

Enhancing Motor Skills of Children with Autism Spectrum Disorder:
The Potential of an Interactive Metronome Approach

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by

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CHAPTER ONE

INTRODUCTION

Autism Spectrum Disorder, with a prevalence of 1 in 110 children, is the most common pediatric diagnosis in the United States (Bhat, Landa, & Galloway, 2011). It is an inclusive term for a group of neurodevelopmental disorders that share similar impairments in communication, reciprocal social interaction, and restricted, repetitive behavior (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010). In addition to these diagnostic criteria, children with Autism Spectrum Disorder also tend to have motor impairments, which was the main focus of this project.

Studies have shown that Autism Spectrum Disorder is associated with greater clumsiness, motor coordination, abnormalities, postural instability, and poor performance on standardized testing of motor functioning (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010). These motor impairments lie within the vestibular system, which is the sensory system that responds to accelerated and decelerated movement (Zachry, 2011). The vestibular system allows subjective awareness of body position and movement in space. Vestibular responses of children with Autism Spectrum Disorder are often delayed or abnormal and this plays a significant role in the integration of sensory processing.

Sensory integration is the neurological process that organizes sensation from one's body and from the environment and makes it possible to use the body effectively in the environment. Motor skills and coordination in children with Autism Spectrum Disorder is affected because of the abnormal vestibular responses and the difficulty to coordinate one's body. Difficulties in motor skills are one of the common reasons of referrals for occupational therapy (Baranek, 2002 as cited in Ozonoff et al., 2007). One of the main motor difficulties children with ASD face is motor planning. Forti, Valli, Perego, Nobile, Crippa, and Molteni (2011) observed 12 children

with Autism Spectrum Disorder and 12 typically developing children and concluded that children with ASD have difficulty planning out their movements and sequence their actions while keeping a rhythmic pace.

To assist children with ASD with their motor skills, there are different intervention techniques. Sensory Integration Therapy is one of the intervention techniques and it is centered on improving sensory and motor abilities (Baranek, 2002 as cited in Schaaf, Benevides, Kelly, & Mailloux-Maggio, 2012). This type of therapy is found to improve fine and gross motor skills as well as upper limb coordination (Hilton, 2011). For instance, Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson (2011) examined the effects of a six-week Sensory Integration Therapy approach with 37 children with Autism Spectrum Disorder. They found that the participants demonstrated significant progress in sensory processing and fine motor skills.

A novel approach to Sensory Integration Therapy is the use of an Interactive Metronome approach. According to Koomar, Burpee, DeJean, Frick, Kavar, and Fischer (2001), the use of a metronome during occupational therapy treatment session can help individuals with Autism Spectrum Disorder learn to better coordinate their visual and vestibular responses by improving timing and rhythmicity related to motor coordination, motor planning, and sequencing. Studies have shown that children are able to organize and sequence their actions in sync with the metronome, which then allows them to gain greater control of their bodies (Koomar et al., 2001).

In this project, I aimed to study whether or not those already using metronomes in therapeutic settings perceive that the approach benefits motor development, specifically. To provide multiple viewpoints on the benefits, I interviewed an occupational therapist, a chiropractor, and a family with a child that is currently using the Interactive Metronome technique. The interview with the occupational therapist supported the trend of prior literature in

that she claimed the use of a metronome to be helpful in improving timing and rhythmicity related to motor coordination, timing, and sequencing. The chiropractor also stated that there are motor benefits, but additionally emphasized that diet played an important role as well. Finally, the parent discussed how there was a potential behavioral benefit to using the Interactive Metronome technique. The results showed that there are benefits of improving motor skills with the use of the Interactive Metronome.

Although I have provided different viewpoints on the positive benefits of the Interactive Metronome technique, a limitation to this novel approach is the lack of research of the Interactive Metronome on children with Autism Spectrum Disorder. Because this approach is fairly new, many people have not yet heard of this type of approach. Therefore, spreading awareness is a key step into conducting more research on the effectiveness of this program. Once there is more research, more professionals will begin implementing the Interactive Metronome technique.

CHAPTER TWO

LITERATURE REVIEW

Children diagnosed with Autism Spectrum Disorder have difficulty in various aspects. One particular challenge they face is in coordinating visual and vestibular responses (Dawson & Levy, 1989 as cited in Case-Smith & Bryan, 1999). The vestibular system is a source of specialized proprioceptive inputs. Proprioception refers to perception of sensations that originate in receptors that are stimulated by one's own movement (Fisher, Murray, & Bundy, 1991). Difficulties with vestibular functioning are important because the vestibular system serves three major functions: subjective awareness of body positions and movement in space; postural tone and equilibrium; and stabilization in space during head movements (Fisher, Murray, & Bundy, 1991). According to Koomar, Burpee, DeJean, Frick, Kavar, and Fischer (2001), the use of a metronome during occupational therapy treatment sessions can help individuals with ASD learn to better coordinate their visual and vestibular responses by improving timing and rhythmicity related to motor coordination, motor planning, and sequencing. Present evidence argues that this specific technique allows children to improve not only their motor planning, but also their behaviors and skills (Koomar et al., 2001). Children achieve this by becoming able to organize and sequence their actions in sync with the metronome, thus allowing them to gain greater control of their bodies by offering an opportunity to practice rhythmic, repetitive movements (Koomar et al., 2001).

Despite Koomar et al.'s claims that metronomes seem to have an effect on improving motor coordination and sequencing for children with Autism Spectrum Disorder, this type of technique is fairly new in the field of occupational therapy, and additional studies conducted in this area are scarce. As a result of its status as an emerging therapy, many therapists may not

have heard of this approach, or may not consider there to be sufficient evidence to merit its adoption. In order to better understand how therapeutic metronome approaches can promote motor skill development in children with Autism Spectrum Disorder, it is useful to first, understand the particular motor challenges faced by children with autism. In particular, recognition that motor skill is a component of sensory integration offers a useful framework for interpreting the potential of metronome use in therapy. Additional information about the potential of this approach is derived from empirical evidence about the effectiveness of its use with multiple clinical populations, in addition to individuals with Autism Spectrum Disorder.

Motor Challenges for Children with ASD

Autism Spectrum Disorder, with a prevalence of 1 in 110 children, is the most common pediatric diagnosis in the United States (Bhat, Landa, & Galloway, 2011). It is an inclusive term for a group of neurodevelopmental disorders sharing similar impairments in communication, reciprocal social interaction, and restricted, repetitive behavior (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010). There are three domains that define autism: social, communication, and restricted/ repetitive behaviors and interests. Examples of social deficits include difficulty making eye contact, not responding to others' approaches, and not participating in group activities. Communication deficits include difficulty in reciprocating in conversations, limited gestures, unusual intonations, very limited engagement in social conversations, and difficulty in imitation and play (Lord, 2010). The third domain, restricted/ repetitive behaviors and interests include the failures to learn through imitation. In addition to these diagnostic criteria, children with Autism Spectrum Disorder also tend to have motor impairments, which may be related to both physiological and cognitive concerns. Studies have shown that Autism Spectrum Disorder is associated with greater clumsiness, motor coordination abnormalities, postural instability, and

poor performance on standardized testing of motor functioning (Fournier, Hass, Naik, Lodha, Cauraugh, 2010). Attention to motor concerns among children with Autism Spectrum Disorder often centers on supporting their sensory integration abilities.

