Using SB, A Computer-Assisted Program, To Treat Attention Deficit Disorders (AD/HD) and Learning Disabilities (LD): Review of 3 Case Studies

06/08/2006

Bob Gottfried, Ph.D.
Clinical Director of Advanced Cognitive Enhancement (ACE) clinic in Toronto, Canada.

Background

Many researchers have questioned whether or not attention deficit and learning disabilities, often co-morbid with AD/HD, can be repaired. Stimulant medication, usually Ritalin, has proven to be an effective treatment modality for many individuals diagnosed with attention deficit. The introduction of Neurofeedback has offered new hope for parents wanting to help their children resolve attentional difficulties without the use of medication. Neurofeedback research has shown that training brain wave patterns can help resolve the cognitive difficulties associated with attention deficits and learning disabilities. SB was developed to help improve cognitive function without the need to connect to EEG instrumentation. It has been demonstrated, in a clinical setting, that SB helps improve various cognitive skills associated with attention and working memory.

Abstract

The question whether or not attention deficit in AD/HD and learning disability populations can be remedied, received attention from many researchers. Treating children and adolescents with stimulant, usually Ritalin has proven to be an effective modality for individuals suffering from any form of attention deficit. The introduction of Neurofeedback, has offered new hope for parents wanting to help resolve the attentional problems of their children without the use of medication. Neurofeedback research has shown that training brain wave patterns can remedy attentional difficulties associated with the above-mentioned conditions. SB was developed to help those wanting to improve their cognitive function, without the need to connect to EEG instrumentation. It has proven, in a clinical setting, to help in enhancing various cognitive skills associated with attention and memory.

Key Words: ADD, ADHD, LD, Neurofeedback, frontal lobes, attention deficit, distractibility, SB computerized program

Introduction:

The use of computer-assisted programs in the treatment of cognitive deficits is not new.
Previous studies have shown the benefits of such cognitive training for treating attention deficit with or without hyperactive disorder (AD/HD) and learning disabilities (LD). The National Institutes of Health (NIH) Consensus Development Conference Statement (1998) confirmed that "Computer-assisted strategies have been used to improve specific neuropsychological processes, predominantly attention, memory, and executive skills. Both randomized controlled studies and case reports have documented the success of these interventions using intermediate outcome measures." I will be reviewing some of the studies done on the use of Neurofeedback to treat AD/HD and LD, explain the principles behind SB, compare it to traditional Neurofeedback modalities, and use three case studies to demonstrate the effectiveness of this computer-assisted program.

SB Computerized Program

SB computerized program was developed for the purpose of enabling individuals suffering from cognitive impairment train using an IBM compatible computer, either at home or in a clinical setting. The program was originally designed to enhance three levels of attention:

Calm: Allows the mind to relax and get ready for different mental tasks.
Terms of brain activity, this is equivalent to an Alpha state (8-11Hz.)

Focused: Enables attention to a specific task, while offsetting distractions.
This is equivalent to a Beta1 state. (12-15Hz)

Alert: Allows fast response and higher levels of alertness.
This is equivalent to Beta2 state. (16-19Hz)

SB addresses the major difficulties of ADHD symptoms, which includes impulsivity, distractibility and hyperactivity. SB was developed under the microscope of EEG instrumentation, and has proven to enhance the above-mentioned states during practice. With continued practice, learning appears to consolidate and generalize to other areas of cognitive performance. The program has 36 regular levels and 18 advanced levels (currently available only in the professional version of the program). These different levels enable individuals to achieve measurable enhancement of a variety of cognitive skill and to be able to apply this skills on a consistent basis, whenever required. It also enables quick shifts from one state of attention to another, at will.

The program trains an individual for developing the different cognitive skills associated with attention. Initial focus is placed on visual-motor integration. According to Fenger (1998), this type of training can enhance achievement in reading, spelling and arithmetic. SB emphasizes both auditory and visual processing. In addition, it trains users to improve concept comprehension, working memory, selective attention, divided attention, attention duration, sensory- motor coordination, visual processing, auditory processing, audio-visual coordination, and speed of processing.

Training procedures are practiced in slow and fast modes, and then repeated while audio/visual distractions are presented at the background.

Feedback to the user and facilitator is provided through a scoring system, which indicates change on a per-level, as well as accumulated progress.

The Use of Neurofeedback in Treating Attentional Difficulties:

Neurofeedback, which is a form of biofeedback, has been used for over 20 years to treat concentration related difficulties associated with AD/HD and LD. In general, Neuro-feedback is a modality which uses an EEG recording system along with training software to enhance brain wave activity that is instrumental for improving concentration.

