Interactive Metronome®

Material

for the field of

Speech Language Pathology

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I. "Improving Motor Planning and Sequencing to Improve Outcomes in Speech and Language Therapy"

article by LorRainne Jones, M.A.,CCC-SLP, Ph.D.

Upon learning about the Interactive Metronome® (IM) technology in the fall of 1999, I became extremely excited about trying this recently available intervention with my clients. At our Tampa, Florida based pediatric therapy practice, Kid Pro Therapy Services; we provide speech, occupational and physical therapy to children with a variety of disabilities including ASD, Down syndrome, language delay, dyspraxia, motor coordination disorders, ADD, ADHD, cerebral palsy, and other neurological disorders. Intuition had me interested in the IM as a way of improving motor planning and sequencing in clients with a wide range of problems.

At Kid Pro Therapy we routinely address the sensorimotor processing and motor planning deficits of children referred to the practice. Taking it a step further, seven years ago we joined with the owner of a local gym to offer a language and sensorimotor based therapeutic gymnastics program for children with more severe challenges, particularly focusing on children with autism. Through the therapeutic gymnastics program we saw gains in a matter of weeks that months or years of more traditional treatment could not achieve.

It has always been clear to me that motor planning and sequencing play a significant role in the acquisition of speech, language, and communication skills. In my book *For Parents and Professionals: Expressive Language Delay*, published by Linguisystems, I encourage clinicians to look at a child's motor planning and sequencing development when doing an overall assessment. I thought that the IM might be a useful tool to add to the therapeutic "tool chest" by offering an objective means to identify and measure, as well as, serving as a systematic training environment for motor planning and sequencing difficulties.

The IM is an innovative technology that creates an opportunity to directly exercise rhythmicity and sequencing of motor patterns and actions. The IM employs a special sound guidance system to systematically guide the user through the learning process during a variety of types of planning and sequencing actions. The IM training format provides a structured, graduated and goal oriented training process, which typically can be completed over a three to five week period.

In a clinical study published in the March volume of the *American Journal of Occupational Therapy*, the IM trained group was compared with a control group receiving no intervention, and a second control group receiving a placebo computer based intervention. The IM trained group showed statistically significant improvements over both control groups in areas of attention, motor control, language processing, reading and the ability to regulate their aggression.

Temporal processing and its relationship to language skills is an area that neuroscientists have researched for some time. In studies of children with and without language disabilities, researchers found that both groups were able to discriminate and sequence tones (Merzennich et al., 1996; Tallal & Piercy, 1973). The disabled group required hundreds of milliseconds, while the non-disabled group only required tens of milliseconds. From these findings the researchers postulated the difference in sound processing rates affected the brain's ability to organize and categorize the building blocks of language.

The field of speech pathology recognizes the role of motor planning and sequencing in speech production and intelligibility. Children with apraxia of speech often have difficulty sequencing and coordinating movement to produce intelligible speech. Greenspan (1993) and Greenspan and Weider (1998), suggest that motor planning and sequencing play a significant role in more than speech production. Greenspan contends that motor planning and sequencing play a role in language, social, and emotional development as well. Language flows from the actions and movements of play. Interaction and engagement for infants and young children are filled with gesture, movement and facial expression, all of which require motor planning and sequencing. Emotional development and attachment evolve from the interactions between infants and their caregivers - interactions that consist of movement and gestures in addition to vocalizations and speech. At higher levels, Greenspan asserts planning and sequencing capacities may influence the development of verbal reasoning and problem solving. Children problem solve by developing a plan and implement it by piecing together steps and motions. Difficulties in planning and sequencing may lead to deficits in reasoning and problems solving skills.

An illustration of the IM's clinical application can be viewed by the case study of a 12-year-old girl with a diagnosis of CAPD and ASD. This patient presented with sensory defensiveness, poor attention span, high distractibility, abnormal prosody, and poor sequential thinking. Following IM training, a decrease in sensory defensiveness was noted. Attention span increased and prosody of speech improved resulting in a more natural sounding voice. Post IM training, standardized assessment of language and motor skills showed as much as a two-year gain in some areas.

