A Novel Approach in Treating Children with Attention Deficit Hyperactivity Disorder
治療兒童專注力失調及過度活躍症的新領域

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Abstract

The study addressed drug dependence and reliance in treating Attention Deficit Hyperactivity Disorders (ADHD). It offered alternative, which was natural (no chemicals were involved), cost effective, substituting the conventional/traditional medical prescription with exercise program and sequential processing intervention. The effect of the study on the method was moving from a quick short-term fix, touching the surface of the symptoms and ignoring the long-term abuse, to a healthier approach, allowing better outcomes at the behavioral, cognitive, and physical levels, with no side effects. The conceptual framework of this study served two main objectives: (a) minimizing medication intake, abuse/addiction, and (b) maximizing the child active role in managing classroom/home functioning. Students with ADHD from Israel, Mexico, and the United States, ages 11-13 (N=103) were assessed on the ADHD checklist (Reif, 1997) 4 times during 3 months. Analysis of the teachers' assessments revealed that incidents of behavioral misconduct decreased and academic achievements increased.

KEY WORDS: ADHD, Children, Sequential Processing, Exercise, Intervention

摘　要

本文嘗試以另一角度去處理和治療兒童專注力失調及過度活躍症，構思目的以少用藥物，多讓兒童主動參與為主，結果顯示了正面的治療作用。

Specific Aims

Children with Attention Deficit Hyperactivity Disorder (ADHD) are capable of learning at an accelerated rate. Given the learning opportunity, ADHD individuals have the potential to improve their daily function. Who these children are a reflection of the stimulation and opportunities to which they are exposed and the environment in which they receive such. The purpose of this study was to test the effectiveness of the National Association of Child Development (NACD) sequential processing intervention in conjunction with a short duration, intense, exercise program in treating ADHD. Due to the sharp increase in the prescribing of stimulant medications such as Ritalin, it was vital to reevaluate the impact of drugs on the brain and to encourage a healthier approach, educating parents/teachers with knowledge and skills. Starting at an early age children on Ritalin develop high tolerance to the effect of the medication and therefore are subjected to potential drug addiction. Children with ADHD who participated in the NACD intervention and exercise program not only had a reduced need for drugs but also improved their behavioral deficiencies and had academic success.

The NACD intervention and exercise program were aimed at increasing neurological organization and function of the brain - not at teaching new skills to bring changes in behavior and in order to develop memory, concentration, and attention. This objective was achieved in three ways: (a) maximizing the brains' reception of information via sensory auditory, visual, and tactile channels, (b) increasing the complexity of thinking by enhancing sequential processing and the ability to process information in short term memory, and (c) optimizing learning by accelerating the components of reading.

The long-term goals were:

1. Decreasing the prevalence in which medications are used to treat ADHD
2. Diminishing reliance and dependence on medications and subsequent juvenile offenses caused by drug abuse in treating ADHD
3. Breaking down the cycle of Ritalin intake in combination with other drugs (amphetamines)
4. Replacing drug consumption with cognitive intervention and physical program
5. Reducing the cost of healthcare in treating ADHD

The short-term goals were:

1. Empowering parents/teachers to take control over the consequences of drug treatment and their children's future
2. Introducing alternatives for better daily function and performance of the child and family
3. Solving academic and behavioral deficiencies
4. Helping the child to reach his/her hidden potential

In this study the NACD intervention and exercise program were tested on children with ADHD ages 11-13 from the United States, Mexico and Israel, whose parents were not pleased with the administration and side effects of Ritalin. The children were compared to an equivalent peer group, their counterparts, who maintained drug treatment with no additional interventions, using the ADHD checklist (Reif, 1997) for a time period of 3 months, to meet the goals of the study. Results indicated improvement over time but without significant differences between the experimental and control groups, suggesting that NACD intervention and exercise program are, indeed, effectiveness as Ritalin and might serve as a substitute for drug treatment.

Background and Significance

Children who have become drug abusers have been found to have a higher incidence and prevalence of attention deficit, rapid brain waves, autonomic hyperactivity, and prefrontal dysfunction (Elkind & Flavell, 1969; Kumpfer, Molgaard, & Spoth, 1996; Tarter, Laird, & Moss, 1990). Recent reviews of the biological and physiological risk factors in children with substance abuse suggest these children are at increased risk of using alcohol and drugs because they seem to reduce their stress (Smith, Cowie, & Blades, 1998; Wagner & Anthony, 2001). Usually, these children have rapid tempo (Tarter et al., 1990), are thrill seekers (Zuker, Boyd, & Haward, 1994), and are often diagnosed with attention disorders typically treated with medications, such as Ritalin. The scope of this study was to exam the effect of a physical exercise program with a cognitive sequential processing intervention on the course of drug abuse and medication intake.

In childhood, Attention Deficit Hyperactivity Disorder (ADHD) is the most diagnosed behavioral disorder characterized by inability to focus on tasks (NIDH infofacts, 2004; Stephen, 2000). The percentage of children diagnosed with ADHD is similar among African-American children and Caucasian children, but a lower percent of African-American children receive medications for treatment and an even a lower percentage of Hispanic children receive medications for treatment (Hartmann, 2002; Wallace, 2003). Overall, a higher percentage of boys than girls take medications (but also a higher percentage of boys are diagnosed with ADHD) (Shaymitz & Shaymitz, 1991).