Sensory Integration

Although sensory concerns are not explicitly included in the diagnostic criteria for ASD, there are children with Autism Spectrum Disorder who appear to seek or avoid ordinary auditory, visual, tactile, and oral stimuli (Ben-Sasson et al., 2009 as cited in Lang et al., 2012). Such behaviors are characterized as “sensory behaviors.” Anna Jean Ayres is a well-known occupational therapist and a developmental psychologist who is known for her work in the area of sensory integration. In 1989, she hypothesized that these abnormal “sensory behaviors” are caused by a defect in the nervous system in which sensory stimuli are processed and integrated abnormally (Lang et al., 2012). Sensory integration is the “neurological process that organizes sensation from one’s body and from the environment and makes it possible to use the body effectively in the environment” (Ayres, 1989 as cited in Schaaf, Benevides, Kelly, & Mailloux-Maggio, 2012).

Children’s sensory processing problems are believed to be a causative factor for self-absorbed behaviors (Greenspan & Wieder, 1997 as cited in Case-Smith & Bryan, 1999). Children with Autism Spectrum Disorder tend to experience atypical patterns of processing sensory input and have difficulty responding to tasks and environmental demands (Dunn, Saiter, & Rinner, 2002 as cited in Hilton, 2011). The brain must register the sensory information and then integrate it. One of the main systems involved in sensory integration is the vestibular system.

The vestibular system is the sensory system that responds to accelerated and decelerated movement (Zachry, 2011). Through the vestibular system, one becomes aware of one's body position in space. This system influences many different functions specifically muscle tone, postural control, balance, and eye and neck muscles (Zachry, 2011). Vestibular responses of children with Autism Spectrum Disorder are often delayed or abnormal. They demonstrate difficulty coordinating visual and vestibular responses (Dawson & Levy, 1989 as cited in Case-Smith, & Bryan, 1999). The vestibular system and being aware of one's body plays a significant role in the integration of sensory processing.

Motor Impairments

Because of the abnormal vestibular responses and the difficulty to coordinate one's body, it affects motor skills and coordination in children with Autism Spectrum Disorder. Pan, Tsia, and Chu (2009) found greater deficits in gross motor development and locomotor skills for children with autism compared to typically developing children (Matson, Matson & Beighley, 2011). Children with ASD are shown to have poor upper-limb coordination during visuomotor and manual dexterity tasks and poor lower-limb coordination (Bhat, Landa, & Galloway, 2011). Studies have also shown that children with ASD have visual-motion integration problems, which are initially expressed as poor visual orientation responses, and problems integrating visual, vestibular and somatosensory information (Mooloy et al., 2003 as cited in Dyck, Piek, Hay, & Hallmayer, 2007). Other specific motor impairments include manual control/ writing, manual dexterity/ coordination, ball skill, gait, balance, body coordination, strength and agility, praxis, imitation, postural stability, and speed (Hilton, 2011). Difficulties in motor skills are one of the common sources of referral for occupational therapy (Baranek, 2002 as cited in Ozonoff et al., 2007).

Motor planning. Some of the motor concerns typical of children with Autism Spectrum Disorder stem from their impaired perception of sequencing and the execution of an action sequence (Hughes, 1996). Hughes conducted a study to explore motor planning with children diagnosed with autism. Thirty-six participants participated in the study. Researchers asked each participant to complete a task of inserting a color-coordinated rod on a disc so that it stood upright. After a few trials, the researchers instructed the participants to insert the rod according to specific color combination, such as black/red, black/blue, white/red, and white/blue. The results showed that the children with Autism Spectrum Disorder had difficulty in executing goal-directed motor acts (Hughes, 1996). Instead, the children with autism seemed to rely on proprioception, such as jumping around or pushing heavy objects, as a means of compensating for their instability to use visual control (Masterton & Biederman, 1983 as cited in Hughes, 1996).

Forti, Valli, Perego, Nobile, Crippa, and Molteni (2011) also conducted a study examining motor planning in children with Autism Spectrum Disorder. To explore this skill, researchers evaluated children's ability to transport an object from one location to another and drop it into a hole. This task required children to engage in a reaching movement with hands from one location to a target destination. Twelve children with autism and twelve typically developing children participated in this study. Each participant attempted ten trials: five on the left side and five on the right side. Results showed that the group of children with Autism Spectrum Disorder exhibited longer movement duration than did typically developing children, meaning that children with ASD were gradually able to cross over from planning to control processes smoothly rather than with jerky corrections (Forti et al., 2011) However, results also indicated a difference between the lower functioning children with autism and the higher

performed with slower movements than did typically developing children, whereas the higher functioning children with Autism Spectrum Disorder performed with faster movements. Thus, this study emphasizes that children with Autism Spectrum Disorder do have difficulty with planning out their movements, sequencing their actions, and keeping it in a rhythmic pace. The particular character of their motor planning concerns, however, may depend on other functional considerations, which have unique consequences on movement time optimization (Forti et al., 2011).

Techniques to Enhance Motor Skills

To assist the improvement of motor skills with children diagnosed with Autism Spectrum Disorder, there are different intervention techniques such as the Sensory Integration Therapy and the Interactive Metronome.

Traditional Sensory Integration Therapy Approaches

Sensory Integration Therapy is centered on “improving sensory and motor abilities to: a) develop between sensory modulation for attention and behavior control, and/or b) integrate sensory information as a basis for improved motor planning”, such as imitation, sequencing, and learning novel tasks (Baranek, 2002 as cited in Schaaf, Benevides, Kelly, & Mailloux-Maggio, 2012, p. 322). By improving the nervous system, sensory integration may reduce problem behaviors and promote more efficient learning. For example, Fisher, Murray, and Bundy (1991) reported that Todd, an eight-year-old, struggled with a specific type of motor planning disorder, which was characterized by problems with planning and producing bilateral and projected action sequences. Because of this disorder, Todd had difficulty with bilateral motor tasks with anticipatory or projected movements that were involved such as catching a ball. Catching a ball required Todd to anticipate where he would need to place his hands so that he would be able to

catch it when the ball reached him. He must “project into the future and plan his movement according to the conditions that will exist when he catches the ball” (Fisher, Murray, & Bundy, 1991, p. 74).

Sensory Integration Therapy also focuses directly on the neurological processing of sensory information as a foundation for learning of higher-level skills, such as motor planning or academic thinking (Baranek, 2002). Some implementation of sensory integration treatments include a child wearing a weighted vest, swinging, sitting on a therapeutic ball, riding a scooter board, and similar activities. This type of therapy improves fine and gross motor skills, and upper limb coordination (Hilton, 2011). For example, Pfeiffer, Koenig, Kinnealey, Sheppard, and Henderson (2011) conducted a study where they analyzed the effects of sensory integration therapy. Researchers divided a group of 37 children from 6 to 12 years old into two groups, one group received sensory integration intervention and the other received fine motor intervention. Participants in each group received eighteen treatments of forty-five minutes over a period of six weeks. Sensory integration-based treatment was defined in this study as “a program of intervention involving meaningful therapeutic activities characterized by enhanced sensation, especially tactile, vestibular, and proprioceptive, active participation, and adaptive intervention” (Bundy, Lane, & Murray, 2002 as cited in Pfeiffer et al., 2011, p. 78). Fine motor interventions focused on three main activity areas: (1) constructional, (2) drawing and writing, and (3) fine motor crafts (Pfeiffer et al., 2011). Results demonstrated significant progress for both the sensory integration and the fine motor groups toward the individualized goals in the areas of sensory processing and regulation, social-emotional function, and fine motor skills. This study also showed that children who received the sensory integration intervention had significantly fewer autistic mannerisms (e.g., stereotypical behaviors) after the interventions (Pfeiffer et al., 2011).

All the participants in this study were also able to process sensory information from the environment around them without having a sensory overload and were able to have a better sense of self-regulation.

