



# Research Summary: BrainWare SAFARI and Students with Learning Disabilities

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# Background

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BrainWare SAFARI is a cognitive training software program that addresses multiple areas of cognitive processing (attention, memory, visual and auditory processing, logic and reasoning and sensory integration) in a digital game-based format. It was derived from over 40 years of collaboration among clinicians in multiple disciplines, including speech pathology, vision development, psychology, and others. The set of therapeutic exercises developed and refined by these clinicians was then incorporated into a computer-based program designed according to key principles of cognitive training. Those principles are listed in Appendix A.

Over the last decade, BrainWare SAFARI has been used with a variety of populations, from low-performing to high-performing students of all economic backgrounds. While BrainWare SAFARI is not uniquely designed for students with learning disabilities, the persistent national academic achievement gap for students identified as having learning disabilities has prompted research and field studies in schools and districts around the U.S. examining the impact of cognitive training on cognitive functioning and academic achievement.

This document summarizes the studies of BrainWare SAFARI with students with learning disabilities. Links to more detailed reports of each study as well as to other published research and field studies with BrainWare SAFARI is available at [www.mybrainware.com/safari/research](http://www.mybrainware.com/safari/research).

Following the study summaries is a discussion of the role of cognitive skills development in special education.

## Study Summaries

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### **Effect of Neuroscience-Based Cognitive Skill Training on Growth of Cognitive Deficits Associated with Learning Disabilities in Children Grade 2-4 (2012)**

- Schools:** Private and Charter Schools in New York, NY
- Subjects:** 40 students in grades 2, 3, and 4, in 2 schools, diagnosed as having a specific learning disability (SLD), randomly assigned to treatment and non-treatment groups. All students continued to receive the standard reading and math interventions to which they were entitled because of their SLD diagnosis.
- Usage:** 3 to 5 sessions per week, 30-45 minutes per session, 12 weeks
- Assessment:** Woodcock Johnson III Cognitive Battery and Tests of Achievement

**Summary of Findings:** Students in the study who used BrainWare SAFARI for 12 weeks improved their cognitive functioning by 2.8 years, compared to 2 months for the control group. This improvement raised the students' overall cognitive proficiency level from 64% to 89% where 90% is the expected performance for a normally developing student. Students in the control group improved just one percentage point, from 63% to 64% proficiency. Students in the treatment group improved their reading and math scores by 0.8 and 1.0 grade equivalent respectively over the 12 weeks.

### **BrainWare SAFARI Shown to Impact Students in Iran with Reading Problems (2012)**

**Subjects:** 35 Iranian children, ages 7 to 12, native Persian speakers, with reading difficulties,  
**Usage:** 5 sessions per week, 50-60 minutes per session, 6 weeks  
Only 6 of the 20 exercises in BrainWare SAFARI were used in this study, focusing on Visual Spatial processing and Working Memory.  
**Assessment:** Raven's Progressive Matrices, tests of Reading Words and Reading Pseudowords

**Summary of Findings:** As reported in two articles, the study showed increases in memory and attention in students diagnosed with reading difficulties. The experimental group showed training effects on non-trained tests as well as transfer effect to visual-auditory sustained attention, visual auditory vigilance/speed, and hyperactivity after training, providing further evidence for shared processes between working memory, attention and reading.

### **BrainWare SAFARI Cognitive Skills Development in Before and After School Programs with Low Performing Readers (2015)**

**District:** School City of Hammond, Hammond, IN  
**Subjects:** 22 students in grades 3, 4 and 5, in 2 schools, economically disadvantaged, chosen because of poor reading performance  
**Usage:** 4 sessions per week, 45 minutes per session, 10 weeks  
**Assessment:** Cognitive Abilities Test (CogAT)

**Summary of Findings:** Students improved an average of 13 percentile points on the composite score on the CogAT, consistent with results from previous studies using the CogAT and the CCAT (Canadian Cognitive Abilities Test), including a previous study in one of the same schools with students with a range of abilities. The average pre-test score on the Verbal Reasoning subtest for these students was markedly low, at the 35<sup>th</sup> percentile, consistent with student selection criteria (low reading performance). On post-test, the average score on Verbal Reasoning increased to the 48<sup>th</sup> percentile.

### **Students Increase Effectiveness of Reading and Math Interventions with the Addition of BrainWare SAFARI (2014)**

**District:** Richmond School District, Richmond, WI  
**Subjects:** 21 students in grades 1-6, recommended by teachers as needing extra support  
Students also received a reading or math intervention  
**Usage:** 3 sessions per week, 30 minutes per session, 11 weeks  
**Assessment:** AIMSweb rate of improvement (ROI)

**Summary of Findings:** The majority of students who used BrainWare SAFARI and were provided with a reading intervention received an ROI score greater than the expected ROI, as did the students who used BrainWare SFARI and a math intervention. Students who used BrainWare SAFARI and received an intervention had a greater increase in ROI than students who only received an intervention.

