MEDICAL AND NONMEDICAL CAUSES FOR INATTENTION AND ATTENTION DEFICITS

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Introduction

This chapter describes medical and nonmedical causes of inattention and attention deficit disorders, and recognizes that both can be unrelated, or found to co-exist. Today's medical science holds that the medical causes of attention deficits are some 80% genetically induced, and that the some 20% are caused by brain damage. Here, too, the causes may be unrelated or found to co-exist.

Non medical causes of inattention and attention deficit disorders cover a broader spectrum of functional and behavioral factors. These include individual's levels of physical fitness, self-control, emotions, motivations, knowledge and interests. They also include the effects of learning and working environments.

Inattention

Simply put, an individual who is not paying proper attention is displaying some sort of inattention. However, determining the cause of this inattention is not simple. Being unable to focus accurately in formulating an intentional thought may result from a lack of knowledge or experience, or how to apply it. Or, as Donaldson[1] puts it, may result from of *errors of thinking*. According to her, these can be *structural*, i.e. not having the required structure to function correctly; they can be *arbitrary*, i.e. not being loyal to what is intended, and therefore making wrong assumptions; and they can be *executive*, i.e. not being able to remember, or apply, the motor plan for appropriate action.

Taken together, not being able to focus on the objective and object of attention will result in not attending appropriately and accurately to the task on hand. Here the cause could be emotional, being overwhelmed, distracted, or through "computer" overload, and in some way jamming or disrupting normal modes of thinking. Poor concentration and focusing ability may also account for lapses in attention. The power to concentrate requires a combination of adequate understanding (intellect), motivated interest, knowledge, memory and motor control. Deficits in any one or all of these areas will lead to reduced concentration and limited attention.

Medical Causes

Attentional Deficit Disorder (ADD) and Attentional Deficit Hyperactivity Disorder (AD(H)D)

The signs and symptoms of attentional deficit disorder (ADD) and attentional deficit hyperactivity disorder (AD(H)D) have evolved in the medical literature with other names. At the beginning of the 20th century, children with AD(H)D characteristics were said to have defects in moral character. Some 60 years later children with attention deficits were believed to have "minimal brain dysfunction (MBD)."[2] Over time, the medical authoritative, Diagnostic and Statistical Manual of Mental Disorders (DSM), has been updated four times (1968, 1980, 1987, and 1994) with

different names being assigned to the attention deficits. In theDSMII, published in 1968, a disorder resembling AD(H)D is listed under the heading of the "hyperkinetic reaction of childhood." This is defined as a type of hyperactivity characterized by short attention span, hyperactivity and restlessness. In DSM-III, published in 1980,[3] the name of this childhood disorder was changed to *Attention Deficit Disorder* (ADD). This definition was based on the assumption that attention difficulties were sometimes independent of impulse problems and hyperactivity; and were primarily associated with a problem of inattention. Terminology was introduced at this time to distinguish between two subtypes of ADD, namely, ADD/H, to denote with *hyperactivity,* and ADD/WO, to denote *without hyperactivity*. In 1987 a revised edition (DSM IIIR) discarded the term ADD in favor of AD(H)D. Under this term, the symptoms were consolidated to describe an unidimensional disorder without any subtypes. This definition excluded the possibility that an individual could have the disorder without being hyperactive. The most recent edition of the manual, DSM- IV (1994) retains the term AD(H)D, but divides the symptoms into two categories: inattentive and hyperactive/impulsive and with three subtypes, namely, AD(H)D, Primarily Inattentive; AD(H)D, Primarily Hyperactive/Impulsive; and AD(H)D, Combined Type.

Newly gleaned information on the genetics of attention-deficit hyperactivity disorder (AD(H)D) and from new neuroimaging technologies is said to hold promise for better diagnosis and treatment of AD(H)D with the added benefits of pharmacogenomics.[4] In terms of etiology, AD(H)D is now defined by the medical profession as a neuropsychiatric disorder which, in about 80% of the cases, involves a number of different genes, and in about 20% of the cases, is the result of an acquired insult to the brain. There is also the belief that both forms of AD(H)D may coexist in some individuals.[5] The medical definition of AD(H)D has, since its inception, held considerable sway and acceptance by scientists, physicians, psychologists, educators, parents and others. However, there is no definitive objective set of criteria to determine who has ADD/AD(H)D and who does not, and a loose set of combined behaviors are listed to describe the hyperactivity, distractibility, and impulsivity AD(H)D disorder. These behaviors are also very general in nature and give no clue as to their real origins, save for evidence from genetic histories, inspection of offending genes, or from brain imaging evidence of brain damage.

