Brain Time: Interactive Metronome

What claims does the company make/what does the programme target?

Brain Time, Ltd. claims that Interactive Metronome can help children and adults with a range of neurological conditions that affect cognitive and motor functioning, including attention deficit hyperactivity disorder (ADHD), attention and motor coordination disorders, auditory processing disorder, cerebral palsy, traumatic brain injury, developmental coordination disorders, post-traumatic stress disorder (PTSD), reading and learning problems, and stroke, as well as healthy individuals seeking to improve general academic achievement and sports-related performance. The corresponding benefits claimed with the use of this programme are in attention, focus, coordination, language processing, reading and math fluency, and control of impulsivity and aggression (Douglas, 2015).

The theory underlying Interactive Metronome is based on "neural timing deficits," described as disruptions in the resolution and efficiency of the brain's internal clock (McGrew, 2013). This internal timing mechanism is held to provide the foundations of organisational and sequencing abilities, which sub serve a variety of diverse higher-order cognitive functions. By requiring individuals to use controlled attention and block external distractions for prolonged periods, the rhythm and timing training is thought to synchronise and improve temporal processing through increased connectivity of the parietal-frontal cortical network. This improvement is expected to directly manifest in better focus and controlled attention, the benefits of which would then extend to various other domains of cognition, including working memory, motor planning, executive functions, and general intellectual performance (McGrew, 2013). Forming the basis of this theory are implications of timing inaccuracy and differential processing rates in language disabilities and cognitive processing disorders (Koomar et al., 2000), and Interactive Metronome has accordingly been used as an assessment tool to measure such deficits in various populations (Douglas, 2015; McGowan et al., 2012, Rosenblum & Regev, 2013).

Evidence for efficacy:

As Interactive Metronome training is intended for a wide variety of clinical and non-clinical populations, the experimental implementations of this programme have correspondingly varied in participant populations and functional outcomes being measured. Unfortunately, with a relatively small foundation of published, peer-reviewed research- a large amount of which is case studies- this means that any results found have been insufficiently replicated to thoroughly establish any robust, population-specific outcomes. Findings have also been mixed, with most of the studies reviewed here reporting at least some measurable gains (Bartscherer & Dole, 2005; Beckelhimer et al., 2011; Cosper et al., 2009; Etra, 2006; Frimalm, 2012; Hill et al., 2011; Johansson, Domellof, & Ronnqvist, 2012; Kim, Bo, & Yoo, 2012; Libkuman, Otani, & Steger, 2002; Nelson et al., 2013; Ritter, Colson, & Park, 2013; Sabado & Fuller, 2008; Shaffer et al., 2000; Sommer & Ronnqvist, 2009; Taub, McGrew, & Keith, 2015), but few reporting the dramatic overall improvements expected. Given the varied distribution of participant populations, expected outcomes, and reported results, it will be more effective to take a piecemeal population approach to reporting the evidence in support of Interactive Metronome training. Unless otherwise specified, the studies described below used a ten- to fifteen-hour training regimen.

1. The efficacy of Interactive Metronome training in clinical populations of children with developmental disabilities has been assessed by two small-scale studies without control groups (see Cosper et al., 2009; Kim, Bo, & Yoo, 2012) and one large-scale randomised control study (see Shaffer et al., 2000). The pilot study by Kim, Bo, & Yoo (2012) included ten children with a large array of unrelated developmental disabilities, including autism, ADHD, and Down's syndrome, among others, reported significantly positive effects on sensory processing, concentration, motor control, bilateral coordination, and reflex integration. These results should be interpreted with a degree of caution, however, as the Interactive Metronome training was applied as only one component of a Sensory Integration intervention, and the differential effects of the Interactive Metronome training are not statistically distinguishable. Cosper et al. (2009) looked specifically at comorbid diagnoses of ADHD and either developmental coordination disorder or pervasive developmental disorder, and found significant improvements in visual choice reaction time and visuomotor coordination. However, contrary to expectations, there were no changes in sustained attention or inhibitory control of motor responses. Finally, Shaffer et al. (2000) included fifty-six boys with ADHD and compared Interactive Metronome training to video game training with blind assessment. While both the Interactive Metronome group and the video game group made significant improvements relative to controls on selected measures of attention, motor control, language, cognition, and learning, suggesting an inherent value of focused perceptual activities to these cognitive functions, this pattern of improvement was significantly stronger for the Interactive Metronome group. It is important to note that one of the authors (James F. Cassily) is the inventor of the Interactive Metronome, and that therefore this study carries a potential conflict of interest.