Case-Smith and Bryan (1999) also examined the effects of sensory integration therapy. Five boys with Autism Spectrum Disorder participated in this study. Each participant individually received direct occupational therapy with an emphasis on sensory integration for ten weeks. Each session lasted for approximately thirty minutes, based on the participant's tolerance. The activities during the session followed a sensory integration frame of reference. Vestibular stimulation was emphasized using suspended swings and tactile (brushing) and proprioceptive input to trunk and limbs were applied at the beginning and the end of the therapy session (Case-Smith, & Bryan, 1999). The therapist also balanced intervention activities that provided vestibular input with those that helped the child learn to motor plan and generalize new skills (Case-Smith, & Bryan, 1999). Results showed that three out of five of the participants made significant improvements in organizing and planning goal-directed motor activity. The two participants who did not make gains continued to demonstrate motor planning problems, poor attention, and limited eye contact (Case-Smith, & Bryan, 1999). These results show the potential changes that can occur in children with Autism Spectrum Disorder during Sensory Integration Therapy. For some, it appears to be very effective but for others, alternative approaches must be considered.

A Novel Approach: Interactive Metronome Training

One technique that can augment more traditional Sensory Integration Therapy approaches is the Interactive Metronome. The Interactive Metronome is a patented, PC-based interactive version of the traditional music metronome that is aimed at facilitating a number of underlying

central nervous system capacities hypothesized to be involved in motor regulation (Shaffer, Jacokes, Cassily, Greenspan, Tuchman, & Stemmer, 2000). The underlying theory of Interactive Metronome is that motor planning process of organizing and sequencing are based on an internal sense of rhythmicity (Koomar, Burpee, DeJean, Frick, Kavar, & Fischer, 2001). Using the Interactive Metronome provides a systematic method of improved timing and rhythmicity related to planning and carrying out a variety of actions and sequences (Koomar et al., 2001). Ayres stated that motor planning was a part of praxis. Praxis is a process that involves three aspects: (a) conceptualization or ideation, (b) planning or organizing, and (c) execution of new or nonhabitual motor acts (Koomar et al., 2001). The Interactive Metronome technique allows children to practice repetitive movements in a timed and sequence manner. Timing and sequencing are very closely correlated. These are not always coordinated in children with ASD. For example, a child may be able to sequence certain actions but might do it with incorrect timing, which will cause the child to be have disorganized thoughts and be unable to execute accurately and successfully.

The promise of interactive metronomes for helping children with Autism Spectrum Disorder is grounded in their existing use to help children with a variety of development concerns. For example, Shaffer, Jacokes, Cassily, Greenspan, Tuchman, and Stemmer (2001) conducted a study focusing on the effects of the Interactive Metronome on children with attention deficit hyperactivity disorder. Increasing evidence suggests that broad constructs such as motor planning and sequencing, rhythmicity, and timing are relevant to attentional problems for children with ADHD (Shaffer et al., 2001). Fifty- six boys between the ages of six and twelve participated in a study to explore the usefulness of the IM approach for treating ADHD. Researchers assigned all participants to one of three groups: one group received 15 hours of

Interactive Metronome training, one group experienced no intervention, and one group receiving training on selected video games. Results showed that the boys who received the Interactive Metronome intervention improved significantly more in areas of attention, motor control, and language processing than did the boys receiving video game treatment or not treatment (Shaffer et al., 2001). Thus, this study suggests that the IM technique can improve aspects of attention, motor, and perceptual-motor functioning (Shaffer et al., 2001).

Metronomes are also being used to help rehabilitate the elderly who have undergone strokes. Rhythmic auditory cuing facilitates movement by providing a mechanism for planning movements (Hill, Dunn, Dunning, & Page, 2011). Hill et al. (2011) investigated the feasibility of integrating the Interactive Metronome into an occupational therapy program for stroke rehabilitation. This pilot study used a 2-group (occupational therapy or Interactive Metronome along with occupational therapy) pretest-posttest design. The intervention involved 60-minutes of IM and OT or 60-minutes of OT alone, three days a week for ten weeks. Results showed that it was feasible to add the Interactive Metronome to an occupational therapy program based on subject tolerance and satisfaction (Hill, Dunn, Dunning, & Page, 2011). Further, the group that received the Interactive Metronome along with the occupational therapy showed larger fine motor increases compared to the group that received only occupational therapy. Reasons for this may include the “cognitive motor processing focus of Interactive Metronome treatment, as rhythmic training has been shown to activate areas of the brain responsible for motor processing and enhance motor control” (Hill, Dunn, Dunning, & Page, 2011, p. 735).

Despite indications that metronomes are useful with clients of diverse age and diagnoses, little attention has been given to its use with Autism Spectrum Disorder. One exception is a case study by Koomar, Burpee, DeJean, Frick, Kavar, and Fischer (2001). Koomar et al. (2001)

describe Kyle, a nine-year-old boy, who was having difficulties attending in a noisy environment and in coordinating motor-related skills, especially fine motor and visual motor tasks. After only a couple of occupational therapy sessions using the Interactive Metronome, Kyle showed significant progress in attention, use of pragmatic language, and motor skills (Koomar et al., 2001). Kyle's social skills also improved due to the Interactive Metronome program because he was able to focus in a conversation. He also became better at being able to throw the ball with shoulder rotation, instead of flinging the ball. As therapy progresses, Interactive Metronomes activities are "employed to improve bilateral coordination, timing, and sequencing to enable the child to increase the complexity of project action sequences and move to higher levels of adaptive responses" (Koomar et al., 2001). Although Koomar et al. attribute the positive outcomes for Kyle to the IM approach, there is clearly insufficient research on the effectiveness of this technique.

In sum, Sensory Integration Therapy assists children with Autism Spectrum Disorder in motor coordination, timing, and sequencing. However, researchers are slowly studying the effects of interactive metronomes during Sensory Integration Therapy. Although there are limited studies that have been conducted with the use of interactive metronomes, there seems to be promising results in motor skills. With further empirical support, the Interactive Metronome could become a viable component of a Sensory Integration Therapy approach. The even beat and rhythm can help children with ASD motor plan and execute their actions smoothly. There is still much research that needs to be done and studies to be conducted but this type of technique shows potential in which could really benefit children with Autism Spectrum Disorder.

To determine practitioners' awareness of the Interactive Metronome technique, I will be interviewing professionals as well as a family about the use of the Interactive Metronome. I will

examine multiple viewpoints on the potential benefits of using an Interactive Metronome approach to promote motor skills in children with Autism Spectrum Disorder.

CHAPTER THREE

METHODOLOGY

Participants

One occupational therapist from the Pediatrics Therapy Solution and one chiropractor with a private practice took part in an interview. The occupational therapist was a licensed and registered therapist and was also certified in sensory integration therapy. The chiropractor was a doctor who was certified in using interactive metronome therapy and used this technique with patients of a variety of disorders, one of them being Autism Spectrum Disorder. A family with a seven-year-old child diagnosed with Autism Spectrum Disorder who went through the interactive metronome therapy with the chiropractor took part in an interview as well.

Materials

I recorded all interviews with an iPhone 4S. The occupational therapist and chiropractor responded to the following 7 open-ended interview questions:

1. Where did you first hear of this technique?
2. What type of clients/ patients do you think this technique is used best for? Why?
3. How useful do you find this interactive metronome technique to be with children with ASD, specifically?
4. What particular benefits might it have for children with Autism Spectrum Disorder?
5. What challenges do you face in implementing this approach with children with ASD?
6. What kind of progress, in terms of motor coordination, are you seeing when using the interactive metronome with your clients/ patients?
7. Are there any stories you can share about the use of metronome?

A parent of child who received IM therapy responded to the following 5 open-ended interview questions:

1. Why did you pursue an interactive metronome therapy approach for your child?
2. What did a typical session look like?
3. How long did you use the metronome technique until you began to see results?
4. Describe any progress in terms of motor coordination, if any, did you see in your child?
5. What challenges did you face while working with this type of therapy?
6. Are there any stories you would like to share about your child's response to this type of therapy technique?

