Article

A Study of the Effectiveness of Cognitive Skill Therapy Delivered in a Video-Game Format

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ABSTRACT

Background: This study was designed to evaluate the improvement in cognitive functioning in students using a cognitive therapy program delivered in a video-game format in a non-clinical setting. A secondary goal was to compare the progress of students using the program to a control group that did not use the program.

Methods: The 38 student participants were volunteers from the Christian Heritage Academy in Northfield, Illinois. The study participants were divided into two groups: study and control. Both groups were tested with the Woodcock-Johnson® III Cognitive Battery before the study began and at the end of the study.

Results: Students in the study group showed an average of 4 years and 3 months improvement on tests of cognitive skills, compared to 4 months improvement for the control group and showed an average of 1 year and 11 months improvement on tests of achievement compared to 1 month for the control group.

Conclusions: The improvement by students using the program in a home-based setting was comparable to previous results with precursor paper-based products in a clinical setting. It is suggested that future research incorporate randomized assignment of participants to the study and control groups and a larger sample size.

KEY WORDS

optometric vision therapy, cognitive development, software, cognitive therapy, cognitive skills, BrainWare Safari

INTRODUCTION

The purpose of this study was to determine the effectiveness of a new cognitive skills development tool, BrainWare Safari (BWS). BWS is a computer-based cognitive skills development program in a video-game format for individuals aged 6 to 12. It is designed to comprehensively develop 41 cognitive skills covering the major areas of visual processing, auditory processing, memory, attention, sensory integration and thinking. Set in a South American jungle, it consists of 20 exercises designed to develop various cognitive skills. Each exercise builds multiple skills at the same time; this enables the player to use their strengths to build their weaknesses. The highly integrated skill development drives them to a subconscious level of processing so they become automatic. Eighteen of the exercises have seven levels which become progressively more difficult. Once a player passes a level they cannot go back to easier levels, forcing the player to continue where they left off. The two logic and reasoning exercises operate slightly differently due to the nature of the logic questions. Multiple attempts at the same question could end up just a guessing game, so after two incorrect answers, the player is shown the correct answer so they can see how to work out the correct answer to similar questions in the future.

Correspondence regarding this editorial should be emailed to ssawtelle@lecforyou.om or sent to Sara M. Sawtelle, Ph.D. Learning Enhancement Corporation, 200 S. Wacker, Suite 3100, Chicago IL 60606. *All statements are the authors' personal opinion and may not reflect the opinions of the College of Optometrists in Vision Development, Optometry and Vision Development or any institution or organization to which they may be affiliated. Copyright 2007 College of Optometrists in Vision Development.*

The procedural content in BrainWare Safari was adapted from techniques that were a combination of computer and paper activities that Dr. Helms developed in his vision therapy clinic. A white paper regarding the results with this program is available upon request.

Dr. Sawtelle works for Learning Enhancement Corporation (LEC) and has responsibility for research involving the company's products, including studies conducted by the company and coordination with independent researchers, developing, researching and coordinating studies that test their products. LEC has a major financial interest in the software noted in this study.

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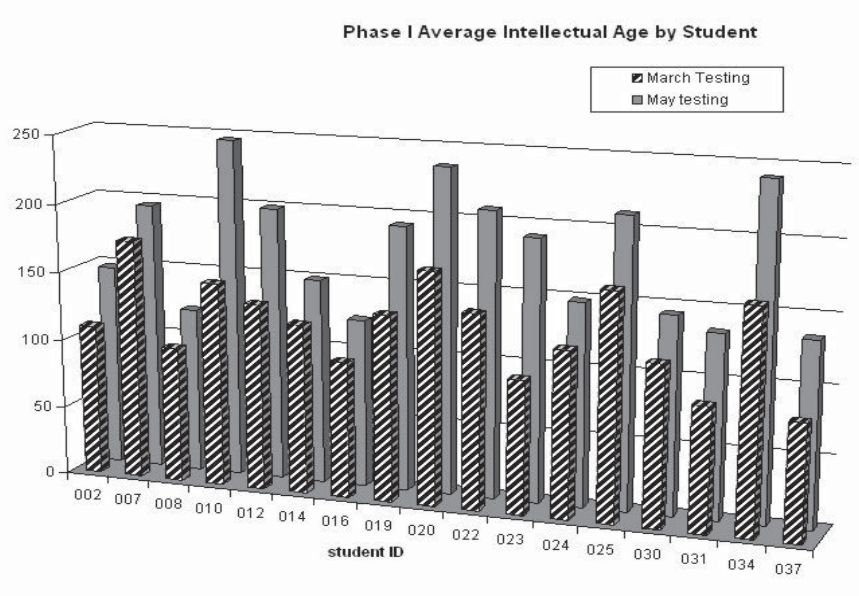

Figure 1.

