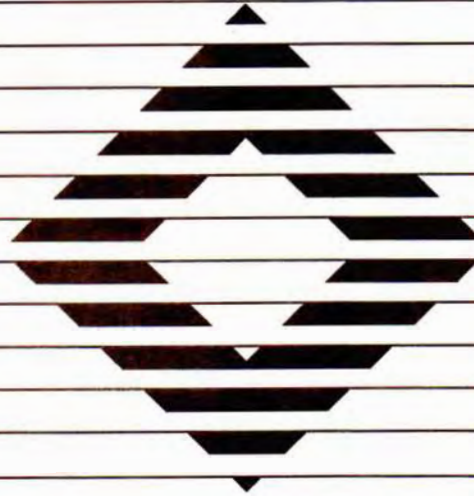


**SPECIAL
ISSUE ON
EEG**

Volume 2, Number 3



MEGABRAIN

R E P O R T

THE JOURNAL OF MIND TECHNOLOGY

The Brainwave Investigation <i>by Michael Hutchison</i>	6
A Tale of Self-Discovery <i>by James Hardt, Ph.D.</i>	14
Alpha-Theta Brainwave Biofeedback <i>by Jonathan D. Cowan, Ph.D.</i>	29
Theta What? <i>by Julian Isaacs, Ph.D.</i>	40
EEG Biofeedback Training <i>by Siegfried Othmer, Ph.D.</i>	43
New Light on Lights, Sounds and the Brain <i>by Len Ochs, Ph.D.</i>	48
The Key West Conference <i>by Dennis Campbell</i>	53
A Review of Personal EEG Equipment <i>by Julian Isaacs, Ph.D.</i>	60

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MEGABRAIN REPORT

EDITORIAL

Peak Performance Brainwaves

by Michael Hutchison

A neuroscientist used to be like a man in a Goodyear blimp floating over a bowl game: he could hear the crowd roar, and that was about it. But now we're down in the stands. It's not too long before we'll be able to tell why one man gets a hot dog and one man gets a beer."

—Floyd Bloom, neuroanatomist
Scripps Clinic

The Brain Revolution has been one of the most momentous events in human history. Perhaps its most exciting development has been that for the first time, as Floyd Bloom observes, humans have been able to get right down into the arena of the human brain and observe the action as it happens—and then look at it again in slow-motion on the instant replay.

With the development of computerized brain monitoring devices of incredible sensitivity, scientists have been able to observe what goes on in our brains during virtually every life experience—pain, ecstasy, depression, love, having a flash of insight, seeing stripes, remembering, forgetting, eating, sleeping, having sex. Most remarkably, scientists have discovered that by watching the activity of our own brains, we can quickly learn how to *change* our brains, and in doing so *change what we are experiencing*.

The implications are enormous. If we can change our own brain states at will, then surely we can learn to shift out of unwanted or unhealthy states or experiences into desired states and experiences. Just as we can change channels on our TVs, we may be able to intentionally switch out of states such as pain, depression, anxiety and anger and switch into pleasure, love, well-being, insight and clarity.

If you can control your brain activity, then you can control your life and your experiences in life.

While there are numerous new tools for observing the brain, including MRI (magnetic resonance imaging), PET (positron emission tomography), and SPECT (single photon emission computerized tomography), to SQUID (superconducting quantum interference device), perhaps the most exciting work in the last few years has been done using the relatively old-fashioned EEG (electroencephalograph)—though in the computerized, multi-channel, superfast models that are

very new-fangled—in the biofeedback or neurofeedback mode

Why potentially revolutionary? Because unlike the other generally immense and immensely expensive devices, which by necessity are used only in institutional medicine and research, EEG feedback systems are relatively inexpensive (and becoming cheaper all the time), relatively easy to use, and available to anyone with an interest in learning to explore or attain optimal brain states. That means that, like the personal computer or home video games, they can enter the cultural mainstream with incredible speed, and change our way of life. Conceivably, within a few years, personal or home EEG systems could be as commonplace as the PC, with millions of people blithely fine tuning their states of consciousness as routinely as they change clothes, adjust the thermostat or fix their make-up.

Just as we change channels on our TVs, we may switch out of states such as pain, depression, anxiety and anger and switch into pleasure, love, well-being and insight.

For the fact is, as we pointed out above, changing our brain waves means changing what we are experiencing. That means changing our reality. As one of the leading EEG researchers, Dr. James Hardt, writes elsewhere in this issue, summarizing his 25 years of research, "I was learning that brain waves relate to everything, and that control of brain waves had life and death implications, as implications for the quality of life. Any experience you can have has a specific underlying brain activity associated with it. If you can control your brain activity, then you can control your life and your experiences in life."

Using EEG feedback, researchers, clinicians and their subjects have, among other things, been able to train the brain to "heal" itself from alcoholism and drug addiction, learning disorders and brain traumas, depression and anxiety. Subjects in some EEG studies have experienced average IQ increases of 20 to 30 points. Some researchers have found certain patterns of brain activity that seem linked to extraordinary or peak brain states, such as transcendence, illumination, flow, awakening. And, using EEG feedback systems as well as other mind technology, they have found that subjects can learn to enter these peak states.

With such a wealth of breakthrough work being done with EEG and EEG feedback, we have decided to devote this issue of *Megabrain Report* to exploring this field. The issue you hold in your hands was to be our "EEG Special Issue." And indeed, it is a very special issue: in the pages that follow are articles by many of the leading researchers, clinicians, and theoreticians of EEG brain training, as well as discussions of the most exciting research being done in the field, and reviews of the latest EEG feedback equipment.

However as the articles began to flow in, it soon became clear that there was simply too much information, too many good articles, too many connections to be made between the work of different contributors, to fit into a single issue, even if we expanded far beyond our usual 48-page format. In fact, the first time we began to count pages—even before many of the articles were in—we had over 300 manuscript pages of what looked like it would expand to well over 400 manuscript pages! That is, we had the equivalent of a good-sized book, and there was just no way to fit it into a single issue without chopping what we felt was important information.

And so our EEG Special Issue has expanded into two jumbo issues—the one you hold in your hand, and Vol. 2, Number 4, (which will appear in about 2 months)—both jam-packed with fresh, mind-stretching and original material.

When we invited scientists to contribute, we asked them to write about developments and discoveries in EEG feedback and research that they felt were most important. So it has been fascinating, as the articles have come in, to see how each of these scientists, working largely independently, has focused on the same few recurrent themes. Dr. James Hardt and Dr. Les Fehmi both provide moving and heart-felt descriptions of how their first-hand experiences of personal transformation through EEG feedback in the 1960's have added an almost spiritual sense of urgency and commitment to their work.

Most of the contributors clearly agree that the extraordinary recent developments in EEG are founded on the pioneering EEG feedback work in the 60's and 70's by Joe Kamiya, Elmer Green, Barry Sterman, Joel Lubar, Tom Budzynski, Jim Hardt, and Les Fehmi, among others. They also seem to share a common perception that the vast potential for human development hinted at by the EEG feedback research of the tumultuous 60's was disturbing to the medical, scientific, and cultural mainstream, and as a result was suppressed, derided or actively discouraged for almost 20 years—what we can now call the Nixon-Reagan Era. As a result, virtually all of

them seem to share a sense of personal satisfaction in the recent vindication of EEG feedback and its emergence as a "hot" field. Perhaps the heat of the recent EEG explosion is a natural result of the years of frustration and lack of recognition.

Hardt, Fehmi, Dr. Jon Cowan, Dr. Len Ochs, Dr. Siegfried Othmer, Dr. Thomas Budzynski and Dr. Julian Isaacs, and Anna Wise all write with more or less evident excitement about the extraordinary power of EEG feedback of specific types or at certain frequencies to produce unprecedented and at times seemingly miraculous healings, resolutions of formerly intractable psychological problems (including addiction, Post-Traumatic Stress Disorder, depression and anxiety), and sudden reorderings of personality. While they may all offer speculations, theories, and conjectures—using fuzzy words like consciousness, unconscious, subconscious, transformation, "witness" consciousness, "inputting" information, brainwave "training", attention and attention deficit—they all emphasize the tentative nature of their conclusions. All of them seem to share the view that "we ain't seen nothing yet"—that we have only begun to begin to understand a bit about the working of brain wave feedback, that astonishing and culturally-transforming breakthroughs are imminent, that the workings of the brain remain the greatest and most fascinating mystery of our age.

Researchers proved that subjects could take voluntary control of virtually any physiological process—even the firing rhythm of individual nerve cells

Each of these scientists look at essentially the same phenomena—high amplitude alpha, whole brain synchrony, alpha-theta training, "good" and "bad" theta and beta training, "optimizing" brain wave patterns—through slightly differing lenses, pose the same questions in differing words, and offer answers or tentative conclusions that, while in differing words, are in remarkable agreement accord. Budzynski, Hardt, Fehmi, Isaacs, and Ochs all discuss the importance of proper instruments and offer insights into what equipment works and what doesn't. Virtually all of them emphasize the importance of the right treatment protocol to attain desired results, and

offer invaluable descriptions and insights into various protocols, ranging from alpha/theta training for addictions to beta training for attention deficit hyperactivity disorder.

