Mind/Body Connection

A Formula for Student Success

Learning new and complex movement patterns +

Participation in aerobic physical activity +

Developing Physical Fitness =

Physical Education: A Strong Contributor to Student Learning in all Subject Areas and High Test Scores on Standardized Tests

Movement is essential to memory, emotion, language and learning. The so called higher brain functions evolved from movement and depend on it (Ratey, 2002, p. 148).

Physical activity has a positive influence on concentration, memory, academic performance (including grade point average, scores on standardized tests and grades in specific courses) and classroom behavior (Strong, Malina, Blimkie, Daniels, Dishman, Gutin, Hergenroeder, Must, Nixon, Pivarnik, Rowland, Trost, & Trudeau, 2005).

The increase in childhood overweight and obesity in the U.S. has resulted in more of a focus on the importance of providing students with regular moderate to vigorous physical activity. However, the major focus of public education in America is to meet test score thresholds that increase each year (adequate yearly progress or AYP) mandated by the "No Child Left Behind (NCLB) Act of 2001." Some schools have responded to the rising pressure to lift standardized test scores by shifting resources away from physical activity (i.e., recess and physical education – as well as the arts) in order to provide more time for the two major tested subject areas - mathematics and English/Language arts. These tested curriculum areas have become the overriding or paramount focus in our "what gets tested gets done" age of education.

Reducing or eliminating physical activity programming in favor of tested subject areas such as English/language arts and math instruction is a penny wise and pound foolish approach to the promotion of student learning (Shephard, Volle, Lavalee, LaBarre, Jequier, & Rajic, 1984; Symons, Cinelli, James, & Groff, 1997; Ratey, 2002, 2008; California Department of Education, 2004; Strong, Malina, Blimkie, Daniels, Dishman, Gutin, Hergenroeder, Must, Nixon, Pivarnik, Rowland, Trost, & Trudeau, 2005; Ahamed, MacDonald, Naylor, Liu-Ambrose, & McKay, 2007; Chomitz, Slining, McGowan,

Mitchell, Dawson & Hacker, 2009; Hillman, Pontifex, Raine, Castelli, Hall, & Kramer, 2009; Texas Education Agency, 2009).

The body of evidence supporting the relationship of physical activity to cognitive development grows stronger each year. However, American educational decision makers neither recognize it nor act in service of it.

The Relationship of Physical Activity and Academic Achievement

In this era of overweight, obesity and sedentary lifestyles it's easy to forget that we were born to move. The human capacity to think, plan and learn is rooted in the parts of the brain that govern movement. Physical activity cues the building blocks of learning in the brain. Physical activity also affects mood, anxiety, and attention, guards against stress and reverses some of the effects of aging in the brain.

Many see the brain as unrelated or unconnected to the body. We view it as a remote commander that mysteriously directs the body. However, those who subscribe to these beliefs fail to see that exercise has a profound effect on cognitive abilities. Physical activity creates an environment in which the brain is ready, willing and able to learn.

The brain responds like muscles do, growing with use and shriveling with inactivity. Neurons in the brain connect to each other like leaves on branches. Physical activity causes these branches to grow and bloom with new buds, enhancing brain function. If you had an hour of physical activity this morning you are in the right frame of mind to read and understand this sentence. Your brain is also better equipped to remember it.

Physical activity influences learning directly, at a cellular level, improving the brain's potential to store and process new information. Interestingly, only creatures that move have a brain. That which we call thinking is the evolutionary internalization of movement. As our species evolved our physical skills have developed into abstract abilities to predict, sequence, estimate, plan, rehearse, observe ourselves, judge, correct mistakes, change tactics, and remember everything we did in order to survive.

Your body was designed to be physically challenged. When you push your body you challenge your brain as well. Learning and memory have evolved together with the motor functions. As far as you brain is concerned if you are not moving there's no real need to learn anything.

