills following Fast ForWord participation. Auditory discrimination skills improved from the 1st to the 11th percentile for students listening in quiet, and from the 2nd to the 71st percentile for students listening in noise. This corresponds to a 32% decrease in errors made in quiet, and a 42% decrease in noise, indicating that the students were better able to discriminate between easily confused English phonemes. The ability to quickly and effortlessly identify English phonemes is critical for fluent mastery of the language. Average improvement across various phonological processing skills, critical for fluent reading, was approximately one standard deviation, corresponding to an improvement from the 36th percentile to the 75th percentile.

Keywords: India, urban, observational study, bilingual English speakers, Fast ForWord Language, Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFW), Comprehensive Test of Phonological Processing (CTOPP).

INTRODUCTION

Numerous research studies in the United States have shown that cognitive and oral language skills are under-developed in struggling readers, limiting their academic progress (Lyon, 1996). University-based research studies reported the development of a computer software product that focused on learning and cognitive skills, and provided an optimal learning environment for building the memory, attention, processing and sequencing skills critical for reading success (Merzenich et al., 1996; Tallal et al., 1996). This prototype of the Fast ForWord Language software showed that an optimal learning environment and focus on cognitive and linguistic skills resulted in dramatic improvements in the auditory processing and language skills of school children who had specific language impairments (Merzenich et al, 1996; Tallal et al., 1996) or were experiencing academic reading failure (Miller et al., 1999).

St. Mary's Orphanage and Day School in Kolkata, India, offers educational services for children. Under the guidance of staff at the St. Mary's Orphanage and Day School, and with assistance from Step One Foundation for Child & Youth Welfare, a local non-government organization (NGO), students used the Fast ForWord software as part of their class curriculum. Dr. D. Dutta Roy of the Indian Statistical Institute reviewed product use of twenty-five students in India to determine the criterion validity of the exercises in the Fast ForWord Language product when used by Indian students. He found that for most exercises, students were able to progress through the content and showed significant improvement in their performance across the different levels of training (Roy, 2008). This report furthers Dr. Roy's study by investigating the impact of the products on external

measures of the cognitive and linguistic skills of students in India.

METHODS

Participants

St. Mary's Orphanage and Day School in Kolkata, India, is more than 150 years old. Run by the Christian Brothers, a world renowned missionary organization, the school has a day scholars program as well as an orphanage wing where students board. The school caters to students irrespective of caste or religion.

The twenty-five students included in this study all attended St. Mary's Orphanage and Day School: 20 were in the day scholars program, five were in the orphanage. All the students spoke colloquial Bengali and were bilingual English speakers. All had an Indian language as their mother tongue.

Participants were 9 through 11 years of age (mean age 10 ½ years). All participants were attending the St. Mary's Orphanage and Day School at the time of the study and used the Fast ForWord product during the late spring of 2006.

Before using Fast ForWord products, students were assessed with the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFW) and the Comprehensive Test of Phonological Processing (CTOPP). After completing the Fast ForWord product, students were assessed a second time. Staff at the St. Mary's Orphanage and Day School administered the assessments and reported scores for analysis.

Implementation

All professionals involved in this study were trained in current and established neuroscience findings on 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 products; methods for assessment of potential candidates for participation; the selection of appropriate measures for testing and evaluation; effective implementation techniques; approaches for using Progress Tracker reports to monitor student performance; and techniques for measuring the gains students have achieved after they have finished using Fast ForWord products.

Materials

The Fast ForWord products are computer-based products that combine an optimal learning environment with a focus on cognitive and early reading skills. The product used by St. Mary's Orphanage and Day School, Fast ForWord Language, includes seven exercises designed to build skills critical for reading and learning, such as auditory processing, memory, attention, and language comprehension as detailed in the following exercise descriptions.

Circus Sequence: 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. This exercise improves working memory, sound processing speed, and sequencing skills.

Old MacDonald's Flying Farm: 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 improves auditory processing, develops phoneme discrimination, and increases sustained and focused attention.

