TMI **Journal**

Vol. I Summer/Fall 2009 Nos. 3 & 4

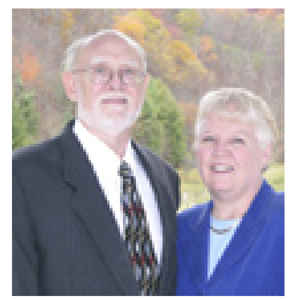
A Research and Educational Publication of The Monroe Institute

IN THIS ISSUE

A version of this paper appeared in *VINE*: *The Journal of Information and Knowledge Management Systems*, **vol. 38, no. 3 (September 2008).**

THE HUMAN KNOWLEDGE SYSTEM: MUSIC AND BRAIN COHERENCE

by Alex Bennet, PhD, and David Bennet, PhD



Alex and David Bennet are co-founders of the Mountain Quest Institute (MQI), a research, retreat, and learning center nestled in the Allegheny Mountains. MQI is dedicated to helping individuals achieve personal and professional growth and organizations create and sustain high performance in a rapidly changing, uncertain, and increasingly complex world. (*See* **www.mountainquestinstitute.com**).

The Bennets are co-authors of the seminal work Organizational Survival in the New World: The Intelligent Complex Adaptive System *(Elsevier, 2004), a new theory of the firm that turns the living system metaphor into a reality for organizations. More recently, they published* Knowledge Mobilization in the Social Sciences and Humanities: Moving from Research to Action *(MQI Press, 2007).*

Alex was the first chief knowledge officer of the U.S. Department of the Navy. David's experience spans the public and private sectors, most recently as CEO and chairman of the board of a professional services firm. Alex has her doctorate in human and organizational systems and holds degrees in management for organizational effectiveness, human development, English, and marketing. David has his doctorate in neuroscience and adult learning and holds degrees in mathematics, physics, nuclear physics, liberal arts, and human and organizational development. The Bennets have been TMI professional members since 2002.

Next Page

Abstract

Purpose—This paper explores the relationship between music and learning in the mind/brain.

Design/methodology/approach—Taking a consilience approach, this paper briefly introduces how music affects the mind/brain, then moves through several historical highlights of our emergent understanding of the role of music in learning—for example, the much-misunderstood Mozart effect. Then the role of music in learning is explored from a neuroscience perspective, with specific focus on its potential to achieve brain coherence. Finally, using a specific example of sound technology focused on achieving hemispheric synchronization, research findings, anecdotes, and experiential interactions are integrated to touch on the potential offered by this new understanding.

Findings—Listening to music regularly (along with replaying tunes in our brains) clearly helps our neurons stay active and alive and our synapses intact. Listening to the *right* music does appear to facilitate learning, and participating more fully in music making appears to provide additional cerebral advantages. Further, some music supports hemispheric synchronization, offering the opportunity to achieve brain coherence and significantly improve learning.

Keywords—Music, Learning, Brain Coherence, Hemispheric Synchronization, the Mozart effect, Transfer Effects

Introduction

When Charles Darwin wrote his *Autobiography* in 1887, he was moved to say,

> If I had to live my life again I would have made a rule to read some poetry and listen to some music at least once a week; for perhaps the parts of my brain now atrophied could thus have been kept active through use (Amen 2005, 158).

Today there's no doubt that the brain atrophies through disuse, that is, neurons die and synapses wither when they are not used (Zull 2002), but would listening to music once a week have kept more of those neurons and synapses active and alive? And if so, what if we *participated more fully* in music making? How could we maximize our learning?

In this paper we briefly introduce how music affects the mind/brain, then move through several historical highlights of our emergent understanding of the role of music in learning—for example, the much-misunderstood Mozart effect. Then we explore the role of music in learning from a neuroscience perspective, with specific focus on its potential to achieve brain coherence. Finally, using a specific example of sound technology focused on achieving hemispheric synchronization, we integrate research findings, anecdotes, and experiential interactions to touch on the potential offered by this new understanding.

The approach of this exploration through the literature—peppered with anecdotes and experience—is one of consilience: specifically, the integrating of knowledge from a variety of fields to discover a common groundwork of explanation (Wilson 1991). This paper considers the findings of, among others, psychologists, physicists, neuroscientists, musicians, educators, biologists, engineers, and medical doctors.

Brain coherence is considered the orderly and harmonious connectedness between the two hemispheres of the brain—in other words, when the two hemispheres of the brain are synchronized, thus the term hemispheric synchronization. Borrowing from physics, when the brain is in a coherent state, systems are performing optimally and virtually no energy is wasted.[1] This, then, would be considered an optimal state for learning.

While specialization and selection occur in various parts of the brain, they do not occur independently (Levy 1985). As will be demonstrated, one of the "jobs" of music in the process of evolution and growth is to increase the interconnections between the two hemispheres of the brain. We begin.

How music affects the mind/brain

Music and the human mind have a unique relationship that is not yet fully understood. As Hodges forwards,

> By studying the effects of music, neuroscientists are able to discover things about the brain that they cannot know through other cognitive processes. Likewise, through music we are able to discover, share, express, and know about aspects of the human experience that we cannot know through other means. Musical insights into the human condition are uniquely powerful experiences that cannot be replaced by any other form of experience (Hodges 2000, 21).

While the effect of music on the critical aspects of learning, attention, and memory may be a relatively new area of focused research, the human brain may very well be hardwired for music. As Weinberger, a neuroscientist at the University of California at Irvine, says, "An increasing number of findings support the theory that the brain is special-

Next Page

The actions we take can literally expand or contract different regions of the brain, pour more juice into quiet circuits and damp down activity in buzzing ones.

ized for the building blocks of music" (Weinberger 1995, 6). Wilson, a biologist, goes even farther as he states that "all of us have a biologic guarantee of musicianship, the capacity to respond to and participate in the music of our environment" (cited in Hodges 2000, 18).

Sousa (2006) forwards that there are four proofs that support the biological basis for music: (1) it is universal (past–present, all cultures) (Swain 1997); (2) it reveals itself early in life (infants three months old can learn and remember to move an overhead crib mobile when a song is played [Fagan et al. 1997], and within a few months can recognize melodies and tones [Weinberger 2004; Hannon and Johnson 2005]); (3) it should exist in other animals besides humans (monkeys can form musical abstractions) (Sousa 2006); and (4) we might expect the brain to have specialized areas for music.

Exactly where this hardwiring might be located would be difficult to say. For example, even though there is an area in adults identified as the auditory cortex, visual information goes into the auditory cortex, just as auditory information goes into the visual cortex. That is why certain types of music can stimulate memory recall and visual imagery (Nakamura et al. 1999). Further, the auditory cortex is not inherently different from the visual cortex. Thus, "Brain specialization is not a function of anatomy or dictated by genes. It is a result of experience" (Begley 2007, 108). This process of specialization through experience begins shortly after the time of conception—selecting and connecting. Many of the interconnections remain into adulthood, or perhaps throughout life. While these connections are not exercised in most adults—they are more like back-road connections—when the brain is deprived of one sense (for example, hearing or seeing), a radical reorganization occurs in the cortex, and connections that heretofore lay dormant are used to expand the remaining senses (Begley 2007).

In the early phases of neuronal growth (during the first few months of life), there is an explosion of synapses in preparation for learning (Edelman 1992). Yet beginning around the age of eight months through sixteen months, tens of billions of synapses in the auditory and visual cortices are lost (Zull 2002). Chugani (1998) says that this explosion is concurrent with synaptic death, with experiences determining which synapses live or die. As Zull explains, before eight months of age synapses are being formed faster than they are being lost. Then things shift, and we begin to lose more synapses than we create (Zull 2002). The brain is sculpting itself through interaction with its environment, with the reactions of the brain determining its own architecture.

This process of selection continues as the rest of life is played out. This is the process of learning, selecting, connecting, and changing our neuronal patterns (Edelman 1992; Zull 2002). Music plays a core role in this process. Jensen contends that "music can actually prime the brain's neural pathways" (2000b, 246).

