



The Power of Music

The use of music protocols to enhance neurological function

By Martha Summa-Chadwick, DMA

When little Jimmy

Miller was brought home from the hospital after spending the first six weeks of his life there, his

newly adoptive parents were thrilled to have their beautiful baby boy home with them. But by the time Jimmy was three to four months old, his parents became painfully aware that he had some form of developmental delay, and they immediately began early intervention therapy, including regular speech and physical therapies. The doctors originally attributed the developmental problems to a cleft palate along with chronic ear infections, but as the years progressed and the problems were seemingly untouched by the traditional therapies, Jimmy was finally diagnosed with pervasive developmental disorder (PDD) and cerebral palsy when he was eight years old. He had acquired many of the characteristics associated with such a diagnosis, including physical problems with unsteady gait, shaking in his hands and fingers, and a seeming inability for any kind of bi-lateral coordination. In addition, the typical distinctions in cognition associated with autism, such as a lack of attention control and executive functioning problems, were characteristic in Jimmy.

At nine years of age, he had been both a willing and unwilling participant in multiple traditional and alternative therapies over the span of his young life; it was at this point that Jimmy started working with a facilitator

utilizing newly developed therapeutic techniques based on the tangible structure of music influencing the redirection of neural pathways. The neuro music protocols were developed at Colorado State University's Center for Biomedical Research in Music; they are utilized for motor, speech/language, and cognition therapeutic entrainment. Jimmy's program was uniquely designed for his needs and included protocols to assist in both gross and fine motor skills, bilateral coordination skills, attention control, and executive functioning. He participated in therapeutic sessions three times per week for a total of ten weeks time and made tremendous progress in the areas of both motor and cognitive improvement. At the end of the ten weeks, both his facilitator and his parents were delighted at the progress he'd made. "He achieved more in ten weeks with the neuro music protocols than in almost ten years of physical and occupational therapy," said Jimmy's mother. Prior to receiving the therapy he'd been unable to move his body in any kind of rhythmic or coordinated fashion, whereas he could now "march like a soldier," as he referred to it.

Perception of Music in the Brain

Discoveries, reached through scientific and technological advances in the evidence-based empirical domain, about how the body physiologically responds to music have opened new possibilities for developing therapeutic archetypes to actively channel specific aspects of music to assist in the

learning processes of children with special needs. The resulting protocols actively engage the brain by using rhythmic entrainment and can have positive outcomes when actively treating issues related to motor, speech/language, and cognition. Rhythm is structured and predictable as well as time-ordered, so the brain responds with predictable entrainment patterns. Music is first perceived as structure in the brain, with the perception of pitch, harmony, rhythm, melodic contour, intervals, dynamic, etc. The act of listening to a piece of music awakens auditory and emotional response areas and, in addition, creates a motor response. Of particular interest in recent research are the findings that the response to the temporal environment is directed not as much to the actual beat itself as it is to the span of time in between each beat's occurrence. This indicates that the motor movement and synchronization of the body is not just occurring at the time of the actual beat, but during the entire duration of the timing pattern.

Music and the temporal structure can evoke consistent response in the body and can therefore be used to intentionally direct therapeutic changes. Due to major advances in technology, neuroscientists have become aware of a condition in the brain referred to as "plasticity," which indicates that changes can occur in the structure of the brain based on the experience and training of each individual. Any process of learning or thinking can assist with brain plasticity.



Martha and Jimmy work with bilateral arm motion as part of his neuro music therapy.

Below, right: Jimmy enhancing his fine motor skills on the piano.

Music and the Neurological Process

The following techniques and protocols utilized in Jimmy's therapy sessions are described as rhythmic entrainment for therapeutic purposes and were developed and researched at the Center for Biomedical Research (CBRM) at Colorado State University; they are defined as techniques which utilize the therapeutic application of music to cognitive, sensory, and motor dysfunction due to neurological disorder or disease. All protocols are based on a neuroscience model of music perception and the influence of music on functional changes in nonmusical brain and behavior functions.

The first motor protocol utilized in Jimmy's therapy is defined as therapeutic instrument music performance and involves the use of musical instruments to assist with simulating motor patterns. Playing instruments utilizes either gross or fine motor skills and generally requires some form of repetitive muscular action. Percussion instruments are particularly suited for this kind of protocol, although other instruments such as strings or keyboard can be

used to target specific muscular areas as well.