Although methylphenidate (Ritalin) is the most frequently prescribed medication for treating ADHD, its mechanism of action and its effects on the human brain have been poorly understood (Congress of the US, 2000). According to the United Nations (News roundup National, 1996), the US produces and consumes about 85% of the world's production of methylphenidate (Office of National Drug Control Policy, 1998). However, a controversy surrounds its abuse, addiction, and side effects (Bierck, 1998; Sillars, 1997). A significant amount of literature is available that describes Ritalin abuse and Ritalin addiction (CQ Researcher, 1999; Fine, 2001). The abuse and addiction are characterized by increasing dosages and frequent episodes of consumption, followed by severe depression (Klotter, 1997). Severe side effects include death (Nicklin, 2000). In 1990, there were 271 emergency room mentions for Ritalin in the Drug Abuse Warning Network, and in 1998, there were 1, 727 mentions (NIH News, 2002). Children between the ages 10 to 17 accounted for 56 of these emergency room visits from Ritalin abuse (Hamilton, 1997). Since safety and the effectiveness of Ritalin have not been established and can cause severe reactions in children under the age of 6, Ritalin should never be used for this age group (Musser, Ahmann, & Theye, 1998). Despite this, the number of stimulants prescribed for children ages 2 to 4 has increased 200% to 300% between 1991 to 1995 alone (Kalb, 2000).

The question of later hazards associated with medications is an important one (Hyman et al., 1998). In 1995, research done for the U.S. government reported that Ritalin might cause liver cancer in mice, but there was no evidence for human cancer (Bogumil, 2001; McFadyen, Brown, & Carrey, 2002). Administration of Ritalin results in increased dopamine levels in healthy individuals and dopamine imbalances appear to be closely related to ADHD symptoms (Di Sclafani, Shams, & Price, 2002). Low doses of methylphenidate affect dopamine cells in the brain in a way that brain cells change frequently, which make them more sensitive to the rewarding effects of cocaine (Hoff, Riordan, & Morris, 1996). Ritalin is often referred to as "kiddie cocaine" because long-term Ritalin effects have been linked to brain development abnormalities similar to those found with cocaine use (Hoff et al., 1996).

Relative to brain development abnormalities, children with ADHD are described as having delays in white matter maturation (Frazen, Wihelm, & Haul, 1995). The most striking size differences is found in an area known as the cerebellum, which is on average 6% smaller in children with ADHD (Alcoholism & Drug Abuse Weekly, 1996). The cerebellum is not only known to be involved in motor coordination but also in controlling the speed at which the brain works (Mendelson & Mello, 1987). However, the reasons for children with ADHD to have atrophied frontal lobe are not clear. A smaller brain (3-4%) than their peers is not always observed (Maier, 1969).

Research with gene expressing in animals suggests that Ritalin has the potential for causing long lasting changes in brain cell structure and function (Panksepp, Burgdorf, & Gordon, 2002). Ritalin appears to initiate changes in brain function that remain long after the therapeutic effects dissipate (Carney, 2002). Position Emission Tomography (PET) and Computerized Axial Tomography (CAT) scan images have raised the question whether the brain atrophy occurs as a result of ADHD or as a result of stimulant medications (Merkel, 2000). It was well documented that long-term injection in rats has been associated with permanent loss of brain cells and short-term memory problems (Mendelson & Mello, 1987). In one of the studies, doses of Ritalin given during rat childhood led to a permanent loss of up to half of the neurotransmitter transporters in some parts of the brains in adulthood (Solanto, 1991). In human, recent research suggested that stimulated behavior and not ADHD causes brain atrophy. Franzen., Wilhelm, and Haul (1995) performed CAT scans on 24 men who were treated for hyperactivity since childhood and found a significantly greater frequency of cerebral atrophy in the hyperactive group than in the control.

Furthermore, in humans, Ritalin has been associated with impaired working memory, reasoning, verbal fluency, and decreased reaction time (Poulin, 2001; Reid & Borkowski, 1984; Swanson, Dandman, Deutsch, & Baren, 1983; Swanson, Kinsbourne, Roberts, & Zucker, 1978). Its therapeutic effect appears to be short lived. A follow up study at Montreal Children's Hospital revealed that the behavior of hyperactive children did not change significantly after taking Ritalin for 5 years, although it seemed that Ritalin made them initially more manageable.

