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## The Research Foundation for BrainWare Safari

The methodology incorporated in BrainWare Safari is derived from techniques used over decades of clinical practice and across a spectrum of clinical health care and behavioral science disciplines. The program is supported both by broadly accepted scientific principles of brain function and by a growing body of research specific to BrainWare Safari. The program's video-game format was designed in accord with the best practices of the medium.

### About BrainWare Safari

BrainWare Safari is a software program that contains 20 exercises, each with multiple levels that become progressively more difficult. The first level of each exercise must be completed by demonstrating a level of proficiency in order to move to the second level, and so on with the second and each subsequent level. Once a level is passed, the player does not go back to that level or previous level in the exercise. Each of the 20 exercises in the program develops multiple cognitive skills, and most skills are developed in multiple exercises, in different ways and in different combinations. Players move freely from one exercise to another at will.

Overall, BrainWare develops 41 cognitive skills in six main areas: Attention, Visual Processing, Auditory Processing, Memory, Logic & Reasoning, and Sensory Integration. The 41 cognitive skills developed in BrainWare Safari are listed in Appendix A.

While each exercise in BrainWare Safari is independent of the others (that is, a player may be at Level 1 in one exercise and Level 3 in another), they are integrated in the overall theme and scoring of the program. The theme is a South American jungle and a character (Safari Friend) grows up as the player passes certain milestones in total levels completed across all exercises.

### Scientific Principles for Developing Cognitive Skills

BrainWare is based on eight scientific principles related to cognitive skill development. The first two principles define the basic premises upon which any type of brain-training program is built – the concepts of neuroplasticity (that the brain can be changed) and automaticity (that the brain can be trained to be extremely efficient and to function without conscious effort).

#### Principle 1: Neuroplasticity.

The general term for the brain's ability to change and to develop in response to its environment and the demands being placed on it is "neuroplasticity." The plasticity of the brain was first characterized by Dr. Donald Hebb of McGill University in the mid-twentieth century.<sup>1</sup> Hebb's seminal work and subsequent research characterize the nature of human learning, starting with the simplest of neurological processes. Hebb described how the brain organizes itself, creating and pruning neural pathways, connections and network patterns in response to the environment and an individual's experience.

Brain development and specific patterns of neural connections are not genetically predetermined in the way that attributes like red hair or blue eyes are determined. While intellect and learning ability are guided by an individual's genetic code, they arise in significant part through the process of development.<sup>2</sup> Many studies suggest that individual variation seems to be accounted for about equally by nature and nurture.<sup>3</sup> The plasticity of the brain is greater in children, but the brain exhibits the ability to change and develop throughout life.<sup>4</sup>

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<sup>1</sup> Hebb, Donald O., *The Organization of Behavior*, (New York: Wiley, 1949)

<sup>2</sup> Getman, G. N., *How to Develop Your Child's Intelligence*, (Luverne, MN: Self-Published Research, 1962)

<sup>3</sup> Pinker, Steven, *The Blank Slate: The Modern Denial of Human Nature*, (New York: Penguin, 2003)

<sup>4</sup> Diamond, Marian Cleves, *Enriching Heredity*, (New York: The Free Press, 1988)

Because the brain can change in response to its environment, cognitive skills can be developed and strengthened with the appropriate training. Hebb's pioneering work has been confirmed and extended through subsequent research, especially with brain imaging techniques such as PET (positron emission tomography) and fMRI (functional magnetic resonance imaging). For example, Dr. Marian Diamond has shown that neurons and neuronal connections in the brain grow at a very rapid rate in enriched environments.<sup>5</sup> Dr. Sally Shaywitz has shown that learning difficulties, such as dyslexia, are related to brain development and that specific training can help many individuals whose brain systems have not been optimally activated.<sup>6</sup> In 2007, Dr. Norman Doidge published a path-breaking book firmly establishing neuroplasticity as a proven scientific concept with myriad implications for therapists and educators.<sup>7</sup>

A number of recent studies have focused on the use of computerized techniques, especially video games, to deliver training that can enhance brain function and have shown that learning from video games may transfer to nongame situations. For example, in one study, training designed to improve working memory (the ability to hold and manipulate information in the mind) was reflected in improvements in fluid intelligence. The study also documented a relationship between the amount of training and the magnitude of the improvement.<sup>8</sup> Improvements in other cognitive functions have been shown, as well.

