

Scientific Research supporting the effectiveness of Binaural Beats

Science ushered in a new era in our ability to learn, be creative, remember, control our moods, reduce stress, resolve unwanted behavior patterns, and a host of other desirable ends, with the publishing of a remarkable paper by Dr. Gerald Oster of Mt. Sinai Medical Center in the October 1973 issue of Scientific American.

Oster's paper, entitled "Auditory Beats in the Brain", describes how pulsations called binaural beats occurred in the brain when tones of different frequencies were presented separately to each ear. As a result, the entire brain becomes entrained to the internal beat and begins to resonate to that frequency. In other words, Oster discovered a method for what is called "entrainment" of brain wave patterns.

Simultaneously, Robert Monroe of the Monroe Institute of Applied Science was also investigating binaural beats. In thousands of experiments, using an EEG machine to monitor subject's electrical brain wave patterns, Monroe verified that he could indeed entrain the brain wave pattern using binaural beats. In addition, he noted that the response did not only happen in the area of the brain responsible for hearing, or only in one hemisphere or the other, but rather the entire brain resonated, the wave forms of both hemispheres becoming identical in frequency, amplitude, phase, and coherence.

Many researchers have also verified this phenomenon. Language and speech pathologist Dr. Suzanne Evans Morris, Ph.D., says "Research supports the theory that different frequencies presented to each ear through stereo headphones...create a difference tone (or binaural beat) as the brain puts together the two tones it actually hears. Through EEG monitoring the difference tone is identified by a change in the electrical pattern produced by the brain. For example, frequencies of 200Hz and 210 Hz produce a binaural beat frequency of 10 Hz. Monitoring of the brain's electricity (EEG) has shown that the brain produces increased 10 Hz activity with equal frequency and amplitude of the wave form in both hemispheres.

Research of Dr. Lester Fehmi, director of the Princeton Behavioral Medicine and Biofeedback Clinic and perhaps the foremost authority on hemispheric synchronization in the brain, also confirms that hemispheric synchronization and brain entrainment can be induced by binaural beats.

Dr. Arthur Hastings, Ph.D., in a paper entitled "Tests of the Sleep Induction Technique" describes the effects of subjects listening to a cassette tape specially engineered to create binaural beats in the brain. In this case, the sounds on the tape were designed to slow the brain wave patterns from a normal waking "beta" brain wave pattern to a slower alpha pattern, then to a still slower theta pattern (the brain wave pattern of dreaming sleep), and finally to a delta pattern, the slowest of all, the brainwave pattern of dreamless sleep.

Hastings says:

"We were able to test the effects of the sleep tape on brain waves with an EEG machine through the courtesy of the researchers at the Langely-Porter Neuropsychiatric Institute part of the University of California Medical School in San Francisco. Dr. Joe Kaniya, Director of the Psychophysiology of Consciousness Laboratory, monitored the brain-wave frequencies of one subject as he listened to the sleep tape."

"The chart showed a typical sleep onset pattern: initial alpha waves, then a slowing of the brain waves with sleep spindles, and finally a pattern of stage 2 and 3 sleep brain waves in the low theta range...the patterns in the various stages suggested that the tape was influencing the subject's state."

Dr. Bill D. Schul also refers to this brain entrainment phenomenon:

"...Phased sine waves at discernible sound frequencies, when blended to create 'beat' frequencies within the ranges of electrical brain waves found at the various stages of human sleep, will create a frequency following response (FFR) within the EEG pattern of the individual listening to such audio waveforms. The FFR in turn evokes physiological and mental states in direct relationship to the original stimulus. With the availability of this tool, it becomes possible to develop and hold the subject into any of the various stages of sleep, from light Alpha relaxation through Theta into Delta and in REM (dreaming)." His conclusion was that "Binaural beat-frequency stimulation creates a sustaining FFR that is synchronous in both amplitude and frequency between the brain hemispheres."

Skip Holmes Atwater describes the neurophysics of the binaural beat entrainment process:

"Within the sound processing centers of the brain, pulse stimulation provides relevant information to the higher centers of the brain. In the case of a wave form phase difference the electron pulse rate in one part of a sound-processing center is greater than in another. The differences in electron pulse stimulation within the sound processing centers of the brain are an anomaly. This anomaly (the difference in electron pulse stimulation) comes and goes as the two different frequency wave forms mesh in and out of phase. As a result of these constantly increasing and decreasing differences in electron pulse stimulation, an amplitude modulated standing wave (the binaural beat) is generated within the sound processing centers of the brain itself. It is this standing wave which acts to entrain brainwaves."

