

- In order for a child to have good self-control (i.e., behavior), the timing system in the brain must be operating normally. Faulty timing is at the heart of ADHD. Researchers in Australia recently developed a set of questions for parents of children with ADHD that will help doctors and therapists better pinpoint whether there is a problem with timing skills and whether or not they are getting better with treatment. This is a valuable tool for professionals who use Interactive Metronome® in the treatment of ADHD to measure and document the effect of the treatment, which improves timing in the brain.

Houghton, S., Durkin, K., Ang, R.P., Taylor, M.F., and Brandtman, M. (2011). *Measuring Temporal Self-Regulation in Children With and Without Attention Deficit Hyperactivity Disorder: Sense of Time in Everyday Contexts. European Journal of Psychological Assessment, 27(2), 88-94.*

- A recent study by the Kennedy Krieger Institute (2011) showed that areas of the brain that control thinking and motor skills are different (smaller) in children with ADHD compared to other children. The specific regions of the brain that were mentioned are known to be involved in mental timing. Mental timing (AKA timing in the brain) is vital for many of our thinking skills and for good motor coordination. Studies have shown that timing in the brain is disrupted in children and adults with ADHD, leading to problems with focus, other cognitive abilities, and motor skills. Interactive Metronome®, a patented non-medical treatment for ADHD, is the ONLY program that simultaneously works on thinking AND motor skills by specifically addressing and improving the areas of the brain responsible for mental timing.

Kennedy Krieger Institute (2011, June 10). *Brain imaging study of preschoolers with ADHD detects brain differences linked to symptoms.*

- Children with ADHD often have social problems that can make living with ADHD so much MORE difficult!! A study by Koflet et al (2011) examined what might be behind this problem so that professionals are able to address this issue more effectively and improve the quality of life for these children and their families. What they found is that each of us must be able to hold information in our memory about what is going on in a social situation at any given time, and that this information must be updated constantly so that we are not “out of sync” with everyone else. To do this, the person must be able to focus without getting distracted. So, at the heart of the problem are two skills: working memory & focus. Research shows that the Interactive Metronome® (IM) specifically addresses both of these important skills, and children and their families frequently report improved social interactions following IM training.

Koflet, M.J., Rapport, M.D., Bolden, J., Sarver, D.E., Raiker, J.S., and Alderson, R.M. (2011). *Working memory deficits and social problems in children with ADHD. Journal of Abnormal Child Psychology, 39, 805-817.*

- Here is an interesting study by Gilden and Marusich (2009) published in Neuropsychology that looked at the ability of adults with ADHD to maintain a rhythm with either a faster tempo (less demand on focus, self-control, and working memory) or a

slower tempo (more demand on focus, self-control, and working memory). Persons with ADHD had MUCH more difficulty when the tempo was slower, requiring them to estimate a longer time interval between beats, maintain the time interval in their memory, and restrain themselves from hitting too soon. This study, like many others, points to the direct relationship between timing in the brain and its command center “working memory.” Researchers theorize that Interactive Metronome® is affecting this critical “control center” for timing in the brain and thereby improving many of the time-related symptoms of ADHD.

Gilden, D.L. and Marusich, L.R. (2009). *Contraction of Time in Attention-Deficit Hyperactivity Disorder. Neuropsychology, 23(2), 265-269.*

- Have you ever heard that ADHD is genetic? Ever notice that children with ADHD seem out of sync? Here is a research study by Nanda et al (2007) that supports this view and does so by showing that not only is timing in the brain disrupted in children with ADHD, but that it IS ALSO slightly disrupted in their siblings who do not have ADHD (when compared to children from families with no diagnosis of ADHD). From this and other studies, evidence shows that the more the brain's timing skills are off, the more symptoms like impulsivity, hyperactivity, inattention, lack of organization, poor time-management, or difficulty with reading and other academic work are evident. The Interactive Metronome® is a relatively easy, non-medical treatment program for ADHD that improves the brain's critical timing skills and is tailored to each child's specific needs.

Nanda, N.J., Rommelse, M.S., Oosterlaan, J., Buitelaar, J., Faraone, S.V., and Sergeant, J.A. (2007). *Time reproduction in children with ADHD and their nonaffected siblings. Journal of the American Academy of Child and Adolescent Psychiatry, 46, 5*

- Timing in the brain is critical for good focus and self-control. Studies like this one by Ben-Pazi et al (2005) show that the brain's timing mechanism is not working properly in children with ADHD, and that it is even worse in younger children with ADHD and those who lack self-control and are impulsive. Interactive Metronome is the only tool available today to effectively improve timing in the brain. By directly addressing timing skills at the level necessary for the brain to function more efficiently, the Interactive Metronome produces results.