Most of the articles in this special issue of *Megabrain Report* and the one which will follow it come right from the cutting edge of current EEG research, and will be thought provoking and stimulating (and in some cases startling) to scientists, therapists and other health professionals. Much of the information they contain is fresh, eye-opening, and is presented here for the first time. It is also, we believe, extremely practical. It is our hope that this special issue may serve as a catalyst and a stimulus to therapists, educators, counselors, researchers, and other professionals, alerting them to the revolutionary potentials for enhancing human performance and well-being through EEG feedback, and providing the basic practical information needed to take the first steps toward incorporating the EEG feedback into their practice.

But of course many of us are fascinated by this work and by brainwaves (both other peoples' and our own) not as professionals, but as individuals who want to learn more about ways we can become stronger, healthier and happier and take greater control over our emotions, states of consciousness, and lives. And so, we have worked with the contributors to be sure these articles are written in language that is clear, jargon-free, down to earth and accessible to non-scientists. And, as an introduction for non-professionals, we first present a short summary of the historical background, and some of the central issues and discoveries of EEG feedback, and brief sketches of the work of many of the leading EEG explorers, whose articles constitute the rest of this extraordinary issue.

—MH

Mega Brain Report
The Journal of Mind Technology

Volume 2, Number 3
 Publisher: Alex Kochkin
 Editor in Chief: Michael Hutchison
 Production & Design: William Barten

Megabrain Report is published four times a year by Megabrain Communications, Inc. Please direct all editorial submissions, circulation inquiries, change of address notices and subscription renewals to MEGABRAIN REPORT, Post Office Box 2744, Sausalito, CA 94965

One year Subscription U.S. \$48/year, Canadian & Mexican subscriptions are \$54/year. International subscriptions are \$62/year, \$74 air mail. Two year Subscription U.S. \$84/year, Canadian & Mexican subscriptions are \$92/year. International subscriptions are \$108/year, \$132 air mail.

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The Brainwave Investigation

by Michael Hutchison

The brain is powered by electricity. Each of its billions of individual cells “fires” or electrically discharges at a specific frequency. The electrical activity of the brain can be monitored by placing sensors or electrodes against the scalp, which register the minute electrical signals happening inside the brain, much the way a seismograph can detect tremors taking place inside the earth. These electrical signals are known as the electroencephalogram; the device that registers them is called an electroencephalograph, or EEG. What the EEG reveals to us are not the firings of individual brain cells, but the cooperative or collective electrical patterns of networks or communities of millions of cells firing together—fluctuations of coherent or synchronous energy pulsing through the networks of the brain. These collective energy pulsations are called brain waves.

Since the first EEG was devised early in this century, scientists have found that the brain has a tendency to produce brain waves of four distinct varieties, which they have called beta, alpha, theta and delta.

BETA. The most rapid brain waves, beta waves, range in frequency from about 14 cycles per second (called 14 Hertz, abbreviated Hz) to more than 100 Hz (some scientists now refer to brain waves above 30 Hz as Gamma waves). When we are in a normal waking state, eyes open, focusing on the world outside ourselves, or dealing with concrete, specific problems, beta waves (particularly beta waves between 14 and 40 Hz.) are the most dominant and powerful waves in the brain. Beta waves are associated with alertness, arousal, concentration, cognition and—at excessive levels—anxiety.

ALPHA. As we close our eyes and become more relaxed, passive, or unfocused, brain wave activity slows down, and we produce bursts of alpha waves, which range in frequency from about 8 to 14 Hz. If we become quite relaxed and mentally unfocused, alpha waves become dominant throughout the brain, producing a calm and pleasant sensation called the “alpha state.” The alpha state seems to be the brain’s “neutral” or idling state, and people who are healthy and not under stress tend to produce a lot of alpha activity. Lack of significant alpha activity can be a sign of anxiety, stress, brain damage or illness.

THETA. As calmness and relaxation deepen into drowsiness, the brain shifts to slower, more powerfully rhythmic theta waves, with a frequency range of about 4 to 8 Hz. Theta has been called the “twilight state,” between waking and sleep. It’s often accompanied by unex-

pected, dreamlike mental images. Often these images are accompanied by vivid memories, particularly childhood memories. Theta offers access to unconscious material, reveries, free association, sudden insight, creative ideas. It’s a mysterious, elusive state, and for a long time experimenters had a difficult time studying it because it is hard to maintain for any period of time—most people tend to fall asleep as soon as they begin generating large amounts of theta.

DELTA. As we fall asleep the dominant brain waves become delta, which are even slower than theta, in the frequency range below 4 Hz. When most of us are in the delta state we’re either asleep or otherwise unconscious. However, there is growing evidence that individuals may maintain consciousness while in a dominant delta state. This seems to be associated with certain deep trance-like, transcendent or “non-physical” states.

Taking Charge: Biofeedback and Brain Power

CONTROL YOURSELF

Stop a moment. Now, change your brain wave activity into an alpha rhythm... The question immediately arises, How? How do I know when my brain waves are in alpha? And how is it possible to change my brain waves intentionally?

One of the central assumptions of western physiology has been that there is a fundamental distinction between parts of the human body that we can consciously control—the so-called “voluntary” components—and those parts over which we have no conscious control—the “involuntary” or autonomic components. These involuntary components traditionally included brain waves, as well as such things as the expansion and contraction of our blood vessels, blood pressure, heart rate, the secretion of hormones, healing and the activity of the immune system.

Then the lightning bolt hit. With the development sensitive instruments that could measure minute changes in the body, scientists found that if they monitored the activity of one of the so-called involuntary processes of a human subject and fed it back to the subject with some sort of visual or auditory signal, the subject could learn to bring that process under voluntary control. They called this process *biofeedback*.

DISCOVERING THE BODYMIND

In a burst of studies throughout the 1960s that caused a sensation in the scientific world, biofeedback researchers

proved that subjects could take voluntary control of virtually any physiological process—even the firing rhythm of individual nerve cells. One researcher, John Basmajian, hooked up subjects so they could monitor the firing rhythm of a specific neuron (called a single motor unit). Each time the neuron fired, the subjects would be fed back a sound like a drumbeat. Amazingly, the subjects quickly learned how to control the rhythm with which the cells fired, creating intricate drum rolls, gallops and beats. Elmer and Alyce Green of the Menninger Foundation wrote with excitement, “It may be possible to bring under some degree of voluntary control any physiological process that can continuously be monitored, amplified, and displayed.”

This was a momentous discovery—it meant that the long-held belief of a clear separation between voluntary and involuntary components of the human system was not accurate. It meant such processes as the secretion of hormones and the operation of the immune system could theoretically be intentionally controlled. It also meant that the whole foundation of mind-body dualism upon which all of western thought had been based—that there was a clear and necessary separation between the mind and the body—had to go out the window. For clearly there was some link, still mysterious, between mind and body.

It was the beginning of a great paradigm shift that was to lead to the development of such fields as psychoneuroimmunology and psychobiology, and to the emergence of a new vision of the mind and body as a single, indivisible unit, a field of intelligence, a bodymind.

ROLL UP FOR THE MAGICAL MYSTERY TOUR

The 1960s was a time when large numbers of people were extremely interested in experiencing peak states. For many, psychedelics were the most quick and reliable mind expansion technique. But drugs, while powerful and effective state change tools, had drawbacks. They were illegal, which caused much inconvenience. The state changes they produced were long-lasting and durable, which made it next to impossible to change back into ordinary brain states on demand. This too caused much inconvenience, not to mention bad trips. They also had unknown long-term effects on health. So, many people were eager to find a “drugless high,” or some way to expand consciousness without the drawbacks of psychedelic drugs.

The Beatles, among others, had become followers of a guru who taught them meditation. They began singing the praises of meditation as a way of reaching heightened states of consciousness without

drugs. The guru appeared on the Johnny Carson show, wearing his white robes, giggling, and holding a flower. Meditation was in. Millions of people began trying to meditate. Millions of people were disappointed to find that meditation took practice and discipline, and did not instantly catapult them into enlightenment.

Many of those most interested in exploring mind expansion were young psychologists and other scientists who had chosen the brain as their field of study. It made sense to them to focus their research, and use whatever technology was available to them, such as EEGs, to explore what was going on in the brain during experiences of expanded consciousness, such as meditation.

When they looked at the EEG tracings it quickly became clear that meditators produced a lot of alpha waves. Some of these young researchers, led by Joe Kamiya, developed a type of EEG that was “tuned” to respond to alpha waves by producing a tone: brainwave feedback. When people used EEG biofeedback, they could quickly learn to produce alpha waves simply by doing things that produced the tone, such as sitting with their eyes closed, in a relaxed, passive state.

The researchers noticed that people who went through this alpha feedback training process experienced interesting changes—they became more calm and relaxed in their daily lives, they tended to give up such habits as smoking and heavy drinking, and they learned how to produce alpha waves at will, even when not hooked up to the biofeedback system.

This was exciting. I remember it well. What a mysterious thing, changing what’s happening inside your head. And when you do it, how exciting, what fun, and what a sudden surge of power!