Mr. Atwater further states, "A conventional binaural beat generates two amplitude modulated standing waves, one in each hemisphere's olivary nucleus. Such binaural beats will entrain both hemispheres to the same frequency, establishing equivalent electromagnetic environments and maximizing interhemispheric neural communication."

The ability to entrain brain wave patterns opens up an exciting world of almost mind-boggling possibilities. Many neuroscience researchers have expressed their excitement.

"It's difficult to try to responsibly convey some sense of excitement about what's going on," said UCLA neurophysiologist John Kiebeskind. "You find yourself sounding like people you don't respect. You try to be more conservative and not say such wild and intriguing things, but damn! The field is wild and intriguing. It's hard to avoid talking that way...We are at a frontier, and it's a terribly exciting time to be in this line of work."

Neurochemist Candace Pert of the National Institute of Mental Health and this to say:

"There's revolution going on. There used to be two systems of knowledge: hard science – chemistry, physics, biophysics – on the one hand, and, on the other, a system of

knowledge that included etiology, psychology and psychiatry. And now it's as if a lightning bolt had connected the two. It's all one system – neuroscience...The present era in neuroscience is comparable to the time when Louis Pasteur first found out that germs cause disease.

David Krech, University of California at Berkeley psychologist predicted almost twenty-five years ago. "I foresee the day when we shall have the means, and therefore, inevitably, the temptation, to manipulate the behavior and intellectual functioning of all people through environmental and biochemical manipulation of the brain."

That day may very well be here now, and the gentle altering of brain wave patterns using sound may be the easiest, most potent, and safe way to do it. This knowledge gives us the possibility to entrain brain wave patterns, giving us the ability to influence and/or create tranquility, pain control, creativity, euphoria, excitement, focused attention, relief from stress, enhanced learning ability, enhanced problem solving ability, increased memory, accelerated healing, behavior modification, and improvements in mental and emotional health.

Michael Hutchison in his book *Megabrain Power* sums up this revolution in neuroscience:

New breakthroughs in neuroscience and microelectronics have permitted scientists to 'map' the electrical and chemical activity of the brain in action. Scientists have used the new technology to monitor the brains of those meditators, artists, and other rare individuals who are able to enter peak domains at will and to map their brain activity during those peak states.

Their first findings were that those peak states are not mysterious and unpredictable phenomena, but are very clearly linked to very specific patterns of brain activity, hemisphere symmetry, and rapid alterations in the levels of various neurochemicals. If we could learn to produce these patterns of brain activity, they reasoned, we should be able to produce the peak states they are associated with.

" ...They found that by using types of mechanical stimulation, such as ...precise combinations of pulsating sound waves...they could actually produce those same 'peak state' brain patterns in ordinary people."

Just as we exercise our bodies to feel better and improve our physical health, stimulating the brain in this manner exercises the brain, bringing better mental and emotional health and increased intellectual functioning. Researcher Robert Cosgrove, Jr., Ph.D., M.D., an authority in pharmaceuticals and biomedical engineering, noted that technologies that alter brainwave patterns "with appropriately selected stimulation protocols have been observed by us to be an excellent neuropathway exerciser. As such we believe it has great potential for use in promoting optimal cerebral performance...Furthermore, the long-term effects of regular use...on maintaining and improving cerebral performance throughout life and possibly delaying for decades the deterioration of the brain traditionally associated with aging is very exciting.

There are four categories of brain wave patterns. The most rapid brain wave pattern is that of beta, from about 14Hz to 30 Hz up to more than 100Hz. This is the pattern of normal waking consciousness, and is associated with concentration, arousal, alertness,

and cognition, while at higher levels, beta is associated with anxiety. As we become more relaxed, the brain wave activity slows into the alpha range, from 7 to 13 Hz. These are the brain wave patterns of deep relaxation, and of what has been called the “twilight state” between sleep and waking, while the higher end of alpha represents a more relaxed yet focused state.