The premise behind Neurofeedback is related to earlier findings that established that individuals with poor concentration lack sufficient levels of Beta1 (this band is also commonly termed SMR - short for sensory

motor rhythms) brain waves to sustain attention. The findings also showed that these individuals exhibit excessive amounts of slow brain wave activity, especially Theta waves (Lubar, 1984, 1976; Tansey 1991, 1985). In these studies, treatment modalities focused on enhancing the SMR/theta ratio, demonstrated the effectiveness of Neurofeedback in treating children with attention deficits and learning disabilities, which usually resulted in improved school performance and behavior control. During Neurofeedback sessions, the person wishing to enhance concentration uses feedback coming through an EEG machine to enhance SMR and decrease Theta. After a certain amount of training, typically between 40 and 60 sessions, the individual is able to produce more SMR at will.

Neurofeedback treatment can also result in significant improvement of intellectual functioning, as measured by increases in IQ scores (Linden, Habib & Radojevic, 1996). Such improvement is most likely the result of the treatment's positive impact on the person's ability to concentrate.

More recently, Monastra (2002) found that Neurofeedback has proven to be successful in long term improvement of AD/HD symptoms. In this study, 100 children, aged six to nineteen years, diagnosed with AD/HD were monitored for one year. All children received parental counseling, academic support, and Ritalin. Half of the children also received Neurofeedback training. After 12 months, all children showed improvement in their attention. However, childrdren who stopped taking Ritalin and did not train with Neurofeedback, lost the gains they had achieved, whereas those who also received brain wave training, kept their gains even after they stopped using Ritalin.

The Difference between SB Computerized Program and Neurofeedback

Neurofeedback works predominately on enhancing Beta1 (SMR) brain waves, while inhibiting slow brain activities, usually Theta waves. Sharper Brain, on the other hand, not only enhances Beta 1, but also reinforces Beta2. Beta2 is an important part of the brain wave spectrum necessary for an enhanced state of alertness, when faster reactions are required. In addition, the program enables the user to practice between the lows and highs of each band. Moreover, SB computerized program trains users to quickly shift from one band to the other (Alpha, Beta 1, Beta 2.) thus developing better attentional flexibility.

Unlike Neurofeedback, which must be administered in a clinical setting, SB can be used without professional supervision, as augmentation of Neuro-cognitive training or as standalone treatment. The software saves the results of progress achieved at home on a floppy disk, which can then be uploaded by a professional supervising the program. These progress reports of cognitive skills training are an added benefit to SB as it indicates not only general progress but also areas of difficulties.

In contrast with SB that targets specific cognitive skills, Neurofeedback focuses predominantly on improving sustained attention. However, other elements of attention, such as selective attention, orienting of attention and executive attention are not directly reinforced. These states of attention are paramount in developing well rounded cognitive skills essential to listening, reading, learning, problem solving, following instructions and interacting responsibly in various settings (Posner & Peterson 1990).

Locality of treatment is another difference between Neurofeedback and Sharper Brain. Most Neurofeedback protocols focus on the Cz point on the top of the head, and some protocols involve other locations. In contrast, SB's protocol is not localized. By establishing the challenge in terms of task and desired outcome, and presenting a method to accomplish the outcome, the program trains the relevant regions of the brain associated with the specific cognitive task. When connected to an EEG instrument, while practicing the SB program, increased levels of Beta1 (SMR) at Cz were measured, while practicing a state of focus, equivalent to reading or listening. Higher levels of Beta2 were recorded when a more alert state was reinforced. Such an alert state is

associated with faster processing and improved mental performance in general (Bellenkes, Wickens, and Kramer, 1997). Basic relaxation associated with Alpha waves was measured when patients stopped practicing and performed diaphragmatic breathing for a few seconds.

A final difference has to do with training under distractions. During Neurofeedback sessions, the practice environment is usually quiet, and therefore does not accurately emulate learning environments, such as in a classroom. During the final 12 levels of the program, SB trains users to repeat cognitive challenges while visual and auditory distractions are presented. This form of training has shown marked improvement in the students' ability to concentrate in the classroom where background stimuli are usually present.

Comparison summary: Neurofeedback protocols focus primarily on developing sustained attention and have to be administered in a clinical setting, whereas SB incorporates training for more specific cognitive skills, and can be practiced both in a clinical setting as well as at home.

A Neural Basis for Treatment

The adverse relationship between attention deficits and brain wave structures is well established in literature. Winkler, Dixon, and Parker (1970) discovered that children suffering from both academic and behavioral problems exhibited excessive Theta (4-7Hz) brain waves. Lubar, Bianchini, Calhoun, Lambert, Brody, and Shabsin (1985) observed that children experiencing learning disabilities exhibited slow brain wave activity compared with controls. Lubar et al. were able to predict which individuals were diagnosable with learning disabilities based solely on their brain wave patterns.