ON THE JOYS OF OBSERVING YOUR OWN BRAIN

I had gotten my first taste of it when I had overheard someone talking about an experiment going on at New York University, and wangled my way into the experimental group by claiming to be an NYU student. I learned to generate alpha waves by making a machine go click click click. For long delightful periods I would sit there with the machine caressing me with timeless strings of beautiful clicks. It was delightful and mysterious, and a large part of the delight and the mystery was that I was listening to the activity of my own brain, and becoming aware of every subtle little change that took place within it, learning that if I thought of certain things the clicks would stop, and if I thought of other things, or stopped thinking, the clicks would start.

To me it was amazing to learn that I could in fact change my brain, and the things that were going on inside it. What a revelation. Until then, I had always assumed that whatever was going on in my mind—sadness, anger, confusion, joy—was simply “going on,” and that it would keep going on until it stopped going on and something else started going on. But as I sat by the alpha trainer learning to spin out lovely chains of clicks—and learning to make them stop, if I wanted to—I learned that you could *change your mind*. It struck me as being a process something like changing TV channels. If you don’t like the soap opera that’s on channel 2, change to the western on channel 4.

What a mysterious thing, changing what’s happening inside your head... what fun, and what a sudden surge of power.

I was filled with a sense of power. Not the power to stop speeding locomotives, or leap tall buildings at a single bound. But much more modest and personal power. The power of being aware of my own mind, of learning how to pay attention to how I was paying attention, and knowing that I had some control over it. I loved the sessions, and would have kept coming back to the lab for years, except suddenly the experiment was over. No more sessions. And so my experience of EEG biofeedback was over. Or, as I was later to find out, put on hold for the next 12 years.

INSTANT SATORI MACHINES AND THE ROYAL ROAD TO BLISS

But meanwhile, the word was leaking out. You could get high on alpha feedback. Some researchers even suggested that the alpha state was synonymous with meditation. This was Big News, and the mass media soon latched onto it. Sensational stories about “instant nirvana,” and “mechanical meditation,” claimed that the Alpha State was not only the same thing as meditation, but could also be a quick cure for stress, one without all the mystic voodoo and spiritual trappings that most people associated with meditation. As research psychologist Joe Kamiya, who was the pioneer investigator of alpha feedback, remembers it, “a surprisingly large number of people seemed to conclude that alpha would be the royal road to bliss, enlightenment, and higher consciousness. Nirvana now, through feedback.” Sales of “alpha machines” boomed. Thousands of people sat around learning to get into alpha.

MEGABRAIN REPORT

The upshot of all this hullabaloo was predictable. Mainstream psychologists, determined to establish psychology as a hard science, were uneasy with talk of nirvana, bliss and higher consciousness, instant or otherwise. Mainstream psychiatrists and the medical establishment—already up in arms about the so-called Psychedelic Revolution—felt a clear duty to suppress this nascent “mind-expansion technology.” Except for those who undertook EEG studies for the express purpose of “debunking” alpha feedback, EEG feedback research was not encouraged—the grants and research fellowships went elsewhere. Some determined psychologists continued to do EEG research, but for the next 20 years their research was largely ignored by mainstream psychologists, or dismissed as “fringe” science.

The medical establishment felt a clear duty to suppress this nascent “mind-expansion technology.”

As a result, by the early 1970s the popular craze for alpha machines came to an end. In part, it was because of the concerted opposition of the medical, scientific and cultural mainstreams. In part it was simply because it is in the nature of crazes to come and go. Another reason personal alpha trainers didn't really catch on was that the machines themselves were still too crude (this was before the invention of the microprocessor, which would later make it possible to shrink such devices down from the size of a suitcase to the size of a pack of cigarettes). Another reason was that people had exaggerated expectations. They'd heard that alpha was a mystic state, satori, bliss and sudden illumination. So they tried it out, and found that it was...well...okay. As I say, it could give you a feeling of power, but it was a very modest and subjective sort of power, the usefulness of which was not immediately apparent. Also, most of these expectant seekers of bliss only used their devices sporadically and for relatively brief sessions, while later research was to reveal that many of the most profound benefits of alpha EEG training depended on “massed practice”—substantial blocks of training time.

Meanwhile, ironically, as the public and mainstream psychologists lost interest in EEG biofeedback, some of the hard-core EEG researchers began making some discoveries that were in actual fact earthshaking and dazzling.

DISCOVERING THE TWILIGHT ZONE

Earlier, in the 1960s, Japanese scientists had conducted a series of EEG studies of Zen monks going into deep meditative states. They had found that as monks went into meditation they did indeed go into alpha, but the most skilled meditators sank right through alpha and began producing the slower theta waves. And, intriguingly, even in the depths of theta—for most people the gateway to sleep—the monks were not asleep but extremely mentally alert.

Interestingly, the more meditative experience a monk had, the more theta he generated. And the only ones who were able to get into this deep theta state quickly and at will were those monks who had more than twenty years of meditative experience.

Excited by this work, biofeedback researchers Elmer and Alyce Green of the Menninger Foundation decided to explore the effects of theta, and designed a biofeedback device that enabled them to train subjects to enter theta. As they observed many people experiencing theta, the Greens concluded it was “associated with a deeply internalized state and with a quieting of the body, emotions, and thoughts, thus allowing usually ‘unheard or unseen things’ to come to the consciousness in the form of hypnagogic memory.”

The Greens next designed a study in which one group learned to enter theta for a period of time every day, while another group—called a control group—simply became very relaxed. They discovered that the theta subjects frequently reported vivid memories of long-forgotten childhood events: “They were not like going through a memory in one's mind,” said the Greens, “but rather like an experience, a reliving.” They also found that those producing theta waves frequently became highly creative, and had “new and valid ideas or syntheses of ideas.”

They were also surprised to discover that the subjects they taught to enter the theta state reported that they had life-altering insights, or what the Greens called “integrative experiences leading to feelings of psychological well-being.” They fell in love, discovered new talents, decided to change jobs and strike out in new, more satisfying directions. In essence, these people felt their lives had been transformed. When they gave them psychological tests, the Greens discovered that the theta subjects were “psychologically healthier, had more social poise, were less rigid and conforming, and were more self-accepting and creative” than the control group.

Finally, and most astonishingly, the Greens were surprised to note that those taught to enter the theta state became very healthy. While the control group (the one

not producing theta) continued to have its normal number of illnesses, the theta group had almost no illness whatsoever.

It seemed the Greens had stumbled onto something unprecedented. They reported that the theta state caused people to “experience a new kind of body consciousness very much related to their total well-being.” Physiologically the theta state seemed to bring “physical healing, physical regeneration.” In the emotional domain, the theta state was “manifested in improved relationships with other people as well as greater tolerance, understanding, and love of oneself and of one's world.” In the mental domain, the theta state produced “new and valid ideas or syntheses or ideas, not primarily by deduction, but springing by intuition from unconscious sources.” All in all, it seemed as if there was something magic about the theta state.

Working independently of the Greens, biofeedback researcher and clinician Dr. Thomas Budzynski also sensed something magic about the theta state. He conducted extensive research into the properties of theta, which he dubbed the “twilight state.” People in theta, he found were hypersuggestible, as if in a hypnotic trance. They are also able to learn enormous amounts very quickly. Theta, Budzynski suggested, is the state in which “superlearning” takes place—when in theta, people are able to learn new languages, accept suggestions for changes in behaviors and attitudes, memorize vast amounts of information. Said Budzynski, “the hypnagogic state, the twilight state, between waking and sleep, has the properties of uncritical acceptance of verbal material, or almost any material it can process.”

The only monks able to get into a deep theta quickly and at will were those with more than twenty years of meditative experience.

“MIRACULOUS RESOLUTIONS” AT THE CROSSEOVER POINT

These findings about theta were exciting, but never became widely known. Then in 1989, Drs. Eugene Peniston and Paul Kulkosky of the University of Southern Colorado (who had learned some of their techniques from the Greens at the Menninger Foundation) conducted studies in which they used EEG biofeedback to train a group of chronic alcoholics to increase alpha and theta activity, while another group served as a control group.

They discovered that the alpha-theta group showed an extraordinary recovery rate many orders of magnitude greater than the control group. More impressively, after thirteen months they showed “sustained prevention of relapse.” (A further follow-up study three years later has showed the same sustained prevention of relapse.)

And, in the most intriguing findings of all, the alpha-theta group showed a profound *transformation of personality*. Among the extraordinary changes in MMPI clinical scales noted in their subjects, Peniston and Kulkosky found significant increases in such qualities as warmth, abstract-thinking, stability, conscientiousness, boldness, imaginativeness and self-control, and significant decreases not only in depression, but also in anxiety and other problems.