Procedure

I interviewed the occupational therapist and chiropractor individually in their offices. Upon arrival, I explained that the purpose of my senior project was to study the effects of metronome use on the motor coordination of children with Autism Spectrum Disorder. With the occupational therapist, I then asked each interview question in the designated order, allowing the participant ample time to respond and elaborate. With the chiropractor, I asked the interview questions out of order to follow his flow of information. After interviewing the chiropractor, he agreed to give me the contact information of a parent who might be willing to participate in an interview about her child's experience with interactive metronome therapy. After contacting the family, the mother agreed to do an email interview, so I sent a list of questions to her and she replied with the answers to each question.

CHAPTER FOUR

RESULTS

In this section, I summarize the results of the interviews by describing the themes and experiences revealed by the occupational therapist, chiropractor, and the parent. The full transcripts are available in Appendices A-C.

Occupational Therapist View

The occupational therapist was very open and eager to do this interview because she was excited about explaining this type of technique since it isn't widely known. During the interview, she discussed how using the metronome works best with clients who don't have a natural rhythm within themselves. Children with Autism Spectrum Disorder show motor planning difficulty and one of the components of motor planning is sequencing and timing. By using the metronome technique, it can overlay a rhythm children with ASD don't naturally have within themselves to help them attune more. She stated that metronome use has been shown to help gross motor coordination by enabling children to establish their own rhythm and their own timing. She shared a story about how she has some clients who come in initially chaotic so their motor control is also chaotic and with the help of the metronome, the children start to attune to it. She seems very optimistic about using the metronome in her therapy sessions because she is seeing positive outcomes with every client she has worked on it with.

Chiropractor View

Before I began the interview, the chiropractor seemed very interested in this project because he was excited to see this technique slowly being heard of since it is not widely known. The chiropractor explained that the interactive metronome has a long form test with fourteen steps and it measures different skills so that the patient can see what he or she can and cannot do.

Research shows that twelve weeks on the IM is sufficient to bring someone up two grade levels in math, reading, and science. One of the main themes during the interview with the chiropractor was that it's not solely the interactive metronome that is a key therapy. He believes that diet also plays an important role. He begins by arguing that there seems to be an imbalance with the hemisphericity with the brain of a child with Autism Spectrum Disorder. His view was that it's also important to understand the antecedents that led to their current condition, and he stated that for a lot of children, their antecedents are dietary related. The chiropractor was very passionate about this idea and has seen a lot of patients where once a diet plan has started the parents and the chiropractor both start seeing results. He stated that with his autistic patients, he would usually start with a dietary plan as a fundamental step before he uses the Interactive Metronome. He also stated that there might not be a sufficient amount of literature in regards to this topic because the literature is behind of what's being applied in the clients. He explains this progress to be very useful and with the proper stimuli, it allows the brain to respond faster. Based on the interview, the Interactive Metronome seems to have positive outcomes in terms of motor coordination such as dexterity, eye-hand coordination, and balance.

Parent View

After attempting to have a face-to-face interview with the parent, it was agreed that an email interview would be the most convenient. She was very open and willing to participate in the interview. The parent discussed how it was due to their frustrations with their son that they began the interactive metronome approach. Prior to the IM, their son had difficulty focusing when a teacher would ask him a question and would stutter and get confused because he could not process the questions nor formulate an answer. They began to see results three weeks later when a parent from a cub scout meeting commented on how well behaved their son was. His

teacher also commented on how well he was doing with raising his hand and not shouting in class. They were happy and amazed to see how quick their son responded to the program.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

The aim of this study was to examine multiple viewpoints on the potential benefits of using an interactive metronome approach to promote motor skills in children with Autism Spectrum Disorder. To explore this topic, I conducted interviews with two professionals familiar with the Interactive Metronome approach, as well as one family whose child was engaged in therapy using that approach. All participants in this small case study suggested that the Interactive Metronome approach plays a positive role in helping children with ASD. Each interviewee, however, emphasized different outcomes. The OT focused on benefits to timing, sequencing, and motor planning. The chiropractor emphasized the importance of diet along with the Interactive Metronome program. Finally, the parent emphasized the behavioral outcomes she had observed with her child.

Participant Views

View of Occupational Therapist

The occupational therapist explained that a “lot of children with Autism Spectrum Disorder have motor planning difficulties and one of the components of motor planning is sequencing and timing.” She went on to state that the metronome “helps to overlay a rhythm and a timing so that it helps to further along their motor planning during an activity.” In other words, the OT understood the process as being one in which the metronome sets a certain rhythm that guides and assists children to develop a steady paced internal rhythm. She also explained that she doesn’t use the actual PC-based Interactive Metronome but she has adapted this technique and uses a small, electronic, portable metronome. She discussed that in the beginning of a session when working with a child with ASD, the child will come in initially very chaotic and their

motor coordination is not intact. She observed that once she turns on the metronome, the child would calm down and begin to attune with the natural, steady beat of the metronome. Her emphasis on the use of this approach is consistent and similar with the prior work of Koomar, Burpee, DeJean, Frick, Kavar, and Fischer (2001), who also found the use of a metronome to be helpful in improving timing and rhythmicity related to motor coordination, timing, and sequencing.

Chiropractor View

The chiropractor agreed with the occupational therapist that there are motor benefits to using the Interactive Metronome approach. However, his emphasis was slightly different than that of the occupational therapist. He discussed that through the Interactive Metronome technique, he has seen improvements in both dexterity and balance in children with Autism Spectrum Disorder. Manual dexterity/coordination and balance are among some of the specific motor impairments typical of children with ASD (Hilton, 2011). The chiropractor claimed to have produced consistent results with his clients in terms of improving a variety of motor skills with the use of an interactive metronome. Prior literature states that using the Interactive Metronome provides a systematic method of improved timing and rhythmicity related to planning and carrying out a variety of actions and sequences (Koomar et al., 2001). Although literature report that manual dexterity/coordination and balance are among some of the motor impairments of individuals with ASD, studies do not report that there are benefits in these motor skills. However, the chiropractor claims that he is seeing positive outcomes.

In addition to attributing positive results in motor development to IM, the chiropractor revealed an understanding that a lot of the effects were based from the brain and diet. The chiropractor stated that the “deficits of autism are really an expression of hemisphericity,

meaning that one hemisphere isn't keeping a balance with the other". In order for us to understand the child's current conditions, he claimed, it is important for us to understand the antecedents. Some of these antecedents could be dietary related or environmentally related. The chiropractor has found that "applying the dietary change has been fundamental". He explained that the diet turns down the cerebral inflammation related to the autoimmune side of autism. Once a gluten and casein free diet is implemented, he has seen improvements on attentiveness, motor skills, and communication.

The chiropractor's focus on dietary interventions are not unique, this approach is being implemented as part of treatment plans for children with Autism Spectrum Disorder (Pennesi & Klein, 2012). Studies on the effects of gluten and casein free diets for children with Autism Spectrum Disorder revealed mixed results. The gluten and casein free diet consists of the elimination of wheat, oats, barley, rye, processed foods, and milk products (Srinivasan, 2009). Pennesi and Klein (2012) conducted a study where they analyzed 387 families' experiences using parental self-report data from a 90-item questionnaire about children's diet and behaviors. The results showed that parents who eliminated all gluten and casein foods reported that a greater number of their children's ASD behaviors, physiological symptoms, and social behaviors improved compared to parents who did not eliminate all gluten and casein free foods. A limitation of this study is that it was based off of a questionnaire so the responses might overestimate the impact of diet. Parents who went through the effort to change their child's diet dramatically may have been more motivated to report behavior benefits than parents who did not take such drastic measures.