Other case reports include results such as improved conversation skills, improved intelligibility, and improved fluency for stuttering clients as well as more "thoughtful and introspective" conversation in some adolescents with attentional problems. Improvements in motor coordination is leading to improved performance in a variety of skill areas which in turn leads to reports of improvements in self esteem.

The research findings and anecdotal reports from children, their parents, and other IM practitioners from around the country, now over 500, provide direction for the comprehensive, systematic study of the relationship between motor planning and a variety of language and social capacities in children. I encourage researchers to systematically study how and why IM might impact motor speech disorders, apraxia, stuttering, auditory and linguistic processing, social skills, conversation skills, narrative skills and verbal reasoning and problem solving.

As for the clinical usefulness of the IM, as my intuition originally suggested, I have found the IM to be an extremely helpful intervention for motor planning and sequencing problems. It is helpful in the motor and sequencing aspects of language as well as attention and motor coordination. The IM is a true complement to the traditional therapy and innovation programs, like gymnastics therapy, we offer to clients. I strongly recommend that speech language pathologists take a closer look at motor planning and sequencing when assessing and treating communication disorders in children.

II. IM Case Reports

by Debbie Brassell, JD, MS, CCC-SLP and Deborah Friedman, OTR/L

Kathy's mother is thrilled with the excellent progress in developing self-help skills that her daughter has achieved. She is participating in community activities that previously she never was able to join. Kathy's mother credits her daughter's new abilities to her Interactive Metronome (IM) therapy at the Center for Rehabilitation and Development (CRD).

CRD has helped children and parents like these for more than 15 years. It operates rehab clinics in Roanoke, Blacksburg, Bedford and Lynchburg, VA. CRD's clinics are the first therapy centers in Southwest Virginia to offer IM.

CRD's sensitive therapists understand the importance of integrated sensory systems for normal development. Other sensory-based treatment modalities already were being offered at CRD's clinics when Aditi Silverstein, MA, CCC-SLP, Speech/Language Pathologist and President of CRD learned about IM. "I was particularly interested in IM because, like some of the other intensive modalities with which I work, such as Fast ForWord, IM can help to drive changes in the brain. The result is that clients can make excellent progress in short periods of time."

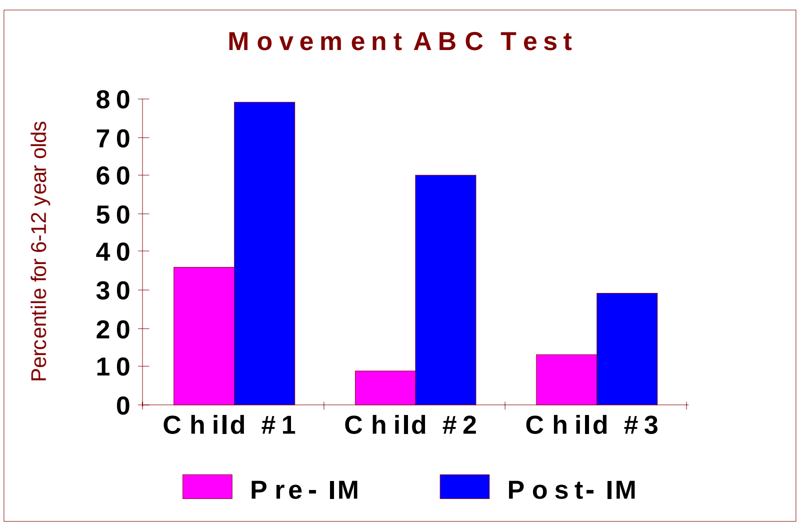
Interactive Metronome combines the principles of a traditional, musical metronome with the precision of a personal computer to create engaging interactive training exercises. Its patented auditory guidance system progressively challenges participants, to improve their motor planning, sequencing and timing, while providing support-like training wheels on a bicycle.

"IM Training can help children to improve their concentration and coordination as well as language skills and academic achievements," says Silverstein. A recent study showed that, following IM training, children with ADHD had better attention, motor planning, language processing, reading comprehension and control of aggression. These findings are consistent with recent research on the brain that indicates that environmental influences, not just genetics, contribute to a child's development. The results of this study about the efficacy of IM will be published in an upcoming edition of the American Occupational Therapy Journal.

At CRD, IM has been shown to be effective not only with clients who have ADHD, but also with children and adults with autism, cerebral palsy and problems involving motor control, coordination and learning and those with speech and language deficits.

