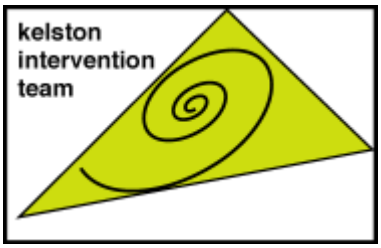

Fast ForWord: A neurological approach to intervention in literacy.

Research Project

Kelston Intervention Team 2011

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FAST FORWORD: A NEUROLOGICAL APPROACH TO INTERVENTION IN LITERACY.

INTRODUCTION

The Fast ForWord Research initiative was a project implemented by the Kelston Resource Teacher Learning and Behaviour Team in West Auckland. This project aimed at evaluating the effectiveness of the Fast ForWord Programme in improving reading and language skills for students who were two years or more behind their peers in reading achievement. In 2010 the Fast ForWord project started as a pilot project involving one school and five students and then in 2011 it was extended to a further seven schools and seventy five students. Free access to the Fast ForWord programme and training was provided by Scientific Learning and Learn Fast. Each school provided a supervisor, computer technology, learning space and access to students for data gathering purposes. For twelve weeks students worked to complete two modules of the Fast ForWord programme. Every school day they practised language and reading skills in a gaming environment for forty minutes while also participating in regular teaching programmes.

LITERATURE REVIEW

Language to Literacy

Before children can learn to read proficiently they must be able to understand and produce spoken language in the same language they are learning to read (Miller& Tallal, 2003). The components of spoken language are phonology, morphology, semantics, syntax and pragmatics. The first four are essential components of the reading process. Phonemes are the building blocks used to construct words. Morphology and semantics provide meaning and include systems for organising words that are related, while syntax refers to rules of language.

In early language development repeated exposure to phonemes in oral language result in neurons that fire together. When reading the child extracts these patterns from inside words and connects them to letters – phonemic awareness. If a child is not exposed to a phoneme or has difficulty processing the phoneme then these are not wired into the brain and may lead to later reading and writing difficulties. Brain systems for sequencing and organising sounds and letters in reading require the ability

to rapidly discriminate successive sounds in words. When a student's neural processing of sounds is slow, confusions arise.

Neurobiology of Reading

Understanding how the brain learns to read requires an understanding of how the brain organises the components of spoken language that connects them to the act of reading. Recent research using functional neuro-imaging techniques (fMRI) has given valuable insights into how the brain learns to read and has enhanced cognitive theories of reading. Efficient reading is a complex skill and current understandings have identified processing speed (Wolf & Bowers, 1999), rapid auditory processing (Tallal, 1980), oral language skills (Scarborough & Dobrich, 1990) and visual processing skills (Cornelissen & Hansen, 1998) as important components of this complexity. Phonemic awareness has been identified as is one of the best predictors of reading success and it has been causally related to reading skill. Instruction in phonemic awareness has been shown to promote the acquisition of reading skills (Sandak, Mencl, Frost & Pugh, 2009). Neuro-scientific studies of word recognition (Sandak et al) have identified a highly organised cortical system that integrates processing of orthographic, phonological, and lexico–semantic features of words and FMRI scans have established a link between developing reading skills and specific areas in the left hemisphere of the brain. These researchers have suggested that the left parieto-temporal and the inferior frontal areas are active when sounding out words, as needed in the early stages of learning to read, whereas the left hemisphere occipito-temporal area quickly recognises familiar words and is used more often by skilled readers. Phonologically or semantically tuned subsystems are widely distributed across both dorsal and ventral cortex and appear to act cooperatively during fluent word reading and in adaptive learning.

There are clear functional differences between readers who learn to read fluently and those that struggle to learn to read. In readers experiencing difficulty, a number of fMRI studies have revealed decreased activity in the left, parieto-temporal region and increased activation in the corresponding region on the right side of the brain. (Shaywitz, Shaywitz, Fulbright, Skudlarski, Mencl, & Constable, 2003). Further to this Shaywitz et al. identified that the decreased activity in the left parieto-temporal regions was due to immaturity as opposed to malfunction and therefore suggested that strengthening of the circuits may be an appropriate process for remediation. Sandak et al. explored the neurobiological effects of reading remediation using phonics based

programmes and found that effective remediation produced an increased activation of the left hemisphere parieto-temporal region with an accompanying decrease in activity in the right hand areas of the brain. Based on their understandings of the intricate neuro-biological processes that contribute to the functioning of the left parieto-temporal region they proposed an architectural model of reading where dysfunction in parieto-temporal regions and associated difficulties with phonologically analytic processing is a result of failed training of ventral subsystems and the consequent development of compensatory responses in frontal and right hemisphere systems.

In addition to deficits in phonological processing, struggling readers have also been shown to have deficits in auditory processing. In particular they struggle with auditory processing of rapid auditory sounds that enter the nervous system in the 10s of milliseconds range (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich; 1996). The deficit in processing rapid auditory stimuli impacts on language and reading because the child is unable to distinguish certain phonemes and consequently develops a 'fuzzy' understanding of the phonology of sounds creating problems when required to map sounds to words. Merzenvich et al. (2006) researched the use of computer games designed to improve temporal processing skills by slowing down the rapidly occurring parts of a sound or speech. This has been likened to glasses for the ears technology (Burns, 2003). They found that students who used the games and trained 8 to 16 hours over a 20 day period improved markedly in their abilities to recognise brief and fast sequences of nonspeech and speech stimuli.

Neuro-plasticity

Brain changes occur each time a person learns and retains new information. These changes involve new connections that form among neurons as well as chemical changes that enable those connections (Miller & Tallal, 2006). Neuro-plasticity is believed to vary with age and in young children the process seems to be an effortless response to new learning with exposure. But it has been shown that the brain can grow and adapt at any age.

Learning is also affected by processing speed and brain chemistry. Some of the neurotransmitters that help learning are acetylcholine which keeps attention high, dopamine which maintains motivation and saves brain connections and norepinephrine which keeps the brain alert and interested in new material. The way

information is presented has been shown to enhance these learning transmitters. Novel material and positive feedback naturally increase norepinephrine and dopamine.