Questioning the exclusivity of the ADD/AD(H)D medical diagnosis

Upon closer critical scrutiny, there are good reasons to question the exclusivity of the ADD/AD(H)D medical diagnosis. Coles[6] is of the opinion that the medical definition does not cover non medical causes of inattention. He suggests that the causative factors could be overall lethargy. They could arise because of an inability to sustain attention, or an inability to select the right thing on which to concentrate. They also could be caused by a problem of focusing too narrowly within the area requiring attention, or the inability to filter out unnecessary information. He asserts, furthermore, that attention tasks such as central incidental learning are not pure measures of attention because they also involve motivation, memory, problem-solving strategies, and verbal abilities.

Non medical causes of inattention and attention deficit disorders

Inattention and *attention deficit* should not be considered as single entities,

but rather as a set of distinct processes. From a diagnostic perspective the goal should be to identify the functional and behavioral components of inattention, and attention deficits systems, and the ways these limit information processing.

While inattention to distractors and extraneous stimuli may be intentional, and purposeful during focused attention, inattention may be unintentional, and purposeless, when it detracts from focused attention. Attention deficit disorders fall within the latter category.

Viewed critically, such behaviors appear to be highly context-dependent, and conceivably, an individual/child may be hyperactive for any number of reasons. These include being bored, depressed, anxious, stressed out, impulsive, reacting to allergens, or to environments considered hostile or uncomfortable.[7] From a clinical perspective, it is important not to define ADD as a primary mental disorder, that ignores an individual's normal and intelligent way for not reacting or paying attention to an irrelevant or abnormal and disordered environment. Ultimately this impacts on intelligence versus unintelligence, motivation versus demotivation and unmotivation, attention versus inattention, action versus inaction, inhibition versus disinhibition, and hypo- as opposed to hyperactivity states of inattention. It is important to bring structural, functional and behavioral evidence to bear on these phenomena to advance our understanding and treatment of ADD and other related deficiencies.

Sensorimotor, perceptual and cognitive aspects of inattention

Aspects of deliberation with adequate knowledge and conceptual processes underlie decision making that, in turn, leads to establishing goals and end points. How to reach these destinations, requires directional knowledge, as well as modes of transport, and the drive – energy, to get there. Seen in this light, learning disabilities and attentional deficit disorders may well result from a combination of causative factors in a range from inabilities to make good decisions, follow directional paths or to the energy required to attend to the road map and reach intended end points.

It appears that few studies have been conducted to find relationships between cognitive executive processes and perceptual and sensorimotor processes. The visual triad that combines fixations, focusing and binocular fusional movements serves to pinpoint objects accurately, and clearly. Such relationships require cognitive, perceptual and sensorimotor integrative functions, that involve planning and execution in order to attain desired and efficient actions.

At a perceptual level, homeostasis and comfort represent two inner perceptual systems[8] that determine and control energy needs and their allocation. These, in turn, influence the arousal and suppression of the classical outer perceptual systems (basic orienting, taste/smell, haptic/ kinesthetic, auditory and visual). [9] In combination, both inner and outer perception act to process cognitive and sensorimotor information on a selective basis for the purpose of maximum understanding and for most effective action.[10] Ultimately these affect intentional and attentional states.

Emotions

Pert [11] has shown the effects of emotions on the chemistry of peptides and catecholamines that affect performance levels. In fact, there is an abundance of evidence that links motivation and enthusiasm to increased energy levels, and demotivation, lack of enthusiasm, and depression, to

decreased energy levels. Neuropeptide interactions take place in both directions. Every change in the physiological state is accompanied bidirectionally by a change in a conscious or subconscious emotional state.

Energy deficiencies and crises

A number of research studies[12-16] provide evidence that energy deficiencies or crises contribute to learning disabilities and the spectrum of attentional disorders. This research concerns space time relationships between the accuracy and speed of cognitive executive objective seeking and controlling, and that of ocular fixations in object seeking and controlling. More than a century ago Hering[17] explained that "[t]he movements from one point of fixation to another are occasioned and regulated by the changes of place of the attention. When an object, seen at first indirectly, draws our attention to itself, the corresponding movement of the eye follows without further ado, as a consequence of the attention's migration and of our effort to make the object distinct. The wandering of the attention entails that of the fixation point. Before its movement begins, its goal is already in consciousness and grasped by the attention, and the location of this spot in the total space seen is what determines the direction and amount of the movement of the eye."