Additionally, recent research has demonstrated that methamphetamines can have significant toxic effects on dopaminergic and serotoergic neurons in the brain (Krystal & Price, 1992). This is of a particular concern because of the spreading distribution of this drug which may relate to the dramatic behavioral effects, including the development of psychotic-like behavior patterns that methamphetamines can have (Volkow, 2001). Since methamphetamines are addictive if they are abused, there is some concern that children who use one of these medications are likely to abuse other substances (Hamilton, 1997; Vatz & Lee, 2001). All drugs are brain altering and therefore abuse can alter brain functions associated with thinking, emotions, and behaviors, in a profound and persistent matter (Giancola, Mezzich, & Tarter, 1998; Singer, 1997). Clinically observed, dependent behaviors induced by drug abuse result from neuropsychological and chemical alterations of complex brain mechanisms (Bhattachary & Powell, 2001). The mechanisms involved are: (a) the production and turnover of the brain neurotransmitters that carry information in the brain neurocircuitry, (b) changes in the brain metabolism and circulation, and (c) alterations in the expression of DNA which programs the functions of the neural cell (Wise, 1999).

ADHD coupled with other behavioral disorders predisposed children to drugs, alcohol, and tobacco use earlier than children without ADHD (Pelham, 1987). The more severe the ADHD, the earlier the abuse starts (Fariey, 1997). Two separate mechanisms are involved in the abuse: (1) increased drug exposure, and (2) increased likelihood to use the drug once the opportunity occurs. Children who have used multiple drugs or have been using amphetamines specifically cannot necessarily gain back brain cells (Fried, Watkinson, James, & Gray, 2002). Ritalin is a type of amphetamine that seems to destroy certain cells in the brain and therefore causes problems in concentration, memory, anxiety and confusion (Holton, 2004; Krystal & Price, 1992). Children with ADHD exhibiting behavioral problems are at the highest risk for Ritalin and other substances abuse (Andrew, 2000; Marks, 2000; Martin, 2004). Children with persistent ADHD but no conduct problems are more likely to drink or be tobacco smokers (Hyman, 1998). Children with severe ADHD are most likely to develop alcohol and marijuana problems and to become cigarette smokers by the time they reach adolescence (Bushnell, 2000). Smoking marijuana, in addition to affecting IQ, affects receptors in the brain that control perception of depth and time, thought, memory, concentration, and coordination (Sarbjit, 1988). Smoking marijuana diminishes judgment, short-term memory, blocks information from making it into long-term memory and weakens problem solving ability (Wilcox, Wagner, & Anthony, 2002). Methamphetamines production and availability have increased dramatically (Curriculum Review, 2001). Research indicated that between 1-7% of children in school take stimulants to control their behavior (Brown University Child Adolescent Behavior Letter, 1998). According to the National Institution of Mental Health (NIH News, 2003), 80% of these who require medications as children still need them as teenagers and adolescents (Martin, 2004).

The National Institute of Health (NIH News, 2003) issued a warning about the relationship of ADHD to the risk of developing alcohol and substance abuse (Haller, 1998). According to the NIH report, children with ADHD were more frequently getting drunk and using tobacco and drugs. Nearly twice as many as children with ADHD admitted drinking alcohol more than once in the past 6 months. Also, 11% of children with ADHD have tried some illegal drugs compared to 3% of their non-hyperactive counterparts. Alcohol or tobacco users were 7 times more likely to start using marijuana than children who had used neither alcohol nor tobacco. Prior marijuana use was closely associated with cocaine experimentation. A family history of alcoholism and other substances contributed further to the problems and initiated the abuse cycle at earlier age. A 13-year prospective study followed 147 hyperactive children, 98 of whom received stimulant medications. At the beginning of the study, the age of the children was 4-12 and at the end, 15 and 21. Results showed an increased risk for trying cocaine in high school (Quirk, 2000). The drop in IQ was similar to the drop shown by children who were exposed to 3 alcoholic drinks a day in the womb. This was a greater drop than shown by children who were pre-natally exposed to cocaine (Kouri, 1994).

Children who are diagnosed with ADHD are more likely to use illicit drugs, including cigarettes and alcohol, by the time they are teenagers (Martin, 2004; Rodriguez, 1993). When a child begins to abuse alcohol or other drugs, s/he undergoes changes in the brain (Gottschalk, 1979). Some children are more predominantly disposed because they might be born with "inefficient" manufacturing brain cells. However, even though the compulsive craving for alcohol or drugs could have a genetic origin, it is triggered by environmental factors Clemet, Willimas, & Waters, 1993). Toxins in the environment disrupt brain development or brain processes, which may lead to ADHD (Maier, 1969). When parents face psycho-emotional crises they are less able to modify the environment in a way that is fruitful for the child (Clement, Williams, & Waters, 1993). Sons of male alcoholics, who have many alcoholic relatives across generations, have been reported to show deficits in verbal and abstract reasoning as well as in verbal learning (Harden & Pihl, 1995). Pihl, Peterson, & Finn (1990) found that cognitive deficits could be caused by heritable dysfunction of the prefrontal cortex and limbic systems. However, cognitive impairment could also stem from fetal alcohol exposure (Streissguth, Barr, Bookstein, Sampson, & Olson, 1999), a lack of environmental stimulation or a chaotic home environment (Chassin, Carle, Kumpfer, & Nissim-Sabat, 2003; Small, 1990).