The brain has the capacity to structurally change throughout life. As Begley describes, "The actions we take can literally expand or contract different regions of the brain, pour more juice into quiet circuits and damp down activity in buzzing ones" (Begley 2007, 8). During this process of plasticity, the brain is expanding areas for functions used more frequently and shrinking areas devoted to activities that are rarely performed.

Further, in the late 1990s neuroscientific researchers discovered that the structure of the brain can change as a result of the thoughts we have. As Dobbs explains, the neurons that are scattered throughout key parts of the brain "fire not only as we perform a certain action, but also when we watch someone else perform that action" (Dobbs 2007, 22). These are mirror neurons, a form of mimicry that bypasses cognition, transferring actions, behaviors, and most likely other cultural norms quickly and efficiently. Thus when we *see* something being enacted, our mind creates the same patterns that we would use to enact that "something" ourselves. Because people have stored representations of songs and sounds in their long-term memory, music can be imagined. When a tune is moving through your mind it is activating the same cells as if you were hearing it from the outside world. Further, as we have noted, when you are internally imagining a

Next Page

tune, the visual cortex is also stimulated such that visual patterns are occurring as well (Sousa 2006).

Not all of these findings were known when music and acoustic pioneer Alfred Tomatis (1983) forwarded the analogy that sound provided an electrical charge to energize the brain. He described cells in the cortex of the brain as acting like small batteries, generating the electricity viewed in an EEG printout. What he discovered that was amazing was that these batteries were not charged by the metabolism, but rather through sound from an external source. With the discovery of mirror neurons, this would mean that imagining tunes is also providing a charge. These early Tomatis studies found that sound impacted posture, energy flow, attitude, and muscle tone, and that the greatest impact was in the 8000-hertz frequency range (Tomatis 1983; Jensen 2000b). Other research took this further, suggesting that low-frequency tones caused a discharge of mental and physical energy and certain higher tones powered up the brain (Clynes 1982; Zatorre 1997).

Researcher Frances Rauscher (1997) contends that music appreciation and abstract reasoning have the same neural firing patterns; however, this was observed in research that occurred several years after her earlier studies introducing the controversial Mozart effect and setting in motion a growing interest in the relationship of music and learning.

The Mozart effect

The Mozart effect emerged in 1993 with a brief paper published in *Nature* by Frances Rauscher, Gordon Shaw, and Katherine Ky. To discover whether a brief exposure to certain music increased cognitive ability, the researchers divided thirty-six college students into three groups and used standard intelligence subtests to measure spatial/temporal reasoning. Spatial/temporal reasoning is considered "the ability to form mental images from physical objects, or to see patterns in time and space" (Sousa 2006, 224). During the subtests one group worked in silence, one group listened to a tape of relaxation instructions, and the third group listened to a Mozart piano sonata (specifically, Mozart's Sonata for Two Pianos in D Major). There were significantly higher results in the Mozart group, although the effect was brief, lasting only ten to fifteen minutes (Rauscher, Shaw, and Ky 1993).

The Mozart effect quickly became a meme, taking on a life of its own completely out of the context of the findings. Perhaps this was because it was the first study relating music and spatial reasoning, suggesting that listening to music actually increased brain performance. There ensued high media coverage with the emphasis placed on the most sensational findings. The details of the study, however—specifically, that these findings were limited to spatial reasoning, not general intelligence, and that the effect was short-lived (ten to fifteen minutes)—were not part of the meme.

In 1994, Rauscher, Shaw, and Ky performed a follow-on study that was more extensive than the first. This five-day study involved seventy-nine college students who were pretested for their level of spatial/temporal reasoning prior to three listening experiences and then posttested. While it was found that all students benefited (again, for a short period of time), the greatest benefits accrued to those students who had tested the lowest on spatial/temporal reasoning at the beginning of the experiment (Rauscher, Shaw, and Ky 1995).

By now, other groups were exploring the Mozart effect. The results were similar to the earlier results, again, for a short period of time (Rideout and Laubach 1996; Rideout and Taylor 1997; Rideout, Dougherty, and Wernert 1998; Wilson and Brown 1997). A series of similar studies with slightly different approaches, however, demonstrated no relevant differences between the group listening to Mozart and the control group (Steele, Brown, and Stoecker 1999a, 1999b; Chabris 1999). Still another study began with the premise that the complex melodic variations in Mozart's sonata provided greater stimulation to the prefrontal cortex than simpler music. When this theory was tested it was discovered that the Mozart sonata activated the auditory as well as the prefrontal cortex in all of the subjects, thus suggesting a neurological basis for the Mozart effect (Muftuler et al. 1999). Other specific case results were emerging. For example, Johnson et al. (1998) reported improvement in spatial-temporal reasoning in an Alzheimer's patient; and Hughes, Fino, and Melyn (1999) reported that a Mozart sonata reduced brain seizures.

As the exaggerated sensation of the initial finding began to sink into disillusionment, other researchers were building more understanding of the effect. For example, it was determined that while listening to Mozart *before* testing might improve spatial/temporal reasoning, listening to Mozart *during* testing could cause neural competition through interference with the brain's neural firing patterns (Felix 1993). Studies expanded to include other musical pieces. Researchers at the University of Texas Imaging Center in San Antonio discovered that "other subsets of music actually helped the experimental subjects do far better than did listening to Mozart" (Jensen 2000b, 247). Thus it was determined that the effect was not caused by the specific music of Mozart as much as the rhythms, tones, or patterns of Mozart's music that

Next Page

enhanced learning (Jensen 2000b). This is consistent with earlier work by researcher King (1991), who suggested that there is no statistically significant difference between New Age music and baroque music in the effectiveness of inducing alpha states for learning (approximately 8–13 Hz), that is, they both enhance learning. Georgi Lozanov, a pioneer of accelerated learning, however, had said that classical and romantic music (circa 1750–1825 and 1820–1900, respectively) provided a better background for introducing new information (Lozanov 1991), and Clynes (1982) had recognized a greater consistency in body pulse response to classical music than rock music, which means that the response to classical music was more predictable.

Considering the exaggerated early claims, publicized without context and based on highly situation-dependent and context-sensitive studies, and the differences in findings among various research groups, it is easy to understand why the Mozart effect has proved so controversial. Note that the Mozart Effect emerged from studies involving adults (not children) and that it involved short periods of listening to specific music and doing specific subtasks to measure spatial/temporal reasoning. In these studies, effects from long-term listening were not studied or assessed, nor was the richer long-term involvement of learning and playing music. This brings us to a discussion of transfer effects.

Transfer effects

The question of if and how music improves the mind is often couched as a question of transfer effects. This refers to the transfer of learning that occurs when improvement of one cognitive ability or motor skill is facilitated by prior learning or practice in another area (Weinberger 1999). For example, riding a bike, often used to represent embodied tacit knowledge (Bennet and Bennet 2008), is a motor skill (in descriptive terms, learning to maintain balance while moving forward) that can facilitate learning to skate or ski.

In cognitive and brain sciences the transfer of learning is a fundamental issue. While it has been argued that simply using a brain region for one activity does not necessarily increase competence in other skills or activities based in the same region (Coch, Fischer, and Dawson 2007), with our recent understanding of the power of thought patterns, one discipline is not completely independent of another (Hetland 2000). For example, a melody can act as a vehicle for a powerful communication transfer at both the conscious and nonconscious levels (Jensen 2000b). Thus, "Music acts as a premium signal carrier, whose rhythms, patterns, contrasts, and varying tonalities encode any new information" (Webb and Webb 1990). By "encode" is meant to facilitate remembering. An example is the "Alphabet Song" sung to the tune of "Twinkle, Twinkle Little Star."