Physical activity helps us learn on three levels (Ratey, 2008, p. 53):

1. It optimizes alertness, attention, and motivation.
2. It prepares and encourages nerve cells to bind to one another, which is the cellular basis for storing new information.
3. It spurs the development of new cells from stem cells in the hippocampus

The Body/Mind Connection

The areas of the brain that control physical movement also coordinate the flow of information (Ratey, 2008, p. 151). The basal ganglia, cerebellum, hippocampus and prefrontal cortex are major players in physical activity and thinking. The view that each brain function is isolated in one area of the brain is false (Ratey, 2002, p. 148).

The cerebellum (with help from the motor cortex and basal ganglia) coordinates physical movement and the movement of thoughts. They order the steps for a physical movement and those necessary for cognitive operations (Ratey, 2002, 362). Just as the cerebellum orders the movement necessary to catch a ball, it helps sequence the thoughts necessary to visualize a room in your house, make a persuasive argument or think up a song. The cerebellum also coordinates attention, emotions and even social skills. The cerebellum is a primitive part of the brain that is hard at work when we learn how to do something physical. It makes up about 10% of the brain's volume and contains half of our neurons. It keeps rhythm for more than just motor activity and regulates certain brain systems so they run smoothly. Finally, the cerebellum is highly involved with the integration of information and the rate at which information is processed, all essential to thinking, learning and memory (Ratey, 2002, p. 176).

When we perform complex physical activities we are also exercising parts of the brain that are involved with the full range of cognitive function. For example, the prefrontal cortex organizes mental and physical activity. It is like the CEO of the brain performing such acts as overseeing working memory, inhibiting stimuli, initiating action, judging, planning and predicting. The prefrontal cortex works closely with the hippocampus and motor cortex (Ratey, 2008, p. 41).

The brain circuits used to order, sequence, and time a mental act are the same ones used to order, sequence, and time a physical act. The entire front half of the brain is devoted to organizing mental and physical action (e.g., working memory, motor planning, the ability to inhibit competing stimuli, thoughts, and action). Physical and mental processes that have been mastered are stored in and executed from the brain stem, basal ganglia and cerebellum in the lower brain. Complex or new physical actions or cognitive processes are managed further up in the brain, toward the frontal cortex. This allows more neurons to be involved along the way to adjust and revise a precise final action or cognitive process (Ratey, 2002, p. 158).

Motor and cognitive functions are handled by the brain in a parallel manner (Ratey, 2002, p. 158). This accounts for why we are unable to solve a mental problem until we go for a walk or perform some physical activity. Here, we activate our motor centers to achieve a desired cognitive function.

Learning New and Challenging Movement Skills and Cognitive Development

In physical education students regularly participate in moderate to vigorous physical activity and practice new and challenging movement patterns. These two aspects of physical education make the brain better equipped to learn. The key aspects are that the movement pattern must be challenging to the student and accompanied by feedback that tells the learner what and how to improve.

When we learn how to perform a movement pattern that requires us to think deeply about what the body will do, how it will move, where it will move and with whom or what they body will move with (e.g., a social dance step, a tennis serve, a backward roll in gymnastics and so forth) in physical education we are exercising the same areas of the brain that are involved in all of the cognitive functions used throughout the school day.

Complex physical activities put all the brain systems to use by strengthening and expanding neural networks. The more complex the bodily movements the more complex the resulting synaptic connections become. These circuits are recruited by other areas of the brain for various types of thinking (Ratey, 2008, p. 55). For example, in dance, moving to an irregular rhythm versus a steady, regular rhythm improves brain plasticity (the flexibility or adaptability of the brain). The brain grows stronger in much the same way muscles do through resistance training.

When students are learning a new motor skill in physical education the circuits linking the cerebellum, basal ganglia and prefrontal cortex get going and your performance improves. While practicing these types of motor skills we create thicker myelin around nerve fibers. This improves the quality and speed of the signals and the efficiency of brain circuitry.