Neurobiology and FastForWord

Fast ForWord uses the neuroscience of reading and language and the principles of brain plasticity to strengthen essential cognitive skills of memory, attention, processing speed and sequencing to accelerate learning (Scientific Learning). This programme comprises seven training exercises designed to stimulate the fundamental skills needed for effective communication and reading. The exercises restructure the brain through repetition, adaptivity to a person's skill level, motivation and immediate feedback. FastForWord games build brain connections by training students to distinguish among phonemes, words and sentences initially at artificially slow speeds and then at normal rates of speech. The programme explicitly focuses on increasing student's processing speed by using a speech algorithm that finds the brief segments within the ongoing speech stream and enhances these acoustic cues by making them longer or louder and then gradually decreasing the amount of acoustic modification. The students respond to stimuli by clicking on animated screen games to identify what they hear. The training is intense requiring students to remain focused for forty to sixty minutes a day for five days over periods of twelve to thirty six weeks. Temple et al. (2003) used fMRI scans and a control, pre/post research design to evaluate the neurological effects of training with the Fast ForWord programme on the brains of students identified to have specific reading disabilities as compared to normal readers. Pre intervention scans showed that there were specific differences in the brain activation profiles of students with reading disabilities and those without. Students with reading disabilities showed the expected lack of activation in their left parieto-temporal cortex compared to normal readers. After eight weeks of participation in the Fast ForWord programme scans showed increased activation in the left parieto-temporal cortex. The changes in brain functioning were accompanied by improved achievement in reading and oral language as measured by standardised assessments.

Effectiveness of Fast ForWord

Multiple international studies have explored the effects of the Fast ForWord programme on the reading and language skills of students in junior and senior programmes. These studies are published on the Scientific Learning website and

include students identified with learning disabilities, bilingual English learners without known disabilities and regular students without known disabilities but struggling with learning to read. Sample sizes are generally small ranging from 10 to 121. All studies used a randomised, pre/post research design and reported standardised assessments of reading and language and multivariate analysis of data. Some studies had a control group while others compared Fast ForWord to other interventions. Results showed that students made significant gains in academic achievement and reading achievement with specific gains reported in phonological awareness skills, reading accuracy, reading comprehension, auditory perceptual skills and oral language skills.

A systematic meta-analytic review (Strong, Torgeson, Torgeson and Hulme; 2011) of evidence for the effectiveness of Fast ForWord language intervention programme found that there was no evidence of significance on any outcome measure. The initial search of studies related to FastForWord identified 79 potential studies but these were reduced to six studies using predetermined quality criteria. Many of the studies were eliminated because there had been insufficient peer review. Only four of the six studies had sufficient data to be included in the final meta-analysis. Students in control groups for these studies participated in alternative programmes such as Success Maker, Earobics, individualised language interventions and other computer assisted interventions. Meta-analysis compared results from intervention groups and control groups for single word reading, passage reading, expressive language and receptive language. A range of tools were used to assess these dimensions across the studies and it was found that there was no indication of a significant difference between the two groups. Within subject pre/post assessments were not evaluated in this meta-analysis.

Hypothesis

Research on the effectiveness of Fast ForWord is mixed. Research that reports effectiveness has been criticised as being non-peer reviewed and privately conducted (Strong, Torgerson, Torgerson and Hulme, 2011) and effect sizes have been reported to be small and variable (Sisson, 2009). Fast ForWord is currently being marketed in New Zealand and schools are reporting positive effects on student engagement and achievement in literacy. It seems timely to conduct well designed research on a group of New Zealand students to determine the effectiveness of Fast ForWord. It is

hypothesised that if Fast ForWord is an effective tool for developing skills in reading then students who participate in the Fast ForWord programme will make gains in receptive language, expressive language, reading accuracy and reading comprehension.

METHOD

Participants

Students were nominated by teachers and selected for participation in the project by the schools' Special Needs Co-ordinators and Resource Teachers Learning and Behaviour on the basis of school records. These students were achieving two years or more behind their peers in reading. The factors contributing to delayed reading progress were not identified at any stage during the research and may have included reading and language disabilities, English as a second language, disrupted literacy experiences, or social/emotional disorders. Eighty two students initially participated in the research but three students left for unforeseen circumstances leaving seventy nine students with data to be included in the analysis. The students came from a range of cultural groups and socio-economic backgrounds. There were initially twenty five female participants and fifty seven males. The students ranged in chronological age from 6 years 10 months to 16 years 3 months with an average age of 10 years 7 months at the start of the study.

Materials

Fast Forword is a computer based reading and language programme that claims to improve early reading, language and cognitive skills through activities that rewire and strengthen the brain's capacity to learn (Scientific Learning, 2011). The research used three products Language Basics, Language v2 and Language to Reading. These modules include three to seven exercises designed to build skills critical for reading and learning and while there are variations across modules related to skills targeted and approaches taken, there are several critical skills claimed to be developed in both of the modules. These include phonological awareness, automatic and rapid use of sounds, structures and patterns of oral language, discrimination for listening accuracy, and systems for storing and manipulating information.

Pre/post data was gathered using standardised tests of reading and oral language. The assessment battery consisted of three assessments. The Neale Analysis of Reading

Ability (3ed.) was used to assess reading accuracy, and reading comprehension. It contains a series of short passages which the student reads aloud, followed by orally answered comprehension questions read by the test administrator. The assessment is appropriate for students aged six to thirteen years. The Peabody Picture Vocabulary Test (4ed.) and the Expressive Vocabulary Test (2ed.) were used to assess receptive and expressive vocabulary development. These assessments were individually administered and contained picture stimulus to assess vocabulary acquisition, expressive vocabulary and retrieval. The scores for the Neale and Peabody assessments were reported as ages and converted to decimal numbers for statistical analysis. The researchers acknowledge that standard score are statistically more appropriate but the Neale does not report standard scores and standard scores can be problematic with scores that are below the lower end of the scale.

Design

The first phase of the research project used a randomised control trial design (RCT) with pre/post data collection. The design measures the impact of the intervention by comparing the results of two groups that were randomly assigned. Randomisation minimises the effects of bias and systematic differences between the groups. The second phase gave the control group an opportunity to use Fast ForWord and was a repeated measures design and enabling these results to be compared to results in the first phase. The effects of the Fast ForWord programme were measured pre/post intervention for each phase using the standardised assessments for reading and language as described above and the results were analysed using multivariate analysis of variance statistical procedures.