Slower still are the theta waves, between 3 and 6 Hz. This is the state of dreaming sleep and also of increased creativity, super learning, integrative experiences, and increased memory. The slowest brain wave pattern is delta, that of dreamless sleep, between 0 and 2 Hz. Generally people are asleep in delta, but there is evidence that it is possible to remain alert in this state – a very deep trance like, non-physical state. It is in delta that our brains are triggered to release large quantities of healing growth hormone.

As we slow the brain wave patterns from delta to alpha to theta to delta, there is a corresponding increase in balance between the two hemispheres of the brain. This more balanced brain state is called brain synchrony, or brain synchronization. This balancing phenomenon was noted in early EEG studies of experienced meditators in the 1970’s. In deep meditative states, their brain waves shifted from the usual asymmetrical patterns, with one hemisphere dominant over the other, to a balanced state of whole-brain integration, with the same brain wave frequency throughout. As we shall see, there are various mental abilities and experiences that naturally happen in these different wave patterns, many of which are rather remarkable.

Robert Monroe reported that inducing brain wave patterns through the creation of binaural beats in the brain had a wide range of effects, including “focusing of attention, suggestibility, problem solving, creative memory, and learning...sleep induction, pain control...and enhanced learning...”

Other scientists have noted that these slower brain wave patterns are accompanied by deep tranquility, flashes of creative insight, euphoria, intensely focused attention, and enhanced learning abilities. Dr. Lester Fehmi, director of the Princeton, Biofeedback Research institute has said that hemispheric synchronization represents “the maximum efficiency of information transport through the whole brain” and “is correlated experientially with a union with experience, and ‘into-it-ness’. Instead of feeling separate and narrowly-focused, you tend to feel more into it – that is, unified with the experience, you are the experience – and the scope of your awareness is widened a great deal, so that you’re including many more experiences at the same time. There’s a whole-brain sensory integration going on, and it’s as if you become less self-conscious and you function more intuitively.

One of the observed effects of this type of sound-induced brain synchronization is increased learning ability. What is now known as “super learning” began in the late 1960’s and early 1970s with the work of Bulgarian psychiatrist George Lozanov. Lozanov used deep relaxation combined with synchronized rhythms in the brain to cause students to produce alpha waves. In this state, he found that students learned over five times as much information in less time per day, with greater retention. In some cases, as much as thirty times as much was learned.

Speech-Language pathologist Suzanne Evans Morris, Ph.D. extensively describes the relationship between different brain wave patterns and learning, as well other related states such as concentration, problem solving, receptivity, and creativity. “Receptivity for

learning is related to specific states of consciousness. Predominant brainwave patterns are associated with different states of consciousness or awareness. For example, beta frequencies ranging from 13-26 Hz are associated with concentration, and alert problem solving; alpha frequencies occur when the eyes are closed and a state of alert relaxation is present; theta is associated with deep relaxation with a high receptivity for new experiences and learning..." Morris also describes how cassette tapes containing binaural beat signals can be used to "create the ability to sustain this theta period of openness for learning."

Morris goes on to say that "the introduction of theta signals...into the learning environment theoretically allows for a broader and deeper processing of the information provided by the teacher" and "increases...focus of attention and creates a mental set of open receptivity." She notes that in the use of such binaural beat signals in a classroom setting, children exhibit "improved focus of attention" and "a greater openness and enthusiasm for learning".

Morris further describes what happens in the brain that makes this type of accelerated learning so effective:

The presence of theta patterns in the brain has been associated with states of increased receptivity for learning and reduced filtering of information by the left hemisphere. This state of awareness is available for relatively brief periods as the individual enters a state of reverie or passes in and out of deep sleep phase of the 90 minute sleep cycle. Binaural beat signals, however, can facilitate a prolonged state of theta to produce a relaxed receptivity for learning...These signals create a state of coherence in the brain. Right and left hemispheres as well as subcortical areas become activated in harmony, reflected by equal frequency and amplitude of EEG patterns from both hemispheres. This creates an internal physiological environment for learning, which involves the whole brain. The linear, sequential style of problem solving preferred by the left hemisphere is brought into balance with the global, intuitive style of the right hemisphere and limbic system. This allows the learner to have greater access to internal and external knowledge and provides a milieu for expanding intuition in problem solving. One of the by-products of hemispheric synchronization appears to be a highly focused state of attending. The ability to reduce 'mind matter' and focus the attention is critical for efficient learning.