Energy, attention, vision and learning

All inner and outer perceptual systems relate in an integrative way with vision. However, this understanding usually relates to the intersensory responses that answer the questions of *what, where,* and *when* objects are experienced in space/time. What is not usually considered are the two major inner perceptual systems of comfort, and homeostatsis that determine needs and apportion energy to balance body functions.

The reticular system of the brain is essential for initiation and maintenance of wakefulness, alertness, and for focusing of attention. It plays a role in perceptual association and directed introspection, and in regulatory action on the brain and spinal cord by excitation or inhibition. In this way, it can be seen to control spinal cord reflexes and voluntary movements. Muscle tone and coordinated muscle activity are dependent on this system.[18]

The homeostasis perceptual system[8] acts as an energy distributor of the whole brain and body according to total and specific perceptual needs. The degree of arousal and suppression of the reticular system therefore appears to be regulated by homeostasis energy control in the interests of total body equilibrium. Clinical evidence leads to the conclusion that the quantity and quality of energy resources of the body determine attentional states and the level of physiological and intellectual functioning. From an optometric point of view, this becomes readily apparent in the assessment of visual acuity, visual fields, ocular motility control, ocular muscle balance, binocular vision reserves and stereoscopic acuity.[19] The accuracy, speed and sustained performance of all these visual functions appears to bear a proportional relationship to the body's quantity and quality of energy supplies and reserves over time.[20]

Shallow breathing and oxygen deprivation

It is well known that severe oxygen deprivation causes a diminution of all sensory and motor functions, and affects levels of wakefulness and attention. Oxygen metabolism is more vulnerable to sugar overload, antibiotic abuse, environmental toxins, and allergies.[21] The brain does not respond uniformly to oxygen deprivation. Hippocampal cells that are involved in

learning, attention and memory, respond to hypoxia with an early depolarization, associated with a decrease in excitability.[22] What is not so well known is that reduction in visual functions also can occur when energy resources have to be diverted to weak parts of the body, which require extra energy because of their more life sustaining and supportive functions.[19]

Physical weakness leading to inattention

Based on the laws of physics, it should be clear how physical weakness can lead to problems of inattention and much more. Figure 1a shows a diagram of the spinal vertebral column with an arrow at its base. It has been estimated that the base of the spine carries 60% of the total body weight with a break load of 1020kg. in a young adult. The low back and stomach girdle of muscles plays an important role in handling this amount of strain. Figure 1b shows how weakness of the low back and stomach muscles (hypotonia) could lead to a compression and collapse of the vertebral column through sheer force of gravity. Depending on the severity, this in turn, would impact on the afferent and efferent nerve supply to the intercostal organs, and compromise their functions. For example, breathing may be expected to become shallower, and metabolism slowed down causing fatigue, sleepiness, and a drop in attention to outside stimuli.[19]

a.

Figure 1a. The base of the spine carries 60 % of the total body weight and a break load of 1020 kilograms in a young adult. The low back and stomach girdle of muscles plays an important role in this support system.

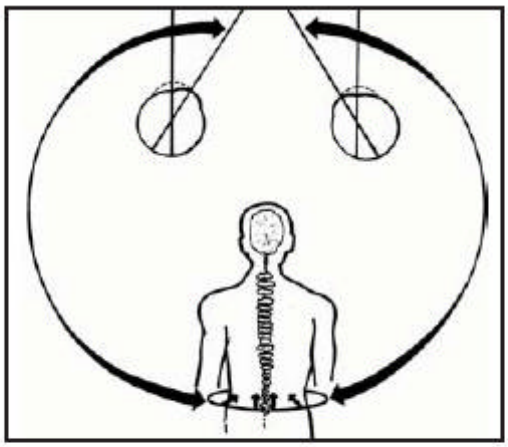
b.

Figure 1b. Weakness of low back and stomach muscles (hypotonia) may seriously affect the functions of the intercostal organs by virtue of inadequate vertebral support.