Phoneme Identification: Students hear a target phoneme, and then must identify the identical phoneme when it is presented later. This exercise improves auditory discrimination skills, increases sound processing speed, improves working memory, and helps students identify a specific phoneme.

Phonic Match: 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 exercise develops auditory word recognition and phoneme discrimination, improves working memory, and increases sound processing speed.

Phonic Words: Students see two pictures representing words that differ only by the initial or final consonant (e.g., "face" versus "vase", or "tack" versus "tag"). When students hear one of the words, they must click the picture that matches the word. This exercise increases sound processing speed, improves auditory recognition of phonemes and words, and helps students gain an understanding of word meaning.

Language Comprehension Builder: 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 develops oral language and listening comprehension, improves understanding of syntax and morphology, and improves rate of auditory processing.

Block Commander: 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 increases listening comprehension, improves syntax, develops working memory, improves sound processing speed, and increases the ability to follow directions.

Assessments

Students' listening skills were assessed with the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFW) and Comprehensive Test of Phonological Processing (CTOPP). The tests were administered before and after Fast ForWord participation.

Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFW): The GFW is a screening measure of speech sound discrimination ability for students in quiet and noisy situations. Words are presented by means of a cassette tape in the absence of any noise and also in the presence of distracting background noise. The student hears a word and then points to a picture. Similar words such as lake, make, rake, and wake are presented as foils.

Comprehensive Test of Phonological Processing (CTOPP): The CTOPP measures a student's awareness of, and access to, the phonological structure of oral language as well as phonological memory, ability to rapidly execute a sequence of operations, and ability to blend and segment words and non-words.

Analysis

Scores for the GFW and CTOPP were reported in terms of raw scores which were converted into normalcurve equivalents (NCEs). Scores from the CTOPP subtest were combined to determine composites. Composite scores are reported in terms of Standard Scores. Normal curve equivalents and Standard Scores are normed, and are therefore provide the most appropriate units for statistical analyses.

The scores were analyzed using a Multivariate Analysis of Variance (MANOVA). Ad hoc paired t-tests were used as appropriate. All analyses used a p-value of less than 0.05 as the criterion for identifying statistical significance.

RESULTS

Participation Level

Research conducted by Scientific Learning shows a relationship between product use and the benefits of the product. Product use is composed of content completed, days of use, and adherence to the chosen protocol (participation and attendance levels). Students at the St. Mary's Orphanage and Day School used the Fast ForWord Language product for 50 minutes a day, five days per week. Detailed product use is shown in Table 1.

	Number of Students	Days Participated	Number of Calendar Days	Percent Complete	Participation Level	Attendance Level
Fast ForWord Language	25	40	63	83%	100%	87%

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

Assessment Results

Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFW): Scores on the GFW were reported in terms of the number of errors students made. These scores were converted into normal curve equivalents (NCE's). NCE's are normed and therefore the most appropriate units for statistical analyses. However, they are normed in the United States, a very different population from the students in this study. This may have resulted in a floor effect where some of the students made substantial improvements, but were still performing below the 1st percentile.

For example, on the quiet subtest, a nine year old needed to make fewer than eight errors in order to be above the first percentile, while ten and eleven year olds needed to make fewer than six errors. For the noise subtest, students needed to make fewer than 18, 16, or 14 errors to be above the first percentile for nine, ten, or eleven year olds. The initial average number of errors for the quiet subtest was 10, while it was 16 for the noise subtest. To permit more complete understanding of the data, raw scores are also reported.

The multivariate analysis of variance (MANOVA) showed that there was a main effect of time, as well as a main effect of test. There was also a test by time interaction. Therefore, post hoc paired t-tests were performed. The t-tests indicated that the students made significant improvements on both tests, with greater improvements in the quiet environment (Table 2; Figure 1).