Binaural beat signals have been used in the classroom to enhance learning ability. Teachers in the Tacoma, Washington public schools, under the direction of psychologist Devon Edington, used audio tapes containing binaural beat sound technology to influence the learning ability of students. They found that students who were taught, studied, and took tests while these tapes were playing did significantly better than a control group not using the tapes.

The theta state also seems to be one where behavior and belief system changes can more easily be made. Suzanne Evans Morris discusses the work of neurotechnology and biofeedback researcher Thomas Budzynski (1981) in which he describes the theta state as "A transition zone between wakefulness and sleep in which one can absorb new information in an uncritical, non-analytical fashion." Budzynski speculated that this allows new information to be considered by the right hemisphere through bypassing the critical filters of the left hemisphere. Thus, information leading to a change in self-concept would become more available; modification of habitual behaviors or

consideration of one's belief system could occur more easily if alternatives were presented during a period of theta activity.

Medical researcher Dr. Gene W. Brockopp also believes behavior modification is enhanced when the subject can be placed in slower, more receptive brain wave patterns. He speculates that using technology to induce brain wave changes can "Actively induce a state of deactivation in which the brain is passive, but not asleep; awake, but not involved with the 'cutter' of an ongoing experience." If this is true, then it may be a state in which new cognitive strategies could be designed and developed... if we can help a person to experience different brain wave states consciously through driving them with external stimulation, we may facilitate the individuals' ability to allow more variations in their functioning through breaking up patterns at the neural level. This may help them develop the ability to shift gears or 'shuttle' and move them away from habit patterns of behavior to become more flexible and creative, and to develop elegant strategies of functioning.

Many other researchers have described the benefits of alpha and theta brain wave states. Budzynski has done extensive research on learning and suggestion when the brain is in the theta state. Theta is the state in which "super learning" takes place – when in theta, people are able to learn new languages, accept suggestions for changes in behavior and attitudes, or memorize large amount of information. He says "we take advantage of the fact that the hypnagogic (theta) state, the twilight state...has these properties of uncritical acceptance of verbal material, or almost any material it can process." In this state, he says, "a lot of work gets done very quickly."

Budzynski and psychobiologist Dr. James McGaugh of the University of California at Irvine have both found that information is also more easily processed and recalled in a theta state. Noted researchers Elmer and Akyce Green of the Meninger Foundation have also studied this phenomenon, finding that memories experienced in theta state "were not like going through a memory in one's mind but rather like an experience, a reliving." Those producing theta waves also had "new and valid ideas or synthesis of ideas, not primarily by deduction but springing by intuition from unconscious sources."

In their seminal book *Beyond Biofeedback*, the Greens further discussed many remarkable effects of the theta brain wave state. They found that those producing theta waves became highly creative. They had life-altering insights, what the Greens called "integrative experiences leading to feelings of psychological well-being." On psychological tests, subjects scored as being "psychologically healthier, had more social poise, were less rigid and conforming, and were more self-accepting and creative". Another remarkable effect was that these subjects became very healthy. Emotionally, these people had "improved relationships with other people as well as greater tolerance, understanding, and love of oneself and one's world.

Alpha and theta states have also been shown to facilitate additional recovery. Dr. Eugene Peniston and Paul Kulkosky of the University of Southern Colorado trained a group of alcoholics to enter the alpha and theta states. These alcoholics showed a recovery rate many orders of magnitude greater than a control group. Thirteen months later, this alpha-theta group showed sustained prevention of relapse, and these findings were confirmed in another follow up study three years later. In addition, this group showed a marked personality transformation, including significant increases in qualities such as

warmth, stability, conscientiousness, boldness, imaginativeness, and self-control, along with decreases in depression and anxiety.

At the brain wave pattern at the juncture between the alpha and theta rhythms, often called the “crossover point” by neuroscientists, subjects have experienced some remarkable changes. Houston therapist William Bechwith has reported that in his clients the experience of this crossover point is often accompanied by “the seemingly miraculous resolutions of complex psychological problems.”

Other studies have suggested that states of brain synchronization increase memory. McGaught’s research on memory and theta waves showed that “the more theta waves appeared in an animal’s EEG after a training session, the more it remembered. This was true in all cases... Apparently, the best predictor of memory was the amount of theta waves recorded in the animal’s brain. Theta waves show that the brain is in the right state to process and store information.”