IM has been fun and easy to incorporate into the clinical setting at CRD. Therapists complete 15 hours of IM training before beginning to use this modality with clients. "It has been really helpful to experience the training first hand. It gives me empathy for the challenges and successes my clients have as they do the IM exercises," says Deborah Friedman, OTR/L and IM therapist. During IM training, stereo headphones are worn to listen to special sounds that the IM computer software program generates. Motion-sensing triggers, connected to the computer via cables, relay information to the computer. One trigger is worn like a glove. The other trigger is placed on the floor. These triggers sense exactly when the hand or toe or heel taps the sensor. The IM program analyzes the accuracy of each tap as it happens and instantaneously creates a sound that is heard in the headphones. CRD's clients learn to focus all their attention on the steady metronome beat heard in their headphones, without being distracted by thoughts or stimuli around them.

Improvement after IM training can be seen in better standardized test scores. At CRD, most children are tested before and after IM treatment with the Movement ABC Test. Typical results are shown on the graph below.



Parent and client reports following IM training are another rewarding aspect of the treatment. "The changes sometimes appear subtle until we get the parents' feedback. They often notice significant differences in behavior and performance," notes Silverstein. One parent noticed that her child had improved after IM training when she saw that he could sit and listen to a story without fidgeting and flipping through all the pages of the book. Another mother gratefully reported that she and her son had stopped arguing. Someone else told us, "I was so surprised when I heard J. carrying on a conversation on the telephone. He never said more than 'hello' before IM". One young man diagnosed with Asperger's Syndrome said that he was able to look people in the eye after IM treatment. A client with spastic diplegia was delighted that her balance was better and she could stand still in line without fearing that she would fall on the person behind her. The Speech/Language Pathologists who work with children who have had IM training report increased sentence length and improved vocabulary usage, problem solving and abstract thinking skills for their clients.

For more information about Interactive Metronome, including background, reprints, training opportunities, and research, you may visit their web site at www.interactivemetronome.com. To learn more about The Center for Rehabilitation and Development, you may visit its web site at www.crdus.com or to find the clinic nearest you, contact our main offices at 2727 Electric Road, Suite 104, Roanoke, VA 24018, 540-989-3550. Article written by Debbie Brassell, JD, MS, CCC-SLP and Deborah Friedman, OTR/L.

III. Applications of Technology to Solutions for Communicative Disorders

by Lisa L. Nelson, M.A., CCC/SLP

The American Heritage Dictionary of the English Language (Houghton Mifflin Co. 1978) defines "technology" as "1.a. The application of science, especially to industrial or commercial objectives. b. The entire body of methods and materials used to achieve such objectives."

The word "technology" is derived from the Greek *tekhne,* which means "craft" or "art", and *logia,* which means "the study of". Thus, one interpretation of technology is the study of crafting, meaning the shaping of resources for a practical purpose. Technology encompasses not only material resources but nonmaterial resources, such as information, as well. One of the primary applications of technology is communication, and language provides the foundation for our species communication. Technology seems to provide ever-improving means for recording and distributing human language. Art, language and machines are all forms of technology, and all are a means for the continuation of evolution. Like most other evolutionary trends, the pace of technology has greatly accelerated over time.

Speech-language pathologists use a variety of methods and materials to achieve objectives in service delivery. Scientific method drives decision making involving assessment and intervention techniques. Many practitioners report feeling "lost in the knowledge explosion", particularly where "high technology" is involved. More experienced practioners may have started professional training at a time when "low technology" was standard practice. Some practitioners even had professors who insisted that one needed as tools only one's mind, a pencil and a pad of paper to achieve any therapy goal. How difficult it was to do many therapy tasks armed with only these instruments!

As the body of knowledge from science grows, and as technological options for diagnosis and treatment expand at an alarming rate, "keeping up" with innovations seems almost a full time job in itself. Do you recall having to use a computer in your work as an initially frightening, frustrating and rather humbling experience? Can you now imagine doing your work without one? Even if you are still somewhat in awe of the constant innovations and the need to keep informed, we now have many more tools and resources to help - in the form of the world wide web and other information/resource sharing endeavors.