Overcoming addiction. Transforming personality. These were magic phrases. The Peniston studies emerged at just the right time. Years earlier, in 1978, Dr. James Hardt, of Langley Porter Psychiatric Institute, had published several groundbreaking papers documenting his EEG feedback research findings that alpha feedback training produced profound changes in personality traits, including dramatic reductions in anxiety (both state and trait anxiety), and changes in the same MMPI clinical scales documented over a decade later by Peniston and Kulkosky. But while Hardt's message had aroused little popular interest, the Peniston studies emerged into the “morning after” hangover of the Reagan era's exaltation of selfishness and self indulgence, when concern with addictive behaviors and personality transformation had become subjects of urgent interest to millions of people: millions of people who were going to 12 step programs modeled on Alcoholics Anonymous to overcome their “addictions” to everything from sex to overeating to shopping, and who were seeking to transform their present addictive personality by stripping away their false masks and communicating with their “inner child.”

With its implied message that EEG alpha-theta feedback could help individuals overcome all sorts of addictive behavior patterns and find a happier, more integrated personality, the Peniston-Kulkosky work aroused enormous interest and excitement among biofeedback researchers and clinicians.

Modifying and expanding upon the work of Peniston and Kulkosky, many researchers and clinicians have now begun using multi-channel “brain mapping” EEGs to explore in more detail what happens in the brain when it goes through these apparently transformational moments. What they have found is that when a sub-

ject becomes deeply relaxed, alpha brain-wave activity increases, and slows down. As relaxation increases, the subject begins to produce more and more theta activity. As theta amplitude increases, alpha seems to slow further until it descends into theta.

At the crossover point between alpha and theta, subjects experience life transforming moments.

At that point, according to some researchers, at what the researchers are calling the “crossover point” between alpha and theta, the subjects experience important, emotionally loaded, even life transforming moments. These frequently consist of creative insights, vivid memories from childhood, or, in the case of the Vietnam vets suffering from Post-Traumatic Stress Syndrome (or adults who were abused or traumatized as children), the emergence of suppressed or repressed experiences. Subjects consistently report these moments as profound, moving, life transforming, even spiritual moments. One of these clinicians, Houston therapist William Beckwith, has reported that in his clients the crossover point is “often accompanied by spontaneous surfacing of previously inaccessible memories, often from early childhood,” as well as “the seemingly miraculous resolutions of complex psychological problems.”

THE MAGIC RHYTHM AND THE GATEWAY TO MEMORY

Meanwhile, other scientists, intrigued by the fact that the theta state seemed to increase learning, and also seemed to produce frequent vivid memories, began investigating the relationship between theta and memory.

They found that for memories to be formed the brain must undergo a process called Long Term Potentiation (LTP), which involves electrical and chemical changes in the neurons involved in storing memory. When LTP does not happen, information that enters the brain is not stored, but totally forgotten. Neurophysiologists Gary Lynch and associates of UC at Irvine, discovered that the key to LTP is theta brainwaves. “We have found the magic rhythm that makes LTP,” said Dr. Lynch. “There's a magic rhythm, the theta rhythm.”

CHILDHOOD MEMORIES AND THETA

As virtually everyone who uses a mind machine discovers, theta seems to trigger the sudden reliving or vivid remembering of

long-forgotten childhood memories. One explanation for this link between theta and childhood is that, while adults rarely produce theta, children are in a theta state most of the time—up to the age of six or beyond, children produce mostly theta waves, and then the amount of theta progressively decreases as the child grows into adulthood. In other words, children spend most of their time in what we adults would call a trance-like, altered state of consciousness, and one that is extremely open and receptive, highly conducive to the learning of new information and the creation of memories.

In recent years a large number of scientific studies have explored a phenomenon called “state bound” or “state dependent” learning. In essence, they have found that things experienced in one state (of consciousness) are far more easily remembered later when we are once again in that same state. Things learned when we're happy are remembered best when we're happy, what we learn when cold is remembered best when we're cold, and so on.

This provides an explanation for the appearance of childhood memories to adults who are in theta. Children spent most of their time in the theta state. But as adults, we rarely experience a true theta state. Most of us have a few seconds of it as we fall asleep, and that's all. During those brief moments in theta we may experience sudden flashes of memory, vivid images, odd disconnected ideas, but we're quickly asleep. Virtually all of our memories from childhood, then, are state dependent—they're laid down while we're in one state, but it's a state that we almost never experience as adults. To remember them, we have to get back to the state in which they were first created.

Subjects report “the seemingly miraculous resolutions of complex psychological problems.” “We have found the magic rhythm...” said Dr. Lynch, “the theta rhythm.”

One of the characteristics of mind machines is that they are capable of putting people into the theta state and keeping them there for long periods of time while they remain awake. Mind machines can put us back into the childlike theta state. That means that all those memories, creative ideas, spontaneous images, and integrative experiences that occur during theta

MEGABRAIN REPORT

become available to our conscious mind—we become consciously aware of what had been stored in our unconscious mind, and we remember it when we emerge from the theta state. This is one of the reasons that psychologist Thomas Budzynski has called one type of mind machine “a facilitator of unconscious retrieval.”

THETA AND INSIGHT

For thousands of years humans have been aware of the enormous creative values of the theta state. Budzynski notes that “Shamanistic and other primitive ceremonies often included procedures designed to produce these states. It was believed (and still is in certain cultures) that the dreamlike images elicited in the twilight state allowed the dreamer to foretell events, instruct as to healing procedures, and give important information.”

The 18th century mystic Emmanuel Swedenborg wrote in detail about his own theta experiences and described ways of inducing them. The chemist Friedrich Kekule vividly described his state of “reverie” in which he suddenly saw a mental image of atoms forming a chain, and of snakes biting their tails, which led to his discovery that organic compounds occur in closed rings—described as “the most brilliant piece of prediction to be found in the whole range of organic chemistry.” There are countless stories of such moments of inspiration and creativity occurring when the thinker is nodding off to sleep, or wandering lonely as a cloud, gazing into the fire. All of them speak of the drowsiness, the relaxation, the vivid imagery appearing unexpectedly, the effortlessness, that mark them as examples of the theta state.

MAPPING THE BRAIN PATHS TO TRANSCENDENCE

Meanwhile, other researchers have been using sophisticated EEGs with 20 or more electrodes, which permit them to monitor the activity of the entire cortex simultaneously, and present it visually in the form of colored “brain maps.” These investigators, including F. Holmes Atwater, of the Monroe Institute and Dr. Ed Wilson of the Colorado Association for Psychophysiology Research have been able to observe the brain maps of numerous individuals as they move from ordinary waking consciousness into peak experience or transcendent brain states. They have found that in progressing toward transcendence, the brain goes through or produces several distinctive whole-brain patterns.

RESTING STATE ALPHA. Normal waking consciousness, these researchers have found, is characterized by dominant beta activity, along with a lot of alpha activity in the rear part of the cortex. This back of the

head alpha is called “resting-state-alpha.” This alpha activity seems to be an “anchor,” serving as a stabilizing force, linking us with our “normal” and familiar modes of mental processing. It’s like the alpha observed in the early stages of Zen meditation.

In progressing toward transcendence, the brain produces several distinctive patterns. Subjects emerged with reports of being abducted by UFOs, having out-of-body experiences, communicating with God...

THE DISSOCIATIVE STATE. However, when subjects enter expanded states of consciousness, they lose awareness of the physical world, and reach a point, as Atwater describes it, “when non-physical phenomena constitute the whole field of perception; when there is no impression of being ‘normally’ in the physical body; when the physical body is asleep or fully entranced.” This is what Atwater calls the Dissociative State.

In the Dissociative State, resting-state-alpha disappears, and is replaced by high amplitude theta and delta activity, centered at the top of the head (the median of the central cortex). Interestingly this high amplitude theta and delta activity is synchronous. This dissociative state seems to be essentially what earlier researchers, such as the Greens, have been describing as the Theta state, and is equivalent to the state reached by experienced Zen meditators as they sink downward past alpha. It also seems to offer access to what has been called the unconscious mind, or the personal unconscious.

THE TRANSCENDENT STATE. Beyond the dissociative state is the state Atwater calls transcendence. In this state, individuals move beyond their own ego, beyond the personal unconscious mind, into a peak state of universal awareness. As Atwater observes, “Experiences in this state are many times ineffable and cannot be explained or described in words. Experiences in this realm are more than passive diversions. Their creative power can change the very nature of the participants’ reality.”

As they observe the transition from dissociation to transcendence on their EEG

brain mappers, these researchers such as Atwater have found something very odd occurs. First, the high amplitude and synchronous theta and delta activity of the dissociative state continues. However, it is accompanied by bursts of very high beta (or gamma) activity in the temporal regions of the brain (in the area of the temples).

INDUCING TRANSCENDENT EXPERIENCES AND UFO ABDUCTIONS

These findings become even more intriguing—and lead to even wilder speculations—in light of the amazing findings of Dr. Michael Persinger of Laurentian University. He was fascinated by evidence that people who had experiences of being abducted by UFOs, and a variety of other sorts of extraordinary or transcendent experiences, were influenced by changes in the earth’s magnetic field. He began placing electromagnets at the temples of subjects and pulsing them at various frequencies. To his amazement, he found that his subjects had transcendent or extraordinary experiences. Even when subjects knew they were seated in a laboratory, with pulsed electromagnetic fields at their temples, they would emerge with realistic reports of being abducted by UFOs, having out of body experiences, communicating with God and so on. Apparently, high frequency, high amplitude activation of the temporal regions of the brain is linked with extraordinary experiences.

