Theoretical and Clinical Perspectives on the Interactive Metronome®: A View From Occupational Therapy Practice

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For many years, occupational therapists have observed motor planning difficulties in a variety of populations, including those with learning disabilities, attention deficit disorder (ADD), central auditory processing disorders, autism, Down syndrome, and cerebral palsy. The research presented by Shaffer et al. (2001) provides important evidence that an updated interactive version of the metronome may be helpful in improving timing and rhythmicity related to motor planning and sequencing. In the study, various measures commonly used by the occupational therapy, psychology, and educational communities showed that improving rhythmicity through Interactive Metronome® training may also bring about improvements in behaviors and skills that are important for occupational performance in many areas. Emerging clinical experience, together with Shaffer et al.'s study, suggest that the Interactive Metronome may have potential usefulness in a wide range of clinical conditions and, therefore, may complement existing interventions currently being used by therapists to address these areas. Further systematic studies are encouraged.

Ayres (1985) described motor planning as a part of praxis. *Praxis* is defined as an action based on will, originating from the Greek word for doing, acting, deed, and practice. Ayres described praxis as being a uniquely human process that involves three aspects: (a) conceptualization or ideation, (b) planning or organizing, and (c) execution of new or nonhabitual motor acts. Children who appear to have problems with praxis (dyspraxia) are reported to have difficulty with a variety of occupational performance areas, such as difficulty with self-care skills, poor handwriting, and difficulty with sports (Gubbay, 1979, 1985).

When assessing and developing intervention plans for children with dyspraxia, occupational therapists have most commonly used a sensory integrative theory base, a "bottom–up" approach that addresses the foundational skills needed to develop the ability to plan and sequence. However, there also has been a growing use of "top–down" approaches within the profession, such as those used in cognitive rehabilitation training (Toglia, 1998) to assist in developing cognitive strategies for tackling new or nonhabitual motor tasks. Frequently, the two approaches are used in combination. Within a sensory integrative frame of reference, it is often deemed appropriate, after evaluation, to begin therapy with an emphasis on enhancing somatosensory discrimination to increase body scheme awareness while improving postural control (Koomar & Bundy, 1991). It is theorized that "internal maps" are developed from which to plan actions more effectively. As therapy progresses, activities are employed to improve bilateral coordination, timing, and sequencing to enable the child to increase the complexity of projected action sequences and move to higher levels of adaptive response.

It appears that the Interactive Metronome program provides a systematic method to improve timing and rhythmicity related to planning and carrying out a variety of actions and sequences (Shaffer et al., 2001). Although the expected outcomes are similar to those anticipated from a bottom–up approach, the actual training sessions for the Interactive Metronome are very different from sessions focusing on a sensory integrative approach. Each session has predetermined goals to reach and specific ways to perform the required movements. These goals are a means to an end, with the true goal being a change in a variety of areas of occupational performance.

In addition, it is useful to consider the Interactive Metronome program in terms of dynamic systems theory. As a dynamic system (Kielhofner & Forsyth, 1997), occupational performance emanates not only from the internal factors of the individual human system (i.e., musculoskeletal, cognition, motivation), but also from the task presented and the environment that the human system occupies. All the factors contribute to the organization of behavior (Kamm, Thelen, & Jensen, 1990). Each time an occupational action (behavior) occurs, the human system, or the environment, experiences a change in its status, requiring the human system to reorganize to allow for accommodation and, ultimately, to reach higher levels of self-organization (Spitzer, 1999).

The Interactive Metronome program appears to have much in common with dynamic systems theory. The human system (child) is being asked to perform a task (i.e., 13 movement exercises that require timing and sequencing in relation to the sound of a metronome). The environment is enhanced by providing the child with auditory input (the computerized metronome beat) to which the child is asked to tap his or her hand, foot, or both at the same time as the beat. Computerized guide sounds are provided via headphones to assist the child in fine tuning his or her movements. The Interactive Metronome trainer structures the activity in a meaningful manner that is intrinsically motivating for the child. Variations of the movements can be developed to accommodate each child's need, and games can be created that provide the child with a sense of competition and fun, such as assigning certain points to the child and others to the trainer or an imaginary opponent. Behavioral disorganization can occur during and after Interactive Metronome sessions; however, this temporary disorganization is typically followed by greater improvement.