Except for studies of prenatal exposure to alcohol, most studies have focused on paternal rather than maternal alcoholism even though research data stress the fact that offspring of addicted mothers are at a particular risk (Russell, 1990). A mother's use of cigarettes, alcohol, or other drugs during pregnancy may have a dangerous effect on the fetus's developing brain (Blume, Davis, & Schmaling, 1999). Heavy alcohol use during pregnancy has been linked to fetal alcohol syndrome (FAS), a condition that can lead to low birth weight, intellectual impairment, and certain physical defects (Noll, Zucker, Fitzgerald, & Curtis, 1992). Under the effect of alcohol, the cortex is freed from its integrative role, thus resulting in confused and disorganized thinking along with disruption of adequate motor control (Nixon, 1999). Many children with FAS show much the same hyperactivity, inattention, and impulsiveness, as children with ADHD (Fitzgerald et al., 1993). Alcohol impairs their judgment and causes memory lapses (Streissguth et al., 1999).

Preliminary Studies

In recent years psychiatrists across America have prescribed children with ADHD million doses of Ritalin to treat hyperactivity, impulsiveness and inattentiveness, despite the side effects, addiction and dependency, which come along with administration of the drug. Armstrong (1999), Jeannette and Vos (2004) suggested that the cause for ADHD is broader than biosocial and formulated educational treatment based on changes in eating habits and exercise. Over the last few years aerobic exercise has been prescribed as a behavioral strategy to eradicate unwanted behavior and improve attention span in children with ADHD (Sylvester, 1994).

Brain learning has been stimulated with motor fitness. Pollatschek and Hagen (1996) compared children who did not participate in motor fitness with counterparts who did. The active students felt less lonely, shy and hopeless than the inactive students. These findings may be particularly important because children with ADHD not only paid little attention but also had serious social skill deficiencies related to higher incidents of school maladjustment, suspension/expulsion and delinquency or child psychopathology prior to participating in the program (D'Alonzo, 1996). The children who underwent the exercise program developed ability to reduce pain and increase euphoria. Morphine like analgesic properties seemed to help with negative behaviors, and neurotransmission played a role in memory, learning, response to stress, reproduction, appetite, temperature, and respiration (Harrison, 1994).

Mcgimsby and Favell (1994) indicated that increased exercise with sufficient intensity, frequency, and duration, is an efficient mean to reducing rates of aggression, misbehavior, stress and anxiety in children with ADHD. Leith (1990) showed a change in body chemistry following exercise which ultimately had an impact on behavior. The changes were dependent on the intensity, duration, and frequency of the aerobic activity. Children who were exhibiting early symptoms of inattention, hyperactivity, were exposed to high incidence of frequent aerobics on a regular basis. The aerobic exercise affected their muscle exhaustion and increased body chemistry changes, consequently eliminating unwanted disruptive behaviors.

Many hyperactive children cannot locate things with their visual system as a result of slow maturation of certain executive systems of the brain (those in the frontal lobes that give the ability to have foresight and self-control) and use their motor system to get to it. In today's world there is a general decline in child-parental communication, mainly due to a very little auditory input exposure, where frustration and withdrawn are treated with drugs. Drugs can permanently "sensitize" certain neural circuits such as dopamine systems of the brain. The brain system becomes chronically over-responsive, and since dopamine controls eagerness, children with ADHD want more of everything than is normal: food, sex, and drugs (Pankseppp, 2002). .

The National Association for Child Development (NACD) has been accomplishing the same results of "blowing off steam" in treating ADHD by exercising the brain in a structured environment (Pankseppp, 2002).The nature of NACD interventions is cognitive; however, they do not only enhance cognitive functions but also increase social competence, emotional management, and behavioral control. The interventions are based on family/school interaction. Family members/teachers work together to treat ADHD in a healthy manner in a supportive, controlled, stable, preserved and cohesive system to avoid drug relationships (Hussong & Chassin, 1997).

NACD developed a sequential processing intervention to improve cognitive mastery, study skills, reading, math, verbal and conceptual skills. The principle behind the intervention was that the more the brain exercises fundamental processing capacities, the stronger, more efficient, and more organized it becomes. As the pathways of neural network proliferate and deepen, so, too, the ability to absorb and process information more quickly and easily. The interaction of NACD sequential processing intervention and the physical exercise program was established to enable children with ADHD with

- √ Focus - ignore interruptions and block distraction
- √ Attention - suppress intrusive and confusing information
- √ Concentration - focus longer on the task ahead and get more done
- √ Comprehension - understand the concept and get the whole picture
- √ Reading - read faster, without the need of repeating the same sentence over again and again
- √ Expressive Language - express oneself constructively
- √ Reasoning - know the rational behind facts such as "why is it like that?"
- √ Writing- write clearly and logically
- √ Problem Solving - come up with ideas relatively quickly
- √ Retention - have a better chance to remember what was said
- √ Self-Esteem - value and appreciate own intelligence