There are different spectral types of real sounds coming from a myriad of sources. Periodic sounds that give a strong sense of pitch are harmonic (sung vowels, trumpets, flutes); those that have a weak or ambiguous sense of pitch are inharmonic (bells, gongs, some drums); and sound that has a sense of high or low but no clear sense of pitch is noise (consonants, some percussion instruments, and initial attacks of both harmonic and inharmonic sounds) (Soundlab 2005). Specific sounds we hear may include different spectral types; music often includes all three. For example, when hearing a church soloist, the noise of a strong consonant is followed by a sung vowel (harmonic). It is also noteworthy that the same part of the brain that *hears pitch* (the temporal lobe) is also involved in *understanding speech* (Amen 2005). Thus, specific combinations of sound may carry specific meaning by triggering memories or feelings whether or not they have words connected to them.

Research findings indicate that music actually increases certain brain functions that improve other cognitive tasks. Perhaps one of the most stunning results in the literature was achieved by a professional musician in North Carolina who was music director of the Winston-Salem Piedmont Triad Symphony Orchestra. The music director arranged for a woodwind quintet to play two or three half-hour programs per week at a local elementary school for three years: the first year playing for all first graders; the second year playing for all first and second graders; and the third year playing for all first, second, and third graders. Note that 70 percent of the students at the elementary school received free or reduced-price lunches. Prior to the study, first through fifth graders had an average composite IQ score of 92, and more than 60 percent of third graders tested below their grade level. Three years into the program, testing of the third graders exposed to the quintet music for three years showed remarkable differences, with 85 percent of this group testing *above grade level for reading* and 89 percent testing *above grade level for math* (Campbell 2000).

The limbic system and subcortical region of the brain—the part of the brain involved in long-term memory—are engaged in musical and emotional responses. When information is tied to music, therefore, it has a better chance of being encoded in long-term memory (Jensen 2000b). Context-dependent memory connected to music is not a new idea.

Next Page

In a study at Texas A&M University examining the role of background instrumental music in memory, music turned out to be an important contextual element. Subjects had the best recall when music was played during learning and that same music was played during recall (Godden and Baddeley 1975). This was confirmed in a 1993 study monitoring cortical and verbal responses to harmonic and melodic intervals in adults knowledgeable in music. The results showed consistent brain responses to intervals, whether isolated harmonic intervals, pairs of melodic intervals, or pairs of harmonic intervals. These results indicated that intervals may be viewed as meaningful words (Cohen et al. 1993).

It has also been found that background music enhances the efficiency of individuals who work with their hands. For example, in a study of surgeons it was found that background music increased their alertness and concentration (Restak 2003). The music that surgeons said worked best was not "easy-listening"; rather, that music was (in order of preference): Vivaldi's *Four Seasons*, Beethoven's Violin Concerto Op. 61, Bach's Brandenburg concertos, and Wagner's "Ride of the Valkyries." The use of background music during surgery did not cause interference and competition, since music and skilled manual activities activate different parts of the brain (Restak 2003). This, of course, is similar to the use of background music in the classroom or in places of work.

Dowling, a music researcher, believes that music learning affects other learning for different reasons. Building on the concepts of declarative memory and procedural memory, he says that music combines mind and body processes into one experience. For example, by integrating mental activities and sensory-motor experiences (like moving, singing, or participating rhythmically in the acquisition of new information, and for our doctors in the example above, their hand movements) learning occurs "on a much more sophisticated and profound level" (Campbell 2000, 173). Conversely, it has also been found that stimulating music can serve as a distraction and interfere with cognitive performance (Hallam 2002). Thus, much as determined in the early Mozart studies, *different types of music produce different effects in different people* in regard to learning.

The right and left hemispheres of the brain

The human brain is divided into two hemispheres, simply referred to as the right and left hemispheres. It was previously believed that the right hemisphere was the seat of music, but today we know that both sides of the brain are used to listen to music (Amen 2005). Music engages the whole brain (Jensen 2000b). For example, as sound enters the ears it goes to the auditory cortex in the temporal lobes. The temporal lobe in the nondominant hemisphere (generally the right hemisphere) hears pitch, melody, harmony, and beat and (recognizing long-term patterns) puts this together as a whole piece. The temporal lobe in the dominant hemisphere (generally the left hemisphere) is better at analyzing the incoming sound and hearing the short-term signatures of music, that is, lyrics and *changes* in rhythm (pacing), frequency, intensity, and harmonies (Amen 2005; Jensen 2000b; Weinberger 1995). The frontal lobe associates the sound with thought and stimulates emotions (in the limbic system) and past experiences (from memory scattered all over the brain) (Sousa 2006), and the cerebellum becomes involved in measuring the beats (spatial aspects) (Jensen 2000b). For example, while a non-musician would process music primarily in the right hemisphere (with potential strong contributions from the limbic system stimulated by the frontal lobe), a musician who was analyzing the content of a musical form would tend to hear music with his left hemisphere (Amen 2005) with a heavy dose of the cerebellum thrown in (Jensen 2000b).

Using PET scans, Eric Jensen, an educator known for his translation of neuroscience, has identified the various brain regions activated by different aspects of music. For example, rhythm activates Broca's area as well as the cerebellum; melody activates both hemispheres (with a specific recognized melody activating the right hemisphere); harmony activates the left hemisphere more than the right as well as the inferior temporal cortex; pitch activates the left back of the brain and may also activate the right auditory cortex; and timbre activates the right hemisphere (Jensen 2000b).

Further, activation of various parts of the brain is highly dependent on which senses are involved: aural (hearing music), sight (reading music), or touch (playing music). Other events, such as hearing a story about the Mozart effect, recalling a Rolling Stones concert, or having an emotional response to certain music, are processed differently in the brain (Jensen 2002). In other words, the experience and thought related to music is spatially diffused throughout the brain. While there are many studies on the connections between music and emotion and between emotion and learning, these are outside the focus of this paper.

As Robert Zatorre, a neuropsychologist at the Montreal Neurological Institute forwards, there is little doubt that

Next Page

music engages the entire brain. Further, as music has shifted over the last hundred years from baroque or classical (stimulating our nondominant hemisphere) to more avant-garde styles (stimulating our dominant hemisphere), it has engaged the brain even more fully (Zatorre 1997).

Impact of musical instruction

Substantiating the long-held "knowing" that music is beneficial to human beings, Hodges outlines five basic premises that establish a link between the human brain and the ability to learn. The first two confirm our earlier discussion of the brain as being hardwired for—or at least having a proclivity for—music. The latter three are pertinent to our forthcoming discussion of the impact of musical instruction on the learning mind/brain. As Hodges forwards (with some paraphrasing): (1) the human brain has the ability to respond to and participate in music; (2) the musical brain operates at birth and persists throughout life; (3) early and ongoing musical training affects the organization of the musical brain; (4) the musical brain consists of extensive neural systems involving widely distributed, but locally specialized, regions of the brain; and (5) the musical brain is highly resilient (Hodges 2000, 18).

There are hundreds of studies that confirm that creating music and playing music, especially when started at an early age, provide many more cerebral advantages than listening to music. In a study involving ninety boys between the ages of six and fifteen, it was discovered that musically trained students had better verbal memory (but showed no differences in visual memory). Thus musical training appeared to improve the ability of the Broca's and Wernicke's areas to handle verbal learning. Further, the memory benefits appeared long lasting. When students who dropped out of music training were tested a year later, it was found that they had retained the verbal memory advantage gained while in music training (Ho, Cheung, and Chan 2003).

Music and mathematics are closely related in brain activity (Abeles and Sanders 2005; Catterall, Chapleau, and Iwanga 1999; Graziano, Peterson, and Shaw 1999; Kay 2000; Schmithhorst and Holland 2004; Vaughn 2000). Mathematical concepts basic to music include patterns, counting, geometry, rations and proportions, equivalent fractions, and sequences (Sousa 2006). For example, musicians learn to recognize patterns of chords, notes, and key changes to create and vary melodies, and by inverting those patterns they create counterpoint, forming different kinds of harmonies. As further examples, musical beats and rests are counted, instrument finger positions form geometrical shapes, reading music requires an understanding of ratios and proportions (duration and relativity of notes), and a musical interval (sequence) is the difference between two frequencies (known as the beat frequency) (Sousa 2006).