### **Principle 2: Automaticity.**

Neuroscience has distinguished multiple types of memory, including declarative and procedural memory. When a certain set of steps or processes are performed repeatedly, the processes are embedded in procedural memory and do not require conscious thought to execute (like riding a bike or driving to a familiar location). When a skill or process becomes embedded in procedural memory, it is said to have become automatic. The strength of neural connections is strengthened by repetition, leading to the ability to perform a function without consciously thinking about it and requiring less energy than if the skill is not automatic.<sup>9,10</sup>

The brain can only perform one skill consciously at a time. When multiple cognitive skills are required, as in most learning situations, all but one of those skills must be performed automatically, at the subconscious level.<sup>11</sup> When a skill becomes automatic and does not require conscious thought, it is possible for an individual to perform that skill at the same time as other skills. Basic skills must be functioning at the automatic level in order to enable an individual to allocate conscious thought and focus to other activities, such as learning, comparing, deciding, and planning drawing conclusions and the like.

### **Principle 3: Cognitive skills are highly integrated and interdependent, like a web.**

Mental processing (cognitive) skills are highly integrated in effective brain functioning.<sup>12</sup> When the brain performs a variety of automatic functions simultaneously, those activities must be coordinated to be effective (seeing and motor control, to give a simple example, in eye-hand coordination). If certain skills are weak or deficient, that will impact the efficiency of other mental processes and the overall effectiveness of mental functioning.<sup>13</sup> Higher order thinking skills cannot be developed in individuals who lack the fundamental mental operations for learning and performing them.<sup>14</sup>

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<sup>5</sup> Diamond, Marian, *Magic Trees of the Mind* (New York: Dutton, 1998)

<sup>6</sup> Sally Shaywitz, numerous publications at <http://myprofile.cos.com/shaywitz85>

<sup>7</sup> Doidge, Norman, *The Brain that Changes Itself*, (New York, Penguin Books, 2007)

<sup>8</sup> S.M. Gaeggi, M. Buschkuhl, J. Jonides, and W.J. Perrig, "Improving Fluid Intelligence with Training on Working Memory," Proceedings of the National Academy of Sciences 105, no. 19 (2008): 6829-6833.

<sup>9</sup> Medina, John, *Brain Rules*, (Seattle: Pear Press, 2008)

<sup>10</sup> Poldrack, Russell A. et.al., "The Neural correlates of Motor Skill Automaticity," *The Journal of Neuroscience*, June 1, 2005.

<sup>11</sup> Gesell, Arnold, *The Guidance of Mental Growth in Infant and Child*, (New York: MacMillan, 1930)

<sup>12</sup> Pribram, Karl, and Joseph King, eds., *Learning As Self-Organization*, (Mahwah, NJ: L. Erlbaum Associates, 1996)

<sup>13</sup> Hebb, Op. Cit.

Repeating a single skill over and over can lead to improvement in that skill and ultimately automaticity, but the integration of multiple skills is what pushes critical skills more quickly to the subconscious. The approach of putting demands on multiple skills at the same time, referred to as “cognitive loading,” is exploited in BrainWare Safari in a comprehensive “cross-training” approach that integrates multiple skills within an exercise and across exercises.

Cognitive loading is a key attribute of the exercises in BrainWare. Lower levels of the exercises are more limited in the amount of information and the number of different skills required to perform them. As the player advances, the cognitive load is increased by adding more information (for example, more cards in the Bear Shuffle exercise) and adding on additional steps or processes which must be managed (for example, adding in the metronome distractor in Web Weaving, which requires simultaneous management of auditory and visual information).

The brain recruits networks and skills to address specific learning situations and many different networks and combinations have the potential to arise in a learning environment. Training multiple skills in different combinations and in different ways assures that conscious processing cannot remain a crutch for any individual skill. It also means that skills can be recruited and relied on in any situation, not just one specific situation that has been trained.

