Music and the Human Brain

By Maria Ramey

May 3, 2005

Music is much more than idle entertainment. It affects the brain in physical ways, altering pathways and stimulating certain areas to grow. Listening to music provides a temporary rise in cognitive IQ levels and learning it actually changes those levels on a more permanent basis. Professional musicians especially show marked differences in physical brain structure and cognitive thought processes.

In 1993, a study was done at the University of California, Irvine that showed a temporary improvement of IQ scores when students listened to ten minutes of a Mozart Sonata. The specific area of increased intelligence was spatial-temporal reasoning. This effect has since been dubbed "the Mozart effect" and has encouraged both further study and opposing views (Jones, "Introduction"). More recent and ongoing studies at the M.I.N.D. Institute have shown dramatic math and cognitive enhancements provided by simultaneous musical instruction. The institute implements a side-by-side program of cognition based math games with specialized piano instruction. Students are tested using nationally standardized tests and score an average of 20 percent higher than students not utilizing this type of program. Scores continue to rise the longer the student has been in the program (M.I.N.D. Institute). Spatial-temporal reasoning is highly developed and the music training provides a basis for the students to recognize patterns and symmetry as well as to understand certain mathematical concepts from a musical angle (i.e. note values and the spacing of music measures).

The record industry has taken advantage of the media hype surrounding this information and put out numerous CD's purporting to enhance your child's brain. What they overlook, however, is the contrast between experiment results that show only a temporary enhancement when listening to music, while permanent cognitive enhancement occurs instead with learning how to play music. What the media should be pushing then is the need for musical instruction.

A skilled and trained musician actually has a larger brain with more enhanced neural pathways as compared to a non-musician. A professional musician's auditory cortex contains 130 percent more gray matter than that of non-musicians (Hotz, par. 5). This would suggest that exercise of the auditory area, as induced by the necessary rigorous and regular music practice for a professional musician, increases its growth. Musicians who began study early in life also appear to have an especially enhanced corpus callosum, or neural bridge, between the brain's hemispheres. In fact it is up to 15 percent larger. (Hotz. Par. 5). This phenomenon is further exemplified by the findings that musicians process music with both ears, and therefore both hemispheres, while non-musicians process music with only their right ear (Mitchell, par. 3).

The region of the brain that processes music once it has entered through the auditory cortex has been located by researchers at Dartmouth who used an MRI machine to track blood flow in the brain while listening to a melody. While music activated several areas of the brain, there was one specific area that all of the subjects had in common for processing that music. That area is the

rostromedial prefrontal cortex. It is the same area that is linked to memory and emotions and is separate from areas that process basic sounds that are not music (Hotz, par. 10). This may explain the strong link between music and emotions, with listeners being easily evoked emotionally by music and with skilled musicians insisting that their success is largely due to the fact that they can "feel" the music.

A unique phenomenon shows yet another neurological link to music. There are a very small number of people who are gifted with a special ability known as Synesthesia. These people experience multiple activation of the senses when exposed to certain stimuli. While some synesthates experience this phenomenon when seeing letters or seeing colors, the majority experience the sensation of multiple sensory activation when hearing music (Cytowic, 3.3). The most common form of this particular synesthesia area is "colored hearing". To these persons, a chord, particular instrument or musical key will create a visual pattern for them, with specific colors and shapes always forming for specific tone qualities. It is a similar experience to an LSD induced hallucination, but no drugs are involved and synesthates report that the colors, shapes, etc. are the same every time they are presented with a particular chord or musical pitch (Cytowic, 2.1). This has been proven through numerous laboratory tests and retests (Cytowic, 4.5). One particular synesthete who was also a famous classical composer attempted to show the world what his synesthetic experience was like. Scriabin composed his symphony "Prometheus, The Poem of Fire" for not only orchestra, piano and organ, but also for a keyboard that controlled colored lights that flooded that hall

and created patterns according to the music (Cytowic, 3.8). Synesthesia is also sometimes invoked in persons who are not normally synesthetic when they experience seizures in the hippocampus. When the seizures are confined to the hippocampus they are described in simple terms by the person experiencing them. When the seizures spread to the cortex of the temporal lobe, the synesthetic experiences are described more specifically and elaborately (Cytowic, 4.8). While no specific cause has been discovered for this phenomenon, it has been proven to run in families and to occur mostly in females who are left-handed (Cytowic, Abstract).