To illustrate, Jimmy's symptoms of cerebral palsy resulted in tremors and spasticity of the hands with a therapeutic goal of strengthening fine motor movement of the fingers. A program was established to work with a keyboard and thus strengthen the individual fingers of each hand. This also assisted in arm control for larger motor movements. Additionally, Jimmy worked towards improving gross motor skills for the whole arm in an exercise utilizing percussion instruments to assist with muscle building and coordination. The end result was the further development of muscle strength and speed of motor response as well as range of motion and more dexterity in physically reaching for different patterns of vertical or horizontal alignment. Using musical instruments in a therapeutic environment has an additional desirable element; it is usually considered fun to play an instrument, and it is not perceived as a chore. By utilizing this technique, an individual can learn or re-learn functional movement skills and increase strength and

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endurance.

The second motor technique utilized in Jimmy's program is defined as gait training. Gait is a biologically rhythmic function that can be affected by many forms of neurological trauma including Parkinson's disease, autism, late stage dementia, stroke, traumatic brain injury (TBI), and many other medical issues. Rhythm functions as an external means to assist the individual in keeping time to a beat; motor functions in gait are entrained or retrained through the cuing of movement patterns. An example of gait training is found in working with an individual in stroke rehabilitation who has lost partial movement on one side of their body. After determining the initial cadence (it will most likely occur at a slow walking pace at this point), a beat is set with either live music or metronome that matches their cadence. The individual will then attempt to walk in time to that beat. Eventually the cadence can be gradually increased so that the client will keep in tempo with the increased tempo. This results in retraining body movements to keep pace at a cadence that is faster than previously accessible.

The next variety of neurological music protocols in Jimmy's therapeutic use is in the field of cognitive rehabilitation. It should be noted that musical perception is experienced on many levels, and the individual receiving the therapy does not need to be highly trained and experienced in music to benefit from the protocols. Cognition techniques engage many areas of the brain; an especially complex neural network provides the potential to reorganize neural activities due to brain plasticity.

Executive functioning training is a primary protocol to consider when using the cognition techniques, since most of the techniques require a client to already have the abilities associated with this skill. Training in executive functioning involves the creation of musical exercises that help practice skills involved with decision-making, comprehension, organization, problem solving, etc. An illustration can be found in working with a child with autism who has some musical background in the way of singing songs and playing instruments but has trouble making decisions. The child can be instructed to

"compose" a song which will require him/her to make decisions on how long the song will be, what form it will take, what instruments will accompany, will there be words, should it be fast or slow, and so forth. These decisions help affect both the creative processes as well as assisting with the creation of neural processes for executive functioning.

Auditory perception protocols integrate sensory stimuli within the auditory system; training takes the form of discrimination of musical components that include the structural elements of pitch, tempo, timbre, and rhythmic patterns. It can also include the tactile or visual systems with such activities as feeling the reverberation of sound while playing a drum or observing and moving to a form of dance with the music.

Attention control is an important protocol for cognition and is appropriate for adults with dementia, children with autism, clients in stroke rehabilitation, and so forth. Any genre of individuals with problems in attention focus can benefit from this protocol. Attention control is divided into the following categories:

- **Focused attention:** the ability to respond specifically and completely to a single stimulus
- **Sustained attention:** the ability to maintain a focus on a stimulus during continuous activity
- **Selective attention:** the ability to maintain an attentive response to a specific stimulus when there is another stimulus competing for the attention
- **Alternating attention:** the ability to shift attention between alternating tasks
- **Divided attention:** the ability to simultaneously respond with multiple tasks present

While music helps facilitate all of these categories of attention control, the simplest to facilitate is focused attention. Generally, the playing of a musical instrument will focus the attention of an individual. Young clients with severe autism who pay no attention to verbal cues will tend to visually focus on a facilitator playing an instrument in front of them. An added advantage of this protocol is that it can readily be used in a group situation, which provides added social benefits for various individuals trying different instruments.

Sustained attention is exemplified by creat-

ing a musical task in which a client focuses on the immediate task for an extensive period of time. An example is demonstrated in a game in which inattentive children diagnosed with autism are given two different rhythmic instruments and allowed to choose two simple songs they wish to hear. The songs are each associated with one of the instruments, and the children are told to play one of the rhythmic instruments when they hear one song (either sung or played on an instrument) and then the other rhythmic instrument when the song changes. In this way, they are focusing sustained attention on the musical task and building the neural networks to focus sustained attention on other generic tasks.