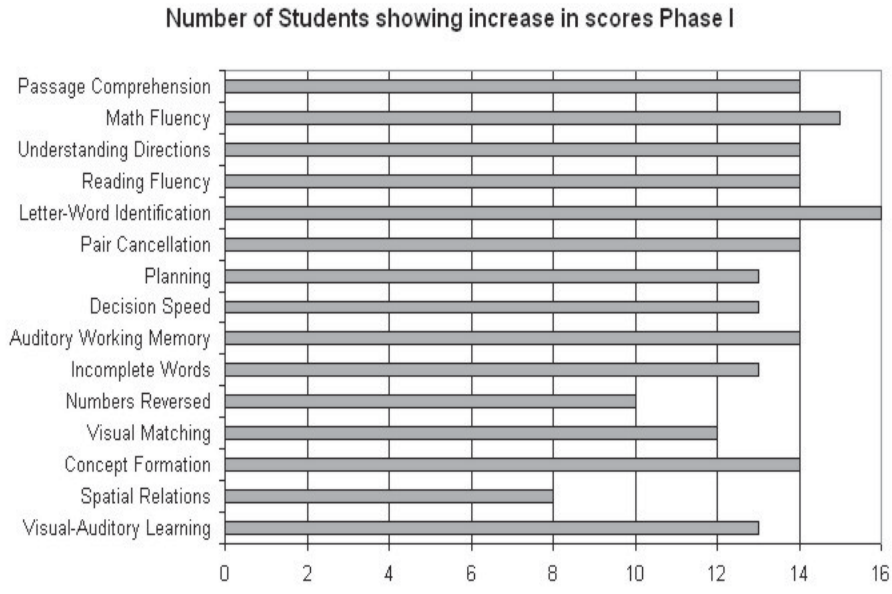

Figure 2.

An investigation of the literature in the areas of vision related learning problems and learning disabilities uncovered few studies that directly discussed the need to develop cognitive skills in children. Most of articles in these areas focused on deficiencies in one or two cognitive areas (i.e., visual or speech or attention) and the types of remedial training provided to persons with these deficiencies. In addition, studies have evaluated the treatment of perceptual deficits in children which indicated a positive effect on the child's ability to read after completing these therapy sessions.[1] Other investigations have validated perceptual therapy and its effect on academic performance.[2] Computer-assistive therapies were used for part of the session during Solan's study,[3] but no study that focused exclusively on the effects of therapy delivered in a video-game format that can be conducted in homes was found.

Traditional cognitive therapy sessions vary depending on the patient and the nature and severity of the problem. Most require in-office visits, with activities extending into the home.[4] The success of at-home therapy has varied depending on the assignment, how motivated the patient is, and how much support the patient receives from family. There has been some discussion in the investigations that have shown a number of factors determine effectiveness of any therapy. These factors include but are not limited to: individualized programs,[5] motivation,[6] and parental involvement.[7]

Cognitive scientists have argued that the most effective learning takes place at the outer edges of a student's competence, building knowledge while challenging the student with new problems.[8] One way to increase the success of at-home therapy is to make the homework more fun and entertaining. For years, many educators and psychologists have been advocating Digital-Game Based Learning as a tool for more effective learning.[9] A video game that is appropriate for learning purposes provides the stimulus that keeps children coming back for more.[10] The secret of video games is that they match what our brains desire: human brains are drawn to the challenge of an environment.[6] In fact, the video-game format provides a medium for delivering the necessary levels of challenge and making the experience enjoyable.

