

2013

The Science Behind Interactive Metronome:

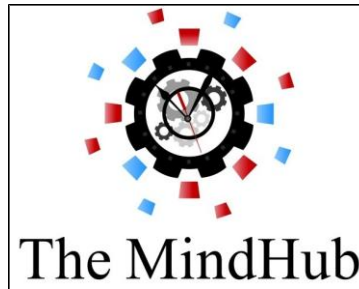
An Integration of Brain Clock, Temporal
Processing, Brain Network and
Neurocognitive Research and Theory

Dr. Kevin S. McGrew, Director, Institute for Applied Psychometrics (IAP)



A MindHub™ Pub: #2 3-4-13 v1.1





This [MindHub™](#) publication is a non-peer reviewed working paper.¹ Feedback, suggested edits, and comments should be sent to Dr. Kevin McGrew at iap@earthlink.net.



The [MindHub™](#) is an internet resource of the [Institute for Applied Psychometrics \(IAP\)](#).

Author information and conflict of interest disclosure

Dr. Kevin S. McGrew, Ph.D., is an Educational Psychologist with expertise and interests in applied psychometrics, intelligence theories and testing, human cognition, cognitive and non-cognitive individual difference variables impacting school learning, models of personal competence, conceptualization and measurement of adaptive behavior, measurement issues surrounding the assessment of individuals with disabilities, brain rhythm and mental timing research, and improving the use and understanding of psychological measurement and statistical information by professionals and the public. Prior to establishing IAP, Dr. McGrew was a practicing school psychologist for 12 years. McGrew received his Ph.D. in Educational Psychology (Special Education) from the University of Minnesota (1989).

Dr. McGrew is currently Director of the *Institute for Applied Psychometrics (IAP)*, a privately owned applied research organization established by McGrew. He is also the *Research Director for the Woodcock-Muñoz Foundation (WMF)*, Associate Director for *Measurement Learning Consultants (MLC)*, and a *Visiting Professor in Educational Psychology (School Psychology)* at the University of Minnesota.

Dr. McGrew authored the current manuscript in his role as the Director of IAP. The majority of this working paper comes from the first draft of a work-for-hire manuscript financed by [Interactive Metronome®](#). The opinions and statements included in this report do not reflect or represent the opinions of WMF, MLC, or the University of Minnesota. More complete professional information, including his professional resume and conflict of interest statement, can be found at the [MindHub™](#).

¹ The current working paper is a summary and expansion of Dr. Kevin McGrew's 2012 Interactive Metronome Professional Conference Keynote Presentation (*I think...therefore IM*) where the complete explanatory model was presented. This presentation is available for viewing at YouTube by clicking [here](#). Dr. McGrew also maintains a blog ([The Brain Clock Blog](#)) devoted to brain clock and neurotechnology interventions and research.



© Institute for Applied Psychometrics (IAP) 3-4-13

The Science of Interactive Metronome: Executive Summary

Cognitive *focus* plays a crucial role in success or failure in school, work, and almost all aspects human performance. Yet, few of us receive formal training on how to improve our focus (control our attention). Contemporary brain research, which is described in this working paper, and which is briefly summarized below, has shed light on the nature of cognitive focus and has provided technology to train and maintain a “focused brain.”

The human mind has a limited capacity to engage in laser-beam like focus or *controlled attention*—up to 20 to 30 minute at maximum. Contemporary brain research describes focus or controlled attention as the ability to direct one’s attentional spotlight on only task relevant information in one’s mental workspace (*working memory*). This requires constant monitoring and timely feedback to the attentional control center regarding the status of one’s “locked on” focus status. When focused, cognitive control mechanisms are constantly monitoring performance and immediately detect and deflect outside distractions and self-generated *mind wandering*. Focus training can result in the “quieting of the busy mind.”

McGrew (2012) has presented a *three-level explanatory model of the IM effect* which is presented in Figure 1. Briefly, IM technology is believed to improve the resolution and efficiency of an individual’s *internal brain clock(s)* and *temporal processing*. In turn, this increased *neural efficiency*, which is hypothesized to result in more efficient brain connectivity, communication, and synchronization via increased integrity of the brains *white matter tract* communication system, produces more efficient communication between critical *brain networks*. In particular, research and theory suggests that IM technology increases the efficacy of the *parietal-frontal brain network*, the brain network most associated with general intellectual functioning, working memory, controlled attention and executive functions.

IM technology incrementally teaches individuals to focus exclusively on a target tone and deploy cognitive tools to deflect distractions, most likely through improvements in the efficiency of communication within the parietal-frontal brain regions. It is hypothesized that IM technology can train individuals to enhance their ability to invoke *on-demand-focus* or *controlled attention*. The IM real-time millisecond feedback requires the user to develop the ability to block out external distractions and mind wandering—and thus, stay focused. Over time, and with sustained motivated practice, it is possible to train the brain to engage in increased on-demand focus. Although the most observable outcome of IM training may be better focus or controlled attention (and thus working memory and cognitive performance), it is suggested that this outcome is likely due to IM producing underlying changes to complex and critical brain and neurocognitive mechanisms. McGrew’s (2012) *three-level explanatory IM model* is currently the best reason-, logic-, and theoretical-based set of hypotheses to explain the *IM effect*.