In the first phase students were ordered within their school groups according to age and then were randomly assigned to two groups (A and B). This ensured that there was baseline similarity between the two groups. The A group was designated the trial group and the B group became the control group. The trial group used the Fast ForWord programme in their schools every school day for forty minutes over a 12 week period. Each school planned their own protocols to suit the individual school timetables. Some students used Fast ForWord during the hours of the school programme while others used it before school. The trial group and the control group participated in their usual literacy programmes during the course of the research. In this way Fast ForWord complimented rather than substituted for regular literacy

programmes. During the 12 week intervention students completed or partially completed two modules of the Fast ForWord programme – Language Basics and Language v2. Progress was individualised to each student and was determined by criteria built into the programme. Some students were flagged by the programme as requiring additional support and these students were given one to one coaching by the facilitator using activities suggested by the programme. On completion of the first 12 week intervention, post data was collected for both group A and group B and comparisons were made.

In the second phase the B group students were given an opportunity to participate in Fast ForWord using the same protocols as the A group. Further data was collected at the end of this twelve week period for the B group. This data was compared to data gathered in the first phase when the B group was the control group and experienced only their regular literacy programmes. In this way B group students were their own control. This single sample repeated measures design has merit in authentic learning situations as it provides a way of reducing the amount of error arising from natural variance between individuals where it is not realistic to control for all variables. It is assumed that extraneous variables for individual students during the first phase are similar to extraneous variables in the second phase. In a control/trial group design randomised assignment of students between the control group and trial group manages this variability but in this study this was limited by the small numbers of students in each school group. Repeated measures designs are open to error from practice effects in the data collection and possible gains in confidence with test taking improving test scores. In this study these effects were minimised by using alternate versions of the same test. Group B students used the A version of language and reading assessments at the beginning of phase 1, then the B version between phase 1 and phase 2, then the A version again at the end of the study. There was a period of 40 weeks between the first assessment and the third assessment. On its own a repeated measures design is not as strong a design as a between subject design but together the two designs have the potential to strengthen the findings of the project.

Students using the Fast ForWord programme were monitored during the intervention using the programme's progress tracker to ensure adequate engagement was happening and students were supported by a trained facilitator throughout the process.

When required incentives were used to ensure that engagement and progress was maintained.

On completion of the Fast ForWord programme, anecdotal data was collected formally through a progress indicator questionnaire (appendix 1) offered to teachers and facilitators and informally through student, parent and facilitator interviews. Some of these interviews were recorded. These conversations were analysed for common themes related to changes in classroom learning and engagement.

RESULTS

Participation

Three students from Group B left the programme for unforeseen circumstance leaving 40 students in group A and 39 students in Group B. Participation rates ranged from 62% to 100% during the trial period with a mean of 94%. Some of the lower participation rates were due to technological issues that prevented students from completing some sessions. Attendance during the trial period was variable ranging from 31% to 100% with a mean of 74%. Group A and Group B had similar mean attendance results with 74.35% and 74.05% respectively. Students used the products for 12 weeks and during that time, they completed as many products and as much content as possible. The goal was for students to complete two products; 86% of the students completed at least one, 37% completed two or more.

There were some gaps in the data for reading accuracy and reading comprehension as some students pre tested lower than the six year floor for the Neale reading assessment. Although some of these students post tested at or above six years their results were not included in the reading analysis as baseline data was incomplete. Thirty six students were included in the Reading Accuracy analysis for Group A and 36 students were included for Group B. Thirty five students were included in the Reading comprehension analysis for Group A and 32 students were included for Group B. There were also some gaps in the data for EVT and PPVT assessments due to absence during assessment times. One student was uncooperative for the post EVT assessment. If pre or post data was incomplete these students were not included in the data analysis for that assessment, hence total participants in each group varied across assessments and ranged from 32 to 39. Thirty two students in Group A and 34 students in Group B had pre and post scores available for all four tests.

First Phase (Trial Group A and Control Group B)

Age scores for the four tests in the assessment battery (receptive language, expressive language, reading comprehension and reading accuracy) were analysed using a repeated measures multivariate analysis of variance (MANOVA). There were two time points for each of the four tests (pre assessment battery and post assessment battery). The p value of less than 0.05 was used as the criterion for statistical significance.

At the time of the first test battery, Group A students and Group B students had an average age of approximately 10 years and 1 month. The post tests were administered 20 weeks after the first test battery when the average age of the two groups was 10 years 6 months.

The repeated measures multivariate analysis (Table 1) indicated that there was not a difference between the trial group and the comparison group overall ($F = 0.005$, $p > 0.10$). However, as shown in Table 1, there was a main effect of Time ($F = 67.0$, $p < 0.10$) indicating that students generally performed better on the post-test than the pre-test. There was also a main effect of Test ($F = 7.4$, $p < 0.10$) indicating that students generally performed better on the Language Tests than the Reading Tests. There was also a statistically significant Time by Group interaction ($F = 3.4$, $p < 0.10$) indicating that the changes in test scores of students in one group were different from the changes in test scores of the students in the other group.

	df	F
Time	62	60.6*
Time x Group	62	10.0*
Test	60	7.5*
Test x Group	60	0.9
Time x Test	60	2.9*
Time x Test x Group	60	3.2*

* $p \leq .05$ † $p \leq 0.1$ trending towards significance

Table 1: Repeated measures multivariate analysis of variance for the variables time, test and group.

The statistically significant Time x Test x Group interaction indicates that the differences between the changes on the tests vary by test consequently further analysis was done test by test.

Further analysis of the impact of group on assessment showed that there was a statistically significant difference in the students' Expressive Language skills ($p \leq 0.05$) with the students in the Fast ForWord trial group (Group A) improving more than the students in the comparison group (Group B). The differences between the changes on the students' Receptive Language skills and Reading Comprehension skills trended towards significance ($p \leq 0.10$) with the students in the Fast ForWord trial group improving more on both assessments but not to a significant degree. There was not a significant difference between the Reading Accuracy scores of the students in the two groups ($p > 0.05$).

