- Because we are made with a “limited” capacity for holding information in temporary memory storage (working memory), we are also made to compensate for this by our ability to direct these valuable resources where feel there is the most need, CAREFULLY SELECTING what to and not to pay attention to when we are engaged in any kind of activity. Otherwise we’d have TOO much information, more than we can hold in this temporary memory bank. This is called “selective attention.” We must constantly, actively DECIDE what to pay attention to. How well we pay attention determines how well the information will be processed and recalled later when needed (think of studying for a test then taking the test at a later date). In this article, Chun et al (2011) show just how COMPLEX attention is and how intricately it is related to working memory. When these two systems work in harmony, a person can more easily select information to pay attention to, process it timely, and tune out distracting thoughts and things going on in the environment that are not important at the moment (i.e., when studying for a test). Interactive Metronome® (IM) training addresses the ROOT CAUSE of problems with attention by facilitating synchronicity between centers of the brain responsible for selecting, processing, and recalling information. Timing is everything!

Chun, M.M., Golomb, J.D., and Turk-Browne, N.B. (2011). A taxonomy of external and internal attention. Annual Review of Psychology, 62, 73-101.

- From birth, parents often recognize that their children differ from one another in terms of their overall disposition. In this study, Posner and Rothbart (2007) explain how development of certain neural networks in the brain control a child’s ability to regulate emotions, control impulsive tendencies, and focus attention. The neural structures described in this paper are all part of the brain’s internal timing network (i.e., anterior cingulate, basal ganglia, etc).

Posner, M.I. and Rothbart, M.K. (2007). Research on attention networks as a model for the integration of psychological science. Annual Review of Psychology, 58, 1-23.

- Taub et al (2007) have theorized that Interactive Metronome®, a patented program that improves timing in the brain, primarily addresses thinking speed and working memory, thereby improving our ability to focus and learn. In the study, they demonstrated that Interactive Metronome® (IM) training has a significant positive effect on reading achievement (affecting 4 of 5 critical pre-reading skills) in elementary school students. They proposed that IM training was primarily improving “processing [thinking] speed,” which in turn improved the students’ ability to allocate resources for attending and holding information in working memory … all essential for fluent reading. Taub et al propose that the wide array of positive treatment results seen following Interactive Metronome (IM) training can be attributed to its impact timing in the brain and these two critically important skills, working memory & controlled attention.

Taub. G., McGrew, K.S., and Keith, T.Z. (2007). Improvement in interval timing tracking and effects on reading achievement. Psychology in the Schools, 44(8), 849-863.

- To be successful in any environment, especially in school, a child must be able to remember the task instructions, stay focused and not get off track due to interference from outside distractions (noise, movement, laughter) or inside distractions (the child's own thoughts or off-target behaviors). Researchers are consistently finding that the amount of information a child can hold in his/her "temporary memory storage bank" (called working memory) makes the difference between being able to stay on task or not. Apparently we are all born with a certain capacity for working memory, some with more, some with less, and in some cases individuals may not be able to efficiently and effectively USE the capacity they are born with. According to experts, the amount of information a child can hold in working memory also depends on how quickly they can process information (thinking speed). If a child is slower to process information, (s)he is not able to hold as much in working memory and is thus less able to direct attention to task and learn. Hall & Blasko (2005) again demonstrate how important working memory is to higher cognitive skills like problem-solving, reasoning, and more complex attending (i.e., switching attention from one thing to another, focusing in distracting environments, or focusing on more than one thing at a time). Interactive Metronome® (IM) improves timing in the brain, irons out the kinks in processing, increases thinking speed, and promotes efficient, effective use of working memory resources so that each individual can realize his/her innate potential.

Hall, M.D. and Blasko, D.G. (2005). Attentional interference in judgments of musical timbre: Individual differences in working memory. The Journal of General Psychology, 132(1), 94-112.

- A neural imaging study (Alpiner, 2004) found that individuals who received Interactive Metronome® training demonstrated more efficient communication between these critical timing centers of the brain (i.e., the brain's circuitry worked in a more effective, efficient manner which allows for better focus and self-control). The brain requires efficient communication to function properly.

Alpiner, Neal. (2004). The role of functional MRI in defining auditory-motor processing networks. White paper presented at 65th Annual American Physical Medicine and Rehabilitation Conference, Phoenix, AZ.