Practicing an activity such as catching a ball with a lacrosse stick on the non-dominant side of the body requires the mastering and coordination of many bodily movements. When people learn to develop such movements they experience an increase in academic abilities such as memory retrieval and cognitive abilities. This is because physical and mental tasks require the same neurons to be shared increasing the likelihood of long term learning (Ratey, 2002, p. 178).

Complex physical activities and aerobic activity have distinct positive and complementary effects on the brain.

Aerobic activity and your Brain

Regular physical activity is the single most important tool you have to optimize your brain function (Ratey, 2008, p. 245). Aerobic activity elevates neural transmitters, creates new blood vessels that send growth factors and spawns new cells. Aerobic activity also improves executive function and moves more blood and nutrients into the brain.

Aerobic activity augments the number and density of blood vessels in the motor cortex and cerebellum. Exercise helps the brain become more fit. The more we move and stress our body, the better our circulation is and the more fit our brain becomes (Ratey, 2002, p. 359). Exercise produces stronger, healthier and happier brains.

The product of regular physical activity is physical fitness. Physical fitness also promotes academic achievement in the form of high scores on standardized tests.

The Relationship between Physical Fitness and Standardized Test Scores

The state departments of education in California and Texas have best demonstrated the strong relationship between a student's physical fitness and high scores on standardized tests.

California

In the spring of 2001, 954,000 fifth, seventh and ninth grade students in California took two tests: the FITNESSGRAM, a physical fitness test that measures health related fitness (i.e., cardiorespiratory endurance, muscular strength and muscular endurance, flexibility and body composition) and the state's California public school students in first through sixth grade participate in physical education for 200 minutes every ten days. Students in grades seven through twelve participate in 400 minutes of physical education every ten days.

Texas

A study of 2.4 million Texas students in grades 3-12 from the 2007-2008 school year found that students who are physically fit are more likely to perform well on the state standardized test (i.e., the Texas Assessment of Knowledge and Skills – TAKS), have better school attendance, and are less likely to have discipline problems than their less fit peers (Texas Education Agency, 2009).

Public school K-6 students in Texas participate in 135 minutes of physical activity each week.

Physical Activity and Student Learning

The following evidence is from recent published work on the relationship of physical activity to cognitive development.

1. Physical activity and physical fitness have been shown to have positive effects on cognition and concentration (Chomitz et al, 2009).
2. Physical activity is consistently related to higher levels of self-esteem and lower levels of anxiety and stress each of which has been associated with enhanced academic performance (Chomitz et al, 2009).
3. Student attention is likely to be greater in an active rather than a sedentary student. This may facilitate favorable interaction between classroom learning and student cognition (Chomitz et al, 2009).
4. Studies have shown a significant positive relationship between physical education time and classroom grades (Chomitz et al, 2009).
5. Scoring within the healthy fitness zone on all five components of the FITNESSGRAM health related physical fitness test battery is positively correlated with passing scores on the MCAS in math and English language arts (especially in math). Similar findings were demonstrated in Illinois on their state standardized test and FITNESSGRAM (Chomitz et al, 2009).
6. Physical fitness may enhance student concentration and classroom behavior, which in turn, contributes to achievement (e.g., standardized test scores and grades) (Chomitz et al, 2009).
7. Regular exercise can alleviate stress, anxiety and depression and boost self-esteem (Chomitz et al, 2009).
8. Academic achievement improves when physical education time increases. Academic achievement increases even when physical education time increases, and reduces “academic learning time.” A reduction of 240 minutes per week in class time for academics to enable increased physical education led to consistently higher mathematics scores (Shephard et al, 1984; NASPE, 2001).
9. Vigorous physical activity has positive effects on academic achievement including: increased concentration; improved mathematics, reading, and writing test scores; and reduced disruptive behavior (Symons et al, 1997).
10. Regular moderate to vigorous physical activity improves memory and enhances greater connections between neurons (CSPI, 2005).

11. Exercise can decrease stress and anxiety and increase self-esteem in adolescents. Active children are less likely to smoke or use drugs and are more likely to behave well and stay in school. Research with adolescents shows that low physical activity is associated with lower fruit and vegetable consumption; higher cigarette, alcohol and marijuana use; more time watching TV; less use of seat belts; and perception of low academic performance (Brownell and Horgen, 2004).

Effects of physical activity on the brain and learning

This article has presented much evidence from the work of Dr. John Ratey. Dr. Ratey is an associate clinical professor of psychiatry at Harvard Medical School who has written two books on neuroscience: A User's guide to the Brain (2002) and Spark: The revolutionary science of exercise and the brain (Ratey & Hagerman, 2008). Dr. Ratey is an advocate of using physical activity to promote cognitive development and for quality physical education. Here are some excerpts from his writing in support of physical activity:

1. The fact that there is constant activity in our brain and throughout our bodies tells us that movement is the ongoing life force without which we could not survive. Whether the activity is maintaining your body's temperature, ballroom dancing or learning to read, movement cannot be separated from other brain systems. A lot of brain function is essentially movement (Ratey, 2002, p. 155).
2. Movement is fundamental to the existence of a brain. Only organisms that move from place to place require a brain (Ratey, 2002, p. 156).
3. The brain's motor function is essential to the brain functions of: perception, attention, emotion, memory, thinking and learning (Ratey, 2002, p. 175).
4. Our physical movements directly influence our ability to learn, think and remember. It has been shown that certain physical activities that have a strong cognitive component, such as tennis or dance enhance social, behavioral and academic abilities. Each person's capacity to master new and remember old information is improved by biological changes in the brain brought on by physical activity. A better brain is equipped to think, remember and learn. During these periods of motor skill practice we exercise our muscles and our brains, particularly our ability to sequence motor actions and information as well as access memory (Ratey, 2002, p.178).
5. Exercise that involves learning complex movements can affect our brains in other ways. Gymnastics, dance and movements from sport (e.g., ballroom dance, dribbling with the non-dominant hand in basketball) involve a variety of coordinated movements, and practicing them causes more connections to grow

between neurons. Exercise that forces us to improve balance and coordination such as those in gymnastics strengthen neural networks in the cerebellum, which is the area responsible for balance, physical coordination and for coordinating our social interactions. This type of motor activity also affects the basal ganglia and corpus callosum, improving memory and increasing the ability to master new information (Ratey, 2002, p. 360).

6. All brain functions are descendants of movement. To improve our brains we have to move our bodies, take action and get going (Ratey, 2002, p. 363).
7. Motor development in infants, especially during the crawling stage of locomotors development, has been found to be of vital importance in the development of learning readiness for reading and writing (Ratey, 2002, p. 179).
8. In 2004, a panel of researchers from the fields of kinesiology to pediatrics reviewed over 850 studies on the effects of physical activity and school children. The committee reported that physical activity has a positive influence on memory, concentration and classroom behavior (Ratey, 2008, p. 22).
9. Physically fit kids have the ability to learn from mistakes. These students can consider a response to a test question and use the experience of a wrong choice as a guide in making the next decision (Ratey, 2008, p. 26).

Summary

Two of the many benefits of participation in physical education include moderate to vigorous physical activity and developing new and complex movement patterns. These two physical education components equip your brain to think, remember, plan, solve problems and learn throughout the school day. Regular participation in physical education with a highly qualified physical educator can help students build, strengthen and expand neural networks, which in turn, improves cognition.

K-6 students should participate in at least 150 minutes of quality physical education each week. Students in grades 7-12 should participate in 225 minutes of quality physical education each week (NASPE, 2004). Finally, if students participate in daily physical education they can achieve a health enhancing level of physical fitness. This can contribute to further cognitive benefits.

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