	Time		Time x Group	
	df	F-statistic	df	F-statistic
Accuracy	70	34.0*	70	0.2
Comprehension	65	36.2*	65	2.1†
Expressive Language	75	37.3*	75	9.9*
Receptive Language	77	7.2*	77	3.5†

* $p \leq .05$ † $p \leq 0.1$ trending towards significance

Table 2: Analysis of variance for each assessment indicating the impact of Time and Group.

Comparisons of mean pre and post scores for reading accuracy, reading comprehension, expressive language and receptive language shows the size of the changes achieved overall across groups (Table 3).

Test	Group A (Trial)			Group B (Comparison)			F
	n	mean		n	mean		
		pre	post		pre	post	
Reading Accuracy	36	7.5	7.9	36	7.4	7.9	0.2
Reading Comprehension	35	7.4	8.3	32	7.5	8.0	2.1†
Expressive Language	39	7.5	8.6	38	7.7	8.0	9.9*
Receptive Language	40	8.0	8.7	39	8.4	8.5	3.5†

* $p \leq .05$ † $p \leq 0.1$ trending towards significance

Table 3: Mean age scores for dependent variables receptive language, expressive language, reading comprehension and reading accuracy.

In diagrams 1 to 4 these results are presented visually showing pre/post changes in mean age scores for language and reading assessment and comparing trial group and comparison group.

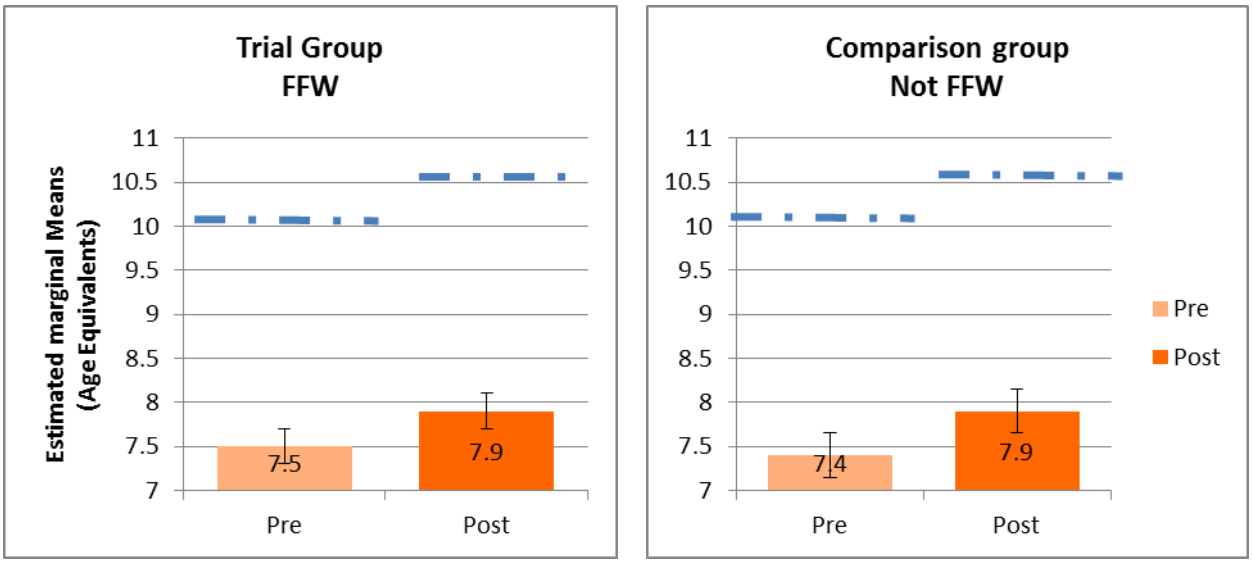

Diagram 1: Phase one pre/post assessments for **Reading Accuracy** comparing the trial group and the comparison group.

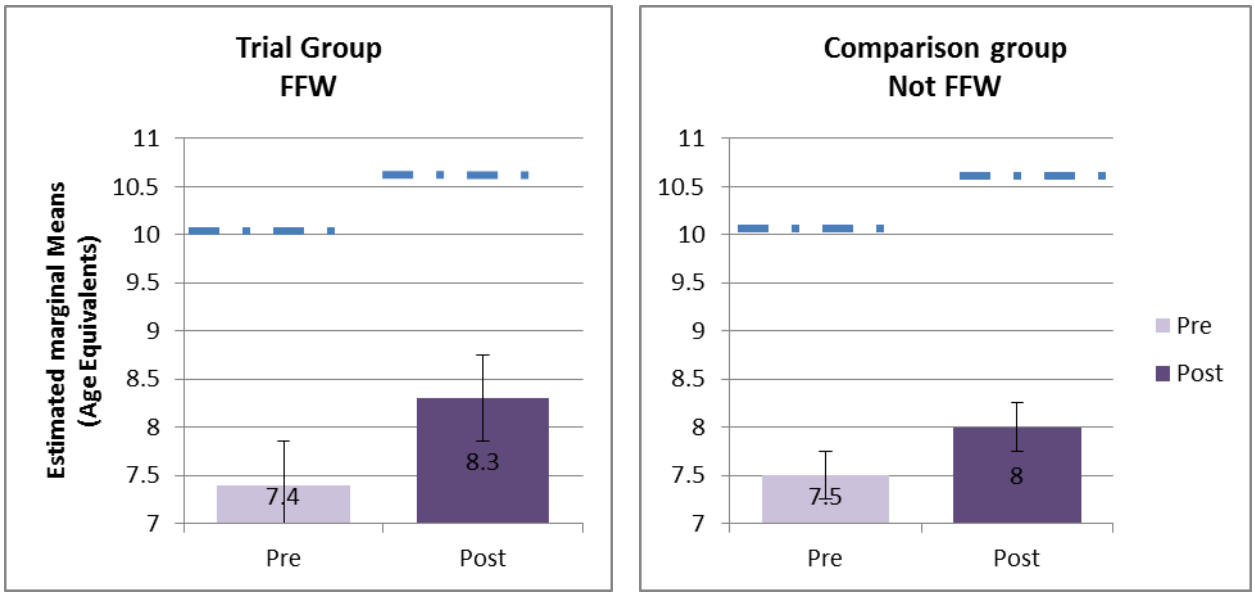

Diagram 2: Phase one pre/post assessments for **reading comprehension** comparing the trial group and the comparison group.