#### **Principle 4: The importance of the visual system.**

Researchers estimate that 80% of what we learn involves our visual system. In fact, vision is by far the most dominant sense, taking up about half of the brain’s resources. Visual processing, visualization and spatial-temporal reasoning are vital in learning and thinking. The ability to transform thoughts into images is what drives new concepts, new ideas, new feelings, and ultimately new behaviors. It is said that Albert Einstein processed information primarily in images, and Beethoven was deaf, but could picture music in his mind.<sup>15</sup>

A variety of visual processing skills connect directly to important thinking processes, such as visualization (the ability to create visual images in the mind) and spatial-temporal reasoning (the ability to use visual images to create a new arrangement of elements, to envision future developments and to solve problems).<sup>16</sup>

Video games are being shown to be a powerful tool to develop and integrate visual skills. For example, certain kinds of video-game structures have been shown to enhance visual attention and the coordination of peripheral and center vision (such as when something suddenly appears at the edge of the screen).<sup>17</sup> It is also believed that the way that video games represent three-dimensional space may improve an individual’s ability to get 3-D information from 2-D depth cues, to find one’s way in a complex situation and to execute mental rotation skills.<sup>18</sup>

The combination of cognitive skills exercises within BrainWare has been carefully designed to develop the skills that are the most important for learning. Cognitive skills are addressed comprehensively and strategically. Thus, BrainWare puts particular emphasis on visual processing skills (including visual thinking) – developing the capabilities of the “mind’s eye” – and memory. Skills such as visual span (the use of peripheral vision involved for visual discrimination and/or scanning), visual figure-ground, visual sequential and simultaneous processing and visualization are all worked extensively in combination with attention, auditory, memory and reasoning skills.

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<sup>14</sup> Pribram, Op. Cit.

<sup>15</sup> Wolfe, Patricia, *Brain Matters: Translating Research into Classroom Practice*, (Alexandria, VA: Association for Supervision and Curriculum Development, 2001)

<sup>16</sup> Horowitz, Mardi J., *Image Formation and Cognition*, (New York: Appleton Century Crofts, 1970)

<sup>17</sup> C.S. Green and D. Bavelier, “Action Video Game Modifies Visual Selective Attention,” *Nature* 423 (2003): 534-537

<sup>18</sup> Gentile article in 4

The final four principles upon which BrainWare Safari is based reflect both good video-game design and good therapeutic technique. Indeed, as Douglas Gentile explains, a well-designed video-game is an almost perfect teacher<sup>19</sup>:

“They [video games] provide immediate feedback on the player’s success by distributing reinforcements and punishments, assist in learning at different rates, and offer opportunities to practice to the point of mastery and then to automaticity. Video games also can adapt themselves to individual learners and train players in a way that helps them transfer knowledge or skills to the real world. Gamers repeat actions as they play, and repetition is one precondition for long-term potentiation—the strengthening of brain-cell connections (synapses) through repeated use that is thought to underlie memory storage and learning. To cite a mnemonic that Canadian psychologist Donald Hebb coined in 1940, “neurons that fire together wire together.”<sup>20</sup>

#### **Principle 5: The need for progressive and appropriately sequenced challenge.**

Cognitive development occurs at the outer edges of an individual’s competence. Therefore, sequenced challenges that address the range of each individual’s strengths and weaknesses are required to provide the appropriate levels of challenge and intensity. If a task is too far above an individual’s learning ability, he or she will become frustrated and may not persist. If tasks are too easy, he or she will become bored.

BrainWare Safari’s exercises are designed to build from relatively easy levels through more difficult ones. Sequencing and the ability to move among exercises according to difficulty and the individual user’s experience help to optimize the intensity and challenge of the training. Sequencing also enables an individual’s experience with BrainWare to be personalized in the sense that a user will spend longer on and be more challenged by exercises and levels that address weaker areas and less time and effort on exercises and levels that address areas of strength.

#### **Principle 6: The value of frequency and intensity.**

Development of any physical or mental function requires the discipline of frequent challenge at an appropriate level of intensity. The brains of experts consume less energy to perform a practiced activity and, in fact, can often do the activity “without thinking” or without conscious evaluation. We may talk about “muscle memory” (for example for a concert pianist or Tiger Woods on the golf course) but we are actually describing the development of procedural memory in the brain. Frequent practice with intensity leads to automaticity of skills.

The exercises in BrainWare Safari were designed with the methodical sequencing need for “smart practice” (intense and rewarding repetition). Importantly, the program avoids the kind of predictable progression that would cause the brain would to lose interest and the necessary level of intensity. BrainWare Safari is designed to make the progression from one level to the next novel and interesting. This enables players to sustain their engagement and intensity.