Evidence of the effects of gross motor weakness on focused attention, and fixation ability

Experiments show how tightening up of the large girdle muscles of the low back and stomach to compensate for their weakness in the gross motor system, gives rise to an over-reactive tension in the small muscles of the fine motor system. (See Figure 2). This gross motor hypotonia/fine motor hypertonia syndrome[19] serves to explain the degree of overconvergence (esophoric posture) that accompanies compensatory tension for gross motor weakness according to Hering's law of equal innervation[23]. (Hering's law shows the overreaction of a set of normally functioning extraocular muscles in one eye, when a weaker set of associated muscles in the other

eye is called upon to fixate a target, and requires extra effort to do so). It would seem that the top down mental cognitive objective, in the case of weakness of the low back and stomach muscles, is to compensate for their weakness by increasing their tone in order to protect the function of the intercostals organs they support. However, this extra effort causes the small muscles to overreact, be pulled out of alignment, and to affect their fixational ability. The inaccuracy of the ocular fixations in pinpointing objects, in turn impacts on the accuracy of pinpointing the mental cognitive objectives, that would normally result in appropriate attention and action.



Extra tension at the level of the large low back and stomach muscle girdle, causes overconvergence of the small extraocular muscles.

Figure 2. Esophoric reaction caused by extra tension at the level of the low back and stomach muscle girdle.

Studies have shown that ocular overconvergence occurs in reduced illumination, with fatigue, illness, hypoxia, the intake of alcohol or barbiturates, or with emotional arousal.[24-26] Such conditions affect the motor control aspects of concentration and attention. Inability to fixate, focus, and team eyes in binocular vision on objects of regard, may well contribute to the spectrum of learning and attention deficit disorders.
Timed tests of stereoscopic thresholds that illustrate the efficacy of pinpointing objectives and objects in space/time, show statistically significant relationships at P levels of 0.001 or better, when related to academic achievement, intellect and sporting ability.[26]

Electroencephalographic correlates related to arousal levels and quality of attention

Electroencephalographic measures[27] attest to levels of arousal, from the "comatose" slow delta, to the increasing speed of "sleepy" theta, the "being awake" alpha, and to the "alert" beta. The energy requirements that regulate these functions stem from the body tone that relates to motivational and physical strength factors. It serves little purpose to test the potential of a flashlight to illuminate a subject, if the batteries are low and/or it is not directed to the appropriate area of regard. Attaching labels of ADD, AD(H)D and other labels to related disorders can never lead to optimal diagnosis or treatment, if the strength of the affected individual's batteries or motivation remain untested.

Possible other causes of AD(H)D besides gene defects and brain damage

Barkley [28,29] provides a radical shift of perspective on AD(H)D, arguing that the disorder is fundamentally a developmental problem of self-control, and that a deficit in attention is a secondary, and not a primary characteristic. Armstrong[7] provides a list of some 50 ways in which parents can address a child's behavioral and self-control issues. The following focus on physical aspects of self-control. They include promoting a strong physical education program in a child's school, enrolling a child in a martial arts program; providing opportunities for physical movement; teaching a child physical-relaxation techniques; and providing hands-on activities. The common denominator here appears to be the building an individual's gross motor energy levels that relate directly to improved levels of motor control and to levels of attention.

Dickens and Flynn[30] hold that a person's ability at any point in time depends on a sort of *average* of all the environmental influences, both good and bad, that have contributed to the total effect of environment on ability over time. While their model conceives of social multipliers, it does not specifically entertain *social additions, dividers* or *subtractors.* Just as intellect and other developmental functions can increase impressively as a result of positive and small environmental influences, the converse also appears to be true. In such cases IQ, learning ability, attentional and other developing skills may be seen, equally, to be decreased. Formal educational settings demand that students sit still, with restrictions of body movement. They also demand listening, rather than talking and interacting for most of the school day. Attending to a set curriculum presented by the class teacher may not meet the immediate needs of individuals to understand, function, and even survive in such structured environments.

Physical fitness

A half century ago Kraus and Hirschland[16] used the Kraus Weber tests of minimum muscular fitness[31] to compare the fitness levels of American children against that of similar age level children from Austria, Italy and Switzerland. Their results, illustrated in Figure 3, show that while less than the 10% of children from other countries failed the fitness tests, almost 80% of American children failed these tests.