In the brain, music is stored in a pitch-invariant form, that is, the important relationships (patterns) in the song are stored, not the actual notes. This can be demonstrated by an individual's ability to recognize a melody regardless of the key in which it is played (with different notes being played than those stored in memory). As Hawkins and Blakeslee detail,

> This means that each rendition of the "same" melody in a new key is actually an entirely different sequence of notes! Each rendition stimulates an entirely different set of locations on your cochlea, causing an entirely different set of spatial-temporal patterns to stream up into your auditory cortex ... and yet you perceive the same melody in each case (Hawkins and Blakeslee 2004, 80–81).

Unless you have perfect pitch, it is difficult to differentiate the two different keys. This means that—similar to other thought patterns—the natural approach to music storage, recall, and recognition occurs at the level of invariant forms. Invariant form refers to the brain's internal representation of an external form. This representation does not change even though the stimuli informing you it's there are in a constant state of flux (Hawkins and Blakeslee 2004).

A 1993 study at the University of Vienna revealed the extent to which different regions of the human brain cooperate when composing music (this also occurred in some listeners). Professor Hellmuth Petsche and his associates determined that brain-wave coherence occurred at many sites throughout the cerebral cortex (Petsche 1993). For some forms of music, the correlation between the left and right frontal lobes increases, that is, brain waves become more similar between the frontal lobes of the two hemispheres (Tatsuya, Mitsuo, and Tadao 1997). For example, in a study involving exposure of four-year-old children to one hour of music per day over a six-month period, brain bioelectric activity data indicated an enhancement of the coherence function (Flohr, Miller, and DeBeus 2000).

In a study of the relationship of coherence and degree of musical training, subjects with music training exhibited significantly more EEG coherence within and between hemispheres than those without such training in a control group

Next Page

(Johnson et al. 1996).[2] In other words, it appeared musical training increased the number of functional interconnections in the brain. Specifically, the researchers suggested that greater coherence in musicians "may reflect a specialized organization of brain activity in subjects with music training for enabling the experiences of ordered acoustic patterns" (Johnson et al. 1996, 582).

Further, in a study of thirty professional classical musicians and thirty non-musician controls matched for age, sex, and handedness, MRI scans revealed that there was a positive relationship between corpus callosum size and the number of fibers crossing through it, indicating a difference in interhemispheric communication between musicians and controls (Schlaug et al. 1995; Springer and Deutsch 1997). In other words, the two hemispheres of the brains of the musicians had a larger number of connections than those of the control group. Thus, as Jensen confirms, "Music ... may be a valuable tool for the integration of thinking across both brain hemispheres" (Jensen 2000b, 246). And as summed up by Thompson, brain function is enhanced through increased cross-callosal communication between the two hemispheres of the brain (Thompson 2007).

Musicians have structural changes that are "profound and seemingly permanent" (Sousa 2006, 224). As Sousa describes, "the auditory cortex, the motor cortex, the cerebellum, and the corpus callosum are larger in musicians than in non-musicians" (2006, 224). This, of course, moves beyond being able to discern different tonal and visual patterns to acquiring new motor skills. Since the brains of musicians and non-musicians are structurally different—yet studies of five- to seven-year-olds beginning music lessons show no preexisting differences (Restak 2003; Sousa 2006; Norton et al. 2005)—it appears that most musicians are made, not born. An example is perfect pitch, the ability to name individual tones. Perfect pitch is not an inherited phenomenon. Restak (2003) discovered that perfect pitch can be acquired by average children between three and five years of age when given appropriate training. Structural brain changes occur along with the development of perfect pitch and continue as musical talent matures (Restak 2003).

We have now answered two of our introductory questions: listening to music regularly (along with replaying tunes in our brains) helps keep our neurons and synapses active and alive; listening to the *right* music does appear to facilitate learning; further, participating more fully in music making appears to provide additional cerebral advantages. But, as we will discover, some music offers an even greater opportunity to heighten our conscious awareness in terms of sensory inputs, expand our awareness of, and access to, that which we have gathered and stored in our unconscious, and grow and expand our mental capacity and capabilities.

Since music has its own frequencies, it can either resonate or be in conflict with the body's rhythms. The pulse (heartbeat) of the listener tends to synchronize with the beat of the music being heard (the faster the music, the faster the heartbeat). When this resonance occurs, the individual learns better. As Jensen confirms, "When both are resonating on the same frequency, we fall 'in sync,' we learn better, and we're more aware and alert" (Jensen 2000b). This is a starting point for further exploring brain coherence.

Hemispheric synchronization

Hemispheric synchronization is the use of sound coupled with a binaural beat to bring both hemispheres of the brain into unison (Bennet and Bennet 2007). Binaural beats were identified in 1839 by H. W. Dove, a German experimenter. In the human mind, binaural beats are detected with carrier tones (audio tones of slightly different frequencies, one to each ear) below approximately 1500 Hz (Oster 1973). The mind perceives the frequency differences of the sound coming into each ear, mixing the two sounds to produce a fluctuating rhythm and thereby creating a beat or difference frequency. Because each side of the body sends signals to the opposite hemisphere of the brain, both hemispheres must work together to "hear" the difference frequency.

This perceived rhythm originates in the brain stem (Oster 1973) and is neurologically routed to the reticular formation (Swann et al. 1982), then moves to the cortex where it can be measured as a frequency-following response (Hink et al. 1980; Marsh, Brown, and Smith 1975; Smith et al. 1978). This interhemispheric communication is the setting for brain-wave coherence, which facilitates whole-brain cognition (Ritchey 2003), that is, an integration of left- and right-brain functioning (Carroll 1986).

What can occur during hemispheric synchronization is a physiologically reduced state of arousal while maintaining conscious awareness (Atwater 2004; Fischer 1971; Delmonte 1984; Goleman 1988; Jevning, Wallace, and Beidenbach 1992; Mavromatis 1991; West 1980) and the capacity to reach the unconscious creative state described above through

Next Page

the window of consciousness. In an exploration of tacit knowledge published in *VINE* at the beginning of 2008, the authors introduced the use of sound as an approach to accessing tacit knowledge. For example, listening to a special song in your life can draw out deep feelings and memories buried in your unconscious. Further, interhemispheric communication was introduced as a setting for achieving brain-wave coherence (a doorway into the unconscious), providing greater access to knowledge (informing) and knowledge (proceeding), thereby facilitating learning (Bennet and Bennet 2008). By reference the ideas forwarded in that work are included here.

In 1971 Robert Monroe—an engineer, founder of The Monroe Institute,® and arguably the leading pioneer of achieving learning through expanded forms of consciousness—developed audiotapes with specific beat frequencies that support synchronized, rhythmic patterns of consciousness called Hemi-Sync®. Repeated experiments occurred with individual brain activity observed. The following correlations between brain waves and consciousness were used: beta waves (approximately 13–26 Hz) and focused alertness and increased analytical capabilities; alpha waves (approximately 8–13 Hz) and unfocused alertness; theta waves (approximately 4–8 Hz) and a deep relaxation; and delta waves (approximately 0.5–4 Hz) and deep sleep. While it was discovered that theta waves provided the best learning state and beta waves the best problem-solving state, this posed a problem. Theta is the state of short duration right before and right after sleep (Monroe Institute 1985). This problem was solved by superimposing a beta signal on the theta, which produced a relaxed alertness (Bullard 2003).

This is consistent with the findings from neurobiological research that efficient learning is related to a decrease in brain activation often accompanied by a shift of activation from the prefrontal regions to those regions relevant to the processing of particular tasks (the phenomenon known as the anterior-posterior shift).