GFW	Type of Score	n	Before		After		t-statistic
			Mean	SE	Mean	SE	
Quiet	NCE	25	2.6	0.91	24.9	2.99	7.2*
Noise	NCE	25	7.2	1.9	62.1	3.5	19.9*
Quiet	Raw	25	10.5	0.7	3.4	0.3	10.6*
Noise	Raw	25	16.4	0.7	6.9	2.3	18.2*

*Table 2. Raw scores were converted into Normal Curve Equivalents (NCE) and analyzed. The majority of the students were below the first percentile on the pre-test so raw scores are also reported. On average, student listening ability improved significantly on the Quiet and Noise subtests after Fast ForWord participation. *p<0.05.*

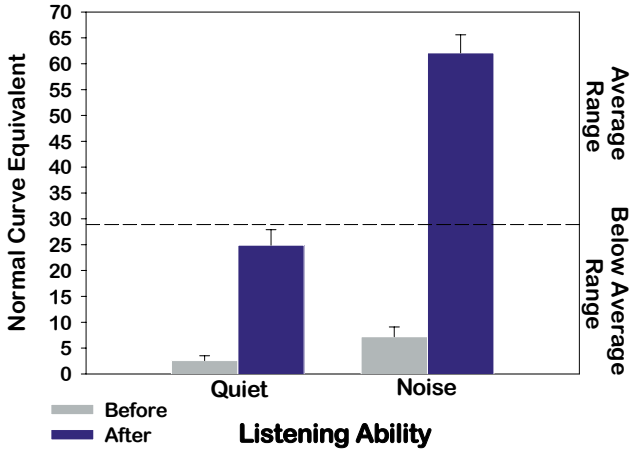

Figure 1. Students overall moved into the average range of listening ability following Fast ForWord use. Results from 25 students are shown.

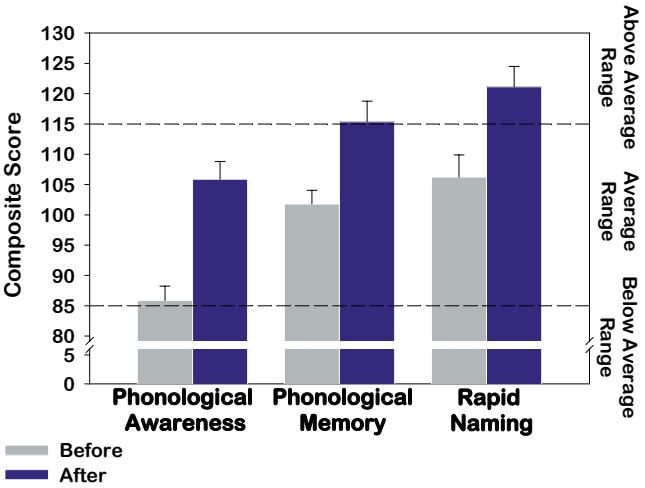

Figure 2. On average, students significantly improved their Phonological Awareness with average improvement of one standard deviation. Standard Scores are shown with a mean of 100 and standard deviation of +/-15. Results from 25 students are shown.

Comprehensive Test of Phonological Processing (CTOPP): Scores from the CTOPP were reported in terms of raw scores for each of the twelve subtests. These scores were converted into percentile scores and normal curve equivalents (NCE's). In addition, the subtest scores were combined to determine performance on the three main composites: Phonological Memory, Phonological Awareness, and Rapid Naming. A multivariate analysis of variance (MANOVA) indicated that there was a main effect of subtest as well as a main effect of time. Visual inspection indicated that initially, the students' skills were lowest on Blending Words (4th percentile) and Blending Nonwords (14th percentile) and highest on Rapid Letter Naming (69th percentile), Rapid Digit Naming (59th percentile), and Memory for Digits (60th percentile). Since there was also a significant text by time interaction, individual t-tests were performed on the twelve subtests. There was significant improvement on all subtests (Table 3).

Average improvement across the three composites (Phonological Memory, Phonological Awareness, and Rapid Naming), was slightly more than one standard deviation (Figure 2).