According to NACD, the neurodevelopment and neural organization in the brain can be greatly enhanced by a carefully planned environmental stimulation. A greater level in the functional organization of neurons is accomplished when properly providing specific stimulation to the brain. Hyperactive students receive information in a hypo/hyper state which affects the way the brain perceives information. Many of the learning difficulties and misbehaviors disappear if they are identified before they are corrected (Doman, 1986). For example, some children with ADHD are distracted by a car, a bird, or overwhelming sounds. Others have recurring fluid in their ear, which distorts auditory information and causes sequential processing delays. NACD treatment is contrary to what is offered in public education. In most schools children with ADHD are placed in settings where less processing at lower levels of complexity is required. Fewer expectations are the cause for these children to fall behind their classmates at an accelerated pace. A great number of parents lose confidence in teaching their children at home once they are labeled "ADHD". According to NACD, parents are best suited to be the primary teachers because the majority of the children's early learning experiences take place at home (Jaquith, 1996). The key for parents to eradicating misbehaviors is to create a routine that they will follow each day or week, where the child accurately predicts what the day holds for him/her and have a consistent plan of action. Children with ADHD like to be active and exercise routine is beneficial for their physical health as well as brain function (Doman, 2003; Jaquith, 1996). Exercise may improve the brain environment/function to help with breathing.

Schools across the country have been using NACD interventions to help the child form a knowledge concept dependent on the ability to receive, process, store, and retrieve information efficiently (Jaquith, 1996). The interventions identify the current developmental level of the child in each sensory and motor area of the brain and determining the specific stimulation needed to move the child to the next developmental level. The sequential processing intervention employed an innovative method of making ADHD manageable to the child environment via practicing brain exercises. The intervention was an NACD product of past research and field experience of knowledgeable and well trained neurodevelopmentalists. It was a masterpiece of 30 years of treating over 30,000 children and challenged the existing accepted paradigm of a "pill to every ill."

NACD sequential processing intervention offered a systematic workout for auditory and visual sequential processing; the two most fundamental building blocks for all cognitive processes (Blume et al., 1999). Auditory and visual sequential processing inefficiencies negatively affect academic ability, decision making, attention span, and behavior as well as social maturity, interaction, learning ability, and productivity. Children with ADHD are forced to spend valuable time, effort, and energy to compensate for being unable to take in, retain, and process information and the sequential processing intervention was designed to improve conceptualization and visualization, which ultimately resulted in faster cognitive processing and minimization of misbehaviors. In three months children progressed one academic year. The sequential processing intervention decreased time of exposure to disturbing stimuli; increased intensity with which information is delivered with enough frequency for the information to be available for retrieval. In this intervention, rather than seeing the brain of the child as stagnant and unable to change, whereas producing changes in curriculums modifications have made, the child learned information with greater ease.

According to Doman (2003), president of NACD, ADHD problems are more than anything else a reflection of neurological inefficiencies. Neurological inefficiencies affect how the brain receives, processes, stores, and utilizes information. Identification of inefficiencies begins with looking at what the brain is receiving. Are the eyes and ears communicating the proper information to the brain? Symptoms which are related to low processing include difficulty in following through on instructions from others, remaining in one's seat, getting easily distracted, waiting for one's turn in game situations, sustaining attention or shifting attention from one task to another, playing quietly, and using what is necessary for task completion (Jaquith, 1996). A child with low processing appears not to be listening to what is being said when s/he is actually unable to process the information completely (Doman, 2003). In ADHD, poor auditory processing is accompanied by low development in tactility where the child bumps into things, fidgets or squirms around, and to a degree is engaged in physically dangerous activities (Jaquith, 1996). Two common issues are tackled with NACD sequential processing intervention: (a) inability to appropriately process sensations of light touch, pressure, and pain, and (b) inability to know where one's body is in space (proprioception) (Jaquith, 1996).

Research Design and Methods

Participants

Participants were sedentary students with ADHD (N=103) ages 11-13 who have been on Ritalin for the last 3-5 years (20 mg). Students from private schools in Mexico City (n=35), Salt Lake City (n=34), and Haifa-Israel (n=34), were assigned into two groups: (a) continue medication treatment, and (b) discontinue medication treatment, replacing it by an exercise program and NACD sequential processing. Group selection was based on parents' interest in substituting medications with an alternative treatment. Participants' ages are considered to be a "window of opportunities", a milestone, in child development because their cognitive ability was in its peak stages. Teachers attested this was a critical period to resolve their academic and behavioral deficiencies which interfered with their learning and function in the classroom or home, and exhaust their potential.

Measurement Instruments

Testing (dependent variables)

The ADD/ADHD Checklist (Reif, 1997, pp.16-17). Number of items was 13 and they were scored on an interval-ratio scale from 1 to 5. The higher the score the more severe the ADHD condition was (the highest is 65); the lower the score the better was the result (the lowest was 13). The items were: 1. distractibility, 2. confusion, 3. concentration, 4. attention, 5. boredom, 6. incomplete assignments, 7. independence, 8. sluggishness, 9. reading, 10. following directions, 11. study skills, 12. forgetfulness, 13. disengagement. Items 1,2,5,6, 8,12,13 are scored on a reverse scale.