## **Cognitive Skills Development Helps Close the Gap for Students Performing Below Grade Level (2013)**

**District:** Millville Area School District, Millville, PA  
**Subjects:** 214 students in 3<sup>rd</sup> through 6<sup>th</sup> grades, subgroup of students with IEPs  
**Usage:** 3 sessions per week, 30 minutes per session, 14 weeks  
**Assessment:** DIBELS ORF in 3<sup>rd</sup> and 4<sup>th</sup> grade, GRADE reading assessment in 5<sup>th</sup> and 6<sup>th</sup> grade

**Summary of Findings:** Test scores were compared to prior year test scores for all students. Students who performed below grade level the prior year experienced significant gains following their use of BrainWare SAFARI and average performance narrowed or closed the gap. For students with IEPs, the 3<sup>rd</sup> grade students more than doubled their WPM gains and significantly narrowed the gap. The 4<sup>th</sup> grade students with IEPs also narrowed the gap to grade level on the DIBELS ORF. The 5<sup>th</sup> grade students with IEPs moved from significantly behind grade level the previous year on the GRADE assessment to ahead of grade level following their use of BrainWare SAFARI. The 6<sup>th</sup> grade students with IEPs gained twice the expected growth on the GRADE test and narrowed the gap to grade level.

## **Special Needs Students Benefit from Use of BrainWare SAFARI (2013)**

**District:** Fillmore Unified School District, Fillmore, CA  
**Subjects:** 7 3<sup>rd</sup> grade students, identified as special needs, as part of a larger study, 5 students ended up in the treatment group and 2 in the non-treatment group  
**Usage:** 3 sessions per week, 30 minutes per session, 11 weeks  
**Assessment:** OLSAT, California State Test (ELA and Math)

**Summary of Findings:** Two students in the treatment group experienced large gains on the OLSAT and on state test scores following their use of BrainWare SAFARI. Neither of the students in the non-treatment group showed improvement. One of the two students achieved a 27 percentile-point increase on their total OLSAT score. In 2<sup>nd</sup> grade, this student received a scaled score on the California state test 116 units below the state-wide median. In third grade, following use of BrainWare SAFARI, this student scored 80 units above the state median score, moving from Far Below Basic to Advance on the ELA. The second student achieved a 15 percentile-point increase on the total OSLAT score. In 2<sup>nd</sup> grade, this student scored 78 units behind the state-wide median on the state test. In 3<sup>rd</sup> grade, the student closed the gap to the state-wide median to 23 units, moving from Below Basic in ELA to Basic and from Basic to Advanced in Math.

## **Strengthening Cognitive Processes in Students with Resource Plans (2012-2013)**

**District:** Nativity Catholic School, Brandon, FL  
**Subjects:** 18 students in 3<sup>rd</sup> and 4<sup>h</sup> grades, with resource plans  
**Usage:** 2 to 3 sessions per week, 30 minutes per session, 10 weeks  
**Assessment:** Woodcock Johnson III Cognitive Battery Subtests: Visual Matching 2, Decision Speed, and Pair Cancellation, age equivalent

**Summary of Findings:** In the Fall implementation, student performance on the three WCJIII subtests improved an average of 1 year 3 months over 10 weeks. In the Spring implementation student performance improved an average of 1 year 6 months. These results are consistent with those from previous studies on these three tests. (NOTE: These subtests were chosen because they could be group-administered, using paper and pencil.)

### **BrainWare SAFARI at Harbor Beach Community Schools (2009)**

**District:** Harbor Beach Community Schools, Harbor Beach, MI  
**Subjects:** Students aged 7 to 16, recommended by teachers because of learning issues, need for extra support  
**Usage:** 4 sessions per week, 45 minutes per session, 12 weeks  
**Assessment:** Woodcock Johnson III Cognitive Battery

**Summary of Findings:** The students' average improvement was 3 years 1 month, following their use of BrainWare SAFARI. Each student exhibited improvement in their intellectual ability on the test. Teachers observed significant improvements in academic performance.