While the old "medical model" is slowly being replaced with more educational and habilitative models of practice, we have also recognized that "symptom management" must be replaced by treatment of underlying causes. When we work with children who have developmental dyspraxias, articulation problems, fluency disorders, we often get the notion that there is *something* which we are missing. When we work with adults who have apraxia, TBI, autistic spectrum disorders, we may get an inkling that there is *something below the level of the cerebral cortex* that we should be addressing. That *something* often involves looking at the neurobiological substrates of the behaviors we are attempting to modify or improve. We need to be able successfully evaluate and treat the substrates of some of the "higher order" communicative behaviors we are working with. There are cases in which those substrates involve the planning, sequencing and execution of motor activity. The timing, rhythmicity and motor skills that are underlying processes vital to cognitive, communicative and learning skills have often seemed "elusive" to precisely evaluate and treat.

IM provides a unique application of technology to evaluate and enhance services to those who have motor planning and sequencing difficulties.

IV. Motor Speech Disorders

by Lisa L. Nelson, M.A., CCC/SLP

The connection between mind-body is becoming clearer as research reveals more subtleties about the human central nervous system. We know that the brain is actually a system of systems. Neurons organize into networks, networks are integrated into structures and functional areas in the brain, and different regions and structures are able to work together as systems. The story of how these systems develop is vital for understanding how we learn and communicate. Our sensory-motor systems are central to the story. All that we know, learn, think and feel is mediated through the sensory-motor systems. The integrity of these systems shapes our experience, and our experiences, in turn, shape the sensory-motor systems.

Development of the brain is interdependent with development of the rest of the body. As we experience our external and internal worlds, that information gets built into neural networks. Sensory input from the environment (seeing, hearing, tasting, touching, smelling, moving) is a major component of our experiences. Neural networks grow out of our unique sensory experiences, and the richer our sensory environments, the greater our freedom to explore, the more intricate the networks become. Learning , thought, emotional well-being, creativity and communication arise from the sensory-motor bases we establish through experience.

As we encounter sensory experiences, sensations travel through the brain stem and the reticular activating system and pass through the thalamus of the limbic system. The sense of smell is the only sense that doesn't pass through the thalamus. The thalamus sends and receives information from the neocortex of the brain, which takes up only about a fourth of the total volume of the brain, but has about 85% of the total neurons in the brain. The neocortex is a central area for making connections. The thalamocortical system is a key to allowing us to create meaning from our experience.

Language and communication arise from integrating sensory-motor information, processing through neural networks that engage mind, body and emotions. The developmental process that supports language begins in utero, as the child moves from a sense of rhythm and vibration. Development of the motor cortex, responsible for muscular movement of the eyes and facial muscles, jaw, mouth, tongue and larynx, begins with these movements in utero. The motor cortex also connects with the thinking, reasoning areas of the frontal lobe of the brain. Development of speech and language skills is a highly complex process, and is subject to disruption at numerous levels.

Oral communication requires:

1. Organization of concepts and their symbolic formulation for expression.

2. Coordination of concurrent motor functions of respiration, phonation, resonance, articulation and prosody in speech.
3. Programming of these motor skills in the volitional production of speech sounds and sequencing these sounds into combinations that form words.

Disruptions in motor speech programming were described as early as 1861 by Broca. There have been a number of terms used to refer to impairments of this nature, including anarthria, motor aphasia, peripheral motor aphasia, apraxia, dysarthria, verbal aphasia, sensorimotor impairment, afferent motor aphasia and efferent motor aphasia. Despite the differences in nomenclature, observers were noting types of behavior that had certain characteristics in common.

Apraxia of speech results from disruption in brain functions needed for volitional programming and execution of articulatory movements. There is no impairment of any part of the speech-generating mechanism when applied to reflexive or automatic acts. Deficits arise when volitional speech movements are undertaken to produce given speech sounds. The major area of deficit is usually in articulation, with errors often characterized by unpredictability and variability. Substitutions, additions and repetitions are typical error patterns. Difficulty in producing speech often increases with increase of the length of the unit attempting to be produced. Prosodic disturbances may arise in compensation for the continuous articulatory difficulty. Speech articulation appears effortful and it often appears that the individual has "forgotten" where to place articulators to make speech sounds. Oral apraxia (difficulty with volitional performance of oral nonspeech and sequence tasks) may occur in conjunction with apraxia of speech. Reduced oral sensation and perception may also be noted in some individuals. Apraxia of speech may also co-occur with impairments in auditory retention and perception.

