Support Healthy Brain Development:

Implications for Attention Deficit/ Hyperactivity Disorder

By Erik Peper, Ph.D.

In class, he fidgets, every auditory and visual stimulus distracts him—he gets up, talks to other students and disrupts the class. Nothing seems to hold his attention; he looks at the page and moments later turns around and disturbs the boy behind him. At home, he grabs his food and leaves the table. He is continuously distracted. The only things that seem to capture his attention are his computer games.

Health is optimized when we live in harmony with our biological and evolutionary background. These behaviors allowed survival for thousands of generations. Disorders often occur when we neglect our evolutionary background during infant, toddler, and childhood stages of development. Diabetes, obesity, allergies, asthma, attention deficit disorder/attention deficit and hyperactivity disorder (ADD/ADHD), and other illnesses are more common in our modern life style.

From the moment of birth, parents realize that each child is different—some are quiet and others react to every sound and movement. Yet, how the infant develops depends upon the synergetic interaction between biology (nature) and environment (nurture). ADD/ADHD disorder is only a disorder if the behavior is too dysfunctional in the cultural setting or if the learning style is not supported by the culture. Drs. Lynda and Michael Thompson, directors of the ADD Centre & Biofeedback Institute of Toronto, observed that in running a boys' camp—ADHD boys are often sent off to camp—ADHD kids were the best on really difficult canoe trips. They were far faster learners of difficult mathematic concepts concerning the relationship of sails and wind if they were taught in the right conditions (wild approaching hurricane winds, etc.). They were terrible if you insisted they sit on a dock and just listen (personal communication, 2014).

ADD/ADHD has become an epidemic in the last 30 years. Now one in seven boys has received this diagnosis by the time he reaches the age of 18, according to the Centers for Disease Control and Prevention, as shown in Figure 1.

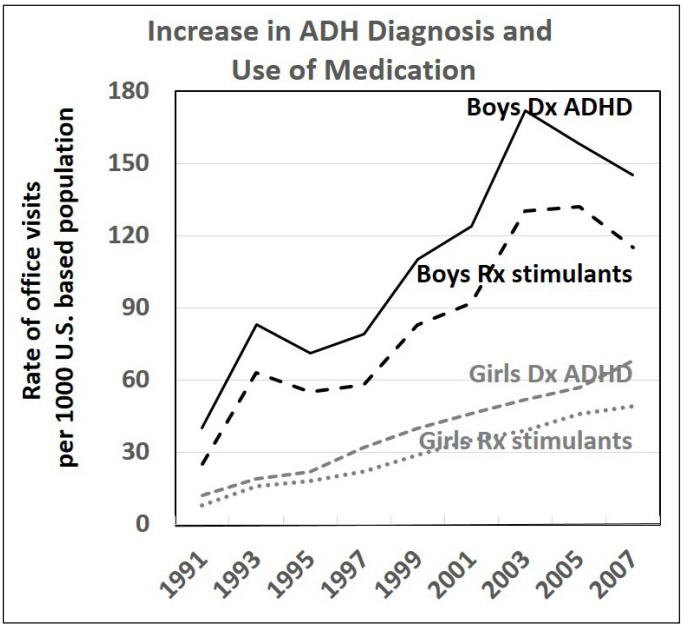

Figure 1. Rate of office-based visits per 1000 U.S. population aged 5 through 18 with diagnosis (Dx) of ADHD and rate of use of medication (Rx) for boys and girls. Redrawn from Sclar et al., 2012.

The increase in ADD/ADHD diagnoses or diagnoses of diabetes, obesity, and allergies cannot be explained by genetics alone. It may depend upon the interaction of genetics and the environment. The problem may develop into a disorder as a result of disrespecting and not understanding our evolutionary background during our development. Diabetes and obesity have increased because of a decrease in mobility and an increase in sugar intake from about 10 pounds per year in the nineteenth century to 150 pounds per year today (O'Callaghan, 2014).[1] Similarly, allergies previously were very rare; however, during the last 20 years their incidence has tripled (Branum & Lukacs, 2009). This spring I was shocked when I asked my students at San Francisco State University how many had allergies. More than 25% of the students said, "Yes." When these illnesses occur, we attempt to remedy them with medications. The medications for ADD/ADHD (e.g., Adderall, Concerta, and Ritalin) provide an 8 billion dollar revenue stream for pharmaceutical companies. Yet, there is little or no evidence of long-term benefits (Molina et al., 2008; Schwarz, 2013). Self-mastery approaches such as neurofeedback have demonstrated long-term benefits in improving reading, writing, and mathematical scores as well as decreasing impulsive behavior (Monastra, Monastra, & George, 2002; Arns et al., 2009; Gevensleben et al., 2009; Steiner, Frenette, Rene, Brennan, & Perrin, 2014). Neurofeedback training teaches children how to control their brain function. It is similar to learning a new language, mastering a musical instrument, or becoming proficient in a sport. It takes time and practice to retrain and rewire the brain. Medications often mask the symptoms.