### **Case Study – Two Special Needs Students (2008)**

**Subjects:** 2 male students, ages 9 and 12, with significant learning and processing issues, whose progress in a reading remediation program had plateaued.  
**Usage:** 3 to 6 sessions per week, 30-60 minutes per session, 12 weeks  
**Assessment:** Woodcock Johnson III Cognitive Batter

**Summary of Findings:** Following their use of BrainWare SAFARI, the boys improved their performance on the cognitive tests by 5 years 4 months and 2 years 2 months respectively. Their parents reported positive changes in attention, tolerance for frustration, pace of work and self-confidence. Both were then able to resume and benefit from further reading remediation.

### **Case Study – Family with ADD/ADHD (2008)**

**Subjects:** 3 male children, ages 9, 10 and 11, diagnosed as ADD or ADHD  
**Usage:** 3 sessions per week, 60 minutes per session, 11 weeks  
**Assessment:** BrainWare Behavioral Rating Scale

**Summary of Findings:** Improvements were noted for all three boys, including their attention skills, perceptual processing, life management and self-esteem.

### **BrainWare SAFARI with Students with Autism Spectrum Diagnoses (2008)**

**Subjects:** 33 Male (28) and female (5) students, ages 5 to 16, with a range of ASD (severe to Asperger's)  
**Usage:** 3 to 5 sessions per week, 30-60 minutes per session, 12 weeks  
**Assessment:** CARS Rating Scale, BrainWare Behavioral Rating Scale

**Summary of Findings:** Over half of the students were able to persist in use of the program over the duration of the study. Subjects aged 9 and older and those with higher functioning and Asperger's diagnoses demonstrated the most benefit, with improvements noted in perceptual processing, sensorimotor function, attention, thinking (logic and reasoning), and life management skills. Improved interpersonal relationships and greater tolerance for frustration were also observed.

## BrainWare SAFARI in a Special Needs School (2007)

**School:** The Gap School, Sarasota, FL  
**Subjects:** Students aged 11 to 17, with IQs of 70-80  
**Usage:** 2 sessions per week, 30 minutes per session, duration of the school year  
**Assessment:** Detroit Tests of Learning and Aptitude, Gibson Cognitive Battery

**Summary of Findings:** Students improved their cognitive skills by 9 months on average over the school year while they used BrainWare SAFARI, a greater improvement than typically experienced by this type of student. Persistence and tolerance for frustration were better than with previous paper-based therapy techniques.

## Cognitive Skills Development in Special Education

Multiple decades of research and practice have resulted in significant shifts in the way students with learning disabilities are supported in schools in the U.S. and elsewhere. In the U.S., federal policy defines various categories of disabilities that may entitle students to special education services or other educational accommodations. Some of the disabilities identified in the Individuals with Disabilities Education Act (IDEA) constitute barriers to access to education or limitations on the students' ability to participate in certain activities. These would include deafness, blindness and orthopedic disabilities. These types of disabilities may exist even when the learning mechanisms of the brain are still intact and functioning normally. Other disabilities, however directly involve the brain's learning processes. Specific learning disabilities, in particular, are defined as deficits in underlying psychological processes involved in learning. Such deficits may affect visual working memory, verbal working memory, processing speed and short-term memory and other cognitive processes. Intellectual disability also directly impairs the brain's learning capacity. And still other identified disabilities may include under-developed cognitive processes. For example, students with ASD or ADHD typically have issues with attention skills, working memory and other executive functions, which play important roles in learning.

The image below is a conceptual representation of the stages and relationships of mental processes involved in learning. Deficits in any of the skills involved at any stage of processing can impair learning.



Educators who work with students with deficits in underlying cognitive processes that impede their ability to learn to read, write and do math typically use three categories of strategies to help students receiving special education services:

Special Education Strategy	Examples
Accommodation	More time on tests. Verbal instructions instead of (or in addition to) written instructions. Help with note-taking.
Curriculum Modifications	Texts at a lower reading level. Fewer spelling words or math problems. Assignments targeted at lower-level skills (e.g., recall vs. analysis).
Compensatory Strategies	Visual planners Mnemonics Color coding

It is important to understand that the purpose of these strategies is to bypass the cognitive processes that are weak in order to minimize the impact of processing deficits. Thus, for example, if a student has limited working memory capacity and can't remember a set of three instructions, the teacher would eliminate the need to hold three items of information in working memory, and, instead, give the instructions one at a time. That is an example of an accommodation.

These commonly used intervention strategies often do not result in student success. Students receiving special education services continue to lag the general population in academic achievement (NAEP). Recent research suggests that the lack of effectiveness of these strategies is explained by the substantial cognitive deficits that impair the students' learning progress. (Swanson, 2009 and Geary, 2004)

Over the last decade, researchers and educators have begun to explore a fourth strategy, the remediation of cognitive processes known to be weak. (Muller, 2012) The concept is that helping students develop weak cognitive areas will help them learn more like their typically developing peers, rather than working around them or using strategies to bypass them.