Whole Brain Power

All the unusual abilities that some people are able to manifest . . . are associated with changes in the EEG pattern toward a more bilaterally symmetrical and integrated form . . . My research has led me to believe that the ‘higher mind,’ on the neuropsychological level, was what Carl Jung called transcendent function, and that it was manifested by the integration of left- and right-hemisphere function.

C. Maxwell Cade
The Awakened Mind

SYNCHRONY: MAXIMUM EFFICIENCY OF INFORMATION TRANSPORT

One of the ways scientists investigated peak brain states was to bring skilled meditators into the laboratory, paste electrodes all over their skull, give them a button to press to signal when they were “there,” and record the activity on an EEG. They found that when meditators were in their peak state, the brain wave activity throughout the whole brain fell into a state they called “synchrony.”

Now whole brain wave synchrony is a very specific state. It does not mean simply that the whole brain produces dominant waves of the same frequency, such as 10 Hz alpha. If you visualize brain waves as a series of peaks and valleys, then synchrony occurs when brainwaves reach their peak at the same time. When brain waves are "in sync," their power increases (think of two waves joining together: they produce a larger wave). So, when researchers noted that meditators produced whole brain synchrony, what they saw was also an enormous increase in power or amplitude throughout the whole brain.

"Synchrony represents the maximum efficiency of information transport through the whole brain."

What are the effects of synchrony? One of the leading researchers into brain wave synchrony, Dr. Lester Fehmi, of the Princeton Biofeedback Research Institute, points out that "synchrony represents the maximum efficiency of information transport through the whole brain." This means that brain wave synchrony produces a sharp increase in the effects of various brain wave states. Fehmi notes that "phase synchrony . . . is observed to enhance the magnitude and occurrence of the subjective phenomena associated with alpha and theta" and of beta as well. Thus, for example, the phenomena associated with theta, such as vivid imagery, access to memory, spontaneous creative insights, and integrative experiences, all are enhanced in "magnitude and occurrence" by whole brain synchrony.

Some of the researchers and clinicians who have been using EEG "crossover point" training now believe that part of the extraordinary transformational powers of moving through that critical point where alpha is superseded by theta are a result of brain wave synchrony. William Beckwith observes that "The production of synchronized, coherent electromagnetic energy by the human brain at a given frequency leads to a 'laser-like' condition increasing the amplitude and strength of the brain waves." He notes that "as clients learn to increase their alpha amplitude and produce theta waves without losing consciousness, a critical point is reached when theta amplitude begins to exceed alpha amplitude. *Cross-lateral brainwave synchronization* also increases, creating a more coherent system. At this point, there are profound alterations in client mood and

behavior," including "the seemingly miraculous resolution of complex psychological problems . . . There is a sudden re-ordering of the entire personality in ways that cannot be readily explained by other models."

BRAINWAVE SYMMETRY AND EMOTIONS

In addition to synchrony, there is now evidence that whole-brain symmetry (i.e. the relative balance of EEG activity between the right and left hemisphere) is an important key to peak brain functioning. The clear link between left side of the face activity and sadness and right side of the face activity and happiness has recently been scientifically documented. In some of the studies the researchers simply asked the subjects to vigorously contract either the right or left sides of their face. They found strong evidence (in over 90% of the subjects) that contorting one side of the face produces emotions, with the left side of the face producing sadness and negative emotions, right side producing positive emotions.

But why does facial asymmetry affect emotions? Several groups of scientists working independently have found that "EEG asymmetry in anterior regions of the brain" can predict and diagnose emotional states and emotional styles. That is, people with more activity in the left frontal cortex than in the right tend to have a more cheerful and positive temperament—they are self-confident, outgoing, interested in people and external events, resilient, optimistic and happy. On the other hand, people whose EEG shows more activity in the right frontal cortex than in the left tend to be more sad and negative in their outlook—they see the world as more stressful and threatening, are more suspicious of people, and feel far more fear, disgust, anxiety, self-blame and hopelessness than the left-activated group.

In one study, researchers found that these brainwave patterns could predict "affective responses to emotion elicitors," i.e. how the subjects would react to film clips that were preselected to elicit positive or negative emotions (the positive film clips were of a puppy at play, or an amusing gorilla taking a bath; the negative clips showed gory surgery scenes). Those with more right-frontal activity showed far more powerful negative emotions, such as fear and disgust, when viewing the surgical scenes than did those with more left-frontal activity. On the other hand, those with more left-frontal activity derived far more pleasure and delight from the positive films than did the gloomy right-frontal subjects.

In other words, things that might produce delight and euphoria in some people will leave others cold, unmoved, or even suspicious; and things that some folks find

only mildly unpleasant will fill others with enormous revulsion, disgust and horror. And, astonishingly, these responses can be predicted, simply by observing their brain-wave patterns!

THE CRY-BABY BIOMARKER & DEPRESSION IN THE BRAIN

There is also evidence that these brain-wave asymmetries may be linked to depression. The researchers tested the EEGs of a group of normal subjects who had never been treated for depression, and a group of subjects who had been previously depressed and later successfully treated for depression. They found that the previously depressed subjects had far less left-frontal activity, and far more right-frontal activity, than those who had never been depressed.

A recent brain mapping study of depressive patients by C. Norman Shealy, M.D., Ph.D. at the Shealy Institute in Springfield, Missouri, revealed that 100 percent of the patients had abnormal brainwave activity, with the most common finding being "Asymmetry of the two hemispheres with right hemisphere dominance."

Another study revealed that patients who had just been diagnosed with depression and were about to begin treatment had less left-frontal activity than non-depressed subjects. "You find similar brain patterns in people who are depressed, or who have recovered from depression, and in normal people who are prone to bad moods," said one of the researchers, Dr. John Davidson, of the University of Wisconsin, Madison. "We suspect that people with this brain activity pattern are at high risk for depression."

There is even evidence that these brain-wave patterns and emotional "styles" may be hereditary or genetically-influenced. Davidson has studied the behavior and the EEG patterns of 10-month old infants during a brief period (one minute) of separation from their mothers, and found that "those infants who cried in response to maternal separation showed greater right-frontal activation during the preceding baseline period compared with infants who did not cry." Observed Davidson, "Every single infant who cried had more right frontal activation. Every one who did not had more activity on the left." He concluded that "Frontal activation asymmetry may be a state-independent marker for individual differences in threshold of reactivity to stressful events and vulnerability to particular emotions."

TURNING UP THE JUICE IN THE JOLLY LOBE

The next step, of course, is to move from simply observing the existing brainwave patterns and using them for diagnosis to active-

ly developing strategies and techniques for altering the patterns. As Dr. Davidson pointed out, "If you learn to regulate your negative feelings better, it may turn out that you have also learned to turn up the activity in your left frontal lobe."

FINDING THE POINT OF BALANCE

All of this research casts new light on the well known differences between the right hemisphere and the left hemisphere. In most people, the left hemisphere is superior in processing verbal material while the right hemisphere shows superiority in handling visual/spatial information. Studies by neuroscientist David Shannahoff-Khalsa of Salk Institute for Biological Sciences indicate that hemispheric dominance is constantly shifting back and forth from right to left hemispheres, with average cycles of 90 to 120 minutes.

At this point of hemispheric balance the brain is at its most fertile and creative.

Other scientists have reached similar conclusions by testing subjects at regular intervals on verbal (left-hemisphere) and spatial (right hemisphere) tasks. They found that when verbal ability was high, spatial ability was low, and vice versa. This discovery, Shannahoff-Khalsa points out, "suggests we can exert more control over our day-to-day mental functioning. For example, certain cognitive functions, such as language skills, mathematics and other rational processes that are thought to be primarily localized in the left hemisphere" might be boosted by "forcibly altering" our cerebral dominance. And in the same way we might "accentuate the creativity that is thought to be characteristic of right-hemisphere dominance," through similar forcible altering.

However, one key finding that has emerged from these studies of shifts in hemispheric dominance is that each time dominance shifts from one hemisphere to the other there is a point at which dominance is equally balanced between both hemispheres. And, the researchers have found, it is at this point, and during this short period of time, when the brain is at its most fertile and creative.

The truth is that two brains are better than one. While each hemisphere seems to have its specific beneficial capacities, each has its downside as well. The right hemisphere has been linked with visual/spatial skills, emotional and musical sensitivities, and intuitive, timeless, imagistic thought, but also with depression, suspicion, sadness, hostility, paranoia and negative emo-

tions. The left hemisphere has been linked with verbal skills, orientation in time, rational, logical, analytical thinking, happiness and positive emotions. But mere analytical thought, without intuitive, emotional, imagistic, time-free insights, is rigid and uncreative.

There is a reason why we have two hemispheres: they are both necessary and complementary, and they function best when they are functioning together, synergistically. This is an obvious point of much of the research we have looked at so far. EEG studies of meditators clearly demonstrated that peak states were characterized by increased synchrony and symmetry between the hemispheres. Neuroscientist Jerre Levy, of the University of Chicago, a leading authority in the field of hemispheric lateralization research, believes that, "Normal brains are built to be challenged. They operate at optimal levels only when cognitive processing requirements are of sufficient complexity to activate both hemispheres. Great men and women of history did not merely have superior intellectual capacities within each hemisphere. They had phenomenal levels of emotional commitments, motivation, attentional capacity—all of which reflected the highly integrated brain in action."