The first *METAMUSIC*® to combine theta and beta waves (*Remembrance* by J. S. Epperson) was released in 1994 (Bullard 2003). A second *METAMUSIC* piece combining theta and beta waves, released that same year (*Einstein's Dream*, also by Epperson), was based on a modification of Mozart's Sonata for Two Pianos in D Major, **the same piece used in the initial study which produced the controversial Mozart effect**. This version, however, had embedded combinations of sounds to encourage whole-brain coherence.

Thus Robert Monroe was developing and releasing audiotapes (and then CDs) specifically designed to help the left and right hemispheres of the brain work together, resulting in increased concentration, learning, and memory (Jensen 2000b). While the range and number of similar music products has expanded over the past years, the many years of both scientific and anecdotal evidence available about the use of Hemi-Sync provides a plethora of material from which to explore the benefits of brain coherence as it relates to learning. Thus we will briefly explore the context around this technology.

The Hemi-Sync[3] experience

There are dozens of recorded studies dated during the 1980s that looked at the relationship of Hemi-Sync and learning, some specifically focused on educational applications. In 1982, for example, students in the basic broadcasters' course (BBC) of the Defense Information School (DINFOS) at Fort Benjamin Harrison, Indiana, "displayed a number of positive differences in stress reactions and performance responses" over the control groups (Waldkoetter 1991). In a general psychology class, Edrington (1983) discovered that students who listened to verbal information (definitions and terms peculiar to the field of psychology) with a Hemi-Sync background signal (4 ± .2 Hz) scored significantly higher than the control group on five of six tests.

In 1986, Dr. Gregory Carroll presented the results of a study on the effectiveness of hemispheric synchronization of the brain as a learning tool in the identification of musical intervals. While the results of the experimental group were 5.54 percent higher than the control group, this was not considered significant. A surprise finding, however, was that individuals in the experimental group had a tendency to achieve higher scores on their posttests than on their pretests. The effect was in both the number of individuals and the amount of individual change. Only 28 percent of the individual responses in the control group posttests were higher than their pretests, while 54 percent of the experimental group did much better (Carroll, 1986). This suggests that Hemi-Sync signals **sustained their levels of concentration during the course of the forty-minute tape sessions** considerably longer than what occurred (when it occurred) in the Mozart effect studies.

Next Page

Hemi-Sync has consistently proven effective in improving enriched learning environments through sensory integration (Morris 1990), enhanced memory (Kennerly 1996), and improved creativity (Hiew 1995) as well as increasing concentration and focus (Atwater 2004; Bullard 2003). There is also a large body of observational research. For example, after fourteen years of using music as part of his practice, medical doctor Brian Dailey found that the use of sound (specifically, Hemi-Sync) not only had a therapeutic effect for his patients with a variety of illnesses, but could be extremely effective in assisting healthy individuals with concentration, insight, intuition, creativity, and meditation (Mason 2004). This short review has not included the many studies specifically addressing the impact of music, and in particular Hemi-Sync, on patients with brain damage or learning disorders, which is outside the focus of this paper.

In a recent study on the benefits of long-term participation in The Monroe Institute programs[4] involving more than seven hundred self-selected participants,[5] it was shown that greater experience with Hemi-Sync increased self-efficacy and life satisfaction (Danielson 2008) at a state of development similar to that of self-transforming (Kegan 1982). As described in the research results,

> Individuals at this stage of development recognize the limitations in any perspective and more willingly engage others for the challenge it poses to their worldview as the means for growing more expansive in their experiences—to consciously grow beyond where they are rather than merely having it happen to them as a function of circumstances (Danielson 2008, 25).

The seven hundred study participants (all adults) were evenly divided between single-program participation (SPP) and multiple-program participation (MPP) (indicating increased usage over a longer period of time). SPP means one week of continuous emersion using Hemi-Sync technology; MPP means multiple weeks of continuous emersion, separated by time periods ranging from weeks to years. Following their Hemi-Sync experiences, participants reported remarkable results. For example, the following percentages of participants *strongly agreed* (on a five-point Likert scale) to the following statements:

"I have a more expansive vision of how the parts of my life relate to a whole" (25.29% SPP, 61.3% MPP)

"I am actively involved in my own personal development" (30.65% SPP, 62.45% MPP)

"I take actions that are more true to my sense of self" (18.77% SPP, 45.21% MPP)

"I have been able to resolve an important issue or challenge in my life" (11.88% SPP, 32.57% MPP)

"I am more productive at work" (4.6% SPP, 14.18% MPP)

"I have a clear sense of further development I need to accomplish" (29.5% SPP, 40.23% MPP)

"I am more successful in my career" (6.56% SPP, 17.97% MPP)

Clearly, Hemi-Sync supports a long-term development program for "those interested in playing on the boundaries of human growth and development ... who want to see positive change in their lives" (Danielson 2008, 25).

Final thoughts

At a dozen places on the Internet, neurologist Jerre Levy of the University of Chicago[6] is credited with saying (paraphrased) that great men and women of history do not merely have superior intellectual capacities within each hemisphere of the brain. They also have phenomenal levels of emotional commitment, motivation, and attentional capacity, all of which reflect the *highly integrated brain in action*.

As we have seen, for the past thirty years, and perhaps longer, there have been studies in the mainstream touting the connections between music and mind/brain activity (from the viewpoints of psychology, music, education, etc.), and another expanding set of studies not as mainstream (from the viewpoint of consciousness). As our thought and understanding as a species is expanding, these areas of focus are openly acknowledging each other and learning together. It is no longer necessary or desirable to limit our thoughts to one frame of reference, nor to place boundaries on our mental capacity and ability to expand or contract that capacity.

We have seen evidence that changes in brain organization and function occur with the acquisition of musical skills. From the external viewpoint, whether as a listener or participant, music clearly offers the potential to strengthen and increase the interconnections across the hemispheres of the brain. As an example, the sound technology of Hemi-Sync offers the potential to achieve brain coherence, thus facilitating whole-brain cognition.

This is not to say that sound—music, Mozart, or Hemi-Sync—offers a panacea for learning. Let's not produce

Next Page

the disappointment of creating a meme without context. When asked what to expect from the Hemi-Sync experience, engineer and developer Robert Monroe responded,

> As much or as little as you put into it. Some discover themselves and thus live more completely, more constructively. Others reach levels of awareness so profound that one such experience is enough for a lifetime. Still others become seekers-after-truth and add an on-going adventure to their daily activity (Monroe 2007).

We've come full circle. Learning is occurring in the mind/brain as long as there is life; this is part of the inheritance of Darwinian survival of the fittest. But the amount, quality, and direction of that learning, and the environments in which we live, are choices. Yes, Charles Darwin, regularly listening to music—and, even better, participating in music making—would have undoubtedly kept more neurons alive and active, and synapses intact.

Now our opportunity is to fully exploit this understanding in our organizations, in our communities, and in our everyday lives.

Notes

1 The terms coherence and entrainment are often interchanged. Entrainment, however, is used to describe a *form* of coherence achieved when two or more body systems are synchronous and operating at the same frequency. For example, at HeartMath® the term entrainment is used to describe this relationship between the respiration and heart-rhythm patterns.

2 It was also found that females had higher coherence than males, which is in accord with anatomical studies showing that females have a larger number of interhemispheric connections than males.

3 While used as a short term for hemispheric synchronization, Hemi-Sync is also the term patented by Robert Monroe to describe the Hemi-Sync auditory-guidance system, a binaural-beat sound technology that has demonstrated changes in focused states of consciousness in over thirty years of study.

4 "The Benefits of long-term participation in the Monroe Institute programs" was released in early 2008 by The Monroe Institute.

5 More than twenty thousand people worldwide have participated in formal Hemi-Sync programs at the Institute. An equivalent number of people have participated in *OUTREACH* programs, which are conducted in English, Spanish, French, German, and Japanese.