Program (independent variable)

Exercise: The program: The nature of the program was short duration, high pace, and frequent tasks, which allowed experimentation with different kind of equipment (balls, bean bags, hoops, steps, ropes, ladders). There was little instruction; yet, the instructions demanded increased attention, concentration, and working memory. Additionally, some of the tasks required computation and/or communication for a successful completion.

Intervention

Sample of NACD sequential processing description (taken from the computer software)

*Visual Base**

This exercise presents the digits/letters at one time. The digits/letters will be presented in a sequence, such as 83947. You have to look at each digit/letter individually from left to right and say it to yourself. Do not group/chunk or chain digits/letters in your mind. In the sequence 83947, you should repeat 8-3-9-4-7. *Those working at span range of 7 and above should remember to conceptualize, not visualize, the sequence.

*Visual Reverse**

This exercise displays the digits/letters one at a time. The sequence must be typed in reverse order from which it was given. For example, if the sequence given were d-k-p-t, the response would be typed tpkd. *Those working at span range of 7 and above can emphasize either conceptualization or visualization, depending on their needs.

*Visual Flash**

This exercise displays the digits/letters one at a time. The sequence must be typed in the same order in which it was given. For example if the sequence given were 5-7-2-1-4, the response would be typed 57214. You have to look at each digit/letter individually from left to right and say it to yourself aloud. Do not group/chunk or chain digits/letters in your mind. *Those working at span range of 7 and above can emphasize either conceptualization or visualization, depending on their needs.

*Auditory Base**

This exercise uses different voices to state a sequence, one digit/letter at a time. Listen careful to the presentation of the sequence. For example, if jdamc is presented, you might want to repeat each letter to yourself, thinking "j, d, a, m, c". *Those working at span range of 7 and above should remember to conceptualize, not visualize, the sequence.

*Auditory Reverse**

This exercise uses different voices to state a sequence, one digit/letter at a time. The sequence must be typed in reverse order from which it was given. For example, if the sequence given were 6-1-0-4, the response would be typed 4016. *Those working at span range of 7 and above can emphasize either conceptualization or visualization, depending on their needs.

*Auditory Random**

This exercise uses different voices to state a random sequence with random pauses. For example, you may start with a sequence of 5 digits/letters, dropped to 4, and continue with 7. *Those working at span range of 7 and above can emphasize either conceptualization or visualization, depending on their needs.

Procedures

The study initiated in May 2004 and terminated in December 2004 in Haifa - Israel (April-June), Mexico City - Mexico (July-Sep.), and Salt Lake City - US (Oct. °V Dec.). Schools psychologist/counselor contacted the principal investigator with a list of interested parents. Protocols about the intervention policy, procedures, commitment, and requirements were provided by the PI and disseminated through the psychologist/counselor office. Parents were asked to complete a written informed consent for voluntary participation and a medical history data form. Family doctor written permission was necessary for participants whose their parents wanted to withdraw them from medications. Teachers had to complete the ADHD checklist (Reif, 1997) every month: at the beginning of first month, and end of the first, second and third months (total of 4 times). Teachers did not know who belonged to the experimental/control groups. Students were divided into two equal groups: (a) continue medication treatment, and (b) refrain from medication intake and substitute medications with an exercise program and NACD sequential processing intervention. The experimental group learned the program and intervention from research staff specialists and practiced it daily for three months. Exercise was implemented for 30 minutes, at home, before school started and NACD sequential processing was implemented via a software for 15 min after school ended.

Limitations/Delimitations

1. short study period, 3 month
2. small sample size, Israel (34), Mexico (35), and U.S. (34)
3. voluntary sample
4. parental attention and encouragement for participants in the experimental group could contribute to the change
5. subjective assessment/scoring which could differ among teachers, schools, and countries
6. could not determine which part of the change, and how much, was due to the exercise program or was explained by the sequential processing intervention

Timetable for the study

Phase	Responsible party	Core of action
1	School psychologist/Counselor	✓ Send letters to families describing the study ✓ Generate interest in parents' school meeting and ask for voluntary participation ✓ Call parents who express interest to enroll their children in the study ✓ Submit a list of participants to PI
2	Parents and Teachers	✓ Parents review, complete, and sign protocols, consent form, medical history data form, and give written permission from the doctor to withdraw their children from medications ✓ Teachers complete ADHD checklist (1 time)
3	Research staff	✓ Assign qualifiers into experimental and control groups ✓ Teach the exercise and intervention to the experimental group
4	Teachers	✓ Keep assessing students on the ADHD list at the end of each month (3 more times)
5	PI and Research staff	✓ Analyze and summarize the results for publication

Statistical Analysis

The sequential processing intervention and exercise program were the independent variable, the ADHD checklist was the dependent variables. A 2X4 mixed repeated measure Multiivariate Analysis of Variance (MANOVA) was computed for the 2 groups (control and experimental) and 4 times (assessment on the ADHD checklist) using the Statistical Package for Social Science (SPSS, 2004). The level of significance was set to 0.5.