- This study (Kane et al, 2004) is part of a growing body of research showing that if you work on improving working memory (the ability to hold information actively in your memory while thinking about it) and the ability to tune out distractions, you can improve MANY areas of performance in school like reading, math, organizational skills, following directions, understanding the teacher, and socializing with peers. It appears that these 2 skills (working memory & controlled attention) are critical first steps to learning, academic, and social success. They are the foundation for all of our skills in the areas of speech, language, thinking, and behavior. They are also dependent upon a network on brain structures that perceive and keep time to the millisecond level. If timing is disrupted, as it is in ADHD, Dyslexia, and other developmental and acquired disorders, then language-learning disabilities often follow.

Kane, M.J., Hambrick, D.Z., Tuholski, S.W., Wilhelm, O., Payne, T.W., and Engle, R.W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. Journal of Experimental Psychology: General, 133(2), 189-217.

- Timing in the brain is critical for communicating effectively or participating in-group activities (i.e., sports, music, play). Some individuals wait until just the right moment to act, while others have a tendency to "jump the gun." This may manifest in a penalty for a false start if playing football or social difficulty if a person constantly interrupts others when they are speaking. Miyake et al (2004) describe the neurological underpinnings of the tendency to make "anticipatory" timing errors like these in a paper published in Acta Neurobiologiae Experimentalis. Once we've learned a task or situation, we tend to respond as if on automatic pilot (without consciously thinking about it). But sometimes, something changes ever so slightly in the situation, and we must adapt and recalibrate our response. How well we do this depends upon our brain's ability to perceive time…even in small increments like milliseconds. During the initial phases of Interactive Metronome® (IM) training individuals with these timing-related problems often clap or move too fast (milliseconds ahead of the beat instead of on it), but soon become more in sync with the beat and with their peers.

Miyake, Y., Onishi, Y., and Pöppel, E. (2004). Two types of anticipation in synchronization tapping. Acta Neurobiologiae Experimentalis, 64, 415-426.

- Again, researchers (Unsworth et al, 2004) demonstrate that the more bits of information a person can hold in their active temporary memory storage (called working memory), the better they can attend to details. Think of working memory as a bucket that can only hold so much. Some individuals are born with a smaller bucket and others have a larger bucket. The bigger the bucket, the more water, or sand, or seashells can be collected (the better the focus and attention). Think of the items collected as "details" (i.e., for following directions, for learning in school, etc) Now, picture either size bucket with holes in it, through which the water, sand, or some of the smaller seashells leak out. It doesn't matter what size bucket the person has if there are holes!! (S)he will continuously lose or forget the "details" and therefore have difficulty recalling and following directions, etc. To effectively treat a problem with attention, such as in ADHD, the treatment regimen MUST work on improving the efficiency and effectiveness of the working memory bucket (i.e., plugging the hole). Interactive Metronome® (IM) training works by plugging the holes so that information that is "collected" stays in the memory bucket,…THEN the individual can devote more of his/her resources to looking for even more "details" to collect (rather than worrying about what was lost)! This frees up the person to focus and learn.

Unsworth, N., Schrock, J.C., and Engle, R.W. (2004). Working memory capacity and the antisaccade task: Individual differences in voluntary saccade control. Journal of Experimental Psychology: Learning, Memory, and Cognition, 30(6), 1302-1321.

- Some of us are good at mental math. Tell me a multi-digit math equation, and I can solve it without writing it down and looking at it. Others must have it written down because they cannot hold onto all of the numbers of the equation in memory. Now, add the

DISTRACTION of someone counting aloud or calling out random numbers while YOU are trying to remember the equation in your head to solve it (without those "other" numbers interfering with your memory). This may just scratch the surface in helping you understand what is going on inside the head of a child with ADHD. Distractions are part of life…they are EVERYWHERE! Children encounter distractions regularly in the academic setting … from themselves, from their peers, from the environment. Researchers Kane & Engle (2003) have continued to study how the brain uses its resources to devote attention where it needs to be despite the presence of distractions that compete for the brain's attention. They found that the better you are at holding information in your head in working memory without all of the "other" distractions interfering, the better you are able to focus and direct your attention to what is important and learn. A great body of research shows that our "internal clock" is responsible for this occurring, and it must be "in sync." This clock is faulty in some individuals, but can be improved with the appropriate training like Interactive Metronome® (IM), the only training program that improves timing in the brain in an organized, systematic and engaging format.