A major focus of many research efforts has been on the training of working memory, a cognitive skill also referred to as an executive function, which is highly correlated with a variety of aspects of academic achievement. Numerous studies have shown a positive effect of training on working memory, but not all have shown a transfer of the gains to academic performance. (Holmes and Gathercole, 2013)

BrainWare SAFARI takes a more comprehensive and integrated approach to cognitive skills development, working on 41 skills in the areas of attention, memory (including working memory), visual processing, auditory processing, sensory integration and logic/reasoning. In the studies summarized earlier in this document, both cognitive and academic gains have been significant for students with specific learning disabilities and IDEA categories of disabilities, including ASD and ADHD, as well as students receiving extra resource support.

In developing an IEP (Individualized Education Plan) to include cognitive skills development, the following aspects of the IEP should be considered:

#### A. Current level of performance

A student's current level of performance on both cognitive and academic measures should be taken into account. Cognitive assessments such as the Woodcock-Johnson III Cognitive Battery, the CAS, the CogAT, or Mindprint can be used to look at a baseline measure of cognitive functioning. It is also usually very helpful to gather parent and teacher observations of behaviors indicative of cognitive development (the BrainWare Behavioral Rating Scale can be used for this).

Formative and summative academic benchmark tests can be used to understand a student's current level of academic performance.

#### B. Measurable goals

Few IEPs have historically established goals for cognitive growth, since most cognitive testing has been used diagnostically, that is simply to diagnose, without any expectation of significant change. However, when cognitive training is part of the intervention, then repeating a cognitive test following the intervention is appropriate. The cognitive assessments listed above can be administered again following the intervention to document areas of improvement. Behavioral goals should also be specified and can be based on parent and teacher observations gathered to document initial performance. For example, if one of the original observations was that the student was not able to accurately copy assignments from the board, then that could form the basis for a behavioral goal that "X will be able to copy homework assignments accurately from the board."

In developing goals for academic performance, educators should recognize that the goal of a cognitive training intervention is to enable the student to learn as his/her normally developing peers. The research cited above suggests that goals should not just envision progress, but progress toward narrowing or closing the gap to grade-level norms and peer performance.

#### C. Services

Cognitive training services defined in an IEP should specify the cognitive training tool and and/or materials that will be used. An effective cognitive training tool will meet the criteria listed in the Appendix of this document. The IEP should also define the frequency and duration of use of the training, the role of the individual or coach working with the student, and how progress will be monitored.

#### D. Participation with non-disabled students

An advantage of computerized cognitive training is that students can work on the program alongside non-disabled students.

Training of cognitive skills with BrainWare SAFARI can significantly remediate underlying weak cognitive processes for many students with learning disabilities. In some cases, students have been able to be mainstreamed more quickly into a general education environment; in other cases, reading- and math-specific interventions have worked more rapidly than prior to the cognitive training. (Avtzon, 2012)

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## Appendix – Principles of Effective Cognitive Training

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**Progressive challenge.** One of the principles of good video games is that each level gets progressively more challenging and that's also critical for cognitive skill development. The concept is sometimes referred to as the "zone of proximal development." The user needs to be challenged but not too far above his or her current ability level.

**Novelty and changing expectations.** More than simple increases in difficulty, effective cognitive training involves novelty and changing expectations.

**Cross-Training.** If a program develops skills independently, then the brain doesn't get practice at using them together. An effective program needs to work cognitive skills in a comprehensive and integrated way so that the brain will know how to "put it all together."

**Feedback.** Good cognitive training programs provide instantaneous feedback. This enables us to learn from our mistakes, make immediate adjustments and try again.

**Coaching.** It is often helpful to have a coach working with the user, whether a parent at home, a teacher with students at school, or a clinician or therapist in their office.

**Engagement.** In order for the program to deliver significant cognitive growth, it will get hard for user – probably very hard – at some point. That is when engagement and motivation to persist are essential. Motivation to persist can be fostered by good coaching but the extrinsic and intrinsic rewards of the training and the degree to which the program delivers on the sense of developing mastery, builds the sense of autonomy and has an overall purpose are vital.

**Protocols to achieve specific goals.** A cognitive training program should have a regimen or protocol for usage to deliver the benefits that it claims, based on research. There may be different protocols for different goals or for different types of users, taking into consideration the frequency and intensity needed to result in changes in the strength of neural networks. Just like going to the gym once a week might make you feel less guilty, but doesn't do much for physical strength, flexibility or stamina, it will take multiple times a week for a number of weeks to make a noticeable difference with cognitive training.