It's evident that a "highly integrated brain," a brain in which both hemispheres are functioning in symmetry, synchrony, harmony and unity, is a key to peak states and peak human performance. But throughout history, humans have found that it's not easy to intentionally bring both hemispheres to bear simultaneously. Much of our lives we spend swinging back and forth between left dominant states and right dominant states. This is where EEG feedback presents revolutionary possibilities. For research has shown that users can quickly learn alter hemispheric asymmetry and imbalance and produce more symmetrical, balanced brainwave patterns. And, the evidence suggests, by doing so they can assist in producing the peak performance states associated with whole-brain integration.

LINKING EEG FEEDBACK WITH LIGHT ENTRAINMENT

Tuning in to Stored Traumas. In *Megabrain Report* Vol. 1, No. 2 (1990) I discussed the enormous potentials of "an entirely new generation of devices that combine sound and light stimulation with biofeedback capabilities. . . [which] enable the machine to read the user's dominant brainwave activity, and then provide the optimal frequency of sound and light to entrain brainwave activity toward the 'target' frequency." But even in my wildest speculations I could never have predicted the extraordinary results some clini-

cians are now attaining using such an EEG—LS feedback loop.

Psychotherapist Len Ochs, Ph.D., had long experience of using EEG and other types of biofeedback. He had studied with interest the success of Peniston and Kulkosky with the alpha/theta training. While exploring the Peniston Protocol in his own therapy practice, Ochs also became intrigued with the potential benefits of linking EEG feedback with LS machines, so that the frequency of the light flashes was directly linked to the brainwave activity of the client. It made sense that by entraining brainwaves downward toward a theta "target frequency" he could speed up the lengthy feedback training procedure used by Peniston and Kulkosky.

It was as if the therapeutic effects of months of "talk" therapy had been compressed into minutes. EEG feedback clearly increases human brain power.

Ochs began using EEG-LS stimulation, which he first called EEG Entrainment Feedback (EEF), and found that as clients moved downward or upward into certain frequency ranges—which were different for each client—many of them would begin to experience discomfort, anxiety or nausea. He found that those who were most hypersensitive were the ones who had the most symptoms. They were, he concluded, hypersensitive at certain frequencies. Ochs used the LS to help gently entrain the clients' brainwaves into the uncomfortable frequency range. He found that as they willingly relaxed and entered that frequency range, they underwent sudden releases of traumatic material. What was even more exciting was that these sudden releases had powerful, life-transforming effects. In the process, their symptoms disappeared, and they became desensitized to the lights. It was as if the therapeutic effects of months or even years of traditional "talk" psychotherapy had been compressed into minutes.

THE BRAINWAVE ROLLERCOASTER

In his explorations of EEF, Ochs experimented with designing the computer program that linked the EEG with the LS to alternately speed up brainwaves and then slow them down, reversing direction every minute or two, and producing a sort of

rollercoaster effect. He found that when he did this many clients experienced an even more rapid release of symptoms and problems. It appeared that as clients learned to move through troublesome frequencies, they released progressively more and more of the stored traumatic material. In effect, Ochs concluded, the process was not really entraining brainwaves, but constantly *disentraining* brainwaves, constantly nudging or pulling dominant brainwave activity out of its habitual "grooves" and responses. In doing this, it seemed to have the effect of "limbering up" the brain, increasing its flexibility, its capacity to move freely up and down through various frequency ranges. He concluded that this technique worked by optimizing EEG.

My own experiences with Ochs's EEG-LS link, which he now calls EEG Disentrainment Feedback (EDF), and my discussions with others who have experienced it, have convinced me that this linking of brainwaves with light stimulation produces a profound brain-altering effect quite different from either EEG feedback or LS stimulation alone.

BOOSTING BRAINPOWER WITH EEG

Out of all the EEG feedback research, one intriguing fact has emerged: EEG biofeedback training clearly increases human brain power, including increases in IQ and in other types of intelligence and achievements. These increases seem to result not only from the altered brainwave states that are the result of EEG biofeedback training, but also from actual physiological brain growth in

response to the challenge and stimulation of learning to use mind tools—i.e. the "enriched environment" effect.

Among those who have found increased IQ in response to biofeedback training are professors Harold Russell, Ph.D. and Jc Carter, Ph.D. of the University of Houston. They have concluded

Learning to self-regulate one's ongoing EEG frequency and amplitude activity is a complex and time consuming task. It requires a highly focused concentration on and the awareness of the brain's activity and the repetition of the patterns of mental activity that produce the desired frequency and amplitude. When the task of control of EEG activity is adequately learned and sufficiently practiced, the functioning of the human brain improves measurably, e.g. . . . scores on standardized tests of achievements or intelligence increase by 12 to 20 points.

In other words, there seems to be something inherently brain-expanding about learning to manipulate your brainwaves.

One valuable but inexpensive technique for manipulating your brainwaves is reading. I have no doubts that there is something inherently brain-expanding about reading. This issue of Megabrain Report contains a compendium of articles from many of the lead figures in EEG feedback, dealing with all of the issues touched above. I cannot guarantee that reading them will increase your IQ by 12 to 20 points, but I can guarantee with total confidence that they will expand your mind. Read on. ▲■●

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Beyond your wildest dreams



A Tale of Self-Discovery

by James Hardt, Ph.D.

Part One

The following story is intended to give the reader a personal experience of how alpha feedback works. The physiological processes of alpha brain waves are strongly coupled to our experience of conscious awareness. Alpha waves reflect even very subtle shifts in awareness or consciousness. This story will help to share with the reader some of the insights into consciousness that flow from doing alpha feedback. As you read it, try to note the development of the perspective of the "Witness" and to imagine how such a perspective could be useful to someone who knew in advance what would be happening to him or to her.

When our story begins in 1968, I had been a subject in Joe Kamiya's alpha feedback lab on three prior occasions. The three prior sessions (part of an ongoing study) had been on three days earlier in the week, and each day had featured about 50 minutes of actual feedback time. A laboratory technician had affixed the electrodes, escorted me into the sound and light reduced chamber, and monitored the equipment from an adjacent room. When instructions were given or the end of the session was to be announced, the technician spoke over an intercom. But this fourth session was to be different. Having been intrigued in the formal experimental sessions by the warbling tone said to reflect my brain's activity, I returned to the laboratory to find that no experiments were scheduled, so I requested that I be hooked up and allowed to explore on my own with the feedback signals. The lab technician was agreeable, affixed the electrodes, escorted me into the experimental chamber, and then left, closing the door. She then started the electronic equipment, and, unbeknownst to me, went upstairs and became involved on another project, since I was not generating data for any of the ongoing studies. Several hours later, apparently forgetting the trainee in the experimental chamber, she went out to lunch with the rest of the lab crew. While she was at lunch, she suddenly realized, 3-1/2 hours later, that she had not checked on her subject. Everyone left the restaurant in a rush, and hurried back to the laboratory. Then the technician and 8 to 12 others came bursting into the feedback chamber in some alarm and interrupted the last stages of an incredible adventure.

THE ADVENTURE BEGINS: IN SEARCH OF THE BURNING GEM

What had happened? Let me start at the beginning of the session as soon as the feedback tone came on. As I had closed my eyes, I sat straight and perfectly still, and relaxed, for I had learned in my first three sessions that this was helpful in making the feedback tone louder and steadier. If I could sit quite still for one of the automatically timed 2 minute epochs, I would be rewarded by seeing a large score when the three-digit illuminated display lit up as the tone briefly shut off. The scores were derived from the integration of the

amplitude of my alpha activity and represented the total alpha energy I had produced during the previous 2 minutes. If I had to cough or move or if my attention wandered from the task, the tone would decrease, and that epoch's score would be smaller. I was most interested to know what made the tone stay on and what turned it off, so I listened very closely to the minute fluctuations and tried to relate them to something, anything, how I breathed, how I sat, what I was thinking.

They came bursting into the feedback chamber in alarm and interrupted the last stages of an incredible adventure.

And there were little successes along the way. When I breathed more slowly, the tone was a little louder and the score a little higher. If I relaxed fully into the emptiness of the bottom of each expiration, that would sometimes help too. If I opened my eyes, even though it was totally dark, the tone and scores were sharply reduced. So I had some control. I could probably have produced statistically significant differences between "enhance" and "suppress" conditions if I had been asked to, but I still didn't feel as though I really knew how to enhance alpha. Pleasant relaxation helped, but there were tantalizing bursts of very loud sound that I would have liked to have sustained. When such a burst would occur, I would mentally leap at it to analyze it, and thus, I thought, understand and be able to reproduce it. But alas, it was not to be. A year later I was to hear Ram Dass say, "the burning gem was in my hand, but when I reached for it, boy, it was gone."