METHOD

The 38 students and their parents who agreed to participate in the study were divided into two groups. The study group used BrainWare Safari during Phase I of the study while the control group followed their normal routine. During Phase II of the study, the students in the control group used BrainWare Safari during the summer months. Students were assigned to the study group or the control group based primarily on their schedules and when their parents felt they could commit the necessary time to using BrainWare Safari during one of the two Phases. Phase I took place during the spring term (March to May) of the 2004-2005 school year. Phase II

Table 1. Level Progression for students in Phase I and Phase II of the study.								
	Phase I				Phase II			
BrainWare Safari Exercises	Avg. Levels Completed	Std. Dev.	Min. Levels Completed	Max. Levels Completed	Avg. Levels Completed	Std. Dev.	Min. Levels Completed	Max. Levels Completed
Rhythm Ribbet	4	2	0	7	3	2	0	7
Whispering Waterfall	3	3	0	7	3	3	0	7
Bear Shuffle	4	2	2	7	4	1	2	6
Tree Tic Tac Toe	4	2	2	7	4	2	1	7
Sky Scanning	3	3	0	7	3	2	0	7
Jungle Labyrinth	6	2	1	7	6	2	1	7
Memory Mountain	6	2	3	7	6	2	2	7
Parroting Colors	7	1	4	7	6	2	0	7
Cave Comparisons	6	1	2	7	6	3	0	7
Web Weaving	6	1	4	7	6	1	3	7
Iguana Lookout	5	2	2	7	5	2	2	7
Piranha Pass	7	1	1	7	5	3	0	7
Crocodile Recollection	3	3	0	7	3	3	0	7
Slithering Symbols	3	3	0	7	3	3	0	7
Arrow Point Bridge	6	1	4	7	6	2	0	7
Volcanic Patterns	7	0	5	7	7	0	7	7
Jumping Jaguar Flash	6	2	2	7	6	2	2	7
Turtle Recall	5	2	1	7	5	2	0	7
Llama Logic	20	2	14	21	21	0	21	21
Ancient Logic & Reasoning	21	1	18	21	21	0	21	21
Levels completed (aggregate)	131 (n=17)	26	87	168	131 (n=11)	29	80	165

took place during the summer following the 2004-2005 school year.

Many of the students were recommended for participation in the study by the school's principal based on a need for some additional academic help. However, some students without such identified need were recruited to participate in the study to increase the sample size. The students who participated in the study ranged in academic level from 1st through 8th grade (ages 6 to 13). The control group was composed of 14 males and 3 females while the study group contained 11 males and 6 females.

All students were pre-tested at the beginning of Phase I using specific portions of the Woodcock-Johnson® III (WJIII) Cognitive Battery and Tests of Achievement. Only the portions of the Woodcock-Johnson III tests that measured cognitive skill areas that BrainWare Safari was designed to address were administered. During Phase I, the study group committed to spending an average of 4 to 5 hours a week using BWS, with the parents serving as coaches for their children, as needed. The control group made a similar commitment during Phase II of the study.

At the conclusion of Phase I, 17 of the 19 students in each of the control and study groups (a total of 34 students) were again tested with the WJIII Cognitive Battery and Tests of Achievement. Of the four students who dropped out of the study, one in the study group had not used the program. The other study group student and the two control group students could not be scheduled for testing, despite multiple attempts. Thus, the results reported here are for the 17 study group students and 17 control group students who completed Phase I of the study.

At the conclusion of Phase II, 12 of the students in the control group were tested a third time after a summer of BrainWare activity (approximately 15 weeks). Of the five students who dropped out during the summer, one had never started using the program and four were unable to be scheduled for testing or were scheduled but did not appear for testing despite multiple attempts. One was removed from the sample due to a lack of commitment to the 11 week program as evidence by levels completed and time spent.

Pre- and Post-Test Format: The majority of the testing was conducted at Christian Heritage Academy. On each test date, four or five students were tested during each of 4 blocks of 2 ½ hours. Students rotated through the five test administrators to complete the designated complement of tests.

In addition to the WJIII tests, questionnaires were administered to parents of children participating in the

Table 2. Total Time using BrainWare and student ages, sorted by Phase and student. Also includes the total levels completed, the pre- and post age of the student and individual cognitive improvement in years and months.