Clinical Challenges

Occupational therapists often report that children with sensory integration dysfunction have a great deal of difficulty with daily tasks because of the conscious control needed to do many things that same-aged peers do easily and automatically. For instance, many children with sensory integration difficulties, including some children with ADD, have difficulty screening out extraneous sensory information, staying seated because of poor postural control, and performing motoric acts automatically. All of these processes may be carried out with cognitive monitoring at a high energy cost to the child. Interactive Metronome training appears, initially, to facilitate control of the body on a conscious level and then to relegate these postural–motor actions to an unconscious or automatic response level. The Interactive Metronome offers an opportunity to repeatedly practice rhythmic, repetitive movements, using extensor and flexor muscle groups, in a smoothly timed and sequenced manner. It may be useful as a complement to other occupational therapy approaches to enhance the capacity to organize our movement patterns through time and space.

Gilfoyle and Grady (1981) defined spatiotemporal adaptation as "the continuous ongoing state or act of adjusting those bodily processes required to function within a given space at a given time" (p. 48). Many of the children occupational therapists evaluate from a sensory integrative frame of reference are "out of sync" with the spatiotemporal aspects of their environments. They often lack the internal sense of timing that is necessary to regulate sleep and their physical and social interactions with the world. In addition, they often have difficulty with visuospatial and constructional praxis skills that are highly dependent on accurate perception of temporal and spatial cues. It is possible that if the Interactive Metronome is used as a technique along with sensory integration, there may be an improved ability to benefit more fully or to achieve further gains from the sensory integration approach. For children who are old enough to follow the Interactive Metronome training directions (usually 5–6 years of age), the program currently appears to be a useful adjunct to the sensory integration approach. As with sensory integration interactions, however, Interactive Metronome training often requires skillful coaching to master the tasks.

Central Role of Timing and Rhythmicity

The underlying theory of the Interactive Metronome is that motor planning processes of organizing and sequencing are based on an internal sense of rhythmicity. Rhythm acts like the string bass of an orchestra; it provides the foundation of timing upon which the conductor can then organize and sequence the individual instruments that make up the piece of music. A child may have developed some ability to organize and sequence, yet if his or her internal sense of time is highly inaccurate, no foundation exists from which to organize and sequence. Sequencing alone is not enough; it must be done within the context of correct timing. A dancer may perform all the steps perfectly, yet if the dance is not to the beat, the piece is disjointed.

Inaccuracy in timing is increasingly being implicated as a major factor in cognitive processing disorders (Harnadek & Rourke, 1994). In studies of children with and without language disabilities (Merzenich et al., 1996; Tallal & Piercy, 1973), findings revealed that both groups were able to discriminate and sequence tones. The group with disabilities, however, required hundreds of milliseconds, whereas the group without disabilities only required tens of milliseconds. It was postulated from this research that differences in processing rates were affecting the brain's ability to organize and categorize the building blocks of language.

With the advent of high-speed computers and the development of the Interactive Metronome, we are able to measure our clients' response speed. Using the Interactive Metronome, we can measure how accurately clients can perform a movement, such as clapping their hands to a rhythmically presented tone. Response time for clients with disabilities is typically in the hundreds of milliseconds. Through training sessions with the Interactive Metronome, however, the response time can be reduced to the tens of milliseconds. The ultimate question is whether our clients are merely learning to play one computer "game" more efficiently or whether they are actually enhancing the praxis processes of organization, sequencing, and execution. Shaffer et al.'s (2001) findings suggest that boys with attention deficit hyperactivity disorder experienced gains from their Interactive Metronome training sessions that extended to areas of performance that depend on praxis. Clinical case explorations, as well as additional research, are needed to confirm these results.