Scientists have discovered that for memories to form, the brain must undergo a process called long-term potentiation (LPT), involving electrical and chemical changes in the neurons associated with memory. Without LPT, incoming information is not stored, but rather quickly and totally forgotten. Neurophysiologist Dr. Gary Lynch and associates at the University of California at Irvine discovered that the key to LPT is the theta brain wave pattern. “We have found the magic rhythm that makes LPT. There’s a magic rhythm, the theta rhythm.” According to Lynch, this is the natural rhythm of the hippocampus, the part of the brain essential for the formation and storage of new memories and the recall of old memories.

Other studies have confirmed the incredible benefits of the theta state. In experiments conducted at the Monroe Institute of Applied Science, subjects who produced theta waves in response to binaural beats “invariably emerged from the experience reporting all the mental phenomena associated with the theta state, such as vivid hypnagogic imagery, creative thoughts, integrative experiences, and spontaneous memories.”

How do these amazing mental and emotional changes take place? Many researchers believe different wave patterns are linked to the production in the brain of various neurochemicals associated with relaxation and stress release, increased learning and creativity, memory, and other desirable benefits. These neurochemicals included beta-endorphins, acetylcholine, vasopressin, and serotonin.

Dr. Margaret Patterson in collaboration with biochemist Dr. Ifor Capel at the Marie Curie Cancer Memorial Foundation Research Department in Surrey, England, has shown that certain frequencies in the brain dramatically speed up production of a variety of neurotransmitters, different frequencies triggering different brain chemicals. For instance, a 10 Hz (alpha) signal boost the production and turnover rate of serotonin, a chemical messenger that increases relaxation and eases pain, while catecholamines, vital for memory and learning, respond at around 2 Hz (theta).

According to Capel “as far as we can tell, each brain center generates impulses at a specific frequency based on the predominant neurotransmitter it secretes. In other words, the brain’s internal communication system – its language, if you like – is based on frequency... Presumably, when we sent in waves of electrical energy at, say, 10 Hz,

certain cells in the lower brain stem will respond because they normally fire within that frequency range.

Dr. William Bauer, one of the foremost experts in the field of electromedicine elaborates: “What I think is happening... is that by sending out the proper frequency, proper waveform and proper current... we tend to change the configuration of the cell membrane... Cells that are at sub-optimal levels are stimulated to ‘turn on’ and produce what they’re supposed to produce, probably through DNA, which is stimulated through the cell membrane... You’re charging the cells through a biochemical process that can possibly balance the acetylcholine or whatever neurotransmitter needs to be turned on...”

The increased production of these different neurochemicals can greatly enhance memory and learning. A research team at the Veterans Administration Hospital in Palo Alto found that a group of normal human subjects, when given substances that increased acetylcholine production in the brain, showed greater improvements in long-term memory, while at MIT, students taking acetylcholine enhancers had improved memory and increased ability to such higher mental processes as learning memory.”

Recent studies show that insufficient acetylcholine causes memory loss and reduces learning and intelligence, and confusion and memory loss in Alzheimer’s disease have been linked in part to a lack of acetylcholine. Other studies have shown that when individuals are given substances that increase the amount of acetylcholine they show significant increases in scored on memory and intelligence tests.

Other neurochemicals that are produced in the brain response to binaural beats have been associated with increased memory, learning and other benefits. Men in their fifties taking vasopressin, a neurochemical closely related to the endorphins, showed significant improvement in memory, learning, and reaction time. In another study, sixteen normal healthy subjects of average intelligence were given vasopressin several times and showed dramatic improvement in their ability to learn and remember. Dutch scientists further found that vasopressin had a long-term “cementing effect on consolidation of information.

At the National Institute of Mental Health, research has indicated that vasopressin boosts memory, enabling subjects to chunk and encode information better. NIMH found that decreasing vasopressin is associated with memory deficits. Vasopressin is also associated with and enhances production of theta waves which are associated with increased access to memories and increased creativity. Vasopressin also stimulates the release of endorphins and has restored memory in amnesia victims.

Scientists have also found that the endorphins released when the brain is exposed to alpha and theta binaural beat patterns enhance many mental functions. Endorphins have a powerful strengthening effect on learning and memory, for instance, and have been known to reverse amnesia. Researcher David de Weid found that rats injected with endorphins increased the length of time they remembered things. 1977 Nobel Prize-winner Andrew Schally found that rats running complex mazes who received injections of endorphins improved maze-running abilities.