Dysarthria results from disturbances in muscular control, characterized by some degree of slowness, weakness, incoordination or altered muscle tone. Impaired innervation of speech musculature lies at the heart of this group of problems. There are a number of different classifications for dysarthrias, based on:

- age of onset (congenital, acquired)
- etiology (vascular, neoplastic, traumatic, inflammatory, toxic, metabolic, degenerative)
- area of neuroanatomic impairment (cerebral, cerebellar, brain stem, spinal; central vs. peripheral)
- cranial nerve involvement (V, VII, IX, X, XII)
- speech processes involved (respiration, phonation, resonance, articulation, prosody)
- disease entity (ALS, Parkinsons, myasthenia gravis, etc.)

The generation of purposeful behavior (attending, interacting, communicating, etc.) must be considered as the functional result of the integrity of the system as a whole. The purpose or idea behind the motor act must be retained until the act can be planned, programmed and performed, and while the end results are monitored to discover if the purpose has been accomplished. Failure to develop a proper concept or inability to retain the concept for a sufficient amount of time have been termed *ideational apraxia,* which may co-occur with other disorders.

In order to accomplish the purpose of a motor act, one must have a good somatosensory map (body scheme), awareness of spatial requirments of the act, and the temporal sequence required by various components of the act. The perceptual information associated with an act and the concepts that are appropriate to the performance are typically mediated by the posterior part of the left hemisphere of the brain. Lesions in this part of the brain can cause a condition which has been called *ideokinetic apraxia*, which results in a breakdown of the planning process, interfering with the translation of the idea into plans for purposeful performance.

IM provides a unique application of technology to evaluate and enhance services to those who have motor planning and sequencing difficulties contributing to speech-language disorders.

V. SLP Scope of Practice & Sensory-Motor Intervention

by Lisa L. Nelson, M.A., CCC/SLP

The revised SLP Scope of Practice will be voted on at the LC meeting, March 31-April 1. Review resolution LC 7-2001 at http://professional.asha.org/ if you have not already done so. Basically, the World Health Organization (WHO) 2000 Framework has been adopted to provide a "...common language for discussing and describing human functioning and disability" (WHO, 2000). A continuum of function is used to express each component of the framework.

Body functions and structures, activity and participation are assessed on a continuum and related to contextual factors (environmental and personal). For example, body structures and functions can range from normal variation to complete impairment, activity can range from no activity limitation to complete activity limitation, and participation can range from no participation restriction to complete participation restriction. Contextual factors can interact with body functions and structures, serving as either barriers or faciltators to functioning. Speech-language pathologists work to improve quality of life in all components and factors identified in the WHO framework. We seek to reduce impairments of body functions and structures, reduce activity limitations and participation restrictions, and minimize environmental barriers to the people we serve.

The first item on the scope of practice list for speech-language pathology involves "providing prevention, screening, consultation, assessment and diagnosis, treatment, intervention, management, counseling and follow-up services for disorders of: speech (i.e., articulation, fluency, resonance and voice including aeromechanical components of respiration); language; language processing; cognitive aspects of communication (e.g., attention, memory, problem solving, executive functions); sensory awareness related to communication, swallowing, or other upper aerodigestive functions" (p.7, LC 7-2001 document, ASHA). It would seem clearly within our scope of practice to use procedures, products and programs that assist in this process.

ASHA has additional information on "How to Evaluate Procedures, Products or Programs" (see http://professional.asha.org/information/evaluation.htm).
This document outlines considerations that may assist in the decision making process before using a treatment procedure, purchasing a product, or attending an educational program. These are good questions to ask yourself when evaluating any assessment or treatment procedure (whether "hi-tech" or "low-tech").