The recommended usage protocol for BrainWare Safari is 30 to 60 minutes, 3 to 5 times per week, for 10-12 weeks. This is the level of frequency and intensity that has been shown to drive rapid skill development and significant cognitive growth for the user. (The research on BrainWare Safari is discussed in the second half of this document.)

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<sup>19</sup> D.A. Gentile and J.R. Gentile, “Violent Video Games as Exemplary Teachers; A Conceptual Analysis,” *Journal of Youth and Adolescence* 9 (2008): 127-141.

<sup>20</sup> Douglas A. Gentile, Ph.D., “Video Games Affect the Brain—for Better and Worse, July 23, 2009, *Cerebrum*, [www.dana.org](http://www.dana.org)

### **Principle 7: Feedback.**

Immediate feedback is necessary to enable error correction and faster, more accurate learning. The speed of feedback also enables more repetitions to be executed in a given amount of time.

In addition to the feedback overtly provided by a video game, there is evidence that success in a video game is related to release of the neurotransmitter dopamine, which is involved in learning and feelings of reward.<sup>21</sup>

BrainWare provides immediate feedback to the user through various mechanisms built into the game. There is no waiting to have a challenge or level scored; the computer response is instantaneous. Positive encouragement is offered continuously as the user progresses through the program. At each challenge, at each level, and upon the completion of exercises, positive and entertaining messages are delivered and the character the player has chosen at the beginning grows, reflecting the development in cognitive skills the player is experiencing. Finally, in many of the settings in which BrainWare Safari is used (schools and various clinical therapies), a coach also plays a role in feedback and support.

### **Principle 8: Engagement (fun) is vital.**

Stimulation is an important factor in motivating attention and meaningful participation in a learning activity.<sup>22</sup> In fact, the science and education communities are increasingly recognizing the value of digital game-based learning (“DGBL”)<sup>23</sup> and the important elements of DGBL programs.<sup>24</sup> The compelling characteristics of good video games motivate initial engagement with a challenging activity and can help sustain motivation as the challenge progresses. Persistence motivated by a feedback loop reinforces and supports the natural mechanisms in the brain that reward us for accomplishing something challenging.

BrainWare incorporates multimedia video-gaming technology with entertaining themes, characters, animation, and interactive elements to stimulate interest. The inherently interesting features of the program help provide intrinsic motivation to persist and overcome more difficult levels.

And, unlike many other mental fitness software programs, the exercises in BrainWare Safari are mutually reinforcing and supportive. As a result, when a user reaches a level in a particular exercise that seems extremely difficult, he/she can move to other exercises that help build those same skills in a slightly different way. Frequently upon returning to the troubling exercise, the user passes it with much less difficulty. Freedom to explore and choosing one’s own path through the program are important contributors to motivation.

### **Research on BrainWare Safari’s Effectiveness**

The specific techniques and exercises in BrainWare Safari came from the collaboration among a cadre of professionally recognized clinical practitioners in a variety of disciplines, including vision therapy, speech and language pathology, auditory processing, learning specialists and psychology. The techniques were specified in a technology transfer process with software development experts and video-game developers. The resulting product, BrainWare Safari, has been studied with a variety of populations and in a variety of environments. The following brief descriptions of the results are supported by more detailed publications and reports.<sup>25</sup>

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<sup>21</sup> M.J.Koepp, R.N. Gunn, A.D. Lawrence, V.J. Cunningham, A. Dagher, T. Jones, D.G. Brooks, C.J. Bench and P.M. Grasby, “Evidence fo Striatal Dopamine Release during a Video Game,” *Nature* 393 (1998): 266-268

<sup>22</sup> Wolfe, Patricia, *Brain Matters: Translating Research into Classroom Practice*, (Alexandria, VA: Association for Supervision and Curriculum Development, 2001)

<sup>23</sup> Federation of American Scientists has stated that video games can redefine education, building analytical thinking, team building, multitasking and problem solving. ([www.fas.org](http://www.fas.org)).

<sup>24</sup> Prensky, Mark, *Digital Game-Based Learning*, McGraw-Hill Companies,; December, 200, [www.markprensky.com](http://www.markprensky.com).

<sup>25</sup> Study reports are available at [www.MyBrainWare.com/education](http://www.MyBrainWare.com/education) or [www.MyBrainWare.com/professional](http://www.MyBrainWare.com/professional).

The initial research on the product was designed to demonstrate the effectiveness of the program in improving individuals' cognitive skills. Subsequent studies have addressed its impact on various populations and the transferability of cognitive skill improvement to academic performance.