Results

Basic assumptions for the 2 X 4 multivariate analysis of variance (MANOVA) were tested. The Leven test was used to compare the variance of the scores across the two independent groups of participants. No significant ($p > .05$) differences were found in the variances of the two different independent groups for the 13 items. The Box M value was used to test the equivalence of the variance-covariance matrices for the two groups of students for each of the item. The Box M values for all 13 items were not significantly ($p > .05$) different indicating similarity of the variance-covariance matrices across groups. The univariate F ratios comparing the experimental and control groups on the tests were non significant ($p > .05$). The values for the Bartlett test of sphericity were used to test whether the correlation matrix for the dependent variables for each of the item was different significantly from the identity matrix; for all 13 items the Bartlett test was significant ($p < .05$) indicating some correlations of the 13 items. The Wilks' Lambda value computed for group differences was not significant ($p > .05$), indicating that the experimental and control groups did not differ on the ADHD checklist. The Wilks' Lambda value computed for time differences was significant ($F(8,600) = 3372.63$, $p =.00$), with most change between the beginning and end of the first month, follow by improvement between the second and third months. There was a semi-plateau between the end of first month and second month mimicking some physiological and cognitive adjustments (See Figure 1).

Figure 1.

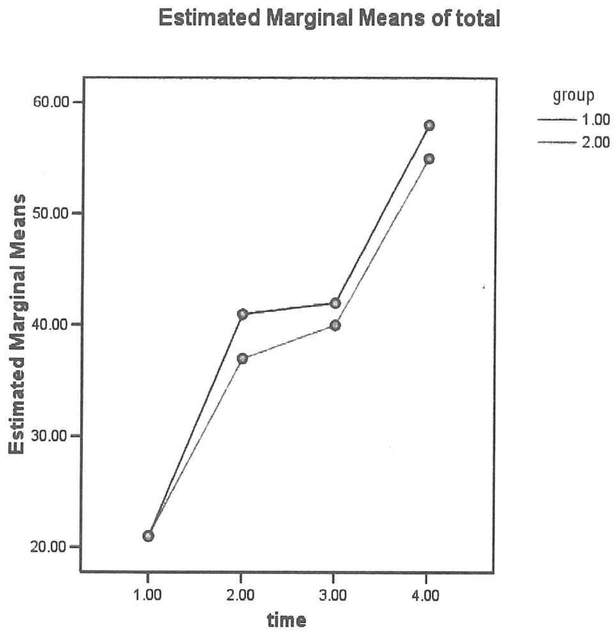

Table 1. Means for the 13 Items on the ADHD Checklist (Reif, 1997).

Item name	Begin month 1		End month 1		Month 2		Month 3	
	Exp	Control	Exp	Control	Exp	Control	Exp	Control
Distractibility	5	5	4	4	4	3	2	2
Confusion	4	4	3	4	2	3	1	1
Concentration	2	2	3	2	4	3	5	5
Attention	1	1	2	1	2	3	4	4
Boredom	5	5	4	4	3	4	1	2
Incomp. Ass.	2	2	3	2	4	3	5	4
Independence	2	2	3	3	3	3	5	4
Sluggishness	5	5	4	3	3	3	2	3
Reading	2	2	3	3	4	4	5	5
Follow Direct.	1	1	2	2	3	4	4	5
Study Skills	2	2	3	2	3	3	4	4
Forgetfulness	4	4	3	3	3	2	2	1
Disorientation	5	5	4	4	4	4	3	3
Total	**21**	**21**	**41**	**37**	**42**	**40**	**58**	**55**

Discussion

The results of the study appeared to meet the short term goals of empowering parents/teachers by educating them about the long term consequences of medications and by offering them alternative options in treating ADHD. Participants who underwent the sequential processing intervention and exercise program improved in academics and behavior as much as their counterparts, who took medications. They seemed to reach their inherent potential and experience better performance being free of medications.

Storage problems in memory reflect neurological disorganization, specifically disorganization of the cortex (Doman, 2003). Cortical disorganization creates a laterality problem and failure to organize the cortex and establish laterality often results in storage, language, and emotionality disorders. The process of organization culminated with the establishment of laterality and brain specificity was practiced through sequential processing intervention (Doman, 2003). Post intervention, the language ingredients of learning and school work became manageable including the ease with which the brain detected differences between the English language sounds, the ability to understand what they read, remember and use new vocabulary, the capacity to express thoughts while speaking and on paper, and the speed of comprehension needed. Writing no more seemed insurmountable threat because they gained attention control to conduct the orchestra needed to express thoughts on paper. More specifically they learned to slow down, plan, organize their thinking, pace themselves, watch what they were putting on the paper, and pay attention to all kinds of small details at once (punctuation, spelling, capitalization, and grammar).

Medications to treat ADHD are common in schools to enable children to remember and in order to learn and prevent emotional disruption to class. School years probably involve more strenuous exercising of memory than at any other time in life. Every course is a memory workout, and much more memory is needed for school success than for most careers. Before the study was conducted participants in the experimental group fell behind in school because they could not prioritize and concentrate on the most useful information. They had trouble retaining new material in short term memory. They either failed to take in information deeply enough or worked too slowly, being preoccupied with the details that they failed to see the big picture.