The prefrontal cortex acts as the control center of working memory, cognition, executive control and attention (Miller & Cohen, 2001). At the ACE clinic (Toronto, Canada), Passive Infrared Hemoencephalography (pIR HEG) technology was used to further test the effectiveness of SB. pIRHEG is a form of Neurofeedback using signals based on thermal output resulting from changes in blood flow and cellular metabolism, instead of electrical activity used in traditional Neurofeedback-based instrumentation. This relatively new technology enables measurement of vascular changes at the frontal lobes through measuring changes in infra red temperatures (Toomim & Carmen, 1999). Patients at the beginning of their treatment for attention deficits and for memory decline were connected to this form of EEG. An infra red sensor device is attached to the forehead. The sensor is connected to a control system that displays the temperature using a LED display. In the beginning, subjects were instructed to play a computer game (pinball) for 10 minutes. After a short break, they were prompted to use the SB program. Measurements demonstrated more significant elevation in frontal temperature, indicating improved circulation in that area. This rise in frontal infra red output is regarded as an indication of better frontal lobe engagement. Similar results where recorded even when the order was reversed (SB first, and pinball game second). With continued practice, another phenomenon appeared to take place. Patients were able to elevate temperature levels and keep it there effortlessly. In this "Focus Zone" the ability to sustained attention, seems to prolong beyond the session. In time, this form of conditioning enables a natural ability to maintain prolonged attention when required.

It is, therefore, hypothesized that SB can effectively engage different regions of the frontal lobes, for instance the superior medial, left dorsolateral, right dorsolateral and more (Stuss, Binss, Murphy & Alexander 2002) to enable improved ability to perform executive functions and various cognitive tasks. The use of SB also indicates better task switching, associated with improved coordination of executive functions (Kramer, Hahn, & Gopher, 1999). More research is being currently conducted to provide empirical evidence to support this hypothesis.

Case study #1:

Mathew K. is a 12 years old boy diagnosed with ADHD, who has been taking Ritalin for two years but stopped taking medication upon his parents decision just before starting the program.

He was evaluated using the SB program itself, in conjunction with a self reported questionnaire filled out by his parents. He attended 12 sessions over a period of four months.

During the initial evaluation, Mathew demonstrated high level of commissions (errors done when an individual reacts when not called for) typical to ADHD individuals. His average score on the first 12 levels was 59%. The score in this program represents the accuracy and speed of responses to the different cognitive tasks. His score on the combined visual-auditory levels alone was 42%. This discrepancy is usually a strong indication of difficulties in auditory processing. With practice, he was able to reduce the rate of commissions and his average eventually progressed to 79%. The goal was to bring his average to mid 80's, which is the desired score for individuals with attentional difficulties. However, at that point treatment was terminated because Mathew moved out of town. Mathew reported improvement in his concentration and retention ability, already after three sessions, and his parents noted marked improvement in his impulsivity and listening skills half way through the program.
During the training period, he wrote a few exams in school. He reported that his mark in math improved from B minus to B plus and his English mark from C to B plus.

Case study #2:

Kevin C. was a 2nd year university student. He was referred by his mother because of difficulties in studying. She reported that Kevin exhibited attentional problems since he was in grade school, but he was assessed and diagnosed with Attention Deficit Disorder (ADD) and Learning Disability (LD) only in high school. At the time of the treatment he was not taking any medication. Kevin reported periods of depression for which he was never treated. He reported difficulties focusing on his studies and noted that he would "tune out" during lectures. He also reported difficulties reading for long periods of time.

He was treated for a period of 16 weeks and received 14 treatments altogether. Treatment consisted of cognitive-behavioral therapy for his mood swings as well as training with the SB program. His average on all 36 levels was 52%. Special difficulties were noted on levels which required divided attention. Shortly after completing 14 sessions, he wrote his second semester exams. His overall average went up from 64% to 76%. He reported being able to focus on reading school material for longer periods of time. His ability to tune out distractions, which was strongly emphasized during the program also improved. He decided to take a break when the school year was over and never retuned for further training. His 36 level average after the 12th session was 81%. Three months after the treatment ended he reported that his motivation and self confidence improved. He estimated that his overall concentration improved by 75%, and that he felt he did not need more work.