Ben-Pazi, H., Shalev, R.S., Gross-Tsur, V. and Bergman, H. (2006). *Age and medication effects on rhythmic responses in ADHD: Possible oscillatory mechanisms? Neuropsychologia, 44, 412-416.*

- Children with ADHD are frequently impulsive. Fortunately, researchers are trying to get to the bottom of this to determine the reason(s) why and what can be done about it. Authors of an editorial in the American Journal of Psychiatry (2006) remarked that watching the brain in action under MRI is helping researchers and doctors better understand the underpinnings of ADHD, or in other words, what is going on in the brain? Interestingly, the areas of the brain implicated in ADHD that are frequently targeted for study are ALSO part of the brain's internal timing network. Timing in the brain is known

to be disrupted in individuals with ADHD & has also been implicated in the ability to control one's impulses and behavior. Interactive Metronome® can be an important part of the treatment program for a person with ADHD by improving timing in the brain and addressing some of the areas of brain function mentioned in this article (i.e., working memory, ability to tune out distractions and pay attention to what is most important).

Casey, B.J. and Durston, S. (2006). *From Behavior to Cognition to the Brain and Back: What Have We Learned from Functional Imaging Studies of Attention Deficit Hyperactivity Disorder?* American Journal of Psychiatry, 163, 6.

- Did you know that listening and reading comprehension are linked? And that both skills are very much controlled by our brain's timing system that functions like a clock? According to a study by Breier et al (2003) published in the Journal of Speech, Language and Hearing Research (2003), the brain must process quite a bit of time-dependent information in the speech stream in order for a person to understand what is being said (i.e., timing of voice onset, voice offset, pitch, frequency, pauses between sounds, syllables, words, phrases, etc) If the brain's timing is off even just a little it affects how the brain perceives sounds, and this in turn affects how well a person can follow verbal directions, comprehend what is said, or read. Fortunately, we can help our brain process time more precisely with the right kind of practice and thus improve such time-dependent skills as listening and reading comprehension. Interactive Metronome® (IM) is a unique, patented program that has been shown in clinical research to improve mental timing through progressive, engaging cognitive and motor exercises. Continuous, real-time feedback is provided so you will know each step of the way how you are progressing! Studies show that by improving the brain's timing with IM, auditory processing and reading not only improve, but do so significantly and in a relatively short period of time compared to other programs like phonics instruction.

Breier, J.I., Fletcher, J.M., Foorman, B.R., Klaas, P., and Gray, L.C. (2003). *Auditory Temporal Processing in Children with Specific Reading Disability With and Without Attention Deficit/Hyperactivity Disorder.* University of Texas, Houston. Journal of Speech, Language, and Hearing Research, 46, 31-42.

- Humans perceive time. We use this ability to predict what is coming, to think about how we will react, and then to respond in a timely fashion. It is well-documented that children with ADHD have an impaired sense of time. Areas of the brain that control our perception of time are affected in children with ADHD (i.e., working memory). In an article published in the Journal of Child Psychology and Psychiatry, researchers found that children with ADHD who also have a Reading Disorder have even more difficulty with timing skills. Research has shown that Interactive Metronome®, a training program that addresses the underlying problem with timing in the brain, improves symptoms of ADHD and reading.

Toplak, M.E., Rucklidge, J.J., Hetherington, R., John, S.C.F., and Tannock, R. (2003). *Time perception deficits in attention deficit/hyperactivity disorder and comorbid reading difficulties in child and adolescent samples.* Journal of Child Psychology and Psychiatry, 44(6), 888-903.

- Dr. Stanley Greenspan, a noted expert in autism and child development/disorders, and his team of researchers conducted a study to see whether Interactive Metronome® (IM) was a beneficial treatment for children with ADHD. They compared boys who received IM to boys who received either no treatment at all or boys who only played video games to try to improve their ability to focus. They found that those children with ADHD who received IM did far better than those that did not, with significant improvement in the areas of attention, motor skills, language processing, reading, and self-control (i.e., less aggressive behavior).

Shaffer R.J., Jacokes L.E., Cassily J.F., Greenspan S.I., Tuchman R.F., Stemmer P.J. Jr. (2001). Effect of Interactive Metronome® on children with ADHD. American Journal of Occupational Therapy, 55, 155–162.