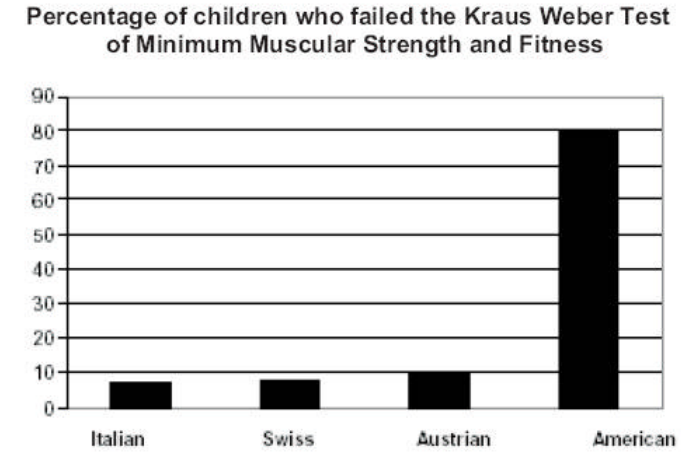


Figure 3.

Some 10 years later, Campbell and Pohndorf [16] compared the performance of American and British boys and girls in the times they took to complete a 600 yard walk/run relative to age in years from age 10 to age 17 years. Figures 4a and 4b show the significant differences in the performances of UK boys and girls, over that of the American boys and girls, and the significant difference of boys over girls.

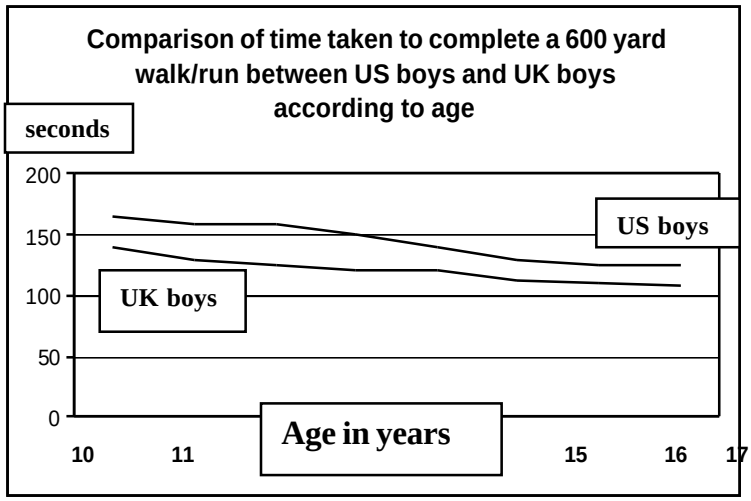


Figure 4a

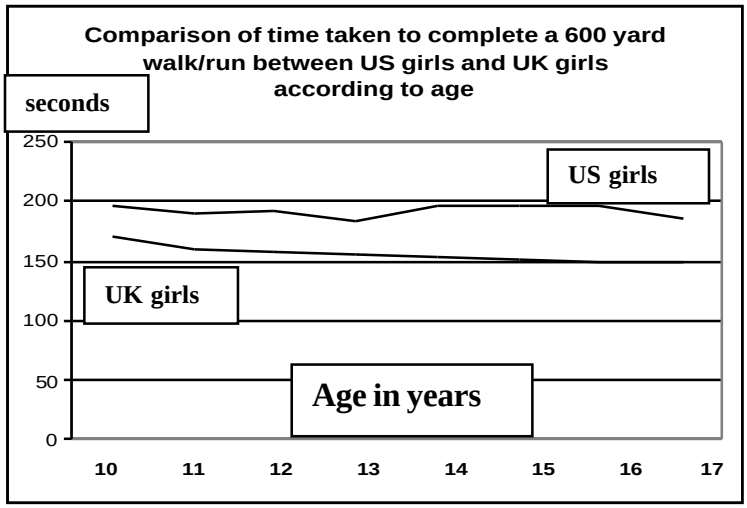


Figure 4b

The school environment and perceptual retrogression

I conducted research [32] on the perceptual development of 6-year-old, first grade children within the first week of their starting school, and then again six months afterward. My results, using the same pre- and post test measures are illustrated in Table 1. This shows the significant perceptual retrogression in visuomotor, auditory, body image, fine motor, and gross motor testing, in spite of the children being some six months older, and having