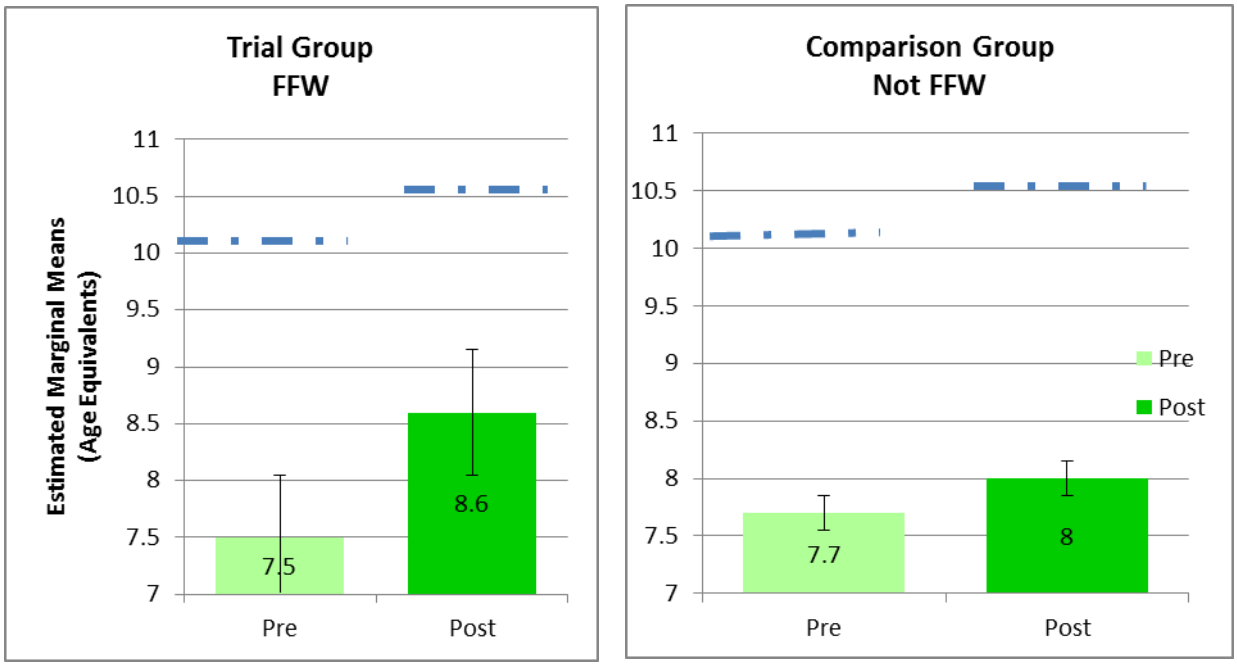

Diagram 3: Phase one pre/post assessments for **expressive language** comparing the trial group and comparison group

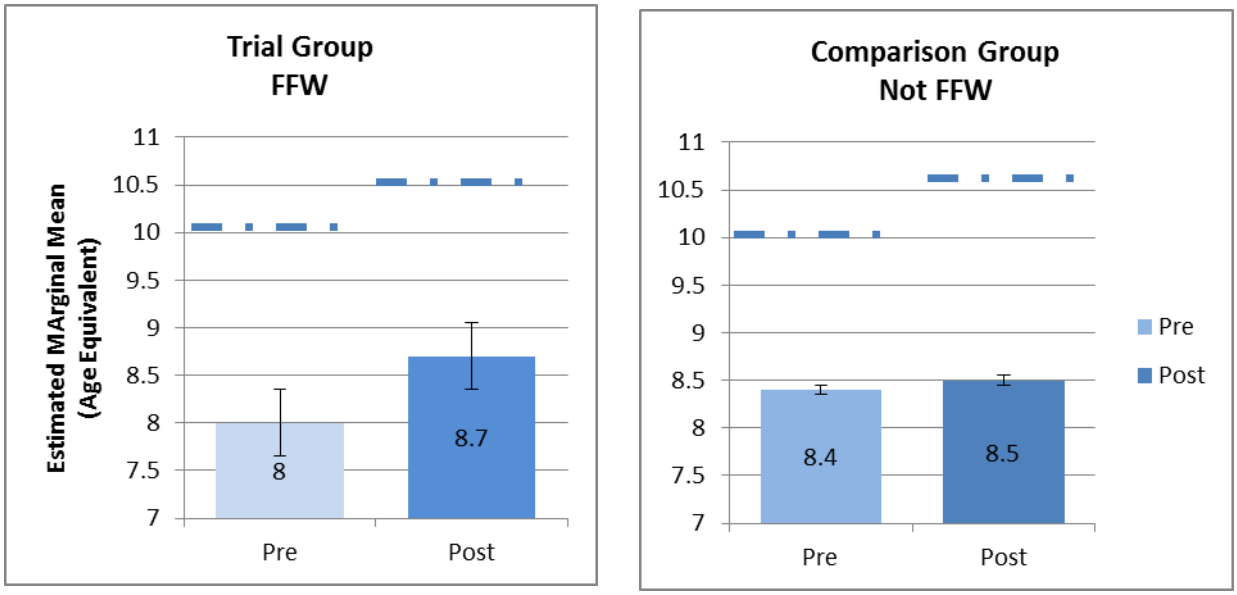

Diagram 4: Phase one pre/post assessments for **receptive language** comparing the trial group and the comparison group.

The diagrams 1 – 4 show that the greatest change in mean scores was for expressive language with the trial group making a mean gain of 1.1 years while the control group gained 0.3 years. The difference in gain was significant ($F = 9.9^*$, $p \leq 0.05$). In receptive language the trial group made a mean gain of 0.7 years while the mean for the control group increased by 0.1 years. This difference was not significant. ($F = 3.5$, $p \leq 0.1$) but is viewed as trending toward significance. In reading comprehension the trial group made a mean gain of 0.9 years while the control group made a gain of 0.5 years. Again this was not significant ($F = 2.1$, $p \leq 0.1$) but viewed as trending toward significant. In reading accuracy the control group scores increased by 0.4years while the trial group increased 0.5years and the difference in scores was not significant. ($F = 0.2$, $p > 0.05$).