In contrast to Pennesi and Klein (2012), there are studies that show evidence that gluten and casein free diet shows no significance in the child's ASD behaviors. Johnson, Handen,

Zimmer, Sacco, and Turner (2010), for example, conducted a pilot study of three months duration that compared the effects of the gluten and casein free diet on children with Autism Spectrum Disorder. This study consisted 22 children with ASD divided into two groups: one group on the GFCF diet and the other group on a healthy, low sugar diet. The results, based on parental reports, showed no significant nutritional differences or side effects on the GFCF diet compared to the control diet. It is possible, however, that the duration of the dietary intervention was not long enough to produce change. Clearly, there is still much research needed in this area to determine whether the GFCF diet is effective for reducing ASD behaviors.

Parent View

Present evidence argues that the IM technique allows children to improve not only their motor planning but also their behaviors and skills (Koomar et al., 2001). A mother with a son who is receiving the Interactive Metronome therapy approach reported seeing improvements in his behavior within both the classroom and in Cub Scouts. After about three weeks of the Interactive Metronome therapy, a fellow Cub Scout parent approached the mother and “commented on how well behaved” her son was acting. She also stated that her son “was able to focus and continue through the day without interrupting the teacher or getting in any trouble at school.” The parent’s emphasis on the benefits of behaviors is consistent with the prior research in which children with Autism Spectrum Disorder tend to experience atypical patterns of processing sensory input and have difficulty responding to tasks and environmental demands (Dunn, Saiter, & Rinner, 2002 as cited in Hilton, 2011). Although the parent has observed a positive outcome with her son’s behaviors in a classroom and Cub Scouts, there doesn’t seem to be literature or research to help support this benefit. The Interactive Metronome emphasizes the benefits of motor skills but it has yet to find benefits of behavior.

In sum, the present research on the effectiveness of improving motor skills with the Interactive Metronome for children with Autism Spectrum Disorder is very limited. Although there hasn't been much research on this technique with children with ASD, it appears as though the Interactive Metronome technique has the potential to become a viable component of a Sensory Integration Therapy approach. According to Koomar et al. (2001), the underlying theory of Interactive Metronome is that motor planning process of organizing and sequencing are based on an internal sense of rhythmicity. I have provided multiple viewpoints of the Interactive Metronome approach and how it could potentially be an effective tool for the improvement of motor skills for children with ASD. The main argument is that the IM approach allows children with ASD to establish an internal rhythm so that they are able to carry out tasks and activities in an organized manner.

However, there seem to be a few limitations that detracting from broader understanding of this technique. One of the biggest limitations to this approach is awareness. This type of technique is fairly new, so many professionals have not yet heard of it. Once people and professionals become more aware of this type of approach, it will lay opportunities to conduct research on the effectiveness of this program. A specific question to consider is whether using the informal metronome technique is just as effective as using the formal IM program. In this study, the occupational therapist adapted the IM into her therapy sessions and used it in an informal way. She reported numerous positive outcomes with this approach. Future research is crucial to gaining a better understanding of the effects on motor skills of using the Interactive Metronome therapeutic approach.

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APPENDICES

Appendix A: Interview with the Occupational Therapist

(R)esearcher: Where did you first hear of this technique?

(T)herapist: Um, I'm not really sure. Um, as far as using a metronome?

R: Mhmm.

T: Well, I've heard of interactive metronome in school. And I mean, I knew it was a standardized treatment approach. Um, but, as far as using a metronome, I think I first heard about it at a therapeutic listening program where they talked about, they had observed somebody using a metronome for a child with handwriting.

R: Okay. Um, what type of clients do you think this technique is used best for and why?

T: Um, I think it could be used best for most clients depending on what you're doing. So it's not so much the client but the activity they are engaged in and it can overlay a rhythm they don't naturally have within themselves to help them attune more to which that we are trying to teach them.

R: Okay. How useful do you find this metronome technique with children with Autism Spectrum Disorder, specifically?

T: Well, a lot of children with Autism Spectrum Disorder have motor planning difficulties and one of the components of motor planning is sequencing and timing. So it helps to overlay a rhythm and a timing so that it helps to further along their motor planning during an activity.

R: What particular benefits might it have for children with ASD?

T: Motor planning. Improving motor planning and help them to establish their own rhythm and their own timing. You can set a metronome.. uhh some kids tend to run high where they have a really high rhythm and they need things speeded up and so you can actually use the metronome to help slow that rhythm down a little bit or for those kids that tend to be really slow and kind of go at a really slow pace to help bring them up a little bit or to match it for the activity.

R: What about some challenges? What challenges do you face in implementing this approach with these children?

T: Uh, some kids have auditory sensitivity and don't tolerate the sound of metronome well.

R: What kind of progress, in terms of motor coordination, are you seeing when using the metronome?

T: Well for handwriting, I see great improvements in just their stroke directionality, the way they approach their writing. They are able to then implement their own rhythm and timing based on how the metronome was utilized to teach them stroke formation for handwriting. And for gross motor, um it again, rhythm and timing is a large part of everything that we do and when your timing is off, your motor coordination is off so it helps improve gross motor coordination and their timing and sequencing, which is huge.

R: Are there any stories you can share about the use of metronome?

T: Um, just, I've had some kids that we start working on metronome with handwriting and it makes such big progress and the teacher will say, "Well what are you working on? What changed?" and you know, I'll have parents pull up a metronome on their own computer, set it so that it's in the background for when their doing their own handwriting at home. So it gives the parents a tool to help their children when they're at home and not just for clinic based. I'll use is here on the trampoline with timing and sequence for like jumping and balloon batting and it's interesting, you know, kids that are on the trampoline are initially very chaotic and you can just see their motor control is chaotic and they're kind of bouncing all over and you can set the metronome and then use your own voice over laid with the metronome so 1, 2, 3, hit and the kids will just start to attune to it. So they just can start to improve their own motor performance just with that rhythm and that timing and then the voice overlaying so your voice is a tool also with the metronome. You can't just set in a metronome. You have to have somebody who uses it that has their own sense of rhythm and timing or else they'll have difficulty working with that metronome and overlaying their voice with it so it's not standardized in any way but it can be really helpful for a lot of kids. We do things too, like going up and down the stairs, 1, 2, 3, and it just, their whole body then when they come in, they can just do everything almost in a more sequential sequenced and better timed. So it's been great but again, it's a tool that we use and it's beneficial but you can't just use it in isolation.

R: Okay well that just about sums up the interview. Thank you again for taking this time to be a part of my project.

Appendix B: Interview with the Chiropractor

(D)octor: We are integrative, in terms of how we approach Autism and what I mean by that is it's not purely a motor deficit and it's clearly not a genetic issue otherwise we wouldn't have seen the increase from 1 in 10,000 to I think the last stat that I saw last month was like 1 in 38 for boys and 1 in 55 for girls. Um, genetics simply don't occur that quickly across any period of time. So I look at it as more of a multifactorial issue with genetics playing a potential groundwork and this individual may have a particular genotype and then depending on their environment, whether they express that and their epigenetics start to take up a role, then they may express that phenotype, um, as their body is um, I'll use the word assaulted by environmental impact. So, I can give you a handful of individuals and just kind of run through their case and perhaps that could let you know what we've observed.

(R)esearcher: Okay.

D: It's not solely the interactive metronome although that is a key therapy. Um, there's a book that you should get if you haven't already read it. It was actually published in January, last month, but um, it's written by Dr. Robert Melillo and it's called Autism.

R: Okay. Is it at the local bookstore?

