What Are Binaural Beats?

Binaural beats are auditory brainstem responses which originate in the superior olivary nucleus of each hemisphere. They result from the interaction of two different auditory impulses, originating in opposite ears, below 1000 Hz and which differ in frequency between one and 30 Hz (Oster, 1973).For example, if a pure tone of 400 Hz is presented to the right ear and a pure tone of 410 Hz is presented simultaneously to the left ear, an amplitude modulated standing wave of 10 Hz, the difference between the two tones, is experienced as the two wave forms mesh in and out of phase within the superior olivary nuclei. This binaural beat is not heard in the ordinary sense of the word (the human range of hearing is from 20-20,000 Hz). It is perceived as an auditory beat and theoretically can be used to entrain specific neural rhythms through the frequency-following response (FFR)--the tendency for cortical potentials to entrain to or resonate at the frequency of an external stimulus. Thus, it is theoretically possible to utilize a specific binaural-beat frequency as a consciousness management technique to entrain a specific cortical rhythm.

The "frequency-following response" effect.

The binaural-beat appears to be associated with an electroencephalographic (EEG) frequency-following response in the brain(3). Many studies have demonstrated the presence of a frequency-following response to auditory stimuli, recorded at the vertex of the human brain (top of the head). This EEG activity was termed "frequency-following response" because its period corresponds to the fundamental frequency of the stimulus (Smith, Marsh, & Brown, 1975). Binaural-beat stimulation appears to encourage access to altered states of consciousness.

Various Uses Of Audio With Embedded Binaural Beats

Uses of audio with embedded binaural beats that are mixed with music or various pink or background sound are diverse. They range from relaxation, meditation, stress reduction, pain management, improved sleep quality, decrease in sleep requirements, super learning, enhanced creativity and intuition, remote viewing, telepathy, and out-of-body experience and lucid dreaming. Audio embedded with binaural beats is often combined with various meditation techniques, as well as positive affirmations and visualization.

Resonant entrainment of oscillating systems

Resonant entrainment of oscillating systems is a well-understood principle within the physical sciences. If a tuning fork designed to produce a frequency of 440 Hz is struck (causing it to oscillate) and then brought into the vicinity of another 440 Hz tuning fork, the second tuning fork will begin to oscillate. The first tuning fork is said to have entrained the second or caused it to resonate. The physics of entrainment apply to biosystems as well. Of interest here are the electromagnetic brain waves. The electrochemical activity of the brain results in the production of electromagnetic wave forms which can be objectively measured with sensitive equipment. Brain waves change

frequencies based on neural activity within the brain. Because neural activity is electrochemical, brain function can be modified through the introduction of specific chemicals (drugs), by altering the brain's electromagnetic environment through induction, or through resonant entrainment techniques.

The Discovery Of Binaural Beats

Binaural beats were discovered in 1839 by a German experimenter, H. W. Dove. The human ability to "hear" binaural beats appears to be the result of evolutionary adaptation. Many evolved species can detect binaural beats because of their brain structure. The frequencies at which binaural beats can be detected change depending upon the size of the species' cranium. In the human, binaural beats can be detected when carrier waves are below approximately 1000 Hz (Oster, 1973). Below 1000 Hz the wave length of the signal is longer than the diameter of the human skull. Thus, signals below 1000 Hz curve around the skull by diffraction. The same effect can be observed with radio wave propagation. Lower-frequency (longer wave length) radio waves (such as AM radio) travel around the earth over and in between mountains and structures. Higher-frequency (shorter wave length) radio waves (such as FM radio, TV, and microwaves) travel in a straight line and can't curve around the earth. Mountains and structures block these high-frequency signals. Because frequencies below 1000 Hz curve around the skull, incoming signals below 1000 Hz are heard by both ears. But due to the distance between the ears, the brain "hears" the inputs from the ears as out of phase with each other. As the sound wave passes around the skull, each ear gets a different portion of the wave. It is this waveform phase difference that allows for accurate location of sounds below 1000 Hz(9). Audio direction finding at higher frequencies is less accurate than it is for frequencies below 1000 Hz. At 8000 Hz the pinna (external ear) becomes effective as an aid to localization. In summary it's the ability of the brain to detect a waveform phase difference is what enables it to perceive binaural beats.