With agencies and entities that provide reimbursement for costs associated with provision of diagnostic and treatment procedures moving toward ever more stringent requirements for documentation of impairment and response to course of treatment, it behooves us as practitioners to look at tools we can use that provide legitimate numbers. We all know that numbers (going up or going down, depending on desired outcome) are often key to successful reimbursement. Numbers can come from standardized assessment batteries, and from acoustic or physiologic instrumentation used for assessment. The problem we often encounter is that perceptual tools (such as the eyes, ears and touch of a skilled SLP) often don't have "numbers" associated with them. We may use our clinical skills to assess the distinguishing speech characteristics of a motor speech disorder (such as a hypokinetic dysarthria associated with Parkinson's disease) but these evaluative judgements are often viewed as "subjective". We might be able to say that alternating motion rates (AMR's) are rapid and blurred, but we often can't attach a number to define the degree of variance. No score will tell us if a patient is apraxic or dysarthric - these are diagnoses based on behavioral observations. Progress in treatment is also often measured behaviorally, which can make reimbursement a more difficult issue.

Motor planning and sequencing are vital to many processes, including attention, engagement, purposeful actions, complex problem-solving, ideational formation and thinking/reasoning skills (Greenspan, 2000).

Speech-language pathologists often work with individuals who have impairments in motor planning and impaired motor capabilities. Many of the treatment procedures we use are designed to teach individuals *how to learn to move* (control and quality of movements, ease and effectiveness of movements) and *how to move to learn* (using movement as a means to an end, to help the individual gain better understanding of himself and his environment). As perceptual-motor theorist Raymond Barsch wrote back in 1967 "Man moves. Man learns. He learns to move. He moves to learn."

IM provides a unique application of technology to enhance services to those who have motor planning and sequencing impairments contributing to speech-language limitations.

VI. Documenting Sensory and Motor Progress

by Lisa L. Nelson, M.A., CCC/SLP

When working with motor speech disorders, the *quantification* of progress has often seemed difficult to capture. We may use perceptual features to indicate progress: increases in ease of articulatory movement, improved vocal quality, improved prosody, increased alternating movement rates (AMR's), increased sequential movement rates (SMR's). We also use observational data to provide information on "attention to task" or "auditory attention." These can be difficult to *quantify,* however, as are the changes in these skills. We can measure pre- and post-treatment speech intelligibility, quantify types of articulatory errors and frequency of errors, and use structured tasks (such as reading passages or conversational speech) to gain error rates. What we might have trouble with is gauging a client's response to a treatment procedure, and knowing with any certainty and immediacy if the exercises or methods are producing positive results. One of the advantages of IM is that it gives you a number of quantifiable measures that indicate progress. Pre- and post- testing (Long Form Test Battery Scores)are completed before starting, at the half-way point and after completing IM therapy, and Short Form scores are used at the beginning of each session. Average response times also give you an indication of each client's progress and "personal best" - and these measures are indicated both during the performance of tasks and summarized following task completion. This ability to have immediate, accurate feedback about performance and efficacy are unique in my experience of therapeutic tools.

Quantifiable change is critical when dealing with third party payers, and when faced with accountability and cost containment measures. It is always nice to have patient reports that "I believe my communication improved because of the SLP services", but we often need something a bit more *precise* to satisfy reporting requirements. There is a need for continued development of tools that can help our profession satisfy these requirements. IM is one tool that we have available, and ongoing research efforts are being conducted to identify measures of therapeutic effectiveness for a variety of presenting problems.

More emphasis is being placed on treatment outcomes and efficiency/effectiveness of treatment modalities. This is reflected by the establishment of a national outcomes database for speech-language pathologists and audiologists by The National Center for Treatment Effectiveness in Communication Disorders . Data collection efforts are underway for a number of populations, including pre-school age children, K-6 school aged students and adults in health care settings. The key to this system is use of a seven-point Functional Communication Measures (FCMs) system, scored by a certified professional upon admission and discharge of a client. For instance, functional progress in adults is measured in areas such as memory, comprehension, expression, swallowing and motor speech. The idea is to use outcome-based measures to supplement documentation of progress through standardized tests. Most therapists have had the experience where a client improves on pre/post test measurements using standardized assessments, but has made limited functional gain in day-to-day activities, or vice versa. The use of functional objectives and outcome measures helps solve this problem. As the national database grows, numerous questions about speech-language pathology services could be answered. Right now, we use peer-reviewed published journal articles, professional experience of ourselves and peers, information from policy/procedure manuals and trial and error to answer many of these questions. Entrance and dismissal criteria, expectations for progress, expected duration of therapy, optimal frequency of therapy, most efficient methods of therapy given specific diagnostic criteria - all of these questions are ones that we deal with on a daily basis. Use of assessment and treatment tools that provide built-in databases to work with are a step in the right direction in helping therapists cope with demands for documentation of services.