D: You can get it at Barnes and Nobles.

R: Oh okay.

D: Yea, it just came out. Um, but Dr. Melillo, he's been one of my instructors for years and he has created what's called the Brain Balance Centers of America. Are you familiar with those?

R: No

D: He has over a hundred of them now across the U.S. and the IM is one of the tools that they use um, but I largely pattern my practice after their approach. Um, the concept there being that the expression that we observe in um, poor interaction, communication, lack of responsiveness, um, all these personality traits or personality deficits that we might consider in relationship to Autism are really an expression of hemisphericity, meaning that one hemisphere isn't keeping a balance with the other. And he simplifies it down into the concept that the left brain is going to be your go brain and your right brain is going to be your brakes and that the um, details are all here on the left hand side that the global picture and how to interface that with um, taking information and actually applying into a context in the right brain. And when you look at a uh, anyone on that um, ASD spectrum, you'll observe those commonalities and some of the triggers that play into that are that the first steps so before I can put somebody on the IM,

R: Mhmm.

D: I have to understand what the antecedents were that um, led to their current condition. And in some individuals, their antecedents are really going to be dietary related. In others, it's going to

be more environmentally related and some it might be a trauma or an infection that set the ball rolling. Um, realistically, it's often a smattering of those things and gathering a comprehensive history and um, understanding that individual before we even get to the unit is key because if I just stick somebody in there, it'll drive my therapist batty. Particularly if it's a youngster that hasn't developed the skills of communication yet

R: Mhmm.

D: I mean it's going to be, you might as well just turn a pinball machine on there and it'll be bouncing around the room but um, if you have the parents on board and you've been able to address some of those initial triggers, and I'm going to use another term, inflammation, turn down the cerebral inflammation, you're going to get a much better result. And so for, I'm going to use the most because realistically, it's all, that I've seen, but in medicine, using the word all is kind of dangerous but um, I've yet to see an autistic child that doesn't have food sensitivities playing a key trigger in enabling me being able to communicate with them so that the parent can see, "Wow there is a potential change here in my child. I'm going to run with this ball." So applying the dietary change has been fundamental and I'll usually do that for about three weeks before I turn the machine on.

R: Oh.

D: And the reason for that is, the parents, within about 10 to 14 days, they're usually going to start seeing the pay out. Um, attentiveness, motor skills, communication, all of those things tend to improve once the inflammation related to the autoimmune side of autism is turned off. And when you look in the literature, there are quite a few published studies in regards to autoimmune aspects of autism but when you communicate with the doctors in the field, that's still a foreign concept so the literature is really, I think, about ten years ahead of what's being applied in the clinics.

R: Mhmm.

D: And I don't know what's really driving that. I tend to be a conspiracy theorist and think well it's perhaps it's just pharmaceutically driven and so since there's no drugs really sell dietary and environment changes, maybe that's why the information isn't being broadly embraced by the practitioners who are seeing these kids.

R: Mhmm.

D: Um, but in my microcosm of medicine, it is strongly embraced and I do see the payout. So having said all that, we will do laboratory testing to identify if there's any cytokine load or immunoglobulin load that is showing reactivity against common foods in their diet. And then, I like to also further test to see if some of those common antibodies are actually attacking neuronal tissue. And in many cases, we'll find antibodies against cortex, cerebellum, amylin and that tells us that okay, some of these dietary changes are probably going to be lifelong for you and one great case, I had a family, they brought their son out from Arizona a little over a year ago now. And this mother had three children and um, Christian was his name and when he was brought in,

I scheduled them as the last patient of the day because she told me it would be really difficult to have any type of communication and it was wise that she told me that because he just tore the place up and so I basically just talked to mom and observed him in his activities and said, "You know what? I think it'd be best just to start with labs" because doing a physical exam on him was an impossibility at that moment with his activity level other than what I observed. And I give kudos to the phobotomist that was able to manage getting his blood but they did and he was off the charts on some of the common foods that we see: gluten, dairy, soy being three of the key ones.

R: Mhmm.

D: She got him off of those and you'll see that most autistic kids, their diet is confined to chicken tenders, hot dogs, and milk. I mean those are three staples they'll eat and they'll eat all day. And all three of those have components of what I was just talking about so changing his diet was difficult but she saw the change within two weeks. This was a four-year-old that wasn't potty trained yet, hadn't said his first word yet, would hit his head against the wall and would scream for communication, couldn't share anything, couldn't look anybody in the eye, and was really abusive to his siblings because of the only means by which he could communicate was hitting and screaming. Within two weeks, she noticed that he was no longer um, averse to viewing somebody in the face, so one of his social barriers began to decline simply by pulling out the dietary input. Um, within a month, I had them doing the IM. I actually trained her on it here and then sent her home and got her a home unit and then we just dealt with it over the phone. Um, but within a month, he was saying his first words. He was able to say, "I love you mommy" and she called me that day and was in tears. Um, within three months, he was potty trained and on month four, his school, they were so excited to see these changes that they came to their home to interview them to find out what have you guys done and so she was discussing the diet and the IM. At month five when I called to find out how things were going because there had been continual progress, um he was now speaking in complete sentences and I mean, he had stored up all this information in his head but he couldn't apply it yet.

R: Mhmm.

D: And so it's fascinating how fast the brain will respond if the hurdles or obstacles are removed and the proper stimuli is put in place but the way she coined it, she said he seems to be developing about six months every two weeks. And it was just boom, boom, boom. Month five, when I called, she said we've had a setback. I said, "Well what happened?" She said, "Well we had a substitute teacher at school and she didn't bother reading his profile and she gave him chocolate milk three days in a row." He began um, losing his bowel control, so he became incontinent again. His ability to have eye-to-eye communication dropped and he lost about 75% of his speech. Like overnight. And it took her another two months to regain what had been lost uh, really cleaning the environment up. And so in her words, she said, "I think his autism was 75% diet." And that was just uh, a really powerful case. Now not all parents express that, but one thing that I have seen is that most parents will agree that diet is playing a big role. I think 75% was on the higher end but I think 50% is pretty realistic for most kids.

R: Mhmm.

D: So once we get the uh, fire in the noggin turned down and we are able to implement the IM, um, before I do that, I actually do what's called a vestibular nystagmography study and it's a study done with um, goggles that put you into a black out situation and it's just measuring eye movement. And the way your eyes move, you have six cardinal planes of motion, and like if I spin you to the right you're going to have an induced optokinetic reflex so your eyes are going to start to pulse and they're going to go in that direction. Go to the left, same thing and it's going to be very rhythmic or it should be if your hemispheres are communicating with your inner ear appropriately. And when you're in a black out, you don't have the capacity to use your surroundings as your frame of reference and so your ability to engage motor control and keep the eyes in any one of their six cardinal planes is purely dictated on motor function and how well that portion of the brain that causes that motion is firing. And when you're like looking up into the right, you're strongly firing your right cerebellum. If you look over to your left, that's also right cerebellum and vice versa. When I run an optokinetic tape pass the eyes, the right parietal lobe should be pushing the eyes that direction. Right frontal lobe would be pushing it the other direction and opposite side cerebellum will be catching it. So if I was to run a tape past you, or if you're driving down the street and you see a picket fence, your eyes will just naturally pulsate kind of like a ping pong ball and it should be in a narrow range right there in the midline, as long as that's where the tape is. And we'll run somebody through some of these simple neurological tests and we'll observe to see okay, is the hemisphericity that we anticipate because of your previous diagnosis also in place. And so I'll observe it objectively there on the computer and take my findings down and then I'll send them in for the interactive metronome. Interactive metronome has what's called a long form test and there's fourteen steps there and it will actually, in an objective fashion, measure what I just observed on the screen and that's really powerful for the patient or the parent of the patient to see because here we've looked at it in one sense. They've seen the screen, they've seen what the motor skills can't do, and then we put them over there and we have the unit time them. And if someone is all left brain, they're going to preempt the tone on the IM and so you'll see the preemptive beat is measuring really high and the late beat is measuring extremely low and they're super right on time is going to be negligible. Or vice versa, depending on the side of the brain that's firing the most. And then we'll use that as their baseline and then every thirty days, we'll do another long form and another visual and we'll start to see how these hemispheres begin to talk more. Well along the way, you're asking questions, okay what are you noticing at home? And then variably, if they're applying the principles, keeping the fire low in the head, doing the exercise here and then doing some of the brain based exercises that we give them at home, it starts to come together. And they see improvements in all areas of life. Um, I've got another little girl uh, she came out from North Carolina and we taught her parents. Uh, we did it with them here for about a week, sent her home to do it, and she's been able to get, uh, she's been able to go up two grade levels in the past year because she was being held back and now she's with her class and functionally normally. Um, the research that they've done shows that twelve weeks on the IM is sufficient to bring somebody up two grade levels in math, reading, and science. And I've done that on enough kids now that I corroborated their initial findings. It works.