We need to recognize that many of the patterns associated with ADD/ADHD have a genetic component. Rapid orienting to external stimuli is very useful for a hunter's survival, as Thompson and Thompson point out (personal communication, 2014). The hunter, with mentorship, learns while doing. The learning process is part of body movement, action, and changing environmental cues. Presently, we tend to support only a single learning strategy: sitting in chair while observing, thinking, and performing. Being aware of one's learning style and optimizing the environment for that style may facilitate achieving success. Numerous successful people have an ADD/ADHD diagnosis; however, they eventually figured out how to use their learning style to their advantage. If the behavior is too dysfunctional, then achievement and success are compromised.

Our modern lifestyle has compromised the healthy development of the brain and behavior. Public health education needs to focus on prevention and support the concept that health is promoted when infants during their early developmental stages live in harmony with their evolutionary background. This means optimizing those factors that during the course of evolution promoted increased survival, reproductive fitness, and healthy brains.

> Until the nineteenth century our biological and activity rhythms were controlled by natural light. . . . When the sun went down, we went to sleep.

1. Breast feed children at least for one year and concurrently introduce new foods slowly after 6 or 8 months to reduce the risk of developing food allergies.

2. Respect the importance of face-to-face contact to provide safety, develop empathy, and nurture social connection (Porges, 2011).

3. Provide routine and ongoing parental attention. Edward Melhuish of Birkbeck College, University of London, has indicated that "children under five who don't receive consistent affection and responsive communication from care-givers may have impaired social and emotional development. Crucially, this affects their language skills, which Melhuish says is a major reason why children from disadvantaged families generally do poorly at school" (Bond, 2014, p. 32; Melhuish et al., 2008).[2]

4. Encourage motor development such as crawling, playing in nature, and physical movement that occurs while playing games to support brain development instead sitting and being entertained by smartphones, computers, tablets or TV screens. Physical movement during play—without being distracted by the overwhelming rapid-changing stimuli shown on LED and TV screens—is necessary for brain development.

Providing Support for Healthy Brain Development

We need to create an environment that promotes brain development and nurtures healthy children or we can continue to disrespect our evolutionary background and pay the long-term cost of treating ADHD and other disorders. Although there are many other risk factors, evidence suggests that the following enhances brain development.

- Breast feed an infant for at least one year. Breast milk contains immune factors and appropriate fatty acids that are necessary for brain development (Makrides et al., 1994; Labbok, Clark, & Goldman, 2004; Oddy, 2001; Verhasselt et al., 2008). Simply put, formula-fed babies are malnutritioned with respect to necessary fatty acids and immune factors that are necessary for brain development. Using formula is like building a large building with substandard materials. Breast-fed babies have slightly higher IQs, less obesity, less anxiety, lower rates of atopic eczema and celiac disease, and less hyperactivity than formula-fed babies when they get older (Belfort et al., 2013; Harder, Bergmann, Kallischnigg, & Plagemann, 2005; Horwood, 2001; Julvez et al., 2007; Odijk et al., 2003). When foods are slowly introduced while the baby continues to breast feed there is a significantly lower allergy rate such as celiac disease than if breast feeding is abruptly discontinued (Ascher, Krantz, & Kristiansson, 1991; Carlsson et al., 2006; Cavell et al., 1992; Kull, Wickman, Lilja, Nordvall, & Pershagen, 2002). More importantly, breast feeding supports the critical social development of face-to-face bonding that is necessary for developing empathy and self-directed attention (Porges, 2009).

Although many mothers would like to breast feed and take care of their babies, they are thwarted by the economic necessity to return to work and/or lack of social and community support to breast feed. In the process of industry and government saving money by not supporting mothers, we all end up paying much higher medical and social costs to treat the illnesses as these babies become adults.