CTOPP	n	Before		After		t-statistic
		Mean	SE	Mean	SE	
Elision	25	54.0	5.2	66.0	2.7	3.9*
Blending Words	25	13.9	2.4	47.7	3.4	11.2*
Memory for Digits	25	55.1	5.0	66.1	3.0	2.6*
Rapid Digit Naming	25	54.5	4.1	71.8	3.6	5.9*
Nonword Repetition	25	49.7	4.2	74.1	2.3	6.0*
Rapid Letter Naming	25	60.2	4.7	76.3	4.8	5.0*
Rapid Color Naming	25	34.4	4.1	44.4	4.2	2.2*
Phoneme Reversal	25	40.9	3.5	70.0	3.3	10.3*
Rapid Object Naming	25	45.2	4.2	60.1	5.3	4.0*
Blending Nonwords	25	27.4	2.2	69.1	3.0	13.9*
Segmenting Words	25	31.5	3.6	57.8	1.9	9.3*
Segmenting Nonwords	25	39.1	3.3	63.0	2.1	11.5*
Average	25	42.2		63.9		

*Table 3. Average Normal Curve Equivalents (NCE's) for each of the twelve CTOPP subtests before, and after, Fast ForWord participation. Significant improvements were made on all twelve subtests with final average scores above the 50th percentile on all subtests except Blending Words and Rapid Color Naming – both of which showed significant improvement, and approached the 50th percentile. *$p<0.05$.*

DISCUSSION

The ability of students at St. Mary's Orphanage and Day School to discriminate between English phonemes was evaluated, as well as their phonological processing skills. For fluent written and spoken English, students must be able to easily discriminate and identify phonemes commonly used in English language, as well as to manipulate English phonemes – pull words apart, put them back together, rapidly recall words and sounds.

Initially, the students struggled with discriminating between various English phonemes. However, after Fast ForWord participation, the students made dramatic improvement with their scores increasing significantly, reaching the average range for discrimination in noise, and approaching the average range for discrimination in quiet.

The improvements correspond to a student going from the first to the eleventh percentile on the quiet subtest, and from the second to the seventy-first percentile on the noise subtest. This corresponds to one and two and one-half standard deviations of improvement on the quiet and noise subtests, respectively.

The students' phonological processing skills started in the average range, and also dramatically increased, reaching into the above average range for Rapid Naming and Phonological Memory. Across the twelve subtests, average improvement was approximately one standard deviation – from an NCE of 42.2 to an NCE of 63.9 which corresponds to an improvement from the 36th percentile to the 75th percentile.

It is important to note that these students were all living in India and had an Indian language as their native tongue. The normative tables used in the analysis were based upon a cross-section of children in the United States. Therefore, the actual magnitude of the improvements might be different than what is shown here. However, the challenges the students would have had discriminating between American-English words, and blending the sounds into words, would have been real. For example, students went from making mistakes on 35 – 55% of the items (in quiet and noise, respectively) to making mistakes on 11 – 23% of the items.

CONCLUSION

Auditory discrimination and phonological processing skills are critical for all students, impacting their ability to benefit from instruction, follow directions, and participate in class discussions. The students in this study initially made mistakes on one-third to one-half of the auditory discrimination items they were presented. After using the Fast ForWord products, the students' skills significantly improved, and the number of errors they made decreased by 58 – 68% (in noise and quiet, respectively).

Their phonological processing skills improved by approximately one standard deviation, from the 36th percentile to the 75th percentile.

The ability to easily and effortlessly process and discriminate between the phonemes in the English language is critical for students who want strong English language skills. This study suggests that using the Fast ForWord products strengthened the students' phonological processing and auditory discrimination skills, allowing them to benefit more from the classroom curriculum. This study supports earlier studies done in the United States and elsewhere, demonstrating that the Fast ForWord products can help bilingual English speakers improve their ability to process English phonemes.

Notes:

To cite this report: Scientific Learning Corporation. (2008). Improved Auditory Discrimination and Early Reading Skills Accelerate English Language Development in Students in Kolkata, India who used Fast ForWord® Products, MAPS for Learning: Educator Reports, 12(16)1-5.

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