Why do endorphins increase learning and memory? Neuroscientists believe that in humans the places in the brain that produce the most endorphins, and contain the

greatest concentration of endorphin receptors, are the same areas of the brain involved most intimately with learning and memory. Aryeh Routtenberg of Northwestern University located these pleasure centers in the brain noted that - the evidence clearly shows that the brain reward pathways play an important role in learning and memory... I have speculated that the pathways of brain reward may function as the pathways of memory consolidation. By this I mean that when something is learned, activity in the brain reward pathways facilitates formation of memory... Evidence for the reward effects of localized electrical stimulation... and for the association of reward paths with memory formation indicates that the neural substrates of self-stimulation play a vital role in the guidance of behavior.

Scientists now know of a least seven chemicals in the endorphin family that have effects on memory and learning. Endorphins, according to neuroscientists, “serve as the body’s natural reward system, providing us with a rush of pleasure whenever we learn something or act in some way that is conducive to our survival as a species”. This means that new belief systems designed to effect desirable behavior changes, if presented to the mind when it is flooded with endorphins, may be perceived as beneficial and adopted as such – a powerful boost to any behavior modification protocol.

Candice Pert of NIMH, the discoverer of the opiate receptor, has also described this process, noting that “the endorphins, our natural opiates, are a filtering mechanism in the brain. The opiate system selectively filters incoming information from every sense – sight, hearing, smell, taste, and touch – and blocks some of it from percolating up to higher levels of consciousness.

Scientists now believe that the movement when learning takes place – the ‘aha’ moment – is that moment when a particular reality has been selected and filtered by our endorphins and is suddenly apprehended by our brain in such a way that we learn something new, this learning being rewarded by a flood of endorphins along our pleasure-learning pathways.

The production in the brain of alpha and theta patterns in the brain is also correlated to the “relaxation response” – the mirror image of the more well known “fight or flight response”. The fight or flight response takes blood flow away from the brain and toward the periphery of the body, floods the bloodstream with sugar, and increases the heart rate, blood pressure and breathing in order to prepare one for defense or flight. In this state learning ability, as well as other mental functions including problem solving and reasoning ability, are inhibited.

The relaxation response, on the other hand, mobilizes us for inward activity by reducing heart rate and blood pressure, relaxing muscles, and increasing the percentage of oxygen flow to the brain. As one might expect, the fight or flight response is accompanied by low amplitude, high frequency beta brain wave patterns in the brain, while the relaxation response so beneficial to learning and problem solving is accompanied by high amplitude, low frequency alpha and theta rhythms. When we use sound technologies to induce these slower brain wave patterns, we also induce the relaxation response, another possible reason for the increases in learning ability noted by so many researchers.

A recent study performed by Dr. Vincent Giampapa, cortisol is the major age-accelerating hormone within the brain as well as a significant bio-marker for stress.

Cortisol also interferes with learning and memory and is bad news for your health and well-being.

DHEA is also produced by your adrenal glands. It is a precursor, or source ingredient, to virtually every hormone your body needs. DHEA levels are a key determinant of physiological age and resistance to disease. When DHEA levels are low, you're more susceptible to aging and disease; when they're high, the body is at its peak – vibrant, healthy, and able to combat disease effectively.

DHEA acts as a buffer against stress-related hormones, which is why as you get older and make less DHEA you are more susceptible to stress and disease.

A study published in the New England Journal of Medicine (December 11, 1986) found that a 100 microgram per deciliter increase in DHEA blood levels corresponded with a 48% reduction in mortality due to cardiovascular disease – and a 36% reduction in mortality for any reason.

Melatonin, everyone knows, is a hormone that helps to create restful sleep. We make less of it as we age, and since during sleep many important rejuvenating substances are created in the brain, the inability to sleep soundly can dramatically decrease the quality of your life and greatly accelerate the aging process.

In a before and after study of audio technology, the following changes were noted in levels of melatonin, DHEA, and cortisol:

In just three days, over 68% had increased in DHEA levels, with an average increase of 43.77%! Several people had increases of 50, 60, even 90%.

Cortisol was down an average of 46.47%, with positive changes in 68% of the people, and with several people having decreases of 70 to 80%

Melatonin levels increased an average of 97, 77% with positive changes happening in over 73% of the people! Many had improvements of 100, 200, even 300%!