• Reestablish circadian (daily) rhythms. Until the nineteenth century our biological and activity rhythms were controlled by natural light. It is hard to imagine not having light at night to read. When the sun went down, we went to sleep. Now, bright lights are everywhere—from the moment of birth in the delivery room to the ongoing glow of night lights, monitors, tablets, and the street lights, or flashes of car headlights leaking through the windows. Light not only illuminates, it affects our physiology, regulating our biological rhythms by blocking melatonin production, which interferes with sleep (Brzezinski, 1997). A child that stays awake after normal bedtime often loses control and, instead of becoming sleepy, tends to become hyperactive. By disrupting the biological rhythms with light, we are contributing to sleep disturbance, which is associated with ADHD. Numerous children with ADHD have mild obstructive sleep apnea and when that is resolved their ADHD symptoms decrease significantly (Garetz, 2008; Huang et al., 2007).

We keep the light on in the room because the child is afraid of the dark. Fear of the dark is a normal evolutionary fear. Throughout human history, this was resolved by babies and children sleeping together with their mothers, family members, and other siblings. We have forgotten that by placing babies in a separate room away from reassuring skin contact, we have created a situation whereby the child cannot feel safe. We then alleviate the fear of darkness with light that interrupts sleep and reduces memory consolidation. In some cases, we can reduce this risk factor by letting the child sleep with the parents or siblings or in the same room, as thousands of human generations did—sleeping together.

• Support touch and movement with vision and sound to develop the brain. During the first years of life, the baby/toddler integrates the visual and auditory world with touch and movement. Motor development is the underpinning of brain development (Wolpert, 2011).[3] Early seminal studies by Professors Held and Hein at Brandeis University in 1963 showed that seeing and making sense of the world occurred if kittens tactilely interacted with the visual world. In an ingenious study, they paired kittens so that one could walk on a carousel and the other kitten would have the same visual experience except that it was carried and did not walk. The kittens who walked developed normal depth perception while the kittens who were carried became behaviorally blind (Held & Hein, 1963; Noë, 2004). The interaction between seeing, touching, and movement is necessary for development.

The more hours that children watch TV, the higher the incidence of ADD/ADHD (Healey, 2004). Babies and toddlers are now entertained by watching smartphone screens, tablet screens, and monitors instead of kinesthetically exploring the world and integrating/connecting visual and auditory stimuli with touch and movement.[4]

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This lack of interconnection is observed in numerous people with learning disabilities. Some have incomplete motor development, e.g., when they skip, they tend to lift the arm and leg on the same side of the body instead of lifting their opposite arm and leg. This incomplete coordination may have been caused by excessive triggering of the defense (flight/flight) reaction to excessive auditory and visual stimuli. By spending the majority of the time fixated and captured by a screen and sound instead of crawling, walking, and playing in nature, children are less likely to develop a mature integrated motor pattern. Children with ADD/ADHD who are re-exposed to nature and play in nature show a decrease in ADD/ADHD symptoms (Kuo & Taylor, 2004; Louv, 2008; Taylor & Kuo, 2011).

• Provide constancy and reduce novelty. *A cacophony of sounds, I could not make any sense of it. I finally comprehended one word when the action, a polite bow, and words were repeated time and time again. All of a sudden I could recognize and even say "Konnichiwa"—good afternoon in Japanese. My hosts wanted to help me learn some more words; however, they said one Japanese word after another. I could not remember any of them. Only when a few words with appropriate action were repeated time and time again were they stored in my memory. Such was my personal experience confronting and attempting to learn a new language in Japan.*

When hearing a bedtime story, the child wants to hear the same story again and again. If part of the story is skipped, the child interrupts and reminds us to read correctly. When the child is stressed, he or she wants to hear a familiar story for comfort and safety. Repetition while the hearer is feeling safe allows memory to create appropriate neural connections. Learning implies making neural connections and during sleep the information of declarative memory is encoded into long-term memory (Walker & Stickgold, 2006). If too many new stimuli occur, the next stimulus overrides and erases the previous one. It isn't rocket science! Neural growth depends upon the appropriate level and type of stimuli.