6 Levy is a strong debunker of the left brain/right brain myth (Levy 1985).

References

Abeles, H. F., and E. M. Sanders. 2005. *Final assessment report: New Jersey Symphony Orchestra's Early Strings Program*. New York: Center for Arts Education Research, Columbia University.

Amen, D. G. 2005. *Making a good brain great*. New York: Harmony Books.

Atwater, F. H. 2004. *The Hemi-Sync process*. Faber, VA: The Monroe Institute.

Begley, S. 2007. *Train your mind, change your brain*. New York: Ballantine Books.

Bennet, A., and D. Bennet. 2000. *Knowledge mobilization in the social sciences and humanities: Moving from research to action*. Frost, WV: MQI Press.

Bennet, D., and A. Bennet. 2008. Engaging tacit knowledge in support of organizational learning. *VINE* 38 (1): 72–94.

Bullard, B. 2003. *METAMUSIC*: Music for inner space, *Hemi-Sync Journal* 21 (3–4): 1–5.

Campbell, D. 2000. *Heal yourself with sound and music*. Boulder, CO: Sounds True.

Carroll, G. D. 1986. Brain hemisphere synchronization and musical learning. Unpublished paper. University of North Carolina at Greensboro.

Catterall, J., R. Chapleau, and J. Iwanga. 1999. *Involvement in the arts and human development: Extending an analysis of general associations and introducing the special cases of intense involvement in music and in theater arts*. Monograph Series No. 11. Washington, DC: Americans for the Arts.

Chabris, C. 1999. A quantitative meta-analysis of Mozart studies. *Nature* 400:826–27.

Chugani, H. T. 1998. Biological basis of emotion: Brain systems and brain development. *Pediatrics* 102 (5): 1225–29.

Clynes, M., ed. 1982. *Music, mind, and brain*. New York: Plenum Press.

Next Page

Coch, D., K. W. Fischer, and G. Dawson, eds. 2007. *Human behavior, learning, and the developing brain: Typical development*. New York: The Guilford Press.

Cohen, D., R. Granot, H. Pratt, and A. Barneah. 1993. Cognitive meanings of musical elements as disclosed by event-related potential (ERP) and verbal experiments. *Music Perception* 5 (11): 153–84.

Danielson, C. 2008. Final report: The benefits of long-term participation in The Monroe Institute programs. Faber, VA: The Monroe Institute. See http://www.monroeinstitute.org/journal/the-benefits-of-long-term-participation-in-tmi-programs/

Delmonte, M. M. 1984. Electrocortical activity and related phenomena associated with meditation practice: A literature review. *International Journal of Neuroscience* 24:217–31.

Dobbs, D. 2007. Turning off depression. In *Best of the brain from* Scientific American: *Mind, matter, and tomorrow's brain,* ed. F. E. Bloom. New York: Dana Press.

Edelman, G. 1992. *Bright air, brilliant fire*. New York: Basic Books.

Edrington, D. 1983. Hypermnesia experiment. *Breakthrough*, September. Faber, VA: The Monroe Institute of Applied Sciences.

Fagan, J., J. Prigot, M. Carroll, L. Pioli, A. Stein, and A. Franco. 1997. Auditory context and memory retrieval in young infants. *Child Development* 68:1057–66.

Felix, U. 1993. The contribution of background music to the enhancement of learning in Suggestopedia: A critical review of the literature. *Journal of the Society for Accelerative Learning and Teaching* 18 (3–4): 277–303.

Fischer, R. 1971. A cartography of ecstatic and meditative states. *Science* 174 (4012): 897–904.

Flohr, J., D. Miller, and R. DeBeus. 2000. EEG studies with young children. *Music Educators Journal* 87 (2): 28–32.

Godden, D. R., and A. D. Baddeley. 1975. Context-dependent memory in two natural environments: On land and underwater. *British Journal of Psychology* 66:325–31.

Goleman, G. M. 1988. *The meditative mind: The varieties of meditative experience*. New York: G. P. Putnam.

Graziano, A. B., M. Peterson, and G. L. Shaw. 1999. Enhanced learning of proportional math through music training and spatial-temporal training. *Neurological Research* 21:139–52.

Hallom, S. 2002. The effects of background music on studying. Pp. 74-75 in *Critical links: Learning in the arts and student academic and social development*, ed. R. J. Deasy. Washington, DC: Arts Education Partnership.

Hannon, E. E., and S. P. Johnson. 2005. Infants use meter to categorize rhythms and melodies: Implications for musical structure learning. *Cognitive Psychology* 50:354–77.

Hawkins, J., with S. Blakeslee. 2004. *On intelligence: How a new understanding of the brain will lead to the creation of truly intelligent machines*. New York: Times Books.

Hetland, L. 2000. Listening to music enhances spatial-temporal reasoning: Evidence for the "Mozart Effect." *Journal of Aesthetic Education* 34:105–48.

Hiew, C. C. 1995. Hemi-Sync into creativity. *Hemi-Sync Journal* 13 (1): 3–5.

Hink, R. F., K. Kodera, O. Yamada, K. Kaga, and J. Suzuki. 1980. Binaural interaction of a beating frequency-following response. *Audiology* 19 (1): 36–43.

Ho, Y-C., M-C. Cheung, and A. S. Chan. 2003. Music training improves verbal but not visual memory: Cross-sectional and longitudinal explorations in children. *Neuropsychology* 17:439–50.

Hodges, D. 2000. Implications of music and brain research. *Music Educators Journal* 87 (2): 17–22.

Hughes, J. R., J. J. Fino, and M. A. Melyn. 1999. Is there a chronic change of the "Mozart effect" on epileptiform activity? A case study. *Clinical Electroencephalography* 30:44–45.

Jensen, E. 2000b. *Brain-based learning: The new science of teaching and training*. San Diego, CA: The Brain Store.

Jensen, E. 2002. *Environments for learning*. Thousand Oaks, CA: Corwin Press.

Jevning, R., R. K. Wallace, and M. Beidenbach. 1992. The physiology of meditation: A review. *Neuroscience and Behavioral Reviews* 16:415–24.

Johnson, J. D., C. W. Cotman, C. S. Tasaki, and G. L. Shaw. 1998. Enhancement of spatial-temporal rea-

Next Page

soning after a Mozart listening condition in Alzheimer's disease: A case study. *Neurology Research* 20:666–72.

Johnson, J. K., H. Petsche, P. Richter, A. Von Stein, and O. Filz. 1996. The dependence of coherence estimates of spontaneous EEG on gender and music training. *Music Perception* 13:563–82.

Kay, A. 2000. Effective music education. *Teaching Music* 7 (8): 51–53.

Kegan, R. 1982. *The evolving self*. Boston: Harvard University Press.

Kennerly, R. C. 1996. An empirical investigation into the effect of beta frequency binaural beat audio signals on four measures of human memory. *Hemi-Sync Journal* 14 (3): 1–4. http://www.monroeinstitute.org/wiki/index.php/An_Empirical_Investigation_Into_the_Effect_of_Beta_Frequency_Binaural_Beat_Audio_Signals_on_Four_Measures_of_Human_Memory (accessed June 20, 2008).

King, J. 1991. Comparing alpha induction differences between two music samples. Abstract from the Center for Research on Learning and Cognition, University of North Texas.

Levy, J. 1985. Right brain, left brain: Fact and fiction. *Psychology Today*, May, 43.

Lozanov, G. 1991. On some problems of the anatomy, physiology, and biochemistry of cerebral activities in the global-artistic approach in modern Suggestopedagogic training. *Journal of the Society for Accelerative Learning and Teaching* 16 (2): 101–16.

Marsh, J. T., W. S. Brown, and J. C. Smith. 1975. Far-field recorded frequency-following responses: Correlates of low pitch auditory perception in humans. *Electroencephalography and Clinical Neurophysiology* 38:113–19.

Mason, R. 2004. The sound medicine of Brian Dailey, M.D., F.A.C.E.P. *Alternative and Complementary Therapies* 10 (3): 156–60.