Selective attention is developed when the musical task created has competing attention from an additional stimulus. Using the above example with sustained attention, an additional step to move from sustained to selective attention levels could involve the addition of a "heckler" to try to disrupt the attention of the child listening to the two songs and associating them with the correct instruments. The heckler is typically given some kind of loud percussive instrument, which is hard to ignore, and attempts to disrupt the attention of the child focused on the original task of listening to the two songs.

Alternating attention develops as an individual deliberately shifts his/her attention focus from one task to another. This is easily accomplished as a musical task with two facilitators who each sequentially play a different rhythmic pattern on some kind of percussion instrument. Assuming the client to be the same as described above, he/she will now be given a rhythmic instrument and asked to follow and imitate the rhythmic pattern given by the first facilitator. Once that pattern is established, the first facilitator will stop, and the second facilitator will immediately start playing with a different rhythmic pattern, which the child will be asked to imitate immediately. The two facilitators pass back and forth and as the child follows first one and then the other; this works with alternating attention skills.

Divided attention is perhaps the most complex of the attention control protocols based on the abilities of a particular client. The difference between divided and alternate attention

lies in the client's stimulus. In the first, the client is given two different rhythmic instruments and allowed to choose two simple songs they wish to hear. The songs are each associated with one of the instruments, and the children are told to play one of the rhythmic instruments when they hear one song (either sung or played on an instrument) and then the other rhythmic instrument when the song changes. In this way, they are focusing sustained attention on the musical task and building the neural networks to focus sustained attention on other generic tasks.

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Application

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lies in the client's ability to focus on two different stimuli simultaneously as opposed to two different stimuli sequentially. An example is as follows: Given the clinical situation previously described with two facilitators carrying out two different tasks, in this circumstance the first facilitator will continuously play a percussive instrument, and the client will be asked to imitate. The facilitator will, however, keep changing rhythmic patterns, and the client will follow and imitate as the patterns change. The second facilitator will set up signals for the client to start playing or stop playing. Anytime the clients are playing their instruments, they are following the rhythmic pattern of the first facilitator, but the second facilitator could ask them to start or stop at any given time. In this way, the children must maintain focus on both facilitators simultaneously and develop the ability for divided attention.

A most useful protocol lies in the creation of musical mnemonics, when working with memory. The structure provides a perfect vehicle to help "chunk" words or phrases together; that structure can then be used to recall the information and assist in the process of learning. When dealing with neural memory issues, the combination of both melody and rhythm is more powerful than the use of rhythm by itself. Rote memorization is greatly assisted by the hierarchical organization found in melody and rhythmic material due to the structure provided by the music.

Application of Music Prototypes

The individual elements for utilizing neurological music protocols for Jimmy's therapy session have all been defined; illustrations will now be made for setting up an effective overall program for use with him. Jimmy's symptoms include a tremor in his hands and an unsteady gait, with no bilateral coordination. His speech is clear, and he enjoys singing, but he is limited in his physical activities due to his unsteady gait and shaky hands. He has cognition problems with comprehension and decision-making and also seems unwilling to focus on a task for any length of time. He follows instructions with tasks he enjoys but tends to withdraw if he doesn't wish to engage in a situation.

Interventions for Jimmy include motor and cognition activities. Motor goals include gross

motor skills in gait and coordination and fine motor skills with hands. Initial cognitive goals incorporate attention focus and decision making with plans to increase criteria levels throughout the duration of treatment.

Ten Week Program

1) Auditory perception—Jimmy enjoys

singing so this protocol has double significance for him. Used as a warm-up, it opens the auditory system as the pathway to entrainment of the neural network. Secondly, since he enjoys music, there is potential for him to learn discrimination of pitches such as high vs. low, loud and soft,

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and major and minor. Following a warm-up of walking and playing drums in time with the music, he will be asked to differentiate between instrument timbres and various pitches in order to train his discernment for musical tones.