Having too few stimuli hinders brain development. Romanian orphans who were warehoused with limited stimuli have brains with less grey and white matter than children who were brought up in an enriched environment (Mehta et al., 2009). These Romanian children had difficulty keeping focused attention and making social connections (Chugani et al., 2001; Porges & Furman, 2011). Similar reduced brain development was shown much earlier in studies with rats by anatomy professor Marian Diamond at UC Berkeley. Rats that were raised in sensory deprived environment had 4% less cortical thickness (fewer and smaller sized synaptic junctions) than rats raised in an enriched environment (Diamond, Lindner, Johnson, Bennett, & Rosenzweig, 1975; Mohammed et al., 2002; Møllgaard, Diamond, Bennett, Rozenzweig, & Lindner, 1971).

Too many novel stimuli may also decrease brain development. When rats were raised in a sensory overload environment—too many toys to play with and too many choices to make—their cortical thickness was slightly less than that of rats who had a normally enriched sensory environment.

Children need more time crawling,

walking, and playing in nature to develop an integrated motor pattern rather than being captured by the screens of digital devices. The rapidly changing visual stimuli from these screens evoke the biological reflexes to attend—there is something new and it could be safe, dangerous, or life threatening. The physiological processes and the important implications for health and illness have been elucidated by the polyvagal theory developed by Professor Stephen Porges (Porges, 2011). This reactivity does not train self-control or internally generated attention. Over-stimulation with digital devices has been associated with impaired learning and decreased ability to self-regulate (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Rowan, 2014). The flood of novel visual and auditory stimuli trains the brain to react, to react again, and again. The ongoing external novelty captures the child's attention, instead of directing attention from within.

Something similar is observed in college students. Professor Andrew Lepp and colleagues at Kent State University discovered that the more the students used their cell phones and texted, especially while studying, the lower their grade point averages and the higher their anxiety (Lepp et al., 2014). In our 2013 survey of university students, almost all students reported texting or internet surfing during lectures, dinner, and social gatherings (Lin et al., 2014). Their attention is continuously interrupted instead of staying on focus. Students can learn to reverse this distractive process through neuro- and biofeedback as well as arranging their environments so that there are time periods without any interruptions. Even adults can experience the paralysis of too many choices and stimuli. If you have only one or two choices, you become happier and more content. With too many choices, you keep thinking, "Maybe the other one would have been better."

In the last 50 years we have radically increased the visual and auditory input to a developing baby, following the concept of more is better. Babies are now exposed to visual and auditory stimuli that pass by them rapidly without repeating or offering the ability to kinesthetically interact with them. Until the nineteenth century, babies were either carried against the chests of their mothers so that they would face their mothers or held in continuous contact in a sling on their mothers' backs. Babies also faced their mothers in the nineteenth century baby carriages. Now babies are often carried on the chest or in baby carriages/strollers facing forward—leading the charge into the unknown—instead of receiving face-to-face reassurance from the parent, touching the parent, or hiding behind the parent for safety.

On the average, babies spend more than two hours a day in a baby carriage and there is much less social interaction between the mother/caretaker and the baby when the baby faces forward. In a study of 2722 observations of parent-child pairs by developmental psychologist Dr Suzanne Zeedyk (2008), parents talked twice as much to their babies when the babies faced them as when the babies were facing forward in the stroller. The impact of stress was measured by the decrease in baby laughing. Babies who faced their mothers/caretakers while being pushed laughed 90% more than those who faced forward. As babies become older, they do want to face the environment as it is more interesting; however, when the infants feel overwhelmed or threatened, there is an opportunity to automatically reconnect with the caretaker to feel safe.

Finally, we park children in front of smart phones, tablets, Gameboys, and television screens that flood the auditory and visual senses without offering the ability to integrate this input through touch and movement. Although TV and computer games are superb baby sitters, providing them to babies is not the same as interacting and playing with babies and toddlers to develop the appropriate motor and emotional control. Sitting and watching computers, tablets, or TV screens provides rapidly changing stimuli and overwhelms the person with competing visual and auditory input and contributes to increase in physical and mental illness (Mentzoni et al., 2011; Rowan, 2014). Let's create an environment that is in harmony with our evolutionary background, an environment where infants play interactively with objects, explore nature, and have face-to-face contact with their caregivers.

