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**Fit Brains for the Future: How Exercise Supports  
Cognitive Function, Learning, and  
Cardiovascular Health**

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Last summer in Cambridge, England, the cannon boomed, hearts pounded, and oars dug deep into the River Cam, as our eight-man crew drove the boat forward. The crew behind was fighting hard to catch us. Every muscle hurt as we moved steadily up on the crew in front. Our coach, keeping pace with us on a bicycle on the towpath by the river, gave two sharp whistles to let us know we were only a length away. Then, three whistles, half a length. An almost-primal instinct powered our blades. In my peripheral vision, I glimpsed the boat in front, and seconds later we caught it. Exhilaration surged as we gave their crew three cheers, wrapped victory wreaths of willow on our sweaty heads, celebrating the fact that we had caught the crews in front of us for the fourth night. We had won our race!   
  
Forty years earlier, when I first achieved this goal for rowing in my high school, competing in the same competition was much easier. I had no idea back then that the training I was doing was laying a healthy foundation for my late 50’s and beyond. In conducting research for our new book, *Positively Smarter: Science and Strategies for Increasing Happiness, Achievement, and Well-Being* (Conyers & Wilson, 2015), I reviewed some fascinating studies on the positive impact of physical fitness and strength training on what we call the Body-Brain System. Our new book shares research and strategies to maximize performance across the life span. This article focuses on the implications of recent research on physical health and cognitive functioning in an educational context. The data indicate that we need a dramatic change in policy and practice to increase fitness levels for children and youth, and to help them understand the lifelong connection between physical health and brainpower.  
  
**The Positive Impact of Cardiovascular Fitness**Making exercise part of your daily routine builds a healthier body and has tremendous benefits for the brain as well:

* Regular physical activity is associated with a larger hippocampus, which is involved in memory and spatial processing. This association holds for people of all ages. Researchers working with groups of older adults found that hippocampal volume increased by 2% among participants in an exercise training regimen but decreased slightly in a control group (Erickson, et al., 2010). Another study with 9- and 10-year-olds found that children who were more fit had hippocampi that were 12% larger relative to total brain size than their less fit peers (Chaddock, et al., 2010).
* Exercise activates the frontal and parietal regions of the brain, associated with executive function (Best, December, 2010). In particular, the prefrontal cortex has been identified as the center for executive functioning, activating awareness of learning stimuli, and regulating and coordinating cognitive skills (Wilson & Conyers, April 2, 2015). Tests of cognitive performance and brain scans of children involved in an after-school program promoting daily moderate to vigorous physical activity indicated more efficient functioning in the prefrontal cortex. “These results suggest that physical activity during childhood may enhance specific elements of prefrontal cortex function involved in cognitive control” (Chaddock-Heyman, et al., 2013).
* Workouts increase the production of the brain chemical BDNF, which doctor and neuroscientist Majid Fotuhi refers to as “effective fertilizer for the brain” for its role in supporting the production and maintenance of neurons and synapses (Fotuhi, 2013). Neuronal and synaptic plasticity are the brain processes that change the function and structure of the brain in response to learning.
* Aerobic exercise increases angiogenesis, the growth of blood vessels that improve oxygen flow to the brain. “A third of the brain is made up of blood vessels and a full 20 percent of the heart’s output goes to the brain, despite the fact that the brain only accounts for about 2 percent of a person’s body weight” (Fotuhi, 2013). This is another link in the chain that ties cardiovascular fitness to healthy brain functioning.
* Exercise can help reduce symptoms of depression, alleviate stress, and put us in a more positive mood, which in turn can make us more creative and productive. Regular physical activity increases activation in the left hemisphere of the brain, which has been shown to support a more positive outlook (Hecht, September, 2013).

In short, these interconnections of our thinking, feeling, and physical selves influence our readiness, motivation, and ability to learn and to thrive. A wide range of research emphasizes the importance of starting children off right by incorporating regular exercise into their daily routines. Making physical fitness a habit will pay dividends throughout their lives in both physical and brain health.  
  
As just one example of these findings, Swedish researchers who have conducted large-scale longitudinal studies that compared men’s health as they entered military service in their late teens with their health later in life conclude that cardiovascular fitness in youth is predictive of lower risk of heart disease, dementia, and other forms of cognitive impairment in middle age and beyond. One such study reported in the *European Heart Journal* (Hogstrom, Nordstrom, & Nordstrom, January 8, 2014) indicates that teens and young adults who exercise regularly have a 35% reduced risk of heart attack later in life. A 15% increase in aerobic fitness as a teenager is associated with an 18% reduced risk of heart attack three decades later, this research suggests.

“An even more titillating pattern exists within the Swedish case,” note authors John Ratey and Richard Manning (Ratey & Manning, 2014). “The data set included 270,000 brothers and 1,300 identical twins and showed that cardio fitness and not familial relationship turned out to be the better predictor of both cognitive ability and IQ. That is, despite the popular assumption that IQ is genetically determined, fitness and not genes held the greater sway over these tests of intellect.” Commenting in a *HealthDay* (Thompson, January 8, 2014) article on the connection between physical fitness in youth and lifelong health, Stephen Daniels, chairman of pediatrics at the University of Colorado School of Medicine and a spokesman for the American Heart Association, said, “Even though the diseases we see are diseases of older adults, it’s increasingly clear that where people are in childhood and adolescence is critically important.”

**The Body-Brain Connection in Education**In the United States, the Centers for Disease Control and Prevention (CDC) have taken the lead in advocating for incorporating physical activity into the school day to nurture healthy bodies and minds. The CDC produced a meta-analysis of 50 studies on the impact of exercise on school performance, encompassing formal physical education classes, active play during recess, after-school sports and other activities, stretch and movement breaks in the classroom, and even “active” transportation to and from school, e.g., walking, riding bikes, skateboarding (CDC, April, 2010). The analysis concludes that exercise breaks throughout the school day boost academic performance and that enhancing students’ physical fitness supports development of their cognitive abilities. This report also offers evidence that trends in some school districts to reduce time for students to engage in physical education and recess in favor of spending more time at their desks may actually be counterproductive. None of the studies included in the meta-analysis found any negative consequences for making physical activity a regular part of the daily learning regimen. In a study of the Naperville Community Unit School District 203 in suburban Chicago, Ratey and Hagerman (2008) report that since the district has focused on creating a “culture of fitness” and required daily physical education for all students, Naperville has posted significant gains on standardized tests.  
  
What researchers have found is that students perform better on reading comprehension, spelling, and math tests when they have the opportunity to participate in 20 minutes of physical activity immediately before their exams, and that more physically fit middle schoolers perform better on assessments of math and reading that do their less fit peers (CDC, April, 2010). In addition to the direct connection between body-brain health and regular physical activity, incorporating movement and exercise into the school day may support learning by:

* Enhancing attention. Experienced teachers see firsthand the benefits of short exercise or stretching breaks or an active recess on the playground in helping to resharpen the focus on learning.
* Supporting cognitive flexibility. You may have experienced this phenomenon yourself. When you are dealing with a perplexing problem, try taking a break and going for a run or walk, or stopping by the gym. Physical movement has the power to free the mind of clutter and help fresh ideas and possible solutions “click” into place.
* Fueling creativity through playful physical activity. In his book, *Shine: Using Brain Science to* *Get the Best from Your People*, Hallowell (2011) suggests that “people at play produce creative results and leap from the humdrum to the exceptional.”
* Engaging the senses. The visual, tactile, auditory, and olfactory senses gather the input that sends signals to the brain, which in turn causes the rest of the body to react and engage with the world. An especially effective way to engage the senses is to get outside every day, if possible. Taking a break outside can help students refresh and refocus (Wilson & Conyers, 2013).

**Making the Grade**Despite all the evidence that incorporating opportunities for exercise and active play into the school day enhances learning, a decline has recently occurred in the amount of physical activity in American schools. According to a review by the U.S. Government Accounting Office, time allotted for physical education has declined, and only 4% of elementary schools, 8% of middle schools, and 2% of high schools offered daily physical education in 2006 (Pekruhn, 2009). A 2014 report from the Centers for Disease Control and Prevention and the Bridging the Gap Research Program (CDC, 2014) found that only five states require daily recess for elementary school students, and only ten states required a set amount of physical activity in the school day.  
  
To head off the argument that they make up for sedentary school days by exercising after school and on the weekends, the *2014 U.S. Report Card on Physical Activity for Children and Youth* (National Physical Activity Plan Alliance, 2014)sounds the alert that only one-quarter of students ages 6–15 meet guidelines for at least 60 minutes of moderate to vigorous physical activity per day. This report card assigns a letter grade of D- to the overall fitness levels of the nation’s children and youth and a C- to the role of American schools in helping students maintain their physical fitness.  
  
We can improve these ratings and, in the bargain, enhance students’ learning readiness by weaving opportunities for physical activity throughout the school day—in the classroom, in the gym, on the playground, on the sports fields, and in going to and from school. In doing so, we can both increase academic achievement and set children on the path for healthier, more productive lives in adulthood. **We can help them develop fit brains for the future**.  
  
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