			Chrono-logical Age	Pre-test age	post test age	Cognitive Improve-ment
ID	Total levels com-pleted	Total time (hh:mm: ss)	y.mo	y.mo	y.mo	y.mo
Phase I						
2	145	16:21:14	9.3	9.2	12.4	3.1
7	131	7:02:28	12.4	14.7	16.3	1.8
8	87	8:38:59	6.7	8.2	10	1.1
10	132	6:37:38	10.6	12.5	20.6	8.1
12	155	11:34:26	11	11.4	16.7	5.3
14	128	13:03:44	10.3	10.4	12.6	2.2
16	103	12:09:44	6.9	8.3	10.3	2
19	103	6:25:25	10.11	11.4	16	4.9
20	168	8:19:46	11.9	14.1	19.8	5.7
22	165	18:00:08	11.1	11.1	17.4	5.3
23	120	12:28:55	9	8.2	15.1	7.8
24	143	31:20:13	11.4	10.1	12.4	2.3
25	164	11:43:47	13.3	13.9	14,1	0.3
30	117	16:50:35	9	9.9	12	2.3
31	113	10:31:46	9	7.7	11.2	3.7
34	163	7:30:05	12.5	13.6	20.1	6.7
37	94	13:13:12	6.7	7.1	11.2	4.1
Phase II						
3	136	7:10:38	8.1	13.9	19.1	6.2
4	80	2:11:39	9.2	9.11	12.9	2.1
5	138	10:08:24	10.1	13.1	19.6	5.9
13	130	8:37:22	8.4	14.4	16.6	2.2
15	160	17:43:06	11.1	11.9	18	6.3
21	165	12:19:01	9.5	15.6	18.8	3.2
29	107	8:49:50	10.7	15.5	20.3	4.1
32	126	12:51:18	9	9.1	13.1	3.3
33	85	5:21:49	9.1	11.5	12.6	1.1
35	163	6:28:22	11.1	14	16.3	2.3
38	146	9:27:53	11.9	15.5	20.12	5.7

study at the conclusion of their time using BrainWare Safari. Respondents were not aware of the WJIII post-testing results at the time they completed the questionnaires.

Since BWS was both software and a new concept, during the time of the pre-testing the parents participated in a workshop to assist them on expectations. They were instructed that the children should be encouraged to engage in BrainWare 3 to 5 times a week for 45 minutes to an hour each session over the 11 week period. The parents of younger children were advised to sit with their children to help them understand what they needed to do to pass a level as necessary. All parents were encouraged to serve in the role of coach, providing additional motivation and guidance as required. As the levels in the program get harder and players spend more time working, they may experience some frustration. The parents were mentored during the workshop with advice on what to do and how to handle that situation. During the study, parents and students received any necessary technical support regarding use of the program and were encouraged to advise LEC of any software bugs they encountered.

Reporting of Results: All results are reported as an average ± standard deviation with the sample size reported as n=sample size. In addition, whenever appropriate, the tables will include minimum and maximum values.

RESULTS

Use of BrainWare Safari: Most parents reported that their students used BWS 45 minutes to 1 hour at a time, 5 days a week at the beginning. In most cases, usage tapered off after the first 5-6 weeks when the novelty wore off and when the children began to find the levels more challenging. In other words, as it became more challenging the children found working for a full hour difficult to do, and would therefore work as long as they could at each session. Two parents reported lower usage – 2 to 4 hours per week throughout the study. During Phase II, the duration of the study was extended to the entire summer break; as a result, reported usage was more erratic.

Actual use was monitored through data collected by BWS itself as shown in Table 1. Students in Phase I completed an average 131 ± 26 (n=17) of the 168 levels in the program. The maximum number of levels completed was 168 while the minimum completed was 87. The average student in Phase II completed 131 ± 29 (n=11) levels. In Phase II, the maximum number of levels completed was 165 while the minimum was 80.

Time spent: As measured by time spent in an exercise, Phase I study group students logged from 6 hours to 31 hours. On average, users spent 12 hours 5 minutes ± 6 hours 3 minutes (n=17) performing exercises over the course of the study period. When the control group used the program during Phase II of the study, they logged from 2 hours to 17 hours, with an average of 9 hours 11 minutes ± 4 hours 9 minutes (n=11) of measured exercise time. This data is outlined in Table 2. The total time spent is under-reported slightly due to computer tracking issues affecting 2 of the 20 exercises. BWS

records the "total time spent in exercise." It does not reflect the time the user spends in front of the computer (logging in, checking progress, time between exercises, etc.) nor is it a measure of intensity using the program. Actual "session time" could be double the recorded exercise time.