Even if the initial conditions during growing up are less than optimum, the brain can change—a process known as neuroplasticity. Thus, nurture inner-directed attention by having your child develop skill mastery. Ways to develop these skills can include neurofeedback training, back-to-nature explorations, learning to play a musical instrument, practicing a sport or martial art technique, or participating in yoga and meditation. These and many other practices will change the neural structure: It is never too late to learn, to change, and to optimize health.[5,6]

References

Arns, M., de Ridder, S., Strehl, U., Breteler, M., & Coenen, A. (2009). Efficacy of neurofeedback treatment in ADHD: The effects on inattention, impulsivity and hyperactivity: A meta-analysis. *Clinical EEG and Neuroscience, 40*(3), 180-189.

Ascher, H., Krantz, I., & Kristiansson, B. (1991). Increasing incidence of coeliac disease in Sweden. *Archives of Disease in Childhood, 66*(5), 608-611.

Bartley, M. (ed.) (2008). *Life gets under your skin*. UCL Research Department of Epidemiology and Public Health on behalf of the ESRC International Centre for Lifecourse Studies in Society and Health. ISBN: 978-0-9527377-8-0 http://www.ucl.ac.uk/icls/publications/booklets/lguys.pdf

Belfort, M. B., Rifas-Shiman, S. L., Kleinman, K. P., Guthrie, L. B., Belinger, D. C., Taveras, E. M., Gilman, M. W., & Oken, E. (2013). Infant feeding and childhood cognition at ages 3 and 7 years: Effects of breastfeeding duration and exclusivity. *JAMA Pediatrics, 167*(9), 836-844.

Bond, M. (2014). The science of success: Blood, or sweat and tears? *New Scientist, 2559*. 30-34.

Branum, A. M., & Lukacs, S. L. (2009). Food allergy among children in the United States. *Pediatrics, 124*(6), 1549-1555.

Brzezinski, A. (1997). Melatonin in humans. *New England Journal of Medicine, 336*(3), 186-195.

Carlsson, A., Agardh, D., Borulf, S., Grodzinsky, E., Axelsson, I., & Ivarsson, S. A. (2006). Prevalence of celiac disease: Before and after a national change in feeding recommendations. *Scandinavian Journal of Gastroenterology, 41*(5), 553-558.

Cavell, B., Stenhammar, L., Ascher, H., Danielsson, L., Dannaeus, A., Lindberg, T., & Lindquist, B. (1992). Increasing incidence of childhood coeliac disease in Sweden. Results of a national study. *Acta Paediatrica,*