been enrolled in a learning development program during this period. It would appear from these results, that at risk children suffer most from the structure of schooling with its demands to sit still at desks and to pay attention to formal instruction. Where the good children performed the same or better, the at risk children did worse, and in fact, defeated the object of the learning readiness program, which was to ensure that all children starting school should be ready to achieve satisfactorily scholastically from then on. The areas of perceptual development reported on from my research attest to findings from other research[33,34] which show the relationship of movement and movement control in specific learning problems. These become apparent in dyslexia where problems manifest in the direction and sequencing of movement; in dyspraxia where difficulties of visualization, imitation and organization of motor output are dysfunctional; in AD(H)D, where difficulty in the inhibition of movement; and in autistic spectrum disorders where lack of perceptual coherence, poor recognition of self/other, and extraneous and repetitive movements and behaviors appear to be part of poor sensorimotor integration.

Table 1.
Percentage of perceptual retrogression comparing pre- and post test scores

Perceptual areas	Boys (n 183)	Girls (n172)	Total (355)
Gross Motor	19	30	24.4
Fine Motor	26.1	22.1	24.2
Body Image	17.4	19.2	18.3
Auditory Motor	18.5	12.2	15.4
Visuomotor	10.9	12.2	11.5

Relating physical fitness factors to attention and scholastic achievement

Although the Kraus and Hirschland experiment results led to the establishment of the President's Council on Physical Fitness in the U.S.,[35] it would seem that judging by the significant numbers of children who present today with AD(H)D, very little has been done besides the administration of stimulant drugs to address the problems of hyperactivity and inattention.
In 2001, more than one million students from 5th, 7th and 9th grade participated in statewide physical performance testing mandated by Assembly Bill 265 in 1995.[36] The tests known as the Fitnessgram[37] were developed by the Cooper Institute for Aerobics Research and assess six major health-related areas of physical fitness. These include aerobic capacity (cardiovascular endurance), body composition (percentage of body fat), abdominal strength and endurance, trunk strength and flexibility, upper body strength and endurance, and overall flexibility. A score of 6 indicates that a student is in the healthy fitness zone in all six performance areas, and meets standards to be considered physically fit. The test, Fitnessgram, uses criterion-referenced standards. These standards represent a level of fitness that offers some degree of protection against diseases that result from sedentary living. Achievement of the fitness standards is based upon a test score falling in the Healthy Fitness Zone (HFZ).

Each of the six tasks measures a different aspect of fitness, and the HFZ represent minimal levels of satisfactory achievement on the tasks. Figures 5, 6, and 7 provide histograms where the height of each bar shows the average (median) SAT-9 national percentile rank of those students with a particular fitness score for the 5th, 7th, and 9th grade students respectively. In each figure it will be seen that higher academic achievement is associated with higher levels of fitness; students who meet minimum fitness levels in three or more physical fitness areas show the greatest gains in academic achievement; and the relationship between academic achievement and fitness was greater in mathematics than in reading, particularly at high fitness levels.