Phase 2

The second phase was a delayed entry design where the B group was assessed twice before using the Fast ForWord programme (Time 1 and Time 2), and then a third time after using the programme (Time 3). On average, there were 20 weeks between the Time 1 assessments and the Time 2 assessments, and 24 weeks between the Time 2 and Time 3. The extra time was to allow for two weeks of school holidays and

disrupted school routines either side in July. Student performance from the first two data points (Time 1 and Time 2) was compared to performance from the last two data points (Time 2 and Time 3). Once again, data were analysed using a General Linear Model with repeated measures and a p-value of less than 0.05 was used as the criterion for statistical significance.

The analysed results were quite similar, lending credibility to the earlier results. The average age of the students at T1 was 10 years and 8 months while the average age at T2 was 11 years and 1 month and at T3 was 11 years and 7 months.

	df	F
Time	63	69.5*
Time x Group	63	14.3*
Test	61	6.3*
Test x Group	61	0.5
Time x Test	61	3.2*
Time x Test x Group	61	3.5*

* $p \leq 0.05$

Table 4: Analysis of variance indicating the effect of Time, Group and Test interactions.

Table 4 shows that there was a statistically significant ($p \leq 0.05$) Time by Test by Group interaction, and further analyse identified the specifics of the interaction as shown in Table 5.

	Time		Time x Group	
	df	F-statistic	df	F-statistic
Accuracy	73	36.5*	73	0.03
Comprehension	65	40.0*	65	6.6*
Expressive Language	77	45.8*	77	13.3*
Receptive Language	79	11.0*	79	5.1*

* $p \leq 0.05$

Table 5: Analysis of variance for each assessment indicating the impact of Time and Group.

As found in phase 1, the results in Table 5 show a statistically significant ($p \leq 0.05$) improvement in Expressive Language, and no significant change in Reading Accuracy. The two tests that trended towards significance in phase one ($p \leq 0.1$), Comprehension and Receptive Language, are also statistically significant ($p \leq 0.05$) in this second analysis.

		Time 1		**Time 2**		**Time 3**	
	n	Mean	SD	Mean	SD	Mean	SD
Accuracy	**34**	7.4	1.0	8.0	1.5	8.6	1.7
Comprehension	**30**	7.4	1.0	8.0	1.4	9.2	1.9
Expressive Language	**35**	7.7	1.8	8.0	1.8	9.4	2.2
Receptive Language	**37**	8.4	2.0	8.5	1.8	9.4	2.2

Table 6: Mean age scores for dependent variables receptive language, expressive language, reading comprehension and reading accuracy across time intervals 1-3.

Table 6 shows the mean age score changes for each of the four tests including results from the beginning of phase 1 (Time 1), the end of phase 1 and beginning of phase 2 (Time 2) and then the end of phase 2 (Time 3). Diagrams 5 to 8 describe these changes in achievement visually.

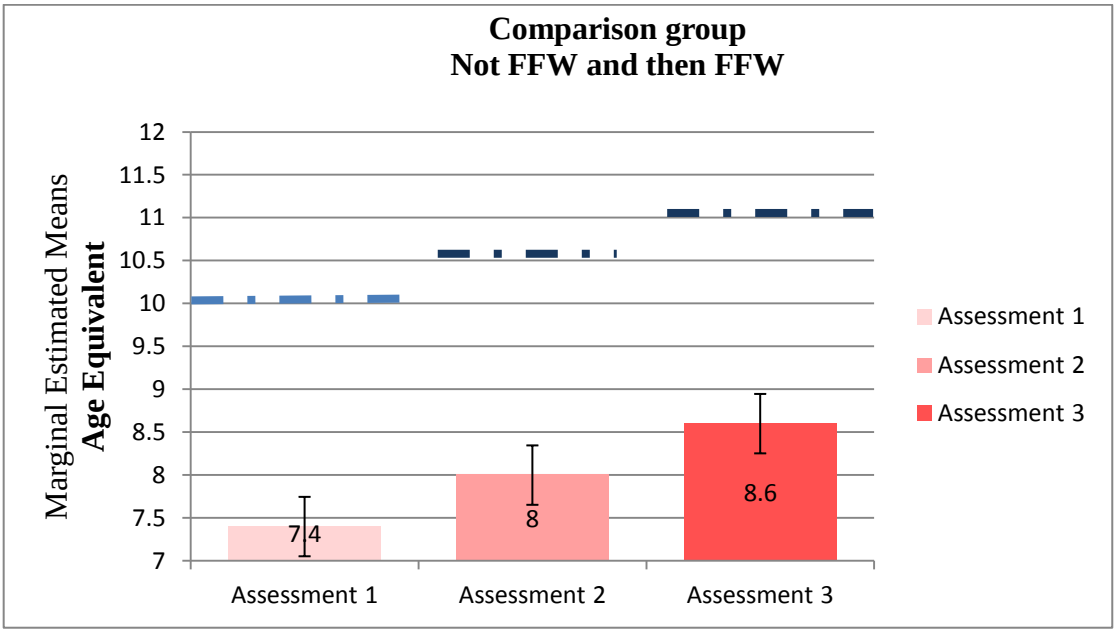

Diagram 5: Phase two achievement scores across three assessment events in **Reading Accuracy** for the comparison group (Group B).