81(8), 589-592.
Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics, 113*(4), 708-713.
Chugani, H. T., Behen, M. E., Muzik, O., Juhász, C., Nagy, F., & Chugani, D. C. (2001). Local brain functional activity following early deprivation: A study of postinstitutionalized Romanian orphans. *Neuroimage, 14*(6), 1290-1301.
Diamond, M. C., Lindner, B., Johnson, R., Bennett, E. L., & Rosenzweig, M. R. (1975). Difference in occipital cortical synapses from environmentally enriched, impoverished, and standard colony rats. *Journal of Neuroscience Research, 1*(2), 109-119.
Garetz, S. L. (2008). Behavior, cognition, and quality of life after adenotonsillectomy for pediatric sleep-disordered breathing: Summary of the literature. *Otolaryngology-Head and Neck Surgery, 138*(1), S19-S26.
Gevensleben, H., Holl, B., Albrecht, B., Vogel, C., Schlamp, D., Kratz, O., Studer, P., Rothenberger, A., & Heinrich, H. (2009). Is neurofeedback an efficacious treatment for ADHD? A randomised controlled clinical trial. *Journal of Child Psychology and Psychiatry, 50*(7), 780-789.
Harder, T., Bergmann, R., Kallischnigg, G., & Plagemann, A. (2005). Duration of breastfeeding and risk of overweight: A meta-analysis. *American Journal of Epidemiology, 162*(5), 397-403.
Healey. J. M. K. (2004). Early television exposure and subsequent attention problems in children. *Pediatrics, 113*(4), 917-918.
Held, R., & Hein, A. (1963). Movement-produced stimulation in the development of visually guided behavior. *Journal of Comparative and Physiological Psychology, 56*(5), 872.
Horwood, L. J., Darlow, B. A., & Mogridge, N. (2001). Breast milk feeding and cognitive ability at 7-8 years. *Archives of Disease in Childhood-Fetal and Neonatal Edition, 84*(1), F23-F27.
Huang, Y. S., Guilleminault, C., Li, H. Y., Yang, C. M., Wu, Y. Y., & Chen, N. H. (2007). Attention-deficit/hyperactivity disorder with obstructive sleep apnea: A treatment outcome study. *Sleep Medicine, 8*(1), 18-30.
Julvez, J., Ribas-Fitó, N., Forns, M., Garcia-Esteban, R., Torrent, M., & Sunyer, J. (2007). Attention behaviour and hyperactivity at age 4 and duration of breast-feeding. *Acta Paediatrica, 96*(6), 842-847.
Kennedy, P. (2014, March 8). The fat drug. *New York Times, Sunday Review.* Retrieved from http://www.nytimes.com/2014/03/09/opinion/sunday/the-fat-drug.html
Kull, I., Wickman, M., Lilja, G., Nordvall, S. L., & Pershagen, G. (2002). Breast feeding and allergic diseases in infants—A prospective birth cohort study. *Archives of Disease in Childhood, 87*(6), 478-481.
Kuo, F. E., & Taylor, A. F. (2004). A potential natural treatment for attention-deficit/hyperactivity disorder: Evidence from a national study. *American Journal of Public Health, 94*(9), 1580.
Labbok, M. H., Clark, D., & Goldman, A. S. (2004). Breastfeeding: Maintaining an irreplaceable immunological resource. *Nature Reviews Immunology, 4*(7), 565-572.
Lepp, A., Barkley, J. E., & Karpinski, A. C. (2014). The relationship between cell phone use, academic performance, anxiety, and satisfaction with life in college students. *Computers in Human Behavior, 31*, 343-350.
Lin, E., Lau, S., Mitose, J., Rogers, E., Williams, T., Harvey, R., & Peper, E. (2014). Smartphone and tablet use survey. Poster presented at the 45th Annual Meeting of the Association for Applied Psychophysiology and Biofeedback. Savannah, GA.
Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder.* Chapel Hill, NC: Algonquin Books.
Makrides, M., Neumann, M. A., Byard, R. W., Simmer, K., & Gibson, R. A. (1994). Fatty acid composition of brain, retina, and erythrocytes in breast-and formula-fed infants. The *American Journal of Clinical Nutrition, 60*(2), 189-194.
Mehta, M. A., Golembo, N. I., Nosarti, C., Colvert, E., Mota, A., Williams, S. C., Rutter, M., & Sonuga-Barke, E. J. (2009). Amygdala, hippocampal and corpus callosum size following severe early institutional deprivation: The English and Romanian Adoptees study pilot. *Journal of Child Psychology and Psychiatry, 50*(8), 943-951.
Melhuish, E. C., Phan, M. B., Sylva, K., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2008). Effects of the home learning environment and preschool center experience upon literacy and numeracy development in early primary school. *Journal of Social Issues, 64*(1), 95-114.
Mentzoni, R. A., Brunborg, G. S., Molde, H., Myrseth, H., Skouverøe, K. J. M., Hetland, J., & Pallesen, S. (2011). Problematic video game use: Estimated prevalence and associations with mental and physical health. *Cyberpsychology, Behavior, and Social Networking, 14*(10), 591-596.
Mohammed, A. H., Zhu, S. W., Darmopil, S., Hjerling-Leffler, J., Ernfors, P., Winblad, B., Diamond, M.C., Erikkson, P.S., & Bogdanovic, N. (2002). Environmental enrichment and the brain. *Progress in Brain Research, 138*, 109-134.
Molina, B. S., Hinshaw, S. P., Swanson, J. M., Arnold, L. E., Vitiello, B., Jensen, P. S., Epstein, J. N., Hoza, B., Hechtman, L., Abikoff, H. G., Elliott, G. R., Greenhill, L. L., Newcorn, J. H., Wells, K. C., Wigal, T., Gibbons, R. D., Hurt, K., & Houck, P. R. (2009). The MTA at 8 years: Prospective follow-up of children treated for combined-type ADHD in a multisite study. *Journal of the American Academy of Child & Adolescent Psychiatry, 48*(5), 484-500.
Møllgaard, K., Diamond, M. C., Bennett, E. L., Rosenzweig, M. R., & Lindner, B. (1971). Quantitative synaptic changes with differential experience in rat brain. *International Journal of Neuroscience, 2*(3), 113-127.
Monastra, V. J., Monastra, D. M., & George, S. (2002). The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback, 27*(4), 231-249.
Noë, A. (2004). *Action in perception.* MIT press.
O'Callaghan, T. (2014). Sickly sweet: The dark side of our sugar hit. *New Scientist, 221*(2954), 34-39.
Oddy, W. H. (2001). Breastfeeding protects against illness and infection in infants and children: A review of the evidence. *Breastfeeding Review, 9*(2), 11.
Odijk, J. V., Kull, I., Borres, M. P., Brandtzaeg, P., Edberg, U., Hanson, L. Å., Høst, A., Kuitunen, M., Olsen, S. F., Skerfving, S., Sundell, J., & Wille, S. (2003). Breastfeeding and allergic disease: A multidisciplinary