FALLING INTO THE GAP

But for now I was in a rut and didn't understand how to get out of it. The tone would come on strong, and I would focus my attention on it, and it would retreat into relative silence. It was almost teasing me. I tried all sorts of maneuvers. I tried "reaching" for it slowly; it retreated slowly. I tried to remember what I'd been doing just before the tone burst began, and I discovered, to my considerable amazement, gaps in what I had always thought had been a continuous and unbroken stream of my conscious awareness.

Now I had two challenges instead of one: (1) The first challenge was that I could not grasp, analyze, or fully control a tone originating from my own alpha brain waves, and (2) the second challenge was that I had discovered gaps . . . GAPS! in my stream of consciousness, lapses of awareness, which I could not explain or account for. Moreover, I suddenly noticed, while intensely consid-

ering the implications of this dual dilemma, that there was very little feedback sound in the chamber, and my scores were quite low. I realized that while my mind had been racing, my muscles had tightened up, and I was taking fast and shallow breath, instead of the preferable slow, deep ones. So I started at the beginning again: I relaxed, I watched my breathing to make it slow, deep, and regular, and I again noted the tone getting louder and louder. I tried to puzzle out my problem while remaining relaxed and slow breathing. When I finally succeeded in separating my thinking process from an uptight body, so that I could concentrate without noticeably tensing or shifting my breathing rate and depth, then I began to notice that thinking itself was what was blocking my alpha and reducing the tone.

Now I realized that the lapses of awareness which preceded those interesting, loud alpha bursts may actually have been instrumental in evoking or permitting the emergence of the bursts. So then I tried *not* focusing on the event of a burst when it occurred. That was hard. I was sitting in a dark, soundproof room, and there was little to do besides listen to the tone. The tone would start one of its bursts, and I would try to ignore it, but I could only do so for a fraction of a second before my attention would swing around and focus on the tone. When it did, the tone would shrink like a balloon being squeezed by my conscious attention. But that fraction of a second was a wedge for my understanding. By slightly prolonging each burst, I noticed that my scores were getting larger, so I persevered. I didn't know it then, but I was practicing the Witness, distancing myself from the processes of my consciousness, and there was no mistaking success for failure. If I failed to keep my attention from focusing on the event of a tone burst, that burst would be dramatically and immediately squelched.

FLOATING ABOVE THE CHAIR

That kind of almost instantaneous feedback accelerated a most difficult self-awareness learning process that might have gone on for years with less success without the feedback. As the scores got slowly larger and the tone remained loud for a longer fraction of each 2 minute epoch, I began to notice a strange sensation of *lightness*. Where my body had pressed against the chair and the floor, the pressure began to give way to the sensation of just a gentle touching. When I "noticed" this and focused on it and began to reflect upon it, I was at once alerted by the tone, which got softer. And I had another clue: reflective or analytical thinking got in the way of alpha

enhancement. That clue helped enormously, because I hadn't fully realized up to then that by adopting an attitude of "not-noticing," I was suspending rational and analytic thinking. I realized that I had, in fact, been aware of tone bursts even when I didn't focus my attention on them. The real work was in being aware of, but not focusing on the tone bursts with the egoic, analytic modes of consciousness.

I was looking down on my own body from a position near the ceiling of the room...

A certain part of me, that ego center which was concerned with *DOING* things, with success or failure, suddenly realized, and I watched myself floating above the chair, which was in the middle of a little room, which was filled with the loud alpha feedback sound. Floating above the chair? Floating!??? My relaxed detachment evaporated, and I awoke back into rational and analytical consciousness almost as from a dream. Of course, as I did so, the tone volume decreased sharply from its loud intensity, so I knew I had been awake and not drowsy or asleep while experiencing this "floating". If I had been asleep or drowsy there would not have been a loud tone (indicating lots of alpha) to vanish as I "awoke" to rational awareness.

"I was floating above the chair," I marveled to myself. I realized at once that my mental focusing on what had been happening had terminated the happening, so as quickly as possible I readopted the detached attitude and the tone again started to increase. Before long, I was again looking down on my body from a position near the ceiling of the room, although how I could see anything in the total darkness I cannot explain. It wasn't a normal kind of seeing. I was almost afraid to deal with the fascinating situation because I had learned that conceptualizing the situation I was in would catch me and pull me down, and reduce the tone and my scores. So I merely floated and observed, and tried to fend off the constant temptation to evaluate, speculate, analyze, reason, congratulate. This last one was especially troublesome. After a particularly sizable series of increases in the scores, which left me feeling indescribably high, light, mellow, clear and pure, I slipped on a fleeting prideful thought. I permitted a conceptual thought to flash through my mind, "Gee I'm doing pretty good." And crash! I was tumbling back into my normal consciousness. The conceptualization caught me and pulled me down.

Non-Breathing States

While I was struggling to regain the disinterested composure of the high alpha state and its loud tone, I noticed the gradual intrusion of the demand of my body for air. I wasn't breathing. I was living sufficiently detached from my physical body, that there was not enough consciousness left to run my respiration processes. I then remembered seeing, as a child, a man on the Ed Sullivan TV show who had breathed pure oxygen for several hours before the show, and then was able to remain submerged under water in a glass tank without having to breathe for almost the entire show, which might have been 45 minutes or more. I longed for such a breathing aid so that I might dwell more permanently in this high alpha state and not have to be concerned with breathing. I did the next best thing. I alternated between periods of slow deep breathing and periods non-breathing with enhanced alpha.

For a while, I would steal part of my attention away from the detached state and use it to regularize my breathing. As a child I had done extensive long distance under water swimming, so I knew how to hold my breath. I would restore to my body an ample supply of oxygen by consciously pumping my lungs slowly and deeply. Then I would withdraw my attention from my breathing and enter into the detached state in which I could just float and feel ecstatically high. I had an image of this process of alternating between breathing and enhancing alpha: I saw the world through the eyes of a white bird, and my pumping of lungs was like the bird's flapping its wings. Flapping and pumping carried both of us to a great height. Then I could cease to consciously breathe and the bird would stiffen its wings and soar outward while wheeling and turning ecstatically and gradually drifting downward in effortless circles while my body gradually drifted downward to poorer blood oxygen levels and, eventually, the necessity to begin to consciously breathe again.

During that drifting downward of the body processes, I could see that the essence which was really me was different from my body, and was even different from my thoughts, for I had actually ceased to identify with my rational ego self and with the thoughts in my mind. I was off soaring in the bliss of feedback enhanced alpha.

Non-Thinking Outside of Time

I was able to exist outside of time, which flowed past almost unrippled by my presence. Even the briefest and subtlest conceptual thought which intruded into my mind during those periods resulted in a faltering

MEGABRAIN REPORT

of the feedback tone. With this infallible indicator of egoic thoughts, I was more and more able to non-think. But non-thinking did not mean non-awareness, contrary to everything my education and experience had lead me to believe. I discovered thoughts to be multi-layered constructions—artifices of a certain egoic relationship to the world... to myself.

A sheep is still a sheep after the wool is shorn. In many ways its perception may even be enhanced by the removal of the insulating wool. The warming sun and cooling breezes are probably felt more readily after shearing. With thinking gone, the wool was removed from over my eyes, and the new awareness seemed vast. Gradually, I even became able to be aware that a person was in a feedback situation, and that a lot of alpha activity was happening. In an inner secret sort of way, I even realized that if I were to think about it (which I now knew better than to do) that person would be revealed as me. This was an aspect of the multi-layering of thought I had seen earlier. Thoughts could exist at different levels of egoicity and at different degrees of attentional focusing.

As this process of quieting the egoic rational processes began to merge into a condition of ego dissolution, my ego, unprepared to dissolve, countered with FEAR. Fear of falling is the only fear I can clearly remember, but there were other vague and nonspecific fears too, all of which reduced my alpha activity or stopped its increase. Slowly I learned to deal with these fears the way I dealt with other thoughts: I fled my thoughts and filled my awareness with the feedback tone, now an almost constantly increasing presence. The scores, also constantly increasing, were like mileposts of my ascent. The chair and the room were left below as I rose ever higher in what appeared to be the front seat of a roller coaster car. I became aware of an approaching summit, and inwardly delighted at the expected rush from swooping down the tracks of the descent. The rate of increase of my scores slowed and the summit was attained. The scores stood above 550—over ten times the minimum I'd seen at about 50 earlier in the day. I felt poised for a plunge of prolonged ecstasy.

THE BIG LIE

My gaze followed the tracks downward eager to see the succession of dips and hills I imagined would follow the initial plunge. But I was startled to see that the tracks, instead of veering upward again near the ground, bore relentlessly downward, entered and were swallowed by the blackest hole I had ever seen.

The blackness lapped like a liquid at the tracks and at the edges of its pool. As I started downward toward this engulfing, enveloping blackness, I, my ego, understood through a flash of intuition that if it entered this place that ego dissolution would occur and it would no long Be In Control. So my ego told me the Big Lie and filled my mind with the warning thought that if I entered this place, that I would never emerge, and I would cease to be.

I was startled to see that the tracks were swallowed by the blackest hole I had ever seen....
So my ego told me the Big Lie....