2. The effects of Interactive Metronome training in children with reading and language impairment were investigated in a large, randomised control study that involved a reading and language intervention combined with four hours of Interactive Metronome training over the course of four weeks (see Ritter, Colson, & Park, 2013) and one case study of an adolescent female (Sabado & Fuller, 2008). In the study by Ritter, Colson, & Park (2013), there were no main effects of the training, as both the experimental and control groups made statistically significant gains in reading and language. Though the effect sizes were larger for the Interactive Metronome group, the only difference of statistical significance

was on one measure of reading fluency (i.e., accuracy and rate), which, when paired with null treatment effects on reading accuracy, suggests improvements exclusively in rate. However, the control group made significant improvements on the two other measures of reading fluency, suggesting that the scoring protocol of the differentiated measure may simply not be as sensitive to gains in reading fluency. The case study by Sabado & Fuller (2008) reported improvements in all language areas assessed as a result of the training, including oral and written language and one-word picture vocabulary.

3. Two pilot trials have approached Interactive Metronome training in individuals with mild traumatic brain injury and PTSD; the first was an unpublished masters dissertation with four healthy participants testing the experimental protocols in a combined intervention with Interactive Metronome and total body resistance exercise (TRX) suspension training (see McBride, 2011), while the second included thirty-six active duty male soldiers who had experienced blast-related traumatic brain injury and associated cognitive difficulties within the last five years (see Nelson et al., 2013). Though McBride (2011) reported "positive change maintaining or lowering aggression levels and increasing life satisfaction," the results indicate no significant changes in any measured outcomes. As with other combined interventions, it is not statistically possible to discriminate the effects of Interactive Metronome training from the effects of TRX training, and therefore these results should be interpreted with a degree of caution. The Nelson et al. (2013) study, however, used a randomised control design and identified positive effects on twenty-one of twenty-six neuropsychological outcomes, although only measures of attention, immediate memory, and delayed memory reached statistical significance.

4. The only study reviewed here to experimentally apply Interactive Metronome training to typically- developing elementary school students assessed its effects on mathematics achievement (see Taub, McGrew, & Keith, 2015). This study included eighty-six students in a randomised control design, and reported significant improvements in both calculation and math fluency as a result of training. Although the magnitude of this effect was small, and accounted for only eight percent of the variance in the test scores, the calculated growth on these tests relative to the control group compares favourably to developmental growth curves derived from standardised mathematics tests. It is important to note that this study carries a potential conflict of interest, as one of the authors (Kevin S. McGrew) is employed as the Research and Science Director of Interactive Metronome and the study was funded in part through a grant from Interactive Metronome, Inc.

5. The effects of Interactive Metronome training on sports-related performance was assessed in three different studies: two randomised control studies on golf shot accuracy (see Libkuman, Otani, & Steger, 2002; Sommer & Ronnqvist, 2009) and one unpublished dissertation on soccer timing ability see Frimalm, 2012). The golf studies included forty and twenty-six golfers, respectively, and both identified significant improvement in swing accuracy over controls as a result of the training (Libkuman, Otani, & Steger, 2002; Sommer & Ronnqvist, 2009), although this was paired with a lack of significant improvements in motor timing in the latter. However, the randomised control study on soccer timing abilities reported significant improvements in motor timing and rhythmicity in twenty-four female soccer players after training (Frimalm, 2012).

6. Three different case studies reviewed here assessed the effects of Interactive Metronome training on two individuals with hemiparesis resulting from brain damage, specifically stroke (see Beckelhimer et al., 2011; Hill et al., 2011) or hemiplegic cerebral palsy (see Johansson, Domellof, & Ronnqvist, 2012). All three of these studies reported decreased impairment in the disabled limb with smoother and shorter movement trajectories (Beckelhimer et al., 2011; Hill et al., 2011; Johansson, Domellof, & Ronnqvist, 2012). However, while Beckelhimer et al. (2011) noted corresponding increases in functional ability, Hill et al. (2011) reported that occupational therapy alone (i.e., without the addition of Interactive Metronome training) produced greater gains in both functional and perceived ability.