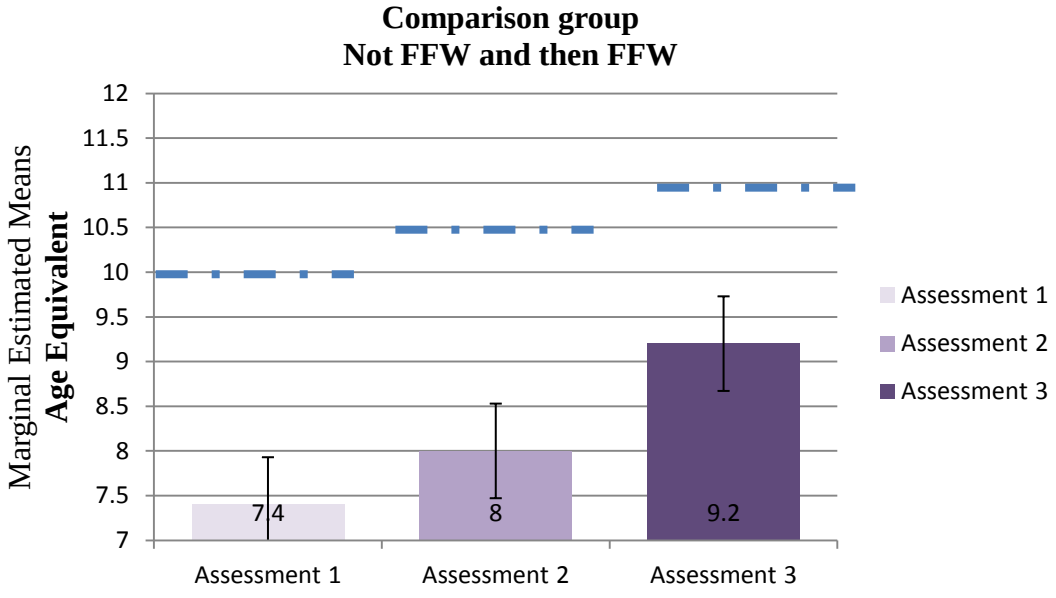

Diagram 6: Phase two achievement scores across three assessment events in **Reading Comprehension** for the comparison group (Group B).

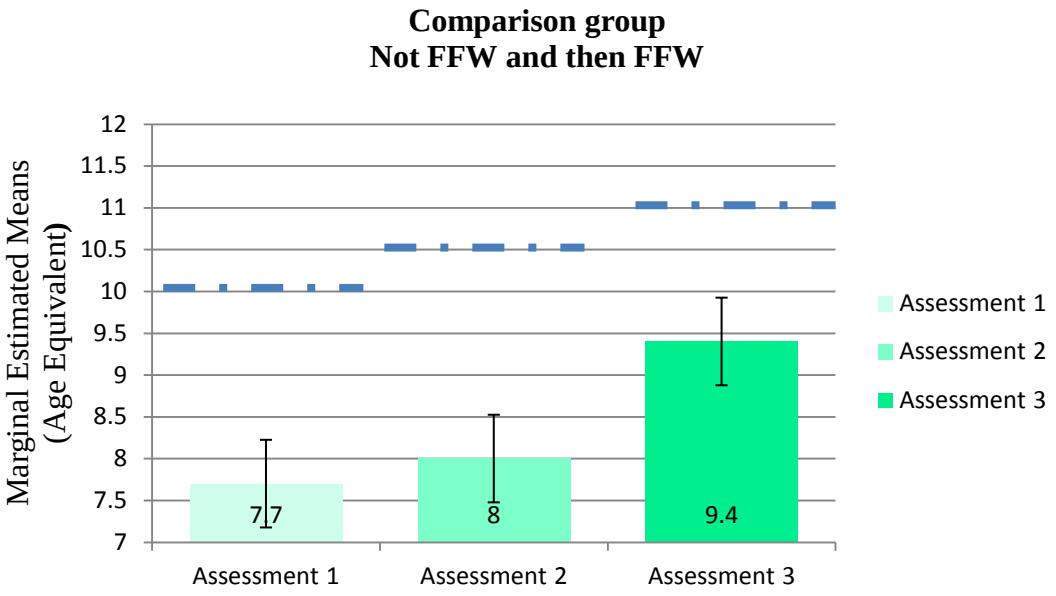

Diagram 7: Phase two achievement scores across three assessment events in **Expressive Language** for the comparison group (Group B).

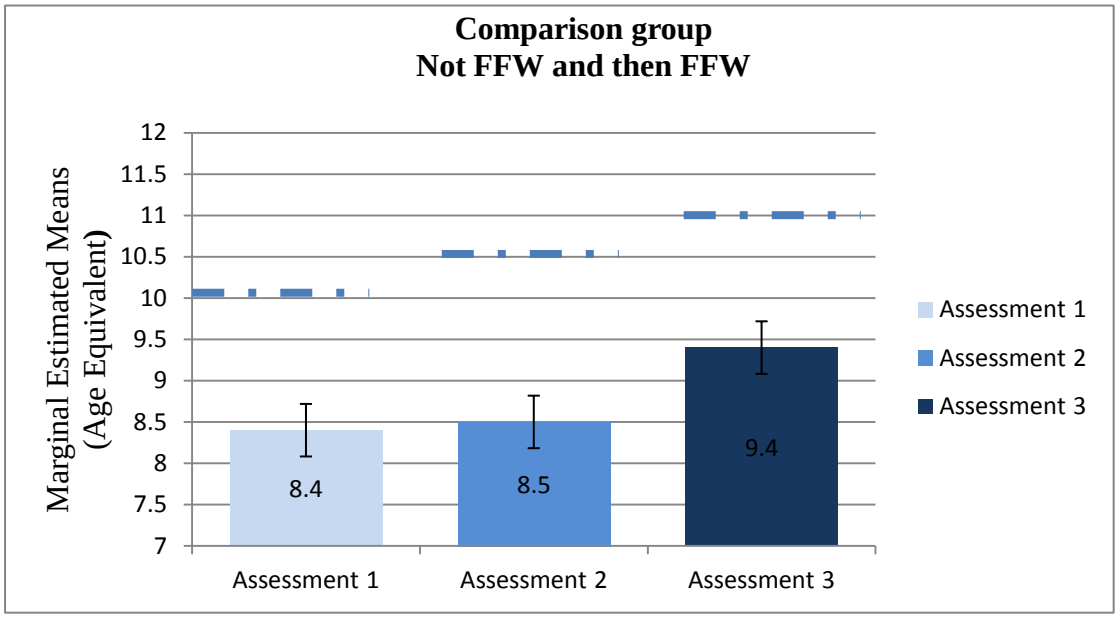

Diagram 8: Phase two achievement scores across three assessment events in **Receptive Language** for the comparison group (Group B).

In reading comprehension the comparison group made mean achievement gains of 1.8 years during the 44 weeks of the trial with 24 weeks of engagement using the Fast ForWord programme. In expressive language there were mean achievement gains of 1.7 years and in receptive language the mean gains were 1.0 years. These results were all shown to be statistically significant. In reading accuracy there were mean achievement gains of 1.2 years but this was not statistically significant.