2) Therapeutic instrument performance—Utilized to help develop gross muscle development in legs and hips. Gait issues are due to a lack of coordination and also to a lack of strength in the legs and hips. In order to help strengthen the leg muscles, the facilitator first positions two drums for playing where 1) one is placed high requiring a reach and 2) the other is placed low requiring a deep body squat. Jimmy moves back and forth between high and low with squats and stretches; he is now strengthening leg and arm muscles as he pats each drum with both hands. Following this, the facilitator places the drums on each side of the child far enough apart to require the child to move from side-to-side to strike the drums, one with each hand. This involves training a different set of muscles in the hips that are required for coordinated gait.

3) Gait training—Begins with just walking in rhythm and then rhythm is used to add various modifications to the walk, such as stepping high, sliding, and walking backwards. Once walking on the beat is established and the rest of the variations are completed, drums are added. Two drums are placed in front of Jimmy so that he can walk in place and strike the drum with the hand that is opposite to the leg that is stepping. This facilitates bilateral coordination, much like how in a normal gait a normal arm swing pattern is employed during walking.

4) Therapeutic instrument performance—Utilized to assist with fine motor skills in the fingers and hands. The facilitator has Jimmy repetitively play two sequential notes on a keyboard, i.e. C, D, C, D, C, D. Additional fingers are added one at a time until eventually all five fingers are playing five sequential notes. Jimmy can then play a song using those five notes with either the facilitator pointing to each note individually or by the creation of a color-coded system with tabs on the keys; he does not need to know how to read music in order to play a song in this fashion.

5) Executive functioning—In order to train

Jimmy to effectively make decisions, the facilitator will create a musical game where the child will be asked to "organize" the game rules. For example, the game may simply be to play instruments associated with a particular song. The facilitator will have him choose the song, choose the instrument that both of them will play, determine how long (how many verses) the song will be, associate any desired body movement or dance to the song, and so forth. This encourages Jimmy to make the decisions and be comfortable not only in the decision process itself but also in the outcome of his decision-making.

6) Attention control—Jimmy has very little ability to focus on a given task, so the facilitator will initiate the attention control process with a game that encourages sustained attention. Three to four instruments, generally rhythmic in nature, are placed directly in front of him and each instrument is assigned for playing during a particular song of the child's choosing. When one of the songs is played, Jimmy plays along on the instrument assigned to the song, and when the song changes he shifts his playing to the new instrument to which it is associated. Once he is able to focus attention for a sustained period, then more complex attention controls can be initiated for selective, alternating, and divided attention.

An additional consideration when utilizing music for therapeutic purposes is that each individual has his or her own personal taste in music. Some children may want to improvise and create their own non-verbal sing-song music; others may want to only work with children's tunes they know, such as *Mary Had A Little Lamb*. Still others may prefer various styles of classical, jazz, or even rock or hip-hop. The music that the child prefers will have the greatest effect on the success of utilizing the neurological music therapy protocols.

Conclusion

The potential of music in medicine and the improvement of cognition processes has been both demonstrated and also intuited for centuries on differing levels; it is now, in the current age of technology, that the benefits of music have been proven to benefit populations of mankind through evidence-based

research. Through using music protocols that can energize the neural networks of the brain, an entire generation of children with special needs can potentially benefit from music in tested therapeutic environments. The field of cognitive neuroscience has proven that the structure of music is truly a gateway to the brain. That miraculous instrument has the capacity to rebuild itself with rhythmic entrainment; reaching these children with the use of neurological music protocols can help to organize their neural networks in a way that will encourage them to mainstream into environments with their typical peers. It should not be assumed that these techniques will "cure" neural afflictions such as autism, but they will provide a basis for those affected to live within bounds of inclusion rather than exclusion.

Neuroscientists, physicians, and professional therapists are becoming more aware of the benefits of these techniques. It is now time for parents and educators to realize the benefits, and deduce that the home and the classroom are potentially as effective an environment to work towards the deliberate rebuilding of neural networks as a clinical setting. A successful parent or pedagogue can utilize these techniques in many different ways to reach special needs children. While this population of children can certainly be challenging to work with, the end result of enhancing the life of a special needs child is truly a remarkable undertaking. The parent or educator is challenged to achieve continuously higher levels of creativity and artistry in the process of pursuing the intellectual quest of the contemplation of how music can serve to improve the life of a child. •

For a copy of this article with references, please make request to jhollingsworth@eparent.com.

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