Attention and memory are compatriots. When the child does not concentrate it is hard to remember and learn. Attention is the administrative bureau of the brain, the headquarters for mental regulators that patrol and control learning and behavior. Attention controls direct the distribution of mental energy within the brain to have the wherewithal to finish what the child starts and stay alert throughout the school day. Children with ADHD face numerous academic challenges in which multiple components have to operate in synchrony. For instance, in writing they have to synchronize letter formation or keyboarding, spelling, punctuation, grammar, capitalization, prior knowledge, and vocabulary. With weak outputs control, they balk at doing homework and become visibly agitated and resistant. The sequential processing intervention kept participants focused while filtering distractions. When they did not understand something they were reading or listening to they realized they did not understand because they were not monitoring their comprehension. To control their mind outputs, participants in the experimental group monitored and regulated 3 main forms of such output: behavioral, social, and academic.

The intervention prepared the mind for thinking making the best use of available newly arrived or remembered facts and ideas. It was helpful for those who had had hard time deciding on relative degrees of importance and those who focused on too many things at once. The children learned selection control; picking out the very best information, most important and currently relevant data. The intervention taught to divide a span of attention while sustaining it to concentrate on more than one thing at a time for the right length of time. It allowed participants to take periodic mind breaks, get back and resume their attention. The mental rests (designed by the software), which are not typical during a school day, helped enormously with adjusting the amount of time given to a specific focus, and replenishes their thought of process. As a result, participants learned to mobilize mental energy at important intervals during the school day. The frenzied pedagogical fast rhythm/pace of the schools is totally contrary to what the child's brain is striving to become and to the outputs control the intervention reinforced. The outputs control existed to promote thoughtful slowly exercised work and did what they could to accelerate thinking and decision making to make participants thoughtful rather than impulsive.

Children with ADHD do things impulsively and then regret having done them leaving parents/teachers pondering if they should punish them for actions beyond their control. Many children with ADHD are smart but not productive. They do not intend to be bad but they annoy embattled parents/ teachers because they lack the controls needed to slow down and think about the consequences before they do something. Daily function is composed of regulated activities in which the child without realizing it takes aim at goals and accomplishes them in a regulated, reasonably efficient manner. Daily activities are guided by three forms of control: control over mental energy, control over intake, and control over output. In controlling the flow of mental energy, attention makes use of four neurodevelopment functions: alertness control, mental effort control, sleep arousal control, and consistency control. In this study the four neurodevelopment functions were executed.

Mental energy turned on and maintained participants' alertness. It enabled participants to be vigilant in the classroom, to concentrate on important incoming information, to feel a sense of being engaged or tuned in during school activity, making participants good listeners. Prior to the intervention, participants in the experimental group felt exhausted when they tried to concentrate. Their mental fatigue inevitably affected their learning and quality of schoolwork, and they reacted to mental fatigue by becoming hyper. Participants who were thought to be lazy were experiencing trouble generating and sustaining their mental effort (homework was a classic challenge).

A good night's sleep (at least 8 hrs) was essential for optimal brain function in school. This became viable as a result of the daily physical workout participants completed. The majority contended with a sleep-arousal imbalance where they originally displayed obvious mental fatigue and had hard time concentrating on high energy drainers. They were helped by the exercise program.

The Intensive, challenging, stimulating exercise program reduced the symptoms of ADHD, assessed on the Reif checklist (1997), leading to a behavioral and academic change. Attention is a starting player in athletic performance because the planning and pre reviewing of exercise move demanded tight control of attention. Within the body there is a need to do some incredible teamwork between various muscle groups and the brain and also among all diverse mind functions. The positive changes could also be attributed to the fact that diverse types of participants' learning style were addressed. The intervention included visual and auditory sequential processing activities, and the exercise program included tactile activities. Some children manifested predominantly visual distractibility which got in the way when they were supposed to be learning. Others appeared to have leaky sounds and they encounter trouble screening out distracting sounds. Some had tactile distractibility and could not resist anything that could be touched or handled. The sequential processing intervention and exercise program assisted children and parents to keep track of periods of good and poor performance and consciously try to increase the proportion of the time they were on target to show greater consistency.

Children vary in how they process information, and by participating in this study parents/teachers learned that the children needed their sympathy and support. They began recognizing that they were struggling, confused, wanted very much to succeed, please themselves and win the respect of their parents/teachers. Participants were able to correct their unintentional tendency to be oblivious of or insensitive to feedback, to express strong communication monitoring. Parents/ teachers also learned to hold their children accountable for working on their ADHD and attention control. They acquired the tools and skills to form strong alliances with these children to replace the adversarial relationships.

Analysis of the teachers' assessments on the Reif (1997) checklist revealed that the incidents of behavioral misconduct in the classroom decreased and academic achievements increased. Results suggest that a fitness-conditioning program in conjunction with NACD sequential processing intervention might be a useful tool in treating ADHD. However, there are some points to consider: the school did not have PE or other activity classes during or after school hours. The positive outcomes of the intervention could be a direct result of the attention the students received from the parents who knew the purpose of the study and exercise program more than the intervention/ program itself. This study should be tested with a larger sample and not sedentary students only in the future.

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