R: Wow.

D: Um, it improves your concentration. I had a teacher that uh, she had a head injury and after

her head injury, she had lost the capacity to concentrate long enough to retain a paragraph of information such that she'd have to read it three, four, five times to actually retain that info before she could move on, so reading a book was all but an impossibility for her.

R: Mhmm.

D: After doing the IM, we had her do about close to four, five months of it but even before the twelve-week mark, she came in and she was smiling, I said, "What are you so happy about?" And she said, "I'm reading two book simultaneously right now." And it's just a neat tool to allow people to retrain their brain. And so that's how we use it here. Um, I have three or four people on it a day, and my goal is to help people understand that this is something they can do at home and then when they're comfortable with it, then we turn them onto what's called a home IM and we send them home with that tool and then I recommend about every one to two months while they are using it, that they come back in and re-measure against their long form and some of our other tools that we observe progress with. But most folks, after you know, four to six months, they're ready to fly on their own because they've seen the improvements, they know how to do it, and it's just a matter of rinse, wash, repeat.

R: Do you work with kids like in the motor area, like motor coordination?

D: Yea, we'll test them with primitive reflexes to see um, what kind of things have been arrested in their development and we'll get down on the floor and we'll go through all the primitive reflex remediation and while we're doing that, you know, that's re-engaging those motor aspects of both parietal lobe so they have familiarity with their body again and how to engage motor so yea we're working on balance, dexterity, um, eye-hand coordination.

R: How useful do you find this interactive metronome technique to be with children with ASD?

D: I think I just told you. (chuckles) Exceptionally high.

R: What challenges do you face when you're implementing this approach?

D: So that was where I was kind of starting. Uh, the real challenge is, like we have a particularly challenging case right now. A young man and you know how I mentioned different antecedents playing a role on how successful this is going to be?

R: Mhmm.

D: He's um, ten years old and high functioning autistic. Um, your environment impact is not just food and it's not just the things you're breathing, it's also your social environment. His parents are divorced and as such, we're dealing with two different home lives. And although both parents are on board, the degree of cohesiveness for their collaboration is questionable at best. And the inner turmoil that a child feels, I don't know how to measure that, but it definitely is playing a role in this boy's life. I observe it depending on what parent brings him in and how effective my therapist is working with him. Um, almost as though if one parent's there, he's

willing to put more time and attention into it versus the other. Having said that, um, he's around the five-week mark now, and some of our objective markers are okay, can he get through the whole therapy and stay focused in the given time we have allotted. Around five weeks, well I just talked to her yesterday about this particular case, we're just starting to get to the point where I would anticipate he would have been at two weeks so I said, "are you seeing any signs of improvement here?" because I did a retest at the one month mark and there was nothing observable in terms of his motor skills and how his hemispheres are communicating when I looked at his eyes. I said, "Because I saw nothing there. Are you seeing anything over here?" I said yea well numerically, the IM mesh is showing some improvement um, she says, "We're actually getting through the therapy now. He's not like hiding in the corner when he first comes into the room." Um, so I think depending on where somebody starts and the type of home support that they have, that really dictates a lot as to how functional they're going to be and receptive to the IM. Another aspect with this particular young man, he had multiple food sensitivities and getting both homes on board for that has been a hurdle.

R: Mhmm.

D: And when it comes to autoimmune aspects of brain inflammation, if you have exposure to things that you're highly sensitive to, even once every six weeks, you might as well eat it everyday. And so being clean for five days with mom and then eating something on the weekends with dad, you won't see the change and so that's been a frustrating thing too. We're not getting the metabolic side as involved as it needs to be.

R: Wow, I didn't know food was such a big factor.

D: Huge. It's totally being overlooked by the majority of the practitioners who are seeing these kids. That's why I'm excited about Dr. Melillo because he's really branching out and you know, with 100 centers now, more parents are waking up and that, kind of like how you found me, when a parent sees a difference, they talk. It's not like uh, most doctors won't refer to somebody that they're not familiar or comfortable with and they're certainly not going to go outside of their comfort zone and say oh you know maybe you should try diet, if it's not something they're familiar with themselves and willing to actually investigate and teach. There's a couple of doctors here in town that do allergy testing and I see their patients and they come in with like the whole book about what they're reacting to and I say well how's this going? And they say, well I don't know they just handed it to me. They didn't teach it to me. And you dump something off like that on a patient's lap and it's like handing them a textbook on Greek. They can't apply it unless they have the actual coddling and handholding for about six weeks that it takes to get somebody through the difficulty of changing something so fundamental as to what do I eat for breakfast, lunch, and dinner. That's hard.

R: Um, what kind of progress, in terms of motor coordination, are you seeing with this technique?

D: Dexterity, handwriting skills, um, eye-hand coordination, um, balance. I have several elderly folks that we use the IM for balance retaining. It's in conjunction with other things that we do,

but um, this may be an interesting thing to you. One of the things that we'll do is we'll look at um, uh, your.. We all have a blind spot

R: Mhmm.

D: Right? Where the optic nerve comes in, there's actually no view there. It's just all nerve tissue and so the retina is kind of surrounding that so if you look into your eye, you see the macula, you'll see that blind spot. Your um, ability to super impose vision over that blind spot is really dictated by how well your frontal and parietal lobes are working. And so as we age, our blind spot on the weaker side of the brain will tend to enlarge. And so this is something you can measure by just having somebody, you close one eye and you do a blind spot test and you'll have them kind of map out that region.

R: Mhmm.

D: Um, you can also shrink that spot. Now the utility of this is in balance work and it has to do with the IM because you're strengthening that part of the brain. Elderly folks commonly when they get into auto accidents when they're pulling out into an intersection and one of the things they'll commonly say is I didn't see him coming. And the reason for that isn't that their inept as much as they literally didn't see him coming because their blind spot on that side is so much larger than the other side. So depending on which way they're turning, they may have better vision than the other. And so you can shrink these things up so when I talk about visual acuity and balance, that's part of what the IM training can help you with.

R: Can you describe to me like uh, like a session where you use the interactive metronome? Because um, the therapist that I talked to, she simply just has like an electric metronome and she just turns it on and then she'll do an activity where um, like they'll toss a balloon but she'll count like 1, 2, 3, hit and the kid catches it and then he counts 1, 2, 3, hit. Is that kind of similar to what you're doing?

D: No um, the interactive metronome actually measures the time delay and there's multiple tones. Well let's turn it on so you can see it. You've never actually seen one?

R: No, I haven't.