The education community has operated under an implicit assumption that better cognitive skills are related to better school performance. Children who do well in school are often described as "bright" while those who struggle are recognized as lacking skills in one or more dimensions of cognitive ability. When students struggle, teachers and specialists have worked to provide lower-performing students with help. And many parents have taken their children to therapists of various kinds to help them overcome any underlying barriers to learning. The assumption is then made that, with stronger cognitive skills, those students will be able to perform better on academic tasks. However, to our knowledge, no broad study of the impact of comprehensive cognitive development on academic performance has ever been made.

### **Published Research<sup>26</sup> – Spring/Summer 2005**

This study was designed to demonstrate that BrainWare Safari as a computerized program could produce results comparable to those seen by with their patients when administering the therapeutic techniques in a one-on-one, largely paper-and-pencil approach. The purpose was also to examine use of the program in a home setting without a trained therapist involved. Study participants were children from the Christian Heritage Academy in Northbrook, Illinois, ages 6-13 (grades 1-8). The 34 participants (male and female) represented a range of abilities from normal to children with learning issues to gifted children. The subjects were divided into a study group and a control group. The study group used BrainWare Safari during Phase I of the study while the control group followed their normal routine. During Phase II, the control group used BrainWare Safari.

In Phase I, the study group used the program 45-60 minutes 3 to 5 times per week for 12 weeks, and were pre- and post-tested with the Woodcock-Johnson® III Cognitive Battery and Tests of Achievement. In Phase I, children in the study group showed an average of 4 years and 3 months improvement on the tests of cognitive skills, compared to 4 months improvement for the control group, and an average of 1 year and 11 months increase on the tests of achievement, compared to an average 1 month increase for the control group. In Phase II, children from the control group used the program in the summer over a 16-week period (with breaks for family vacations and camps) and showed an average of 4 years improvement in cognitive skills and 1 year 1 month increase on the academic achievement tests. Every child in the study showed improvement in cognitive skills following their use of BrainWare Safari.

Children and parents in both phases of the study observed behavioral changes as well, including improvements in self-esteem, more willingness to do schoolwork and homework, more attention to detail, better ability to follow directions, and other positive behavioral changes.

### **Harbor Beach Community Schools (Harbor Beach Michigan) – Spring 2008**

This was an independent validation of BrainWare Safari's impact demonstrated in the published research summarized above. Under the supervision of one of its Speech and Language Pathologists, Harbor Beach Community Schools (HBCS) decided to test BrainWare Safari (BWS) to see if they could achieve results comparable to the results reported in the initial published study of the program's effectiveness. Students whose teachers felt they could use some extra help were nominated to participate in the study and 10 students were selected for the study. For the pre- and post-tests, HBCS used the same subtests of the

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<sup>26</sup> A report of this study has been published: Helms D, Sawtelle SM. *A Study of the Effectiveness of Cognitive Skill Therapy Delivered in a Video-Game Format*, Optometry & Vision Development, Volume 38, Number 1, 2007.

Woodcock Johnson III Cognitive Battery (WJIII) as in the published research. The students worked on BrainWare for 45 minutes, 4 days a week for 12 weeks, in the computer lab under supervision.

The students in the study ranged from 7 to 16 years of age, similar to the age of the students in the published research. The students' average improvement on the cognitive tests was 3 years 1 month, and, as in previous studies, each individual exhibited improvement in his or her intellectual ability. Teachers observed significant improvements in academic performance by students who used BrainWare Safari.

### **Indianapolis Public Schools (Edgar Evans Academy) – Spring 2006**

This study had a dual purpose: 1) to demonstrate how BrainWare Safari fits into the regular curriculum of an elementary school classroom and 2) to see how effective it can be with even the most challenging users. The Edgar Evans Academy for Boys, the site for the study, had been created to provide a structured, disciplined environment for male children in grades 4 and 5 with a history of disciplinary problems. The program was used in one 4<sup>th</sup> grade and one 5<sup>th</sup> grade class.

The 25 students in the study were pre- and post-tested with a subset of the Woodcock-Johnson III Cognitive Battery. The students had an average chronological age of 11 years at the time of the pre-test. Based on the WJIII results, however, their intellectual age was measured at only 8 years 2 months. Thus these students were, on average, almost 3 years below the norm for their age in terms of cognitive development.