How It Works On The Brain

When signals of two different frequencies are presented, one to each ear, the brain detects phase differences between these signals. "Under natural circumstances a detected phase difference would provide directional information. The brain processes this anomalous information differently when these phase differences are heard with stereo headphones or speakers. A perceptual integration of the two signals takes place, producing the sensation of a third "beat" frequency. The difference between the signals waxes and wanes as the two different input frequencies mesh in and out of phase. As a result of these constantly increasing and decreasing differences, an amplitude-modulated standing wave -the binaural beat- is heard. The binaural beat is perceived as a fluctuating rhythm at the frequency of the difference between the two auditory inputs. Evidence suggests that the binaural beats are generated in the brainstem's superior olivary nucleus, the first site of contralateral integration in the auditory system (Oster, 1973). Studies also suggest that the frequency-following response originates from the inferior colliculus (Smith, Marsh, & Brown, 1975)" (Owens & Atwater, 1995). This activity is conducted to the cortex where it can be recorded by scalp electrodes.

Altered States

Binaural beats can easily be heard at the low frequencies (< 30 Hz) that are characteristic of the EEG spectrum (Oster, 1973). This perceptual phenomenon of binaural beating and the objective measurement of the frequency-following response (Hink, Kodera, Yamada, Kaga, & Suzuki, 1980) suggest conditions which facilitate entrainment of brain waves and altered states of consciousness. There have been numerous anecdotal reports and a growing number of research efforts reporting changes in consciousness associated with binaural-beats. "The subjective effect of listening to binaural beats may be relaxing or stimulating, depending on the frequency of the binaural-beat stimulation" (Owens & Atwater, 1995). Binaural beats in the delta (1 to 4 Hz) and theta (4 to 8 Hz) ranges have been associated with reports of relaxed, meditative, and creative states (Hiew, 1995), and used as an aid to falling asleep. Binaural beats in the alpha frequencies (8 to 12 Hz) have increased alpha brain waves (Foster, 1990) and binaural beats in the beta frequencies (typically 16 to 24 Hz) have been associated with reports of increased concentration or alertness (Monroe, 1985) and improved memory (Kennerly, 1994).

Passively listening to binaural beats may not spontaneously propel you into an altered state of consciousness. One’s subjective experience in response to binaural-beat stimulation may also be influenced by a number of mediating factors. For example, the willingness and ability of the listener to relax and focus attention may contribute to binaural-beat effectiveness in inducing state changes. "Ultradian rhythms in the nervous system are characterized by periodic changes in arousal and states of consciousness (Rossi, 1986;

Shannahoff-Khalsa, 1991; Webb & Dube, 1981). These naturally occurring shifts may underlie the anecdotal reports of fluctuations in the effectiveness of binaural beats. External factors are also thought to play roles in mediating the effects of binaural beats" (Owens & Atwater, 1995). The perception of a binaural beat is, for example, said to be heightened by the addition of white noise to the carrier signal (Oster, 1973), so white noise is often used as background. "Music, relaxation exercises, guided imagery, and verbal suggestion have all been used to enhance the state-changing effects of the binaural beat" (Owens & Atwater, 1995). Other practices such as humming, toning, breathing exercises, autogenic training, and/or biofeedback can also be used to interrupt the homeostasis of resistant subjects (Tart, 1975).

Brain Waves and Consciousness

Controversies concerning the brain, mind, and consciousness have existed since the early Greek philosophers argued about the nature of the mind-body relationship, and none of these disputes has been resolved. Modern neurologists have located the mind in the brain and have said that consciousness is the result of electrochemical neurological activity. There are, however, growing observations to the contrary. There is no neurophysiological research which conclusively shows that the higher levels of mind (intuition, insight, creativity, imagination, understanding, thought, reasoning, intent, decision, knowing, will, spirit, or soul) are located in brain tissue (Hunt, 1995). A resolution to the