IM is a clinical education tool that provides a focused and systematic way to exercise underlying motor planning and sequencing capacities within the brain. IM uses relatively simple physical motion exercises to help a trainee
(a) learn smooth, continuous control of each of the IM exercise motions,
(b) learn to consciously recognize and correct timing errors and inefficient movement habits,
(c) learn to achieve and maintain focus on the metronome beat sound.
The movements are "outward, physical" habits used as a catalyst to help a trainee directly exercise and improve "inward" mental functions.

VII. Motoric & Rhythmic Bases of Communication

by Lisa L. Nelson, M.A., CCC/SLP

Many processes influence motor planning, and in turn motor planning interacts with other factors to influence important learning, cognitive and social skills. How well we function in different contexts is influenced by environmental factors, learning opportunities, and the integrity of underlying central nervous system mechanisms. Today we'll look at various aspects of communication that are influenced by rhythmicity and motor regulation, starting with attention.

Rhythm is a factor that must be considered in *all* sensorimotor assessments. Rhythm provides a temporal component to sense thinking and to somatosensory constructs (mental body map). Rhythm involves a sense of internal timing coordinated with an auditory, visual, tactile, kinesthetic and proprioceptive component. In order to make skilled, directed movements one has to have an internal directional focus - an internal reference for three-dimensional space. We have to be able to coordinate and integrate sense information from all sections of the body, and develop mental schemes for directing movements. By age six, a child should be developing these internal references for movement, and will gain the foundation needed for right-left concepts necessary for literacy learning in our culture. Many kids who have reversal problems have not appropriately developed internal and external visual-spatial skills.

Rhythm and timing are involved in a number of skills critical to communication: attention, eye contact (knowing *when* to look and *how long* to look, *where* to look), two-way purposeful interactions, gestural communication, imitation skills, creating ideas (imaginative play, realistic play, symbolic play sequences, responding to others, prediction of how others will feel or act in given situations), articulation, syntax, auditory processing, problem-solving skills, graphomotor skills.

Attention and memory are critical for successful functioning in even the most basic aspects of everyday living. The term *attention* has been used in the literature to refer to a broad array of states, processes and abilities. Aspects of attentive behavior include very basic processes, like the normal sleep/wake cycles, and higher levels of attention such as integrity of orienting responses to novel stimuli. Duration or maintenance of attention over time (vigilance), speed of information processing, speed of responding and problems of working memory have all been related to attentional capacity and control. Distractibility, inability to inhibit responses to irrelevant information, and tendency to over-process redundant stimuli are also considered as attentional problems ("inattentive behaviors"). Problems with higher-level attentional control include difficulties with set shifting (cognitive and behavioral flexibility) and with "multi-tasking" (dual task processing or divided attention). We have developed both externally focused interventions (modifying the environment by minimizing distractions, organizing workspace, providing visual cues like checklists) and internally focused interventions (restorative and compensatory approaches) for helping alleviate attentional deficits. We have used behavioral approaches for increasing attentive behaviors and direct retraining approaches (repeated opportunities to practice and exercise a variety of attention-dependent skills or processes).

The type of intervention you choose will be related to the cognitive theories of attention you utilize as a working model. Most models of attention define it as a multidimensional cognitive capacity that directly affects ALL dimensions of cognition - new learning, memory, perception, communication and problem solving. There are hierarchical levels of attention that include focused attention, sustained attention, selective attention, alternating attention, and divided attention (Sohlberg & Mateer. 1989. Introduction to cognitive rehabilitation: theory and practice. New York: Guilford Press.)

The article recently published by Shaffer, Jacokes, Cassily, Greenspan, Tuchman and Stemmer in AJOT (Vol. 55, Number 2, p. 155-162) suggests that IM can be used as a tool to improve attention, motor and perceptual-motor functioning in children with major attentional problems. Use of IM as a complement to existing interventions for this population should continue to yield data from which we can work with even greater confidence.