The primary conclusions from the detailed scientific explanation of the *IM* are:

- The diversity of domains positively impacted by IM technology is due to IM improving the function of crucial brain-based *domain-general* neurocognitive mechanisms.
- The precise, real-time IM millisecond feedback impacts the *temporal processing resolution* of the *internal brain clock*, which in turn improves *neural efficiency*—and thus, more efficient temporal and information processing in the brain.
- The *IM effect* appears to be the result of increased efficiency and synchronization of communication between the primary brain structures that comprise the *functional brain networks* involved in performing both the cognitive and motor demands of IM training.
- IM technology may be improving brain network communication, especially within the major brain networks at the core of the *P-FIT* (parietal-frontal integration) model of general intelligence. IM technology may be improving the efficiency of the parietal-frontal brain network which is critical to general intellectual functioning, working memory, controlled attention, and overall cognitive efficiency.
- One of the most important IM training outcomes (but not the only outcome) is improved focus via increased efficiency of the *attentional control system* (ACS) that maintains goal related information active in working memory in the presence of internal (mind wandering) and external distractions. Improvement in efficiency of executive functions and working memory results in more efficient complex cognitive processing and learning.

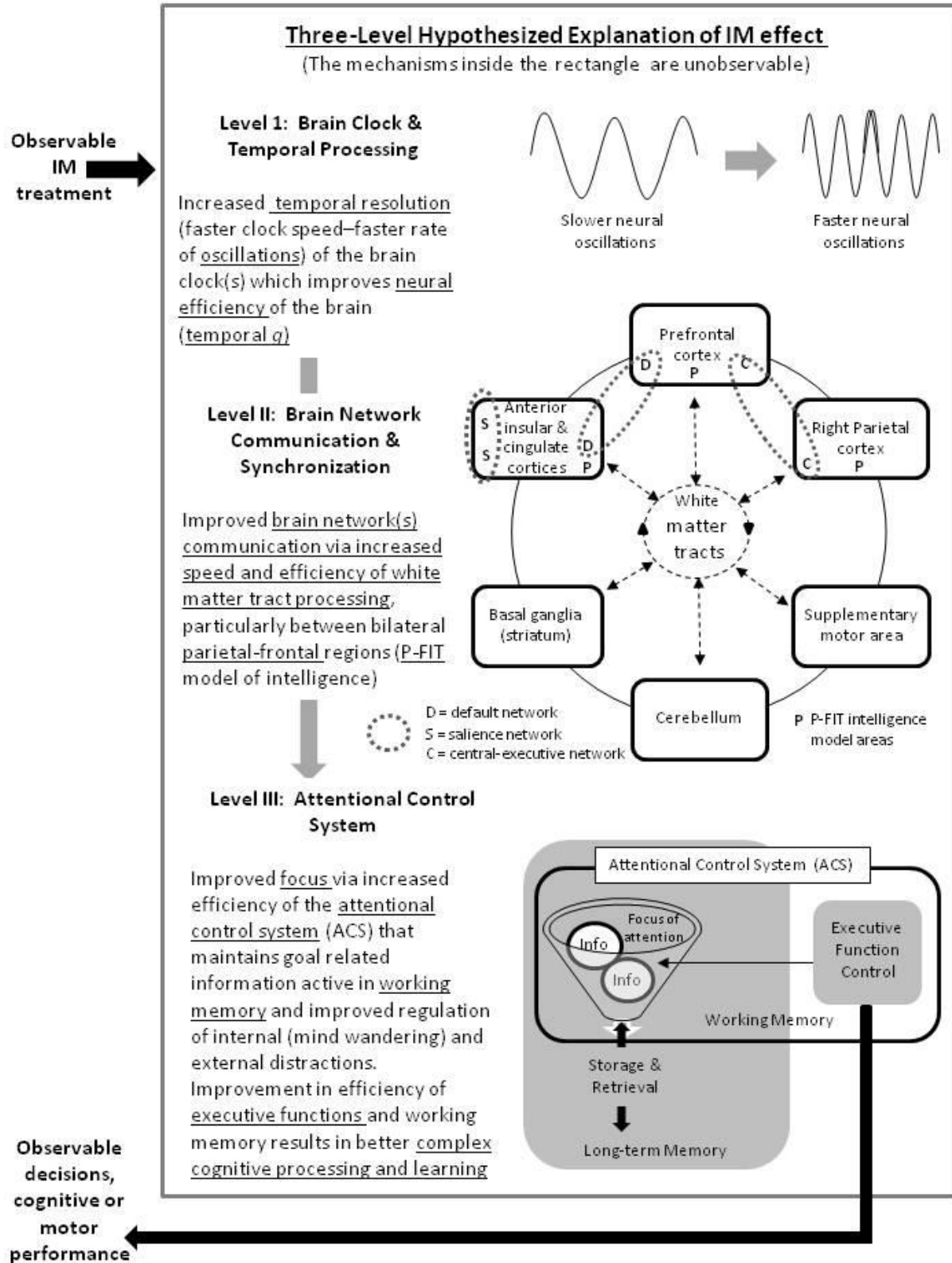


Figure 1: Three-Level Hypothesized Explanation of the *IM effect* (McGrew, 2012)