Mavromatis, A. 1991. *Hypnagogia*. New York: Routledge.

Monroe, R. 2007. Quote in *The Hemi-Sync® catalog*. Faber, VA: Monroe Products.

Monroe Institute. 1985. Achieving optimal learning states. *Breakthrough*, March. Faber, VA: The Monroe Institute.

Morris, S. E. 1990. Hemi-Sync and the facilitation of sensory integration. *Hemi-Sync Journal* 8 (4): 5–6.

Muftuler, L. T., M. Bodner, G. L. Shaw, and O. Nalcioglu. 1999. fMRI of Mozart effect using auditory stimuli. Abstract presented at the 87th meeting of the International Society for Magnetic Resonance in Medicine, Philadelphia.

Nakamura, S., N. Sadato, T. Oohashi, E. Nishina, Y. Fuwamoto, and Y. Yonekura. 1999. Analysis of music-brain interaction with simultaneous measurement of regional cerebral blood flow and electroencephalogram beta rhythm in human subjects. *Neuroscience Letters* 275 (3): 222–26.

Norton, A., E. Winner, K. Cronin, K. Overy, D. J. Lee, and G. Schlaug. 2005. Are there pre-existing neural, cognitive, or motoric markers for musical ability? *Brain and Cognition* 59:124–34.

Oster, G. 1973. Auditory beats in the brain. *Scientific American* 229:94–102.

Petsche, H. 1993. Brainwave coherence. *Music Perception* 11:117–51.

Rauscher, F. H., G. L. Shaw, and K. N. Ky. 1993. Music and spatial task performance. *Nature* 365:611.

Rauscher, F. H., G. L. Shaw, and K. N. Ky. 1995. Listening to Mozart enhances spatial-temporal reasoning: Towards a neurophysiological basis. Neuroscience Letters 185 (1): 44–47.

Rauscher, F. H., G. L. Shaw, L. J. Levine, E. L. Wright, W. R. Dennis, and R. L. Newcomb. 1997. Music training causes long-term enhancement of preschool children's spatial-temporal reasoning. *Neurological Research* 19:2–8.

Restak, R. M. 2003. *The new brain: How the modern age is rewiring your mind*. New York: Rodale.

Rideout, B. E., and C. M. Laubach. 1996. EEG correlates of enhanced spatial performance following exposure to music. *Perceptual and Motor Skills* 82 (2): 427–32.

Rideout, B. E., and J. Taylor. 1997. Enhanced spatial performance following 10 minutes exposure to music: A replication. *Perceptual and Motor Skills* 85 (1): 112–14.

Rideout, B. E., S. Dougherty, and L. Wernert. 1998. Effect of music on spatial performance: A test of generality. *Perceptual and Motor Skills* 86 (2): 512–14.

Ritchey, D. 2003. *The H.I.S.S. of the A.S.P.: Understanding the anomalously sensitive person*. Terra Alta, WV:

Next Page

Headline Books.

Schlaug, G., L. Jancke, Y. Huang, J. Staiger, and H. Steinmetz. 1995. Increased corpus callosum size in musicians. *Neuropsychologia* 33:1047–55.

Schmithhorst, V. J., and S. K. Holland. 2004. The effect of musical training on the neural correlates of math processing: A functional magnetic resonance imaging study in humans. *Neuroscience Letters* 354:193–96.

Smith, J. C., J. T. Marsh, S. Greenberg, and W. S. Brown. 1978. Human auditory frequency-following responses to a missing fundamental. *Science* 201:639–41.

Soundlab. 2005. http://soundlab.cs.princeton.edu/learning/tutorials/SoundVoice/sndvoic2.htm (accessed May 26, 2008).

Sousa, D. A. 2006. *How the brain learns*. 3rd ed. Thousand Oaks, CA: Corwin Press.

Springer, S. P., and G. Deutsch. 1997. *Left brain, right brain: Perspectives from cognitive neuroscience*. New York: W. H. Freeman and Co.

Steele, K. M., J. D. Brown, and J. A. Stoecker. 1999. Failure to confirm the Rauscher and Shaw description of recovery of the Mozart effect. *Perceptual and Motor Skills* 88 (1): 843–49.

Swain, J. 1997. *Musical languages*. New York: W. W. Norton.

Swann, R., S. Bosanko, R. Cohen, R. Midgley, and K. M. Seed. 1982. *The brain: A user's manual*. New York: G. P. Putnam and Sons.

Tatsuya, I., H. Mitsuo, and H. Tadao. 1997. Changes in alpha band EEG activity in the frontal area after stimulation with music of different affective content. *Perceptual and Motor Skills* 84 (2): 515–26.

Thompson, J. D. 2007. Acoustic brainwave entrainment with binaural beats. http://www.neuroacoustic.com/entrainment.html (accessed June 16, 2008).

Tomatis, A. 1983. Brain/mind bulletin collections. *New Sense Bulletin* 8, no. 4A (Jan. 24).

Vaughn, K. 2000. Music and mathematics: Modest support for the oft-claimed relationships. *Journal of Aesthetic Education* 34 (3–4): 149–66.

Waldkoetter, R. O. 1991. Hemi-Sync uses in military settings: Education and counseling. *Hemi-Sync Journal* 9 (4): 11–12.

Webb, D., and T. Webb. 1990. *Accelerated learning with music*. Norcross, GA: Accelerated Learning Systems.

Weinberger, N. M. 1995. Nonmusical outcomes of music education. *MuSICA Research Notes* 2 (2): 6.

Weinberger, N. M. 1999. Can music really improve the mind? The question of transfer effects. *MuSICA Research Notes* 5 (6): 12.

Weinberger, N. M. 2004. Music and the brain. *Scientific American* 291:89–95.

West, M. A. 1980. Meditation and the EEG. *Psychological Medicine* 10:369–75.

Wilson, F. 1991. Music and the neurology of time. *Music Educators Journal* 77 (5): 26–30.

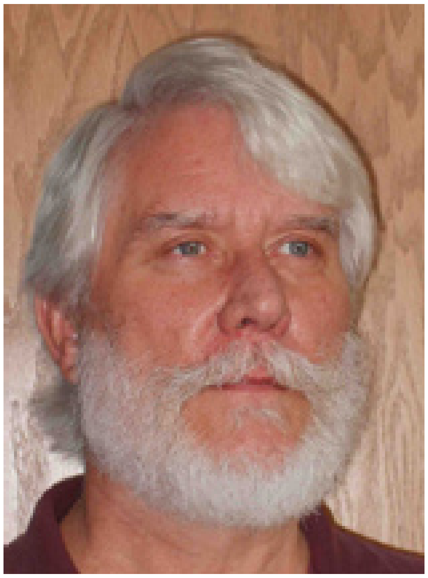
Wilson, T. L., and T. L. Brown. 1997. Reexamination of the effect of Mozart's music on spatial-task performance. *Journal of Psychology* 131 (4): 365–70.

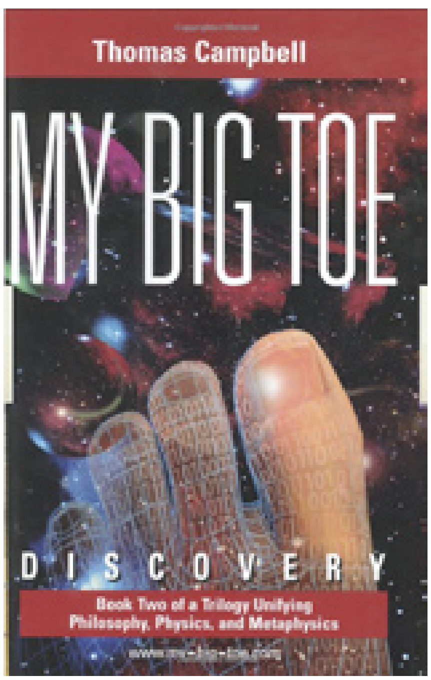
Zatorre, R. 1997. Hemispheric specialization of human auditory processing: Perception of speech and musical sounds. *Advances in Psychology* 123:299.