Musical training has been proven to develop the brain and increase specific skills. What about using music to treat the brain in a healthcare setting? Music therapy is recently becoming a big business, with more and more schools and hospitals recognizing the psychological benefits that musical experience provides. It is particularly effective with autistic children who can use music as a tool to express emotions they are otherwise unable to express and who are drawn to the mathematical regularity of the beats in a piece. While an autistic child generally shrinks from interaction with a person because that person may not reflect them correctly, they are drawn to interaction with a musical instrument because the instrument accurately reflects the energy the child puts into the experience *Smith/Patey, p. 99). Music therapy is also very effective in psychiatric hospitals, where music is used to calm patients and enable them to express themselves in an acceptable form. It is also used with cancer patients who report less pain and

easier sleep when presented with the proper music for listening (American Music Therapy Association). As explained by the Association of Professional Music Therapists, "Music Therapy provides a framework in which a mutual relationship is set up between client and therapist… By using music creatively in a clinical setting, the therapist [establishes] interaction… leading to the pursuit of therapeutic goals" (Smith/Patey, p. 36). Another recently developing area in music therapy is work with neurological rehabilitation. Studies show that patients with traumatic brain injuries who receive music therapy "show improvement in the areas of communication, depression and anxiety… as well as on motivation, social interaction, emotional stability and cooperation" (Smith/Patey, p. 131).

Music has also been utilized in the treatment of insomnia and anxiety. In an experiment conducted by the Sleep Research Clinic at Toronto Western Hospital, patients who experienced difficulty sleeping due to anxiety were provided specialized music to listen to that was computerized based on their specific brain waves. Their personal brain waves were converted mathematically into specific tempos, octaves, volume, chords and instrument voices and the resulting music was played for them when they experienced their anxiety-provoked insomnia. What they found was that patients who listened to "soothing" music as defined by record industry standards, or to music created from other patient's brain waves did not experience any improvement. The patients who listened to the music tuned to their own brain waves, however, did experience significant improvements in their sleep patterns and anxiety levels (Romano). This signifies a deep

biological link between the brain and music. Perhaps it also explains why different people are drawn to different types of music and even to specific instruments. They may be finding a personal link based on their own brain waves.

Different styles of music have been proven to activate different areas in the brain of the same person. One particular imaging study showed specific areas of the brain lighting up when playing music by Bach with other areas lighting up when playing scales. There was only a small overlap of the areas (Popp, p. 901). There is also a more specific area that lights up in musicians with absolute or "perfect" pitch as opposed to those who do not have absolute pitch. It is an asymmetrical area located in the left planum temporale (Popp, p. 899). The same areas do light up each time certain music is performed or heard and it is clear that synapses become trained to respond through repeated exposure (Hotz, par. 6). Another study showed that different styles of music (i.e. classical versus heavy metal) and even different composers produces different frequencies and activates different brain waves (Kasabov, p.6).

Music is clearly imbedded deep within our minds and produces physical changes based on the type and amount of exposure and instruction. It can enhance learning in other areas and it can be used to treat mental illnesses. Music is not only a product of your brain; it also exerts a powerful influence on it.

Works Cited

American Music Therapy Association. 2004. 2 May 2005. <http://www.musictherapy.org/>

Cytowic, Richard. "Synesthesia: Phenomenology and Neuropsychology." Psyche. 2 July 1995. 2 May 2005 < http://psyche.cs.monash.edu.au/v2/psyche-2-10-cytowic.html>

Darnley-Smith, Rachel and Helen M. Patey. Music Therapy. California: Sage Publications Inc. 2003.

Hotz, Robert. "Music Changes Links In Brain." Euphyscia Institute. 13 Dec 2002. 2 May 2005 <http://www.eupsychia.com/perspectives/articles/musicbrain.html>

Jones, Martin. "The Mozart Effect." Indiana University: Human Intelligence. Fall 2002. 2 May 2005 <http://www.indiana.edu/~intell/mozarteffect2.shtml>

Kasabov, Nik. "Dynamic Modelling of Brain Functions and Cognitive Processes." School of Languages at AUT. 16 Dec 2002. 2 May 2005 <http://www.aut.ac.nz/research_showcase/research_activity_areas/kedri/downloads/pdf/BookChapters/ch09.pdf>

The M.I.N.D Institute. 2004. 2 May 2005 <http://www.mindinst.org/>

Mitchell, Ann. "The Neurobiology of Music." Serendip. 2000. 2 May 2005 < http://serendip.brynmawr.edu/bb/neuro/neuro00/web2/Mitchell.html>

Popp, John M.D. "Music, Musicians and the Brain…" American Association of Neurological Surgeons. 2004. 2 May 2005 <http://www.aans.org/education/journal/neurosurgical/dec04/17-6-pp1.pdf>

Romano, Justin. "Brain Music Therapy for the Treatment of Insomnia and Anxiety." Neuropsychiatry Reviews. Sept 2002. 2 May 2005 <http://www.neuropsychiatryreviews.com/sep02/npr_sep02_brainmusic.html>