

Executive Function

In this study by Zakay & Block (2004), the authors tease out the difference in how we attend to & manage information in the brain when we are required to anticipate how much time it will take to do something versus go back and retroactively estimate how long it took to do a task already completed. They found there is a different cognitive process involved in each. Other researchers have discovered that regions of the brain involved in information processing for time-management are part of the brain's temporal processing neural network (structures of the brain involved in mental timing that must communicate with each other in a synchronized fashion to operate efficiently and accurately). We often see problems with "temporal processing" that manifest as poor awareness of time, time-management, and time-estimation in individuals with ADHD or Dyslexia or following a Traumatic Brain Injury or Stroke. Interactive Metronome, a patented treatment program that measures and improves timing in the brain, and thus time-related cognitive abilities, is an important part of a comprehensive treatment program for these conditions.

Zakay, D. & Block, R.A. (2004). Prospective and retrospective duration judgments: An executive control perspective. Acta Neurobiologiae Experimentalis, 64, 319-328.

In this study, Whitney et al. (2001), show that individuals who perform poorly on tests of working memory do so because they are more easily distracted or think a bit more slowly when making mental comparisons (the ability to mentally manipulate information to make a decision). They argue that mental manipulation is not the same as processing speed, or the rate that your brain can take in and understand information. Others have reasoned that processing speed and working memory share the same mental resources and compete with one another, thus one influencing the performance of the other. And so goes the world of research...there is always healthy debate and this is how we advance knowledge. Professionals who incorporate Interactive Metronome into treatment sessions to improve "temporal processing" (or mental timing) report improvement in language and cognitive skills that depend upon processing speed and working memory, i.e., following directions, reading comprehension, math computations, time-management. IM researchers (Taub et al, 2007), argue that IM is impacting the brain's ability to process information more efficiently, thus facilitating more efficient and effective use of working memory.

Whitney, P., Arnett, P.A., Driver, A., and Budd, D. (2001). Measuring central executive functioning: What's in a reading span? Brain and Cognition, 45, 1-14.

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.

Here is an interesting study by Mantyla et al. (2007), looking at 3 basic components of executive functioning in both children and adults as they monitored the passage of time: 1) the ability to tune out distractions or information that is not pertinent to the task at hand, 2) the ability to keep up with the pace of information and retain the information in working memory necessary to complete the task, and 3) direct self to shift the focus of attention as needed. Subjects had to simply indicate the passing of time every 5 minutes while watching a movie. They found that those individuals who had difficulty with working memory, either by keeping the task in mind (monitoring time) while engaged in another simultaneous task (watching a movie) or keeping up-to-date information in working memory about the task (i.e., recalling how much time had passed already) had the most difficulty with a sense of time. They tended to be more reliant on external cues to keep time, such as repeatedly checking a clock. On the other hand, those with stronger working memory ability were far less reliant on an external clock and were much more accurate in monitoring time “in their head.” The authors did not find the third variable of shifting attention to be as much of a factor in task performance as the first two. Working memory is a skill that is heavily dependent upon temporal processing (or timing in the brain) for efficient and accurate performance. When timing in the brain is disrupted, as is often seen in ADHD, Dyslexia, and other developmental and acquired disorders a problem with working memory arises. Researchers theorize that the Interactive Metronome addresses this critical cognitive function by improving synchronicity between regions of the brain that communicate with those involved in working memory.

Maytyla, T., Carelli, M.G., and Forman, H. (2007). Time monitoring and executive functioning in children and adults. Journal of Experimental Child Psychology, 96, 1-19.

Palladino et al. (2003) studied 20 subjects to determine whether there was a difference in how the brain handles information when it is presented verbally versus visually. They did find that there is a difference in processes involved in working memory depending on how the information is presented. Complex thinking involved in tasks like reading comprehension depend upon working memory. It has been reported that working memory is very sensitive to intrusion errors (or corruption from information that is not relevant to the task at hand that enters the mix). Humans possess a very important skill called inhibition, which is the ability to filter information to only keep in active working memory what is important to the task and discard the rest. Filtering may not occur if the person cannot selectively attend to incoming information, mentally manipulate information for comparison, and/or keep up with the pace of incoming information (slower processing speed). Many studies have reported on the central role of “temporal processing” or timing in the brain in working memory. Researchers who studied the Interactive Metronome (IM) specifically, a patented program that improves timing in the brain, theorize that IM improves timing in the brain by increasing the flow and

efficiency of information processing, an important precursor to working memory function.

Palladino, P., Mammarella, N., and Vecchia, T. (2003). Modality-specific effects in the inhibitory mechanisms: The interaction of peripheral and central components in working memory. Brain and Cognition, 53, 263-267.