The students used the program in their classrooms an average of 2-3 hours per week. The average post-test intellectual age after 11 weeks of working with BrainWare Safari was measured at 14 years, 2 months, an improvement of 6 years (2 years 10 months above the norm for their age).

### **Indianapolis Public Schools (Coleman Academy) – School Year 2007-2008**

In this study, no new academic measures were imposed on the school. The study looked at improvement in students; DIBELS® (oral reading fluency) scores, the measure this school and many others use to track reading progress. Of the eight 4<sup>th</sup> through 7<sup>th</sup> grade classes in the school, only one – the 4<sup>th</sup> Grade Girls – used the program during the spring term. The 4<sup>th</sup> Grade Girls class was the only class that exceeded their DIBELS benchmark score at the end of the year. In fact, the average (absolute) score for the class exceeded the average score for all other classes. The rate of progress for the 4<sup>th</sup> Grade Girls accelerated during the second half of the year when they were using BrainWare Safari, moving from 9 points above benchmark to 26 points above benchmark. The teacher observed behavioral improvements in the students as well, specifically in making fewer careless errors, memory, grasping new concepts and communication with parents, peers and teachers, following use of the program.

### **Glenwood School for Boys and Girls (Glenwood, IL) – School Year 2008-2009**

As far as we are aware, this is the first study to show a clear correlation between cognitive skill development and academic performance. The effects were dramatic, as in previous studies, and the number of students was sufficient to demonstrate the impact trend over multiple grades.

Glenwood School for Girls and Boys in Glenwood, IL, is a community supported non-profit organization dedicated to helping economically and socially disadvantaged children from low income, mostly single-parent homes undergoing extreme hardship due to serious family and community issues. Glenwood offers them a comprehensive residential, education and life-skills program in a structured and nurturing environment.

During the 2008-2009 school year, 96 students in the 2nd through 8th grades used BrainWare Safari for either first quarter or second quarter (8 weeks), 5 days a week for 30 minutes. They were tested in September and February using the Visual Motor Inventory and five Woodcock-Johnson® III tests routinely used by Glenwood for student assessment.

The results of the student assessments are reported in grade equivalents. Between the pre-test and post-test, average improvement on the academic tests ranged from 0.5 GE in 2nd grade to 2.9 GE in the 8th grade. Average improvement on the cognitive tests ranged from 1.5 GE in 2nd grade to a high of 3.0 GE in 7th grade.

The Glenwood school results show a clear relationship between improvement in the underlying attention, memory and other mental processing skills developed by BrainWare Safari and performance on academic tests. Improvement in the higher grades is more significant than in the lower grades, although gains were also seen in the younger grades and the magnitude of the gains is generally relative to grade level. It is reasonable to surmise that cognitive deficiencies had a cumulative effect over time. Thus older students, once those deficits were lessened, were able to quickly realize more substantial academic gains.

This study is being prepared for publication as one of the first examples of how developing underlying cognitive skills has an immediate and direct effect on academic ability. Glenwood will continue to use the program during the 2009-2010 school year.

#### **Xilin Community Center – Fall 2005**

The purpose of this study was to continue to evaluate BrainWare Safari in additional settings and populations, following the original published research. The subjects were nine students in the after-school program at the Xilin Community Center in Naperville, Illinois, who used the program at home. English was a second language for the students in this study.

The students showed an average of 3 years and 6 months cognitive improvement over the 11 weeks of the study. In addition, the students showed an average of 2 years and 4 months improvement on the tests of achievement. Every student improved his or her performance on the tests.

#### **The Whitney Center (Richmond, IN) – Spring 2006**

While BrainWare Safari was not designed solely as a remedial program, it has been studied with individuals with cognitive issues and/or deficits:

Two of the most challenged students in this learning center were selected to participate in this case study. The two boys, ages 9 and 12 had reached a plateau in their ability to benefit from the reading remediation the center was providing. Following use of the program, the boys improved their performance on the Woodcock-Johnson Cognitive Battery 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. The center found that they were subsequently able to resume and benefit from further reading remediation.

#### **Study of Children with Autism Spectrum Disorders – Winter 2006/Spring 2007**

33 students, ranging in age from 5 to 16, with diagnoses across the Autism Spectrum, from severe to high-functioning ASD and Asperger's used the program. Over half of the students were able to persist in use of the program over the duration of the study. Subjects 9 and older and those with high-functioning and Asperger's diagnoses demonstrated the most benefit, as measured by pre- and post-evaluation with the LEC behavioral rating scale and the CARS rating scale (childhood autism rating scale). Parents

noted improvements in perceptual processing, sensorimotor, attention, thinking and life management skills, as well as improved interpersonal relationships and lower levels of frustration.

### **The Gap School, Sarasota, Florida – 2006-2007 School Year**

This study followed the progress of seven students with very low cognitive ability (IQs in the 70 to 80 range) that used the program regularly in their technology lab. Based on the Gibson Cognitive Battery and subtests of the Detroit Tests of Learning and Aptitude, these students improved their cognitive skills by 9 months on average over the school year. This type of student seldom experiences cognitive growth, and may even decline over the course of a school year. Persistence and tolerance for frustration were better than with previous paper-based therapy experiences.

### **Students Qualifying for a Gifted Program (South Carolina) – 2008-2009 School Year**

When the State of South Carolina changed the criteria for admission into gifted programs and moved to selection based on CogAT test scores, some schools no longer had any students qualifying for the programs. In this study, 64 second-graders in one elementary school used BrainWare Safari for 17 weeks. Following use of the program, 2 students qualified for the gifted program based on their composite CogAT score (98<sup>th</sup> and 99<sup>th</sup> percentiles); 5 students qualified based on having at least one CogAT score at the 93<sup>rd</sup> percentile or higher combined with MAP testing results; and 3 students qualified for additional performance testing based on their CogAT scores.

60 of 64 students improved their results on the CogAT test over the period during which they used BrainWare Safari. On average, students experienced an average increase in their composite score on the CogAT of 11 points (Nonverbal – 8 points, Quantitative – 9 points, Verbal – 12 points). The number of students scoring in the top three deciles doubled following their use of BrainWare Safari.

### **Summary**

BrainWare Safari is supported by extensive brain research demonstrating 1) that the brain is plastic and changes in response to its environment, 2) that mental processes can be developed to the point of automaticity where they no longer require conscious thought, 3) that cognitive skills are highly integrated and interdependent, and 4) that integration of vital visual system skills underlies is essential for effective learning. BrainWare Safari also addresses key principles shared by effective therapies and video games, providing appropriately and progressively sequenced challenge, the frequency and intensity required for the development of automaticity, immediate rewarding feedback, and motivation and engagement.

BrainWare Safari has been shown to be effective in an array of studies with various populations and settings. Since all good research engenders new questions and since there is much still to learn about the relationship between underlying cognitive skills and performance of academic and life tasks, research is ongoing. New research reports may be available at [www.MyBrainWare.com/education](http://www.MyBrainWare.com/education).

BrainWare Safari is based on sound neuroscience, tried-and-true clinical techniques, and the critical elements of effective video games to deliver substantial intellectual gains that can translate into improved academic performance across the curriculum.

## Appendix A – Cognitive Skills Developed in BrainWare Safari

### **Attention Skills (6)**

- Visual Sustained Attention
- Auditory Sustained Attention
- Visual Selective Attention
- Auditory Selective Attention
- Divided Attention
- Flexible Attention

### **Visual Processing Skills (9)**

- Visual Discrimination
- Visual Figure Ground
- Visual Form Consistency
- Directionality
- Visual Span
- Visual Simultaneous Processing
- Visual Sequential Processing
- Visualization
- Visual Processing Speed

### **Auditory Processing Skills (3)**

- Auditory Discrimination
- Auditory Sequential Processing
- Auditory Processing Speed

### **Sensory Integration Skills (5)**

- Oculomotor Skills
- Visual-Motor Integration
- Auditory-Motor Integration
- Timing-Rhythm
- Visual-Auditory Integration

### **Memory Skills (10)**

- Visual Short-Term Sensory Memory
- Auditory Short-Term Sensory Memory
- Visual Short-Term Immediate Memory
- Auditory Short-Term Immediate Memory
- Working Memory
- Visual Spatial Memory
- Long-Term Memory
- Visual Sequential Memory
- Auditory Sequential Memory
- Visual Simultaneous Memory

### **Thinking Skills (8)**

- Logic
- Reasoning
- Planning
- Problem Solving
- Strategic Thinking
- Visual Thinking
- Conceptual Thinking
- Decision Speed