D: It's just that tiny little blue-lighted box right there. But the software related to that is, it's truly what you pay for. Alright so actually here's a partial long form um, that I was just discussing to you.

R: Mhmm

D: So these are the fourteen different activities that the metronome will have you do. And so you're using both hands for an activity, just your right hand, just your left hand, both toes, right toe, left toe. And so you're challenging different sides of the brain in different body parts and you're doing it to a specific um, metronome beat. It's measuring, these are all sensors so I have foot sensors, and I have hand sensors. You can wear the sensors and so um, sometimes we will

use different balls. Um, sometimes we'll use alphabets so like for some of the children, um, as soon as they're able to read we'll say okay, the word is dog and they'll have the metronome on their hand and they will go D-O-G.

R: Oh, Okay.

D: Okay? And if we're trying to work the left cerebellum, I'll have them do that standing to the side, looking over the left shoulder using their left hand because as you rotate your head to the left, you fire your left cerebellum and left hand motion is strong left cerebellum, right frontal lobe. And so you can take the data that we gather there, and apply that specifically here to what your end goal is. Um, and so we have a variety of different props and I've got another board up here where I'll have people do larger sentences or shapes or color matching. Um, but this particular individual they left it open, they didn't close it out last night. You can see on these last five tests that they did, the disparity between early hits and late hits. The goal is to have a one to one ratio. So essentially this is your left hemisphere and this is your right hemisphere. And so they've got a ways to go there. They've got 40 to 7. This one's not bad 18 to 10 but there's a lot of disparity. That one's almost perfect.

R: Mhmm.

D: And so different um, parts of your parietal lobe will have a better map than other parts of your body. Like some elderly folks, they can't feel their feet. So, we will do some um, neurological stim, we'll do some vibratory stim, and then we'll come in here and while those feet are still a little bit awake, we'll try to stimulate their parietal lobe to identify their feet. And so we might pull out the balance beam, or the rocker board, or the balance pad here and have them walk to the beat.

R: Okay.

D: Have them catch a ball and throw it in the air to the beat while they're walking so you can start to layer different activities. Um, all the while this thing is measuring you. There's two sets of headphones so as the therapist, you can engage with them. Um, I'm not sure which one is which. Oh I think they marked the red one for the therapist. Um, one is a little bit more quiet and then for the patient, it's a little bit louder but you're going to hear a couple of different tones. So go ahead and hold that and I'm going to give you a... Okay so this one is reading that one and you just put this on your hand. And if you were to do this, this is just going to be both hands, it's going to start to give you a beat so your goal is to match that beat and so since you're on the both hands right here, and you can see your activity is actually what's going on the top and this is the actual beat. So the goal is to make those happen at the exact same time and right now it's measuring your delay or your accuracy.

R: Wow, this is hard.

D: It's very difficult and when you start to test different parts of your brain, you see how hard it is. But we all have imbalances, most of us compensate for them. At the end, what you would see is how many of those clicks that you just put in, were before, how many were on the beat, and

how many of them were after. And then, from that you would have a goal to work for until you start getting them. And then it gives you bursts where if you start nailing multiple in a row, there's a lot of different interactive things that this is allowing you to do now visually so if you have a kid and like video games are just destroying them because it's so centrally mediated but you're still able to use some of the things that kids like out of video games, like the visual aspect. Um, because ideally, I wouldn't even allow you to look at that. I'd just turn that around and see what you could do without you kind of cheating, using your visual stimuli. Um, but once they get comfortable with this concept, they now have games where you can like make a balloon flow higher the more accurate you are or you could um, if you're into shooting things, you can make something get destroyed the more, you know, whatever their likes are, they have sports ones where you can move the golf ball closer to the hole and those types of things.

R: Ooh

D: So IM has built a lot of uh, software around their fundamental aspect of using a metronome. Sometimes we do the um, other metronome. But just like what you were talking about with that other therapist, it's just a basic metronome and if all we're trying to do is familiarize someone with it, we'll do that, but you're not getting any feedback in terms of objective data. Um, it's still a useful tool but it's very subjective. How much progress am I getting? I don't know. What are you seeing? But on here, I can say, well here's where you were at last time, here's what you're able to accomplish today so let's focus on these key movements next time to see if we can strengthen that as well. That's the utility of the program. Beyond that, it's \$5,000 that people generally don't need to spend, which is why they came up with this home unit. This right here, people can get and it has the exact same software in it, it's \$400 so it's within reach of the general public and you, as the practitioner, can control the program because you can design a custom made activity for them depending on the diagnosis at the initial evaluation and then every time they do one at home, it's connected centrally, you'll get an email, so and so has completed a session and please review.

R: Oh wow.

D: And so then you can go in and you can see okay look they're progressing in these key areas maybe we should give them a little more challenge there so you might layer a few more activities and then they'll go back and they'll do some more. And so it allows you as a practitioner to have actually a practice outside of your office and you've got people all over the country then doing work that you're just getting fed into your email and then you manage at night or whenever you need to and the software that they put on the backside has been really handy as it takes all of maybe ten minutes to manage a case and you can say oh this one's too hard for them. I'm going to ease that up a little bit or I'm going to add a couple of things and you know, about every 40 days, I have to go in and I have to redo someone's program. That's been a really nice tool for the IM.

R: Oh wow. That's very convenient.

D: Yea. And then for sports players or the balance, you've got these floor pads so we'll see up multiple floor pads and if someone's trying to enhance footwork playing soccer, you know, we'll

build some cones here and put those floor pads around and then they have to match the beat while they're doing different feet activities, while they're not looking at their feet so you might be distracting them up here, til I add another layer of difficulty but it's fun.

R: That sounds really cool and fun. Well I think that pretty much sums up all the questions that I have for you. Thank you again for taking this time to be a part of my project.

Appendix C: Interview with the Family

1. Why did you pursue and interactive metronome therapy approach for your child?

My husband and I sought out counseling due to our continued frustrations with our son. He seemed to be having such difficulties with every day activities. He was also getting into trouble at school with yelling out, talking out of turn, etc.

2. What did a typical session look like?

The sessions change accordingly. They are about 15 minutes long.

3. How long did you use the metronome technique until you began to see results?

We started him at the beginning of Christmas break. About three weeks later, we went to our regular cub scout meeting. After the meeting the parent leading the session approached me and commented on how well behaved my son was. At that time, she did not know we started the program with him. His teacher also commented on how well he was doing with raising his hand and not shouting in class.

4. Describe any progress, in terms of motor coordination, if any, did you see in your child?

Prior to the IM program, when asked a question, my son had a difficult time focusing on the question and would stutter and get confused and upset because he could not process the question nor formulate an answer. He would tell me how frustrated he got because it was like his brain would not work right.

5. What challenges did you face while working with this type of therapy?

The biggest challenge with this is the financial aspect of the program as our insurance did not cover hardly any of it.

6. Are there any stories you would like to share about your child's response to this type of therapy technique?

We are happy and amazed at the results and how quick our son was to respond to the program. He went from not able to think straight to being able to interact with others. Another Boy Scout who had been around our son over the last couple years, worked with him again just recently. The Boy Scout was not aware of the program, but his mother was. The scout went to his mother and commented on how well our son had done with the activity and how impressed he was with how calm my son seemed. It was a nice compliment to know the program is working.

Another story, I received a call from my son's teacher. My son was having a difficult day, he was not able to sit still in class, he was interrupting the teacher, finally she told him one more time and he would have to call me. When I was talking to him, he was so upset. He said he doesn't know what is going on and he cannot stop himself. I gave him instructions to do an IM exercise, one where he traces the figure 8 with his left hand (he is right handed). After this, he was able to refocus and continue through the day without interrupting the teacher or getting in any more trouble at school.