Qualitative Research

Qualitative data collected during the research trial showed a general consensus that Fast ForWord made a difference to student learning. Data was collected using written questionnaires, through interviews and informal conversation. Statements were made by students, teachers, parents and Fast ForWord co-ordinators and six of the eight schools were represented in the qualitative data gathering. Participants described changes in students' ability to focus in the classroom, with consequent improvements in how students followed instructions and completed work. Participants reported an overall increase in student confidence with improved organisation for learning. Most teachers replying to the student progress questionnaire did not describe noticeable improvements in reading and writing achievement during the FFW experience. All coordinators identified individual differences in engagement with the FFW programme and in the classroom over the trial period. Most students were able to engage independently with the programme and were able to stay on task throughout the 40 minute sessions. A few students had considerable difficulty staying focused and required constant encouragement, motivational incentives and supervision to complete tasks. These students made very slow progress with the programme and there were also minimal changes in post assessment data.

Informal observations of two groups of participants at two different schools showed that students who struggled with attention in the classroom also struggled with Sky Gym and Moon Ranch activities. It was also noted that students previously identified as cognitively able with specific learning disabilities, had difficulty maintaining motivation. Informal observation also suggested that students who were English second language learners or who had been exposed to a second language in the home had difficulty with the Robo Dog activity. These observations suggest opportunities for further investigation.

DISCUSSION

Randomized controlled trials are considered high quality study designs since they minimize systematic biases, balancing both known and unknown variables.
In Phase one the students nominated for the project were randomly assigned to the trial and comparison groups. The randomisation procedure minimised the effect of unknown variables possible in a heterogenous group. The classroom programmes that these groups experienced were not modified any way. These programmes were based in a diverse range of schools – secondary, intermediate and primary; with decile 10 to decile 4 socio economic ratings – decile 10 being high and 1 being very low. For individual students these classroom based programmes may have involved further interventions related to literacy such as Rainbow Reading, Toe by Toe, Steps or MultiLit. The second phase minimised the possibility of bias from extraneous and uncontrolled variables by using the comparison group as its own control. In this way the influence of varied classroom programmes was minimised further.

The effect size and even the presence of an effect, is sensitive to implementation variables such as participation rates and completion rates. In this study the participation rates were high with a mean of 94%. Some of the nonparticipation scores were related to computer glishes that interrupted some students' sessions. Only 37% of students completed the languagev2 module during the 12 week time frame of the trial. Completion data ranged from 24% to 100% with a mean of 77% of the Languagev2 module completed. Completion rates in Phase one were 10% higher than in Phase two. It was expected that most students would complete the module within the 12 week time frame and the slower completion rates may be indicative of the complexity of processing issues experienced by the group. Slower completion rates may also have limited the success of the Fast ForWord programme in influencing the final reading and language results. The second module, Language v2 focuses on the development of neural pathways for listening to and hearing sounds while the following module Language to Reading introduces letter sound relationships and begins to develop reading skills. It is suggested that if the students had completed three modules then there may have been more significant results with reading accuracy and reading comprehension.

Age equivalent scores were used in this study as standard scores were not available for the Neale reading assessment. Age equivalent scores are more sensitive to

differing rates of development at early ages as compared to later years. With age equivalent scores a change of a few raw score points can translate to a greater age score for a younger person than for an older person meaning for example that a 3 month delay in a younger person represents a greater difference in performance than for an older person. This is why the Neale does not report age equivalents beyond 6 years and 13 years. While age equivalents require special considerations when making comparisons over extended periods of time and for subjects of widely different age groups, in this study the comparisons involved changes over a period of 44 weeks and with students in a relatively narrow age band. Consequently age equivalent scores do not pose a problem for this study.

Phase one multivariate analysis of trial group means and control group means in conjunction with further analysis of within test means shows that there was a significant increase in the trial group scores for expressive language. The null hypothesis that participation in Fast ForWord has no effect on expressive language is shown to be not true. Phase two multivariate analysis also showed that there was a significant increase in scores for expressive language, receptive language and reading comprehension after experiencing Fast Forword Language v2 as compared to just experiencing the classroom programme earlier in the year. Again the null hypothesis that Fast ForWord has no effect on reading comprehension, expressive language and receptive language has been shown to be untrue in this phase.

The improved outcomes for phase 2 cannot be attributed to differences in baseline data as baseline data shows that both groups were similar as regards age, gender and age equivalent scores for language and reading assessments.

On the other hand, time of year may have been a factor influencing results. Phase one was implemented in March through to June and Phase two was implemented in August through to November. March to June is the first half of the school year when classroom literacy programmes and routines are being established. Fast ForWord claims to work in conjunction with literacy programmes building the capacity to learn. If those programmes are working more effectively in the second half of the year then it stands to reason that Fast ForWord would be more effective in the second half of the year. Further investigation with a control group that did not experience Fast

ForWord during the year would be needed to test this idea. Also analysis of literacy data gathered in contributing schools may also support or dispute this idea.

Implementation of the programme may also have been a factor in the differing results between phase one and phase two although participation rates in phase1 and phase 2 were similar with phase 2 participation being 10% lower than phase 1 for the Languagev2 module. The facilitators of the Fast ForWord programme were new to the role in the first phase and were developing skills in how to support and co-ordinate the programme and this may have had a small impact on the outcomes.

Significant results for reading comprehension, expressive language and receptive language are comparable to results achieved in international studies reported on the Scientific Learning website. It is interesting that initial improvements after using 2 modules of the Fast ForWord Language programme are language related as identified in the literature review, there are strong theoretical and neurological links between oral language and reading. It is suggested that these initial results may lead to further improvements in reading comprehension and accuracy on completion of advanced modules of Fast ForWord Language.

CONCLUSION

This research contributes positively to the literature on the benefits of Fast ForWord Language for oral language and reading and the randomised control trial design (RCT) with pre/post data collection is reflective of the requirements for gold standard in educational research. These results provide evidence that support Fast ForWord as a programme appropriate for meeting the learning needs of students who are struggling with learning to read and who are 2 years or more behind their age peers. The qualitative results also suggest that further analysis would be appropriate exploring other independent variables such as gender, cultural grouping and identified learning differences such as dyslexia, auditory processing and attention deficits.

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