Kane, M.J. and Engle, R.W. (2003). Working-memory capacity and the control of attention: The contribution of goal neglect, response competition, and task set to Stroop interference. Journal of Experimental Psychology: General, 132(1), 47-70.

- In this study, researchers (Kane & Engle, 2002) show that those individuals who can resist interference from distractions, information that is not related or important to the task at hand, are the most successful at holding information in their memory and learning. They show that for learning to occur, the person must be able to do 3 things effectively: 1) hold bits of information actively in memory, 2) update the information in memory as needed, and 3) PERHAPS MOST IMPORTANTLY, direct attention ONLY to what is important!!! How many children do you see these days that have difficulty with #3? These 3 important learning skills are all governed by our brain's "internal clock," which researchers have shown is not operating appropriately in certain conditions, like ADHD, Autism, Reading Disorders, and Dyslexia. Interactive Metronome® (IM) is an engaging, rewarding, and systematic program that improves timing in the brain, thus improving symptoms of time-related learning differences.

Kane, M.J. and Engle, R.W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-difference perspective. Psychonomic Bulletin & Review, 9(4), 637-671.

- The ability to adapt to our surroundings is key to our survival. We must constantly take in new information and adjust where our focus is directed in order to stay in tune with the environment whether in a work, social, or academic setting. In a study published in Brain and Cognition, Meck & Benson (2002) discovered that certain regions of the brain responsible for mental timing (AKA timing in the brain) are also responsible for our ability to focus attention and switch attention from one thing to another appropriately (i.e., stopping what you are doing to complete another task that needs your attention). The

same timing centers of the brain are also responsible for coordinated movement. Ever notice how so many children who have difficulty with focus & attention also tend to be less coordinated? Interactive Metronome® (IM) is the only treatment program that systematically measures and improves the brain's ability to keep time, affecting all areas of function that depend upon our internal clock: speech, language, cognitive, motor, and social/behavioral skills.

Meck, W.H. and Benson, A.M. (2002). Dissecting the brain's internal clock: How frontal –striatal circuitry keeps time and shifts attention. Brain and Cognition, 48, 195-211.

- Researchers like Pashler et al (2001) put a lot of time, thought, and effort into figuring out how our brain's work, like "How DO we only pay attention to what we need to and ignore all of the other [distracting] information???" Apparently we don't do this on auto-pilot, rather we must keep in mind the goal that we are trying to accomplish while at the same time sorting through information that is presented to us (when listening or viewing information), deciding to "keep it" or "toss it." As we have seen from other research, we must be able to keep up with the PACE of the information coming at us while fully utilizing our innate capacity & available resources for working memory (picture it coming at you on a conveyor belt…and picture you sorting it as fast as you can). We now KNOW that there is a breakdown in the brain's timing system in children with ADHD, Autism Spectrum, Dyslexia, and other developmental disorders that interferes with the smoothness of this process (picture all of the information piling up on the floor in a disorganized heap next to the conveyor belt because the child cannot keep up with the pace and/or sort it correctly)!!

Pashler, H., Johnston, J.C., and Ruthruff, E. (2001). Attention and performance. Annual Review of Psychology, 52,629-651.**[/ebs_toggle]**

- A person can only hold only "so much" information in working memory … here is an analogy: There are 5 babies in the bed. Put another one in, and one of the babies in the bed falls out. The bed can only hold "5" babies. Period. This study by Kane et al (2001) published in the Journal of Experimental Psychology further bolsters the theory that our ability to focus and pay attention is largely driven by how many bits of information ("babies") we can hold in our working memory without losing them in the presence of more bits of information or distractions ("more babies"). Working memory is a skill that is dependent upon timing in the brain. The better the brain's timing, the better working memory can hold onto the bits of information and use them for the situation (i.e., learning) or problem at hand.

Kane, M.J., Blecky, M.K., Conway, A.R.A., and Engle, R.W. (2001) A controlled attention view of working-memory capacity. Journal of Experimental Psychology, 130(2), 169-183.

- Cognitive psychologists theorize that the faster we are able to process information (or think), the more intelligent we are, and the more readily we can learn and demonstrate what we've learned. There are many recent studies that support this view, including this one published in the journal Intelligence. Each individual is born with a certain amount of

resources for attending to and processing information. How well a person allocates those resources appears to be a major factor in determining intelligence.

Ben-Shakhar, G. and Sheffer, L. (2001). The relationship between the ability to divide attention and standard measures of general cognitive abilities. Intelligence, 29: 293-306.