controversies surrounding the higher mind and consciousness and the mind-body problem in general may need to involve an epistemological shift to include extra-rational ways of knowing (de Quincey, 1994) and cannot be comprehended by neurochemical brain studies alone. We are in the midst of a revolution focusing on the study of consciousness (Owens, 1995). Penfield, an eminent contemporary neurophysiologist, found that the human mind continued to work in spite of the brain's reduced activity under anesthesia. Brain waves were nearly absent while the mind was just as active as in the waking state. The only difference was in the content of the conscious experience. Following Penfield's work, other researchers have reported awareness in comatose patients (Hunt, 1995) and there is a growing body of evidence which suggests that reduced cortical arousal while maintaining conscious awareness is possible (Fischer, 1971;West 1980; Delmonte, 1984; Goleman 1988; Jevning, Wallace, & Beidenbach, 1992; Wallace, 1986; Mavromatis, 1991). These states are variously referred to as meditative, trance, altered, hypnogogic, hypnotic, and twilight-learning states (Budzynski, 1986). Broadly defined, the various forms of altered states rest on the maintenance of conscious awareness in a physiologically reduced state of arousal marked by parasympathetic dominance (Mavromatis, 1991). Recent physiological studies of highly hypnotizable subjects and adept meditators indicate that maintaining awareness with reduced cortical arousal is indeed possible in selected individuals as a natural ability or as an acquired skill (Sabourin, Cutcomb, Crawford, & Pribram, 1993). More and more scientists are expressing doubts about the neurologists' brain-mind model because it fails to answer so many questions about our ordinary experiences, as well as evading our mystical and spiritual ones. The scientific evidence supporting the phenomenon of remote viewing alone is sufficient to show that mind-consciousness is not a local phenomenon (McMoneagle, 1993).

If mind-consciousness is not the brain, why then does science relate states of consciousness and mental functioning to brain-wave frequencies? And how is it that audio with embedded binaural beats alters brain waves? The first question can be answered in terms of instrumentation. There is no objective way to measure mind or consciousness with an instrument. Mind-consciousness appears to be a field phenomenon which interfaces with the body and the neurological structures of the brain (Hunt, 1995). One cannot measure this field directly with current instrumentation. On the other hand, the electrical potentials of brain waves can be measured and easily quantified. Contemporary science likes things that can be measured and quantified. The problem here lies in oversimplification of the observations. EEG patterns measured on the cortex are the result of electroneurological activity of the brain. But the brain's electroneurological activity is not mind-consciousness. EEG measurements then are only an indirect means of assessing the mind-consciousness interface with the neurological structures of the brain. As crude as this may seem, the EEG has been a reliable way for researchers to estimate states of consciousness based on the relative proportions of EEG frequencies. Stated another way, certain EEG patterns have been historically associated with specific states of consciousness. It is reasonable to assume, given the current EEG literature, that if a specific EEG pattern emerges it is probably accompanied by a particular state of consciousness.

As to the second question raised in the above paragraph, audio with embedded binaural beats alters the electrochemical environment of the brain. This allows mind-consciousness to have different experiences. When the brain is entrained to lower frequencies and awareness is maintained, a unique state of consciousness emerges. This state is often referred to as hypnogogia "mind awake/body asleep." Slightly higher-frequency entrainment can lead to hyper suggestive states of consciousness. Still higher-frequency EEG states are associated with alert and focused mental activity needed for the optimal performance of many tasks. Perceived reality changes depending on the state of consciousness of the perceiver (Tart, 1975). Some states of consciousness provide limited views of reality, while others provide an expanded awareness of reality. For the most part, states of consciousness change in response to the ever-changing internal environment and surrounding stimulation. For example, states of consciousness are subject to influences like drugs and circadian and ultradian rhythms (Rossi, 1986; Shannahoff-Khalsa, 1991; Webb & Dube, 1981). Specific states of consciousness can also be learned as adaptive behaviors to demanding circumstances (Green and Green, 1986).

Synchronized brain waves

Synchronized brain waves have long been associated with meditative and hypnogogic states, and audio with embedded binaural beats has the ability to induce and improve such states of consciousness. The reason for this is physiological. Each ear is "hardwired" (so to speak) to both hemispheres of the brain (Rosenzweig, 1961). Each hemisphere has its own olivary nucleus (sound-processing center) which receives signals from each ear. In keeping with this physiological structure, when a binaural beat is perceived there are actually two standing waves of equal amplitude and frequency present, one in each hemisphere. So, there are two separate standing waves entraining portions of each hemisphere to the same frequency. The binaural beats appear to contribute to the hemispheric synchronization evidenced in meditative and hypnogogic states of consciousness. Brain function is also enhanced through the increase of cross-collosal communication between the left and right hemispheres of the brain.

Resetting Your Brains Sodium/Potassium Ratio In Theta

Your brain cells reset their sodium & potassium ratios when the brain is in Theta state. The sodium & potassium levels are involved in osmosis which is the chemical process that transports chemicals into and out of your brain cells. After an extended period in the Beta state the ratio between potassium and sodium is out of balance. This the main cause of what is known as "mental fatigue". A brief period in Theta (about 5 - 15min) can restore the ratio to normal resulting in mental refreshment.