Clinical Case Illustration

Kyle, a 9-year-old boy, was diagnosed with a nonverbal learning disability. He was referred to occupational therapy to assess and treat suspected sensory integration difficulties. Kyle was having difficulty attending in a noisy environment and in coordinating motor-related skills, especially fine motor and visual-motor tasks. At home, his sleep patterns and activity level were out of sync with the rhythms of his family. He had difficulties making friends due to his lack of awareness of the timing of social interaction. Phonemic awareness, reading, and math skills were difficult for him. Kyle often needed to use his fingers to complete math computations, causing his completion of math assignments to be slow and laborious.

Because of his challenges, Kyle was thought to be an appropriate candidate for the Interactive Metronome, but the training was initially frustrating for him. The guide sounds confused him, and he was unclear about which sounds to tune in and which to tune out. Tears and refusals were common. Creativity was needed to find a way to motivate Kyle. He became a "coach," and the motor exercises were the "signals" to his "team." Clarity and precision in the "signals" was needed in order for his team to win. After just three sessions using this intrinsically motivating approach, progress was noted in his attention, use of pragmatic language, and motor skills.

Over time, Kyle showed many signs of improvement that his therapist attributed to the Interactive Metronome program because he was not receiving any other new services in addition to ongoing school-based occupational therapy. Kyle's mother reported an increase in his ability to focus from 20 minutes to a remarkable 5 hours on a computer task. Math was becoming easier for Kyle, and changes in his conversational abilities were also noted. Kyle became better able to remain focused on a topic and to take appropriate "social" turns within a conversation. Word retrieval skills were advancing as well. Finally, Kyle's ball-handling skills were noted to improve. He began to throw with rotation at his shoulder rather than flinging the ball.

Extending Clinical Applications

As the authors of this article explore the use of Interactive Metronome technology in our own practices, we are beginning to think of expanded applications. One of the authors has had excellent success within her sensory integration intervention when she uses goal-directed activities developed to specifically tap a combination of oculomotor, auditory, vestibular, and cervical components involving dynamic, integrated performance strategies. This therapist has found that coupling this combination of components with activities that elicit rotation–counterrotation of the shoulder girdle and pelvis around the central core of the body during movements of the extremities has further enhanced the effectiveness of her therapy. She reports observing excellent improvements in total body coordination and integration as well as in reading, writing, spelling, and communication. She would like to suggest that Cassily and colleagues consider some possible modifications in the Interactive Metronome activities to incorporate some of these integrated strategies.

Currently, all of the 13 Interactive Metronome patterns are done without rotation or crossing of the body midline. One simple example of adding a rotational component is to use the foot plate as a hand plate and require the client to sequentially touch specific stickers located in a particular pattern, visually guiding reach across the midline of the body with each hand and with the eyes. This pattern can also be done with the feet. Additional trunk rotation can be elicited by having the client touch the designated spots on the hand plate with the elbows rather than the fingers. Such activities help to refine neurodevelopmental and sensory integration patterns, which frequently are addressed in other ways in therapy before the commencement of the Interactive Metronome program. In short, we anticipate that the exercises used with the Interactive Metronome can be elaborated to further enhance the observed results.

Conclusion

From a clinical perspective, Interactive Metronome training provides a promising new tool that may be helpful in improving timing and rhythmicity related to praxis;

improved timing and rhythmicity may serve as a foundation for improvements in complex problem-solving behavior in school, at home, and in social relationships. Both continuing clinical experience and systematic studies, such as Shaffer et al.'s (2001), will make it possible to explore the Interactive Metronome's potential usefulness across the age span with a wide range of clinical conditions that share the common feature of difficulties in timing, rhythmicity, and motor planning and sequencing. ▲

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