review of the literature (1966–2001) on the mode of early feeding in infancy and its impact on later atopic manifestations. *Allergy, 58*(9), 833-843.
Porges, S. W. (2009). Reciprocal influences between body and brain in the perception and expression of affect. In D. Fosha & D. Siegel (Eds.), *The healing power of emotions: Affective neuroscience, development, and clinical practice* (pp. 27-54). New York, NY: W. W. Norton.
Porges, S. W. (2011). *The polyvagal theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation*. New York, NY: W. W. Norton.
Porges, S. W., & Furman, S. A. (2011). The early development of the autonomic nervous system provides a neural platform for social behaviour: A polyvagal perspective. *Infant and Child Development, 20*(1), 106-118.
Rowan, C. (2014). 10 reasons why handheld devices should be banned for children under the age of 12. Retrieved from http://www.huffingtonpost.com/cris-rowan/10-reasons-why-handheld-devices-should-be-banned_b_4899218.html
Schwarz, A. (2013). A.D.H.D. experts re-evaluate study's zeal for drugs. *New York Times*, December 29. Retrieved from http://www.nytimes.com/2013/12/30/health/adhd-experts-re-evaluate-studys-zeal-for-drugs.html
Sclar, D. A., Robison, L. M., Bowen, K. A., Schmidt, J. M., Castillo, L. V., & Oganov, A. M. (2012). Attention-deficit/hyperactivity disorder among children and adolescents in the United States trend in diagnosis and use of pharmacotherapy by gender. *Clinical Pediatrics, 51*(6), 584-589.
Steiner, N. J., Frenette, E. C., Rene, K. M., Brennan, R. T., & Perrin, E. C. (2014). In-school neurofeedback training for ADHD: Sustained improvements from a randomized control trial. *Pediatrics, 133*(3), 483-492.
Taylor, A. F., & Kuo, F. E. M. (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being, 3*(3), 281-303.
Verhasselt, V., Milcent, V., Cazareth, J., Kanda, A., Fleury, S., Dombrowicz, D., Glaichenhaus, N., & Julia, V. (2008). Breast milk–mediated transfer of an antigen induces tolerance and protection from allergic asthma. *Nature Medicine, 14*(2), 170-175.
Walker, M. P., & Stickgold, R. (2006). Sleep, memory, and plasticity. *Annual Review of Psychology, 57*, 139-166.
Wolpert, D. (2011). The real reason for brains. Retrieved from http://www.ted.com/talks/daniel_wolpert_the_real_reason_for_brains.html
Zeedyk, S. (2008). What's life in a baby buggy like? The impact of buggy orientation on parent-infant interaction and infant stress. London: National Literacy Trust. Retrieved November, 21, 2008 from http://www.literacytrust.org.uk/assets/0000/2531/Buggy_research.pdf

Notes

1. New evidence suggests that antibiotics use in early childhood changes the bacteria in the babies' guts and makes them more prone to obesity. The same phenomenon has been observed and purposely used to increase animal growth; see Kennedy (2014).

2. A superb summary that a good start in life has far-reaching benefits for health and social functioning is provided in the publication, *Life Gets Under Your Skin*, http://www.ucl.ac.uk/icls/publications/booklets/lguys.pdf

3. See neuroscientist Daniel Wolpert's (2011) superb TED video presentation: *The Real Reason for Brains*.

4. See Cris Rowan's (2014) blog, *10 Reasons Why Handheld Devices Should Be Banned for Children Under the Age of 12*.

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