Since I was a Physics major with a Protestant fundamentalist religious background, I was totally ignorant of mystical experiences, ego dissolution, transcendence, etc., and I foolishly believed my ego's self-serving warning... and I panicked. A soundless scream of fear and unwillingness filled my mind, and of course my alpha instantly disappeared, so the feedback tone disappeared; then the whole scene disappeared, and I tumbled back into he-who-was-sitting-in-a-chair in Joe Kamiya's feedback laboratory.

At once I felt sheepish embarrassment for over-reacting; then a vague sense of loss and regret at having missed some kind of opportunity began to grow. I tried to resume the attitude of alpha enhancement, but the doorway I was now seeking remained closed and unapproachable. [The good news about alpha training is that you can only get as much experience as you can handle and integrate. The bad news is that you can only get as much experience as you can handle and integrate.]

There were other experiences after that, also of considerable interest, but the physical fatigue and the fear of the abyss conspired to keep my alpha levels well below those at which the most profound experiences had occurred. The fatigue, which I had also felt in the three earlier sessions about 5 minutes before the technician ended those sessions caused me to estimate I had been there for about 45 minutes. I was therefore not at all surprised when the door began to open; but I was surprised when the technician burst into the room in a sudden flood of light and a state of some alarm. In the background were about a dozen people, most of the lab crew, who had all been at lunch together when my technician remembered, ["Oh my God!"] that she had forgotten me in

the feedback chamber, and they all rushed back together to "rescue" me.

The rest of the afternoon was spent in telling and retelling the story of my adventure. For two days afterwards, I walked around feeling light and buoyant and not at all sure I was touching the ground. Four months later, still moved by the realness of what had happened, and having heard that similar things can happen in meditation, I started Raja Yoga lessons to prepare for another encounter with the unmanifest, which my ignorance and unreadiness had led me to fear and to avoid.

CODA

"Persevere in the work... For, when you begin it, you will find that there is at the start but a darkness; there is... a cloud of unknowing. No matter what you do, this darkness and this cloud is between you and your God and because of it you can neither see Him clearly with your reason... nor can you feel him with you... love. Be prepared, therefore, to remain in this darkness as long as must be.... For if you are ever to feel Him or see Him, it will necessarily be within this cloud and within this darkness... you are to try to pierce that darkness.... You are to strike that thick cloud of unknowing with a sharp dart of longing love: and you are not to retreat no matter what comes to pass."

From *The Cloud of Unknowing*, by an anonymous 14th century English mystic (Translated by Ira Progoff)

History of Alpha Brain Wave Feedback

Historically, the roots of alpha brain wave feedback training lie in a discovery made in 1908 by an Austrian Psychiatrist named Hans Berger. He discovered the existence of oscillating electrical waves in the brain, and he called them alpha waves, because they were the first electrical activity to be discovered in the brain. Alpha is the first letter of the Greek alphabet, like our "a", and is often used to mean the first or the beginning. He kept his discovery secret for 10 years while he conducted research into what he thought was the basis of ESP. Berger also discovered that alpha waves were uncommon in anxious people, and if an anxious person did have a few alpha waves, they were smaller than usual. After he published his findings in 1918, interest in electrical waves in the brain spread rapidly around the world. Early scientists mapped out the different types of brain waves

(alpha, beta, delta, and theta), and began to do psychophysical studies on the "natural reactivity" of these brain waves to sensory stimulation. None of these early investigators (pre 1982) ever imagined that people could learn voluntary control of their own brain waves, which were thought to be exclusively an autonomic function.

The new science of Biofeedback was actually launched in April of 1962 by a report by Dr. Joe Kamiya (my former teacher, then colleague and co-author) that people could in fact learn voluntary control of their own brain waves. Brain wave feedback training was heralded primarily as promoting relaxation and mental creativity. Brain wave studies of meditation established that meditators could exert profound control over their brain waves, and brain wave feedback was thought to make possible an "instant Zen" experience. Speculations became confused with claims, and by the late 1960s a firestorm of media attention ensued. This firestorm of popular attention to exaggerated or unsubstantiated claims disturbed the conservative authorities of the medical, psychiatric, and psychological communities.

As a result, a number of eminent scientists began to do alpha brain wave feedback studies expressly to rebut the popularized claims. Many of these eminent scientists were unfamiliar with the vast classical literature of scientific research on brain waves and psychophysics, especially the work done on the psychophysics of alpha waves. As a result their studies did not employ anything approaching optimal designs or ergonomic feedback technology. Without an informed understanding of the causes of the natural waxing and waning of alpha rhythms it proved to be quite difficult to successfully train people to increase their alpha, resulting in most alpha researchers in the 1970s failing to teach their research subjects how to increase alpha activity, obviously resulting in a flood of publications stating that alpha feedback did not work. Some of these reports even suggested that people innately lacked the ability to learn control of their alpha activity. Most of these researchers did not know that their incomplete findings were caused by non-ergonomic feedback technology and inappropriate training protocols, and virtually all employed too little feedback time. Also absent in these reports were any alpha-related benefits. If benefits come with increased alpha, then no alpha increase means no benefits.

Some in the cultural establishment may actually have been relieved that alpha feedback was being shown not to work, given the difficulties that were experienced in countering the psychedelic drug movement

and movement known then as the "counterculture". The popular belief that alpha feedback was an electronic technology for consciousness expansion and transformation, was now contradicted by the existing consensus of so called experts. So the word went out: "Brain waves can NOT be voluntarily controlled." As a result the alpha brain wave feedback movement went underground by the mid 1970s, and most brain wave training fell into obscurity as just another fad spawned by the Psychedelic '60s.

Brainwave feedback was thought to make possible an "instant Zen" experience.

However, the considerable clinical and popular enthusiasm, which had been generated for doing "biofeedback" could not be put back into the bottle. That energy and enthusiasm was blocked from going into brain wave research by the negative findings of experts, so all that energy went, instead, into doing "biofeedback" with the NON-brain activity of the body. Biofeedback came to be synonymous with the peripheral modalities of muscle tension (learning to relax the muscles), of skin temperature (learning to warm the hands and feet), and electrodermal (learning to change the electrical responses of the skin which are induced by shallow or transient emotions).

Most of this "biofeedback" work was done under the label of "stress reduction", which was acceptable to established authorities. At the same time the clinical practitioners of peripheral modality biofeedback were gradually eroding resistance to the idea that the mind and body are inextricably interconnected. There were also specialty applications which began to infringe on the domains of medicine, dentistry, and psychiatry. For example, learning to relax the jaw muscles would prevent teeth grinding and the tooth loss associated with bruxism. In addition, learning to warm the fingers and toes cured a painful disorder characterized by inadequate blood circulation in the digits known as Reynaud's disease. Medicine had been ineffectively treating Reynaud's disease with powerful drugs, which had negative side effects, and as a last resort, by amputation of the fingers and toes. Temperature biofeedback was a big improvement over traditional medicine in this regard.

Although there will soon be major changes as people rediscover the power and the range of brain wave feedback training, most of the work done today by

biofeedback clinicians is still done with the peripheral modalities of skin temperature, muscle tension, and electrical conductivity (or resistance) of the skin. Peripheral modalities of feedback are generally only effective in working with some peripheral symptoms. *The peripheral modalities are largely ineffective in working centrally, with the brain itself.* This limits the results to treatment of symptoms rather than treating their underlying causes. Because would-be brain wave biofeedback practitioners have been limited by grossly inadequate equipment, until just the last few years, and because they continue to be limited by lack of knowledge of proper brain wave training protocols, biofeedback has been limited to the peripheral modalities. Biofeedback has remained, in the official view, as an interesting curiosity of limited power and limited range of applications. As a result, biofeedback has not been highly regarded by the medical professions.

CURRENT CONTEXT OF BRAIN ACTIVITY FEED BACK

An ever increasing body of evidence is defining and substantiating the knowledge that the brain has the power to regulate all bodily functions. In addition, brain activity is increasingly being implicated as a significant, even a controlling, factor in both wellness functions and in the onset and progression of illnesses, including addictive behaviors.

Disease is not so much the effect of external forces as it is the faulty efforts of a person's mind and body to deal with them.

In recent years, an explosion of knowledge in the neurosciences has uncovered dozens of chemical messengers that the brain uses for its far ranging influence in the body and communication between cells. Among these potent compounds are stress hormones and fast acting neurotransmitters that vary in magnitude, time of action, and kind of action depending, in part, on a person's moods, attitudes, and learned ways of reacting to one's perceptions of various situations. How one thinks about an experience and how one defines it to oneself effects cell receptors for the neurochemicals.

However, medicine's archaic biomechanical/disease model gives only limited recognition to the mind's influences on the bodily processes we call wellness or disease. The old disease model includes mainly genetic and external factors in the

MEGABRAIN REPORT

Illness/Etiology equation. As a consequence, much of medicine has not considered relevant the manner in which a person reacts to life's experiences. Up until now, the person's reactions to life's events and the person's brain activity have not been considered relevant in the diagnosis and treatment of most illnesses.

The "bio-mechanical/disease" model of medicine is now no longer considered valid for up to 80 percent of all illness and with most addictive behavior. It was founded on the incomplete assumption that mind and body are separate and the incorrect view that there are no mechanisms by which attitudes and moods could physically affect organs and tissