Integrated Brain and Body Exercises for ADHD and Related Problems with Attention and Executive Function

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ABSTRACT

This paper reviews the neuroscience foundation for understanding and harnessing neuroplastic processes that shape the structure and function of the human brain after birth, describes a newly developed, integrated series of computer presented and physical exercises to promote activity-related development of neurocognitive systems of attention and executive function in elementary school children, and reviews evidence of the efficacy of the program. The computer-presented brain exercises have new functionalities that more fully shape the training to each user’s individual profile of cognitive strengths and weaknesses than was previously possible. The programs also provide assessments of each child’s cognitive strengths and weaknesses based on built in formal tests of cognition and error analytic algorithms applied to 15-20,000 responses from each child while using the brain training program.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD), Brain Training, Brain Training Games, Cognitive Development, Elementary Education, Executive Function, Neuroplasticity

THE PROBLEM

A recently completed study assessed attention skills in 2,000 elementary school children and followed them for 16 years (Pingault et al., 2011). Children with attention problems when they were six years old were 7.6 times more likely than their classmates to never graduate from high school. This poor attention group included 17% of the study population. Failure to graduate from high school is associated with underemployment, unemployment, drug use and jail time. Current estimates are that approximately 7-10% of elementary-aged children have been diagnosed with ADHD. Childhood ADHD is similarly associated with many of the same undesirable long term outcomes. In some schools, attention problems are even more common. In all schools, children with attention problems require disproportionate teacher time and can affect the learning environment for all children in the classroom.

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NEUROPLASTICITY AND THE SCIENTIFIC FOUNDATION FOR BRAIN TRAINING TO IMPROVE ATTENTION

The neural basis of all cognitive functions are networks of hundreds of thousands of neurons distributed widely throughout the brain. The interconnections among nerve cells that create these functional systems are not determined by our genes, but instead are heavily influenced by stimulation and experience after birth. Hubel and Weisel (1970; 1988) were awarded the Nobel Prize for demonstrating the great extent to which early sensory experience shapes brain structure and function in mammals. Meaney and colleagues at McGill extended this work to show the particular importance of maternal stimulation in shaping life-long features of the brain and behavior (Champagne et al., 2008). They further demonstrated that these effects are produced in part by altering methylation of DNA and thus turning specific genes on (Weaver et al., 2004). In an experimental tour de force, Sur and colleagues at MIT converted normal auditory cortex into visual cortex by replacing auditory with visual input in new born ferrets (Sharma et al., 2000), suggesting that neuroplastic potential may have even fewer limits than previously thought. Merzenich and others have now conducted numerous experiments in animals elucidating training and stimulation parameters that maximize neuroplastic reshaping of structure and function (e.g., Jenkins et al., 1990).

The structure and function of the human brain are shaped after birth by stimulation from the environment to a much greater extent than are the brains of any other animal. Moreover, only human beings shape the environment that in turn shapes their brains, a transgenerational process called cultural evolution (Wexler, 2006). Education is an important component of these processes. Figure 1 shows basic sensory plastic-

Figure 1. Activation of normal visual cortex by auditory stimulation in early blind individuals. fMRI study with white indicating areas of activation (image provided by the author A. Stevens and reprinted with permission).