Case study #3

Amanda a ten year old - grade four student was diagnosed with ADD about a year prior to starting the program. She did not take any medication for her condition. Her parents reported that she used to daydream frequently, could not concentrate in class and required substantial more time to complete her homework. Amanda did well on the first three levels of SB (average of 78%), but had difficulties on the next levels, which required divided attention ability (she scored 54% on these levels) and those levels, which required combined auditory-visual processing (she scored 48% on these levels.) She also scored very low on the levels which

incorporate distractions (42% average). Amanda's case was quite remarkable, because after 4 sessions her 36 level average went from 52% to 72%. She reported being able to pay better attention to the teacher, and her mother confirmed that she required less time and less help to prepare homework. We cannot explain this rapid improvement; however believe that Amanda was able to figure out how to quickly make a connection between the goals of the program and how to apply it in her life. She had 8 sessions in total, with an average score of 78% during the last session.

Other cases:
The SB program has been tested with a broader population of individuals experiencing concentration and memory impairment such as post stroke, closed head and traumatic brain injuries as well as cognitive decline associated with aging. In most cases, marked improvement was recorded in terms of working and long term memory and ability to sustain attention and multitask. A recent follow up on three cases, who were the first to train on SB over two years ago, confirmed that these individuals retained most of the benefits gained from the program.

Summary:
The use of the SB program has proven to be effective in treating a variety of cognitive deficits for both young and adult population. The program may prove to be an effective tool to help individuals suffering from attention deficit and cognitive impairment. The program can be used in a clinical setting, classroom or at home. Presently, there are two versions of the program. One for home use and the second one for use by professionals. This version allows more flexibility in terms of designing outcomes. It also incorporates 18 advanced levels.

Quantitative studies are now being designed to further establish the efficacy of the program in children with AD/HD and LD. Further studies to evaluate the efficacy of the program in head/brain injury population are also being planned for the near future.

References:

Bellenkes, A.H., Wickens, C.D., and Kramer, A.F. (1997). Visual scanning and pilot expertise: The role of attentional flexibility and mental model development. Aviation, *Space and Environmental Medicine*, 48(7), 569-579.)

Fenger T.N. (1995). Visual-Motor Integration and its Relation to EEG Neurofeedback Brain Wave Patterns, Reading, Spelling, and Arithmetic Achievement in Attention Deficit Disorders and Learning Disabled Students. Presentation at 1995 Society for the Study of Neuronal Regulation, Scottsdale, AZ.

Kramer, A. F., Hahn, S., & Gopher, D. (1999). Coordinative executive processes during Task Switching. *Acta Psychologica*. 101, 339-378.

Linden, M., Habib, T., Radojevic, V. (1996). A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities. *Biofeedback & Self-Regulation, 21*(1), 35-49.

Lubar, J.O., Bianchini, K., Calhoun, W., Lambert, E., Brody, Z. and Shabsin, H. (1985*).* Spectral analysis of EEG differences between children with and without learning disabilities. *Journal of Learning Disabilities, 18, p. 403-408.*

Lubar, J.F., Shouse, M.N. (1976a). EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR): A preliminary report. *Biofeedback and Self Regulation, 3*, p. 295-306.

Lubar, J.O., Lubar, J.F (1984) Electroencephalographic biofeedback and SMR and beta for treatment of attention deficit disorder. *Biofeedback and Self Regulation. 9* (1) p. 1-23.

Miller K.E., Cohen D.J. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24,* p.167-202.

Monastra, V. J., Monastra D., George, S (2002). The effects of stimulant therapy, EEG Biofeedback, and parenting style on the primary symptoms of attention deficit hyperactivity disorder. *Applied Psychophysiology and Biofeedback, 27* (4), p. FFF.

Posner, I.M., & Peterson, E.S. (1990). The attention system of the human brain. *Annual Review of Neuroscience,* 13, p. 25-42.

Stuss, D.T., Binss, M.A., Murphy, K.J., & Alexander M.P. (2002) Dissociations within the anterior attentional system: Effects of task complexity and irrelevant information on reaction-time speed and accuracy. *Neuropsychology, 16* (4), p. FFF

Tansey, M. A. (1985). Brainwave signatures -An index reflective of the brain's functional neuroanatomy: Further findings on the effect of EEG sensorimotor rhythm biofeedback training on the neurologic precursors of learning disabilities. *International Journal of Psychophysiology, 3*, p. 85-89.

Tansey, M. A. (1991). Wechsler (WISC-R) changes following treatment of learning disabilities via EEG biofeedback in a private practice setting. *Australian Journal of Psychology, 43*, p. 147-153.

Winkler, A., Dixon, J., & Parker, J. (1970). Brain function in problem children and controls: Psychometric, neurological, electroencephalogic comparisons. *American Journal of Psychiatrv, 127, p. 94-105.*