Woodcock-Johnson Test Results – Phase I: The average chronological age of students in the study group was 10 years 0 month ± 2 years 0 month (n=17) at the time of the pre-test. The average calculated age equivalent at the time of pre-test was 10 years 7 months ± 2 years 4 months. Students in the study group had an average chronological age at the time of the post-test of 10 years 3 months ± 2 years 0 months. The average calculated post-test age was 15 years 8 months ± 4 years 1 month. These results indicate that the study group showed an average of 4 years 3 months ± 3 years 0 months (n=17) improvement (Table 3) on the tests of cognitive skills during Phase I, compared to 4 months ± 15 months (n=17) improvement for the control group. Students in the study group showed an average of 1 year and 11 months ± 11 months (n=17) improvement on the tests of achievement compared to an average 1 month ± 11 months (n=17) improvement for the control group.

Within the Phase I study group, all students showed overall improvement in cognitive skills. Figure 1 is a graphical representation of the overall improvement of each student in Phase I. While some individual scores decreased on a few tests, all students showed overall average improvement on the WJIII Tests. Eighty-six percent of the study group students showed improvement on all the tests. Figure 2 represents the improvement on each of the tests that were administered, while Table 4 details the number of students who increased on each of the administered tests.

Table 3. Woodcock-Johnson® III results for Phase I and Phase II participants.

	Avg. Intellectual Age Difference Phase I				Avg. Intellectual Age Difference Phase II			
	March and May testing				May and August Testing			
	Control Grp.		Study Group		Avg. March to May		Avg. May to August	
Cognitive Ability Tests	Yrs	Mos	Yrs	Mos	Yrs	Mos	Yrs	Mos
Visual-Auditory Learning	0	3	6	6	0	3	7	7
Spatial Relations	-1	7	5	0	-1	7	8	8
Concept Formation	1	8	4	10	1	8	3	11
Visual Matching	0	2	0	5	0	2	0	10
Numbers Reversed	0	-11	2	3	0	-11	2	1
Incomplete Words	0	4	7	10	0	4	13	5
Auditory Working Memory	0	-4	3	3	0	-4	3	9
Decision Speed	0	5	2	2	0	5	3	4
Planning	3	0	9	7	3	0	-2	-9
Pair Cancellation	0	3	0	11	0	3	1	1
Average	4 mo		4 yrs 3 mo		4 mo		4 yrs	
Standard Deviation	1 yr 3 mo		3 yrs		1 yr 7 mo		4 yr 7 mo	
	n=17				n=11			
Achievement Tests	Yrs	Mo	Yrs	Mo	Yrs	Mo	Yrs	Mo
Letter-Word Identification	0	2	1	5	0	2	1	6
Reading Fluency	0	1	1	1	0	1	1	3
Understanding Directions	0	5	3	5	0	5	3	1
Math Fluency	0	-4	1	7	0	-4	0	-10
Passage Comprehension	0	0	1	11	0	0	0	1
Average	1 mo		1 yr 11 mo		1 mo		1 yr 1 mo	
Standard Deviation	3 mo		11 mo.		11 mo		1 yr 6 mo	

Phase II: Students in Phase II showed an average of 4 years ± 4 years 7 months (n=11) improvement on the tests of cognitive skills and an average of 1 year 1 month improvement ± 1 year 6 months (n=11) on the tests of achievement. (Table 3). This compared to the 4 months ± 15 months (n=17) improvement on tests of cognitive skills and 1 month on the tests of achievement for the same group when they were not using BWS. The age range for the students was 9 years 8 months ± 1 year 7 months (n=11).

During Phase II, all students showed overall improvement in cognitive ability. Figure 3 is a graphical representation of the overall improvement of each student in Phase II. While some students' scores decreased on a few individual tests, all students showed improvement and overall average improvement on the Woodcock-Johnson Tests. Figure 4 represents the improvement for each test in Phase II while Table 5 indicates the details.

In both Phase I and Phase II, the tests that showed the most increase were Incomplete Words, Spatial Relations, Visual Auditory Learning, Auditory Working Memory, and Concept Formation.

Questionnaire Feedback: Parents of 12 of the 17 students in the study group and parents of seven of the students in the control group completed a questionnaire regarding their experience using BrainWare Safari. Among other things, the questionnaire asked them if they had seen any changes in their children over the course of the study period.

DISCUSSION

The Woodcock-Johnson® III results are very striking, especially looking at individual achievement (Figure 1 and Figure 3). Considerable improvement in cognitive development was experienced by all of the children who participated in this study. Table 2 allows a closer look at the individual achievements based on levels completed, total time, chronological age and testing ages.

While the standard deviation is quite large, some of the variation in results for both the control and study

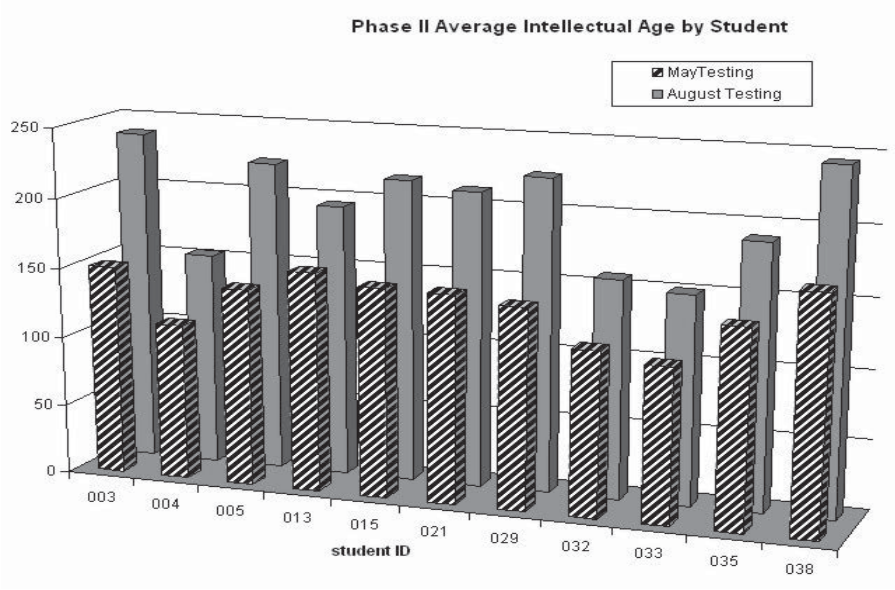

Figure 3.

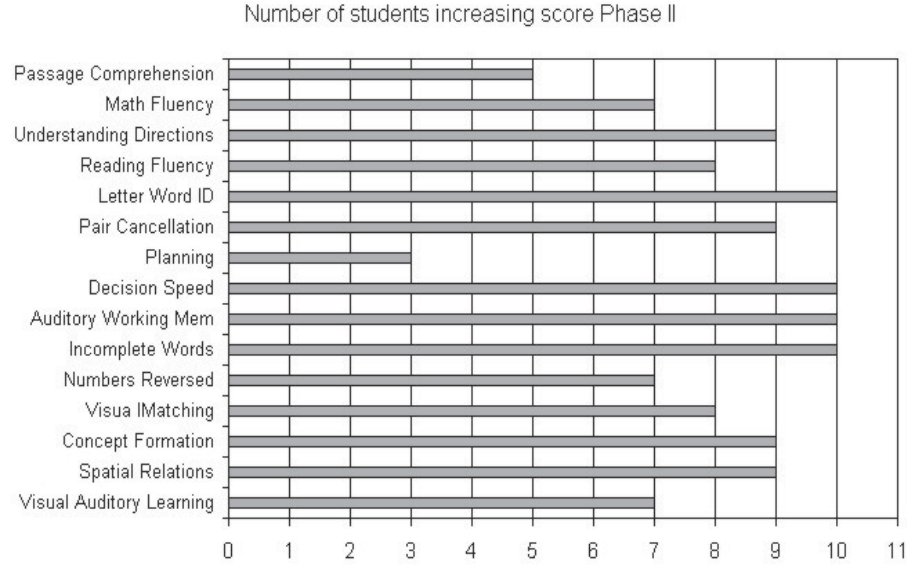

Figure 4..

group is associated with the small sample size and wide age range. In addition, there was a wide variety in individual ability among the participants. A cursory look at the chronological age compared to the pre-test age demonstrated the variety of skills represented in this small sample size. The study did not focus on gifted, or normal, or challenged, but there were some of each in the small sample size used. The average improvement in cognitive ability for the control group was not unexpected since the tests were administered within a 12-week period and there could be some test recognition among individuals. However, the improvements in the Study Group were significantly above those of the Control Group. In Phase II, the Control Group's results from the second test were used as the pre-test results to compare against post-BrainWare Safari tests, and significant improvement was again noted.

In analyzing the data, we determined whether there was a correlation between BWS progress and the amount of cognitive skill improvement experienced by the students. To this end, we looked at individual levels completed and time spent in BWS for a correlation. We found that the number of levels completed, although interesting to see on an individual level, does not provide any insight into the degree of improvement experienced by students using BWS. For example, Student 16 completed 103 levels of BWS in 12:09:44 while Student 19 completed 103 levels of BWS in 6:25:25. Student 16 was 6.9 years old at the time of pre-test, pre-testing at 8.3 and post-tested with 1.11 years of growth. Student 19 was 10.11 years old at the time of the pre-test, pre-testing at 11.7 and post-tested with 6.5 years of growth. This clearly demonstrates that there is not a simple correlation in time and levels to the cognitive growth.

The lack of correlation is not surprising due to the design of the program which is designed to build multiple skills in each exercise and the fact that each person brings a unique combination of skills to the experience. BWS is effective because it uses a person's strengths to build weaker cognitive skills, thereby automatically individualizing the experience for the needs of the player. Although a correlation would make it easy to justify the results, a simple one does not exist. Further scientific investigations may find a correlation between neural activity and growth but that study has yet to be done, especially in a more homogenous study group.

It is unknown whether any of the students were part of other therapies during the time of the BrainWare Study. As we were looking for real-world examples, we did not request that they not participate in any others while in this study.

We do not believe that there were any improvements due to the Hawthorne effect since the testing was completed using the techniques in the Woodcock-Johnson® III tests eliminate much subjectivity on the part of the test administrators. The persons doing the testing follow a specific script. The impact of blind test administration may be minimal as the Woodcock-Johnson III tests and answers are pre-defined and objective;

Table 4. Woodcock Johnson III Results Phase I. For each WJIII test, the number and percent of students that increased their scores and the number of students that achieved the highest possible on the pre-test. The total number of students in the study group was 17.

	Number of Increases	% Increase	Number of High Scores
Visual-Auditory Learning	13	100%	4
Spatial Relations	8	73%	6
Concept Formation	14	100%	3
Visual Matching	12	71%	0
Numbers Reversed	10	67%	2
Incomplete Words	13	87%	2
Auditory Working Memory	14	100%	3
Decision Speed	13	81%	1
Planning	13	93%	3
Pair Cancellation	14	82%	0
Letter-Word Identification	16	94%	0
Reading Fluency	14	82%	0
Understanding Directions	14	82%	0
Math Fluency	15	94%	1
Passage Comprehension	14	82%	0

there is no speculation on the part of the evaluator as to whether an answer is right or wrong. Administrators are given specific things to say and directed when to indicate a correct answer However, eliminating the Hawthorne effect with respect to the students was not part of this particular study design.

The role of the parent as coach, as reported by the parents, varied. Some parents said that they didn't give their children any help. Some said that they simply reminded their children to make sure they put the time in. The parents of younger children (first and second graders) reported sitting with their children the entire time they were using the program to help interpret instructions and to provide encouragement. Most parents found their children quickly became more independent in their use of the program as they progressed.

In addition, parents observed behavioral changes which they attributed to their children's use of BrainWare Safari. The parents were not asked for their observations until the end of the 11-week study period, but many spontaneously reported changes before then. Improvement in memory, attention and focus were the most commonly reported changes (slightly over half of respondents). Improvement in self-confidence, careless errors, and effective thinking were also reported by half the parents.

Interestingly, 16 of 19 cases, parents reported seeing improvement on one or more of the attributes they were asked to assess. Three of the 18 reported no change on any of the attributes. One parent who reported positive change on one attribute (memory) also reported a negative change on one attribute (self-confidence), the only negative change reported. Table 6 shows parental responses regarding each of the attributes they were asked to assess.

Table 5. Woodcock-Johnson® III Results Phase II. For each WJIII test, the number and percentage of students that increased their scores and the number of students that achieved the highest possible on the pre-test.

	Number of Increases	% Increase	Number of High Scores
Visual-Auditory Learning	8	67%	3
Spatial Relations	9	75%	1
Concept Formation	10	83%	0
Visual Matching	9	75%	1
Numbers Reversed	7	58%	0
Incomplete Words	10	83%	0
Auditory Working Memory	11	92%	0
Decision Speed	11	92%	0
Planning	4	33%	2
Pair Cancellation	10	83%	0
Letter-Word Identification	11	92%	1
Reading Fluency	8	67%	0
Understanding Directions	10	83%	0
Math Fluency	7	58%	0
Passage Comprehension	6	50%	0

Table 6. Parent Feedback. This table shows how many of the parents attributed improvement in specific areas. 12 parents responded out of the 19.

Attribute	Number of Parents Noting Improvement
Memory	9
Attention & Focus	9
Careless Errors	8
Self-Confidence	8
Effective Thinking	8
Distractibility	7
Recall of Information for Tests	7
Attention to Details	6
Grasping New Concepts	6
Visualization (Mental Pictures)	6
Ability to Complete Schoolwork	4
Following Directions	5
Desire to Perform (Effort)	4
Parent/Peer/Teacher Communication	3

Questionnaires were also provided to the students and 16 completed them (Table 7). Of the 16, 11 noticed a change in one or more of the behavioral attributes they were asked to rank. As with the parents, memory was the most commonly reported area of improvement.

Table 7. Player Feedback. This table shows how many of the players observed improvement in specific areas.	
Attribute	Number of Players Noting Improvement
Memory	9
Following Directions	7
Listening & Understanding	7
Self-confidence	6
Attention & Focus	6
Ability to Complete Schoolwork	4

Most struggling school-age children receive detailed assessments of their performance either in or out of school. The most frequent characteristics that become generalized as learning disabilities include: spoken language delays, written language delays, arithmetic difficulties, reasoning delays and memory difficulties. Individual diagnoses may be influenced by budgetary limitations and special education laws that encourage the identification of specific disabilities in order that funds can be made available to help the child. This presents situations where children are diagnosed incorrectly or slip through the cracks.[7] The characteristics that lead to the assessment of a child being labeled as LD are hyperactivity, perceptual-motor deficits, emotional liability, general orientation and lateral defects, distractibility, short attention span, impulsiveness, disorders of memory and conceptual thinking and specific learning defects.[11] The difficulty lies in determining which of these characteristics correlate to poor performance, especially when most persons will exhibit at least one or two of these throughout their lives. Because BWS addresses these issues, it could be beneficial in numerous settings, whether treatment is recommended or not.

The feedback received about the use of BWS showed that the students did experience improvement in their cognitive skills and as a result their academic performance increased. This was accomplished working at home with their parents, using a therapy program that most found fun and entertaining. BWS appears to have most of the characteristics of good therapy: individualized, motivating and involved, or in other words, therapy children want to do.

CONCLUSIONS

It is not surprising that a video-game format works with this type of therapy, since it stimulates the desire and effort that are so important in the effect of the therapy. Although the experimental methodology in this first study of cognitive therapy presented in a video-game format has some limitations, these limitations do not vitiate the outcome: significant improvement in cognitive skills and academic achievement for the study group as measured by the Woodcock-Johnson® III Cognitive Battery and Tests of Achievement. This study demonstrated that improvement in cognitive skills and academic achievement can be attained by students using BWS in a home-based setting with parent coaches. While we would expect to observe limited behavioral changes in the time frame of the study, most parents did observe some improvement in students within the study period.

We expect that the results in a clinical setting with the same product would be even more effective because of the more directed nature that clinical use implies. In a clinical setting the program can be even more individualized and include other therapeutic methods which are unavailable to the untrained parent.

Implications for Further Research

Future research should include randomized assignment of participants to the study and control groups and utilize blind test administrators. A larger sample size and inclusion of students with a wider range of abilities, in such a way that more homogeneous groups within the range could be evaluated, would also be desirable. Evaluation of BrainWare Safari used in a clinical setting in conjunction with and as compared to other therapies would also be very informative.

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