In addition to the effects described above, there is an even more remarkable generalized effect when brainwave patterns are slowed into the alpha, theta and delta ranges. Slowing of brain wave patterns increases electrical fluctuation in the brain, changing the neural structure and pushing the brain to recognize itself at higher, more complex levels of functioning. This reorganization process is predicted by the work of scientists Ilya Prigogine, 1977 Nobel Prize-winner.

What Prigogine noticed was that what he calls “open systems” – systems that are able to exchange energy and matter with their environment – are able to maintain their structure and even grow and evolve into more complex systems because they actually have the ability to dissipate entropy to their environment in such a way that the total amount of entropy, overall, does increase – obeying the second law of thermodynamics. These systems maintain their orderliness – and even increase it – at the expense, entropically speaking, of their environment.

An open system – of which a human being is a prime example – is a flow of energy. We constantly take in light, air, water, heat, nutrients, as well as all kinds of information from

our senses. In turn, we dissipate to our environment carbon dioxide, heat, waste products, activities of various kinds, and so on. And, scientists have noted, we are more than just a tube with something flowing through it, we are the flow itself – not just a “thing,” but a living, changing, evolving process.

Open systems are very plastic and can handle all kinds of fluctuation and variations in input from their environment, but each system has an upper limit of how much randomness, how much entropy, it can dissipate to its environment. This limit is based on the system’s structure and its degree of complexity. The higher the complexity the greater the ability to dissipate entropy.

If fluctuations from the environment exceed this limit, the system can not dissipate enough entropy to maintain its structure. If this condition persists, at a certain point the system is pushed to recognize itself at a higher level of functioning in order to create a new structure that can handle these increased fluctuations.

This point, which Prigogine called a bifurcation point is the point at which the system spontaneously re-orders itself in an entirely new way. The new structure will be totally non-causal and non-linear with what went before – the change is a true quantum leap, a death and re-birth, and the main characteristic of the new system is that it has the capacity to handle the fluctuations, the input from the environment, that the original system could not handle. In Prigogine’s words, the system, “escapes into a higher order.”

Prigogine’s work has been applied to all changes in all kinds of open systems – everything from a seed germinating, to a corporation expanding, a highway system growing, a cell dividing, or a human being making behavioral or emotional changes.

The human brain is the ultimate open system, constantly changing energy with its environment. Up to a point, the system can handle all kinds of fluctuations. But if the input becomes too much, the system is pushed past its limits and the system recognizes itself at a higher order. A runner, for instance, gives more physical input to his body than it can handle, and it responds by recognizing itself at a higher level that can handle increased input – which we call “getting in shape”.

In using binaural beat technology to change brain wave patterns, we are creating a similar effect in the brain. The alpha, theta, and delta brain wave patterns are creating a similar effect in the brain. A graphic representation of these brain wave patterns shows that the amplitude increases as we move from alpha to theta to delta. In other words, the amount of fluctuation increases. These increased fluctuations are more than the nervous system can handle with its current structure, and the brain responds by recognizing itself at a higher, more complex level of functioning. It does this by creating new neural pathways in the brain, creating increase communication between parts of the brain that previously were not communicating. This synchrony brings with it many remarkable changes. As noted earlier, Lester Fehme of the Princeton Biofeedback Research Institute feels that “synchrony represents the maximum efficiency of information transport through the whole brain.

As demonstrated earlier, there are two main effects of reorganization and increased synchrony in the brain. One is an increase in various mental capabilities: increased learning ability, creativity, mental clarity, intelligence, intuition, and so on. Second, each

time the neural structure changes, positive changes in mental and emotional health occur. As the brain reorganizes at the next level of functioning, the subject's modal pf the world changes with it. With the creation of new neural pathways, more connections are perceived between bits of information that previously seemed unrelated, and more choices are available. Herein lies the theoretical explanation for the amazing personality changes that researchers have reported in subjects using this type of sound technology to change brain wave patterns.

Clearly we are on the frontier of a marvelous new field with untold possibilities. The ability to map and entrain brain waves, and the states they represent, gives us a powerful new tool to effect human change and growth. It has been shown that induced brain wave states can effect human changes and growth. It has been shown that induced brain wave states can affect super learning, increased creativity, sleep induction, pain control, behavior modification, focusing of attention and relief from stress, increased longevity and slowing of the aging process, increased memory, and dramatic improvements in mental and emotional health. We invite you to participate as we leap into the 21st century.