Evidence against efficacy:

As described above, the extent of the research available on Interactive Metronome is relatively limited, and many of the studies highlighted on the Brain Time website are case studies (see Bartscherer & Dole, 2005; Beckelhimer et al., 2011; Hill et al., 2011; Johansson, Domellof, & Ronnqvist, 2012; Sabado & Fuller, 2008) or unpublished manuscripts of masters or doctoral dissertations (see Etra, 2006; Frimalm, 2012; McBride, 2011). While such research provides valuable insight and foundations for future studies, large-scale, peer-reviewed research and randomised control designs are critical for a reliable evaluation of the efficacy of any such intervention programme, and there are as yet only a few studies which meet this expectation (see Libkuman, Otani, & Steger, 2002; Nelson et al., 2013; Ritter, Colson, & Park, 2013; Shaffer et al., 2000; Sommer & Ronnqvist, 2009; Taub, McGrew, & Keith, 2015) and, with the exception of the two golf studies, each of these focused on distinct, unrelated populations with equally diverse outcome measures. Furthermore, two of these studies were susceptible to bias due to conflicts of interest (see Shaffer et al., 2000; Taub, McGrew, & Keith, 2015).

Conclusions:

As the reported results of the Interactive Metronome training varied significantly from study to study, even within the various participant populations, it is difficult to draw generalised conclusions regarding the efficacy of the programme. Approaching the literature through the lens of the training's effects on specific cognitive functions across these distinct populations (ignoring the studies without sufficient power for statistical analysis) only serves to accentuate this difficulty, as the only specific measured outcomes to be reported in more than one study were golf swing accuracy (significantly improved in both cases- see Libkuman, Otani, & Steger, 2002; Sommer & Ronnqvist, 2009) and motor timing (significantly improved in one case, but not the other- see Frimalm, 2012 and Sommer & Ronnqvist, 2009, respectively), and attention (significantly improved in one case, but not the other- see Nelson et al., 2013 and Cosper et al., 2009, respectively). This last result- of conflicting effects on sustained attention- is concerning, as the underlying theory of Interactive Metronome predicts direct improvements to focus and controlled attention (McGrew, 2013). Within isolated studies, a wide array of other cognitive functions have been identified as benefitting significantly from Interactive Metronome training, including concentration, motor control, bilateral coordination, reflex integration, and sensory processing (Kim, Bo, & Yoo, 2012), immediate memory and delayed memory (Nelson et al., 2013), visual choice reaction time and visuomotor coordination (Cosper et al., 2009), calculation and math fluency (Taub, McGrew, & Keith, 2015), and rhythmicity (Frimalm, 2012). However, this isolated evidence of training-related improvements would have been stronger if any of these results were replicated in other research.

As it stands, Interactive Metronome training could be described as resulting in benefits to some cognitive and motor functions within isolated experimental conditions in varying populations, but there is insufficient and conflicting evidence regarding the general efficacy of Interactive Metronome training as a therapeutic treatment tool.

What it involves:

Interactive Metronome is a biometric technology that measures and improves human timing (Douglas, 2015). It is based on the design of a traditional music metronome, but the computer-based system uses specialised hardware and software to provide a movement-based repetition programme to develop rhythm and timing. The hardware setup includes headphones and contact-sensing triggers for the hands and feet, and the game-like software programme produces a steady beat through the headphones that the user matches with continuous rhythmic movements, which are registered by the sensors and then analysed for speed and accuracy to provide individualised visual and auditory feedback. Through this feedback, the user is meant to adjust their movements until they are synchronised with the auditory stimuli. Variations on the rhythmic movements required include two-hand clapping, one-hand clapping, toe-heel tapping, and toe tapping with hand clapping, among others (Sabado & Fuller, 2008).

Standard implementation of the Interactive Metronome programme includes fifteen one-hour sessions, each of which has specific objectives and instructions and must be administered by a certified Brain Time trainer (Sabado & Fuller, 2008). However, the session duration, intensity, and total implementation time may vary based on individual needs and capabilities, determined through a free initial assessment and consultation with the provider (Douglas, 2015). Home-based training requires purchase of the Interactive Metronome equipment and an appropriate tuition package, which may include thirty or sixty minutes of administered tuition over five, eight, or twelve weeks. Support and assessment by the certified trainer is ongoing throughout the tuition period and clients are expected to complete three to six additional practice sessions per week outside of the weekly tutored session. School-based implementation is also available as a training, support, and equipment package (Douglas, 2015).

Price:

School package

Full two-day training for two school personnel, unlimited virtual support, unlimited student trainees, all equipment and twelve-month warranty: NZ$12,500 (excl. GST)

Home training

IM Home Unit equipment (with one license): NZ$790 (incl. GST)

Five-week tuition for sports or performance-arts outcomes (30m per week): NZ$325

Eight-week tuition for moderate learning disabilities (1h per week): NZ$800

Twelve-week tuition for severe learning disabilities (1h per week): NZ$1,200

Extended training: NZ$65/30m or NZ$100/1h

Website/for more information see:

http://braintime.co.nz/

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