Zull, J. E. 2002. *The art of changing the brain: Enriching the practice of teaching by exploring the biology of learning*. Sterling, VA: Stylus.

Next Page

CAMPBELL TO DELIVER KEYNOTE ADDRESS





A reminder: Thomas W. Campbell has graciously accepted our invitation to offer the keynote address at **Consciousness: The Endless Frontier,** The Monroe Institute's Twenty-second Professional Seminar, which will be held March 20–24, 2010.

Tom holds a Bachelor of Science in physics and math from Bethany College and a Master of Science in physics from Purdue University, as well as having done doctoral-level work at the University of Virginia. He is the physicist described as "TC" in Bob Monroe's *Far Journeys*. Tom began researching altered states of consciousness with Bob in the early 1970s. He and a few others helped to design experiments and develop the technology for creating specific altered states. They were also the main subjects of Bob's investigations at that time. For the past thirty years, Campbell has been focused on scientifically exploring the properties, boundaries, and abilities of consciousness. During that same time period, he excelled as a working scientist—a professional physicist dedicated to pushing back the frontiers of cutting-edge technology.

Using his mastery of the out-of-body experience as a springboard, he dedicated his research to discovering the outer boundaries, inner workings, and causal dynamics of the larger reality system. In February of 2003, Tom published the *My Big TOE* trilogy. The acronym "TOE" is a standard term in the physics community that stands for "Theory Of Everything" and has been the Holy Grail of that community for fifty years. *My Big TOE* represents the results and conclusions of Tom's personal and scientific exploration of the nature of existence. This overarching model of reality, mind, and consciousness merges physics with metaphysics, explains the paranormal as well as the normal, places spirituality within a scientific context, and provides direction for those wishing to personally experience an expanded awareness of All That Is.

Please join us in March to hear Tom share the knowledge and wisdom he has acquired since following his personal inclination to "find out for himself."

Theory Of Everything
Theory Of Everything
Theory Of Everything
Theory Of Everything

Next Page

EXPANDED VISION, EXTENDED CONTENT

by Leslie France

This is a pivotal issue in the history of the *TMI Journal*. In keeping with TMI's re-visioned position as a hub and clearinghouse for matters of consciousness exploration, we are introducing items of interest from a variety of sources other than the Institute. They may appear as article reprints, short synopses with links to a complete article, links to Web sites or books, etc.

This extended content is meant to complement the work of our professional members and Institute staff, whose research remains the soul of the *TMI Journal*.

The *TMI Journal* (originally *Breakthrough,* then the *Hemi-Sync® Journal*) has been published by The Monroe Institute since the mid-1980s. Along with the *TMI Focus*, it was created to preserve and disseminate the rich legacy of material that had begun accumulating. As the work of The Monroe Institute penetrated larger populations—making its unique consciousness-exploration and development tools available to a growing community of users—reports on the results of those uses streamed in. Over the years an impressive library has accrued.

Now it is time to expand the focus of our publications to include the larger community of consciousness explorers. Executive Director Paul Rademacher, in his article "A Vision for the Future" (summer/fall 2007 *Focus*), said of the Institute's technology, education, and research: "They are . . . vital pieces of an expanded vision comprised of interlocking and mutually reinforcing elements. This network of elements will work to enhance the TMI image as a hub for the exploration of consciousness—a place inspired by curiosity and creativity. . . . TMI is well situated to be a leader in the ever-expanding field of consciousness. . . . The time is right for a new energy to emerge that may be beyond anything we could imagine."

It is our aim to continue offering timely, relevant, forward-thinking subject matter from a broader global perspective. The *TMI Journal* emerges from our collective vision. We welcome your links, feedback, and suggestions—your vision—in this process. Please submit recommendations by e-mail to **ann.vaughan@monroeinstitute.org**

Next Page

WHAT DO YOU SEE?

Emotion may help the visual system jump the gun to predict what the brain will see

by Jenny Lauren Lee

Science News, August 29th, 2009; Vol.176 #5

"Scientists have long been interested in what role emotions play in recognizing objects …" As researchers look more deeply into the human capacity of visual perception they are finding it's about more than what meets the eye. The components of affect, mood, and emotion appear to influence what people see and don't see.

Science News **writer Jenny Lauren Lee explains, "Studies show that the brain guesses the identity of objects before it has finished processing all the sensory information collected by the eyes. And now there is evidence that how you feel may play a part in this guessing game. A number of recent studies show that these two phenomena—the formation of an expectation about what one will see based on context and the visual precedence that emotions give to certain objects—may be related. In fact, they may be inseparable."** Read more …

DEFINING THE ESSENCE OF CONSCIOUSNESS

Students and teachers of human consciousness abound. When in the 1950s Robert Monroe began his journeys out of the body, he was hard pressed to find someone who could offer the kind of guidance he sought. Not so these days. Our challenge lies in evaluating the plethora of available resources and identifying those that best serve our needs. One such resource is prolific British author and philosophy professor Mark Rowlands.

Wikipedia introduces Rowlands as "a peripatetic professional philosopher who achieved widespread fame for his critically acclaimed autobiography, *The Philosopher and the Wolf,* published by Granta in 2008. This is the story of a decade of his life … spent living and travelling with a wolf and the philosophical reflections that resulted from [the experience]. As a professional philosopher, Rowlands is known as one of the principal architects of the view known as *vehicle externalism or the extended mind*, and also for his work on the moral status of animals."

Among Rowlands' many scholarly papers that speak to our collective investigation into the nature of consciousness—or in this case, phenomenal consciousness—is "Consciousness: The transcendentalist manifesto," published in 2004 in the journal *Phenomenology and the Cognitive Sciences* by Springer Netherlands. From the abstract published on SpringerLink: "Consciousness, it will be argued, is not an empirical but a transcendental feature of the world. That is, what it is like to have an experience is not something of which we are aware in the having of that experience, but an item in virtue of which the genuine (non-phenomenal) objects of our consciousness are revealed as being the way they are."

Our attention was also captured by Rowlands' 2001 book, *The Nature of Consciousness,* published by Cambridge University Press. Reviewer Ion Georgiou on MentalHelp.net says of *The Nature of Consciousness* that it is "a book filled with scholarly argument, well-developed—but also well-defined—complex jargon, [an] excellent critique of all the previous important works of the field (thought experiments included) and written by a philosophy lecturer. This book is required reading not only for those wanting to get to grips with what is going on in consciousness studies, but for those who are dissatisfied with the current accounts which, as Rowlands points out, tend to base themselves on an objectualist thesis."

A complete bibliography of Mark Rowlands' published books and papers can be seen on his website.

Next Page

Kudos to the Professional Membership

Our recent continuing education certification is cause for gratitude and celebration. It is a significant milestone that represents a vast quantity of work over several decades, most recently, the strong efforts of the TMI staff ably led by Development Director Karen Malik. Thanks to all who participated in that effort!

It was possible to pull together the quantity and quality of substantive documentation required to support our certification due, in large part, to TMI's Professional Membership. They are the researchers, practitioners, and educators who have meticulously applied and tested the effects of binaural-beat technology and who publish their results independently, as well as through the Institute. As we celebrate this milestone in TMI's evolution, we give special recognition to the men and women of the Professional Membership whose dedication and tenacity has only begun to pay off.

Editors: Shirley Bliley, Ann Vaughan
Layout & Design: Grafton Blankinship

The **TMI JOURNAL**, a publication of The Monroe Institute®, an educational and research organization dedicated to exploring and developing the uses and understanding of human consciousness, offers current reporting on research and application of binaural beat technology in a variety of professional fields.

The **TMI JOURNAL** is published by The Monroe Institute, 365 Roberts Mountain Road, Faber, VA 22938-2317. Telephone: (434) 361-1252. Membership rates from $50 to $100 per year.

Back to page 1