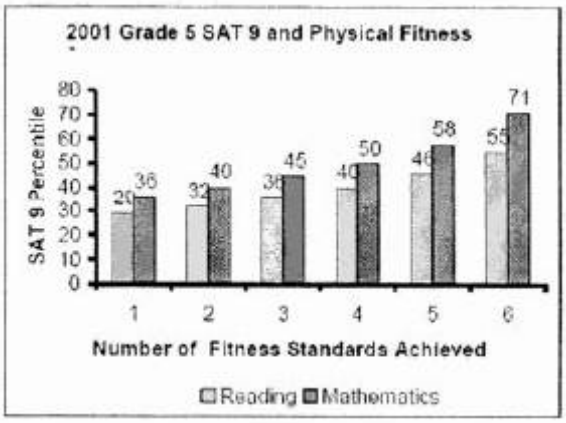


Figure 5

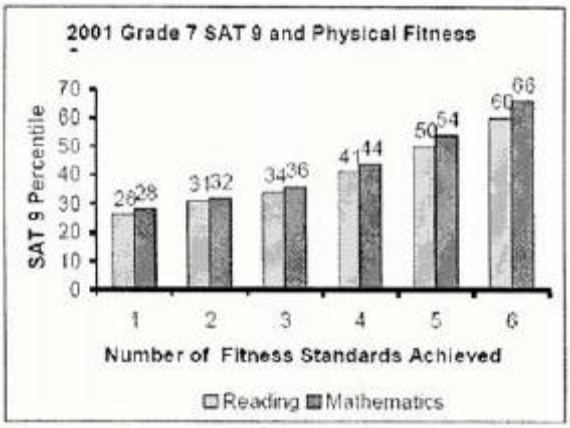


Figure 6

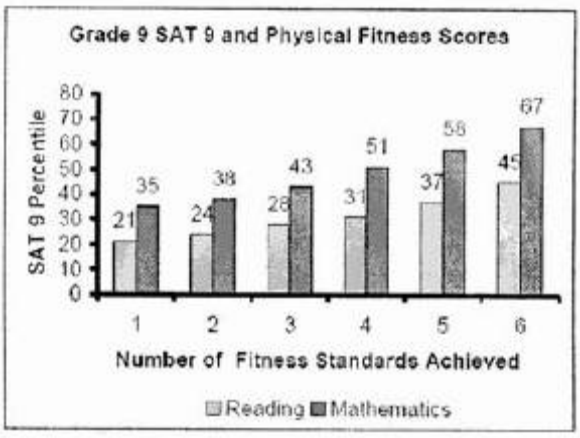


Figure 7

Implications of the Fitnessgram tests in relation to the No Child Left Behind Act of 2001[38]

The Fitnessgram tests show conclusively that there is a statistically significant positive relationship between physical fitness and scholastic reading and math ability. However, the accent placed on raising the reading ability levels of children which is the mission of the No Child Left Behind Act (2001) does not make an equal case for raising the level of children's physical levels in spite of the evidence that reading and math ability relate positively, and that physical unfitness is a contributory factor in poor reading and math performances.

Conclusions

While genetic causes and brain damage can account for attention deficits, the same can be anticipated for physical weaknesses, from birth onwards. It has been shown that the first lessons in posture begin at birth when the infant experiences the full force of gravity for the first time. Children normally develop the muscle tone, balance, and sensorimotor coordination to be able to lift their heads after birth while lying in the prone position. It takes some three months to be able to do this from the supine position, and some six months before an infant can sit up unaided, and three or more months to be able to stand up and later to take his or her first steps. Every movement helps to strengthen connections between the body and the brain. The experience of movement helps to build the architecture of the brain by strengthening pathways between nerves and association areas, which eventually provide a stable platform for coherent perception and learning.

Reflexes connected to the functioning of the balance mechanism affect specific aspects of learning. The balance mechanisms located in each inner ear are connected to centers in the brain involved in control of the body, eye movements and the regulation and modulation of motor output. A well functioning balance mechanism is also necessary for the understanding of a sense of direction. The symmetrical tonic neck reflex affects coordination between the upper and lower halves of the body, is associated with poor muscle tone and can often be seen in the child who has poor sitting posture and who tends to slump on the desk when writing.

Under-developed postural reflexes, such as the head righting reflexes, affect not only posture and muscle tone but can also impair the development of eye movements such as convergence and tracking, upon which reading

and writing and even catching a ball depend.[34]

Motor skills are the primary tools of learning. Attention occurs when there is orientation to a particular stimulus – orientation is characterized by a sudden stillness – stillness requires the ability to inhibit action, to have control over reflex responses. The fluent expression of thought, whether it is through speech, writing or drawing, depends on control of appropriate muscular activity, and muscular control begins with reflex maturity and control of balance. Memory has its roots in the association between nerve cells which is improved by repetition and practice. Even thought, in its many guises, begins as an internalized form of action. In this sense, Attention, Balance and Coordination are the primary A,B,C upon which all higher forms of learning are built.[39]

Environmental factors that account for attention deficits

A major feature of school readiness is the measure of self-control a child can demonstrate. This quickly translates in being able to sit still in a classroom environment and pay attention. In fact, all learning is connected in some way to the control of movement. Movement is an integral component of behavior. Just to sit still a child must be able to inhibit movement to maintain stable posture or there will be a constant need to fidget, squirm and change position and display the signs of AD(H)D.

In addressing attentional deficits that seriously impact on learning ability, it is therefore necessary to attach the right proportion of blame to uncontrollable factors such as genes and brain damage, on problems of self control, and lastly on environments that cause defective attention. In the final analysis, we should pay much more attention to physical fitness and charging the batteries necessary for developing self control and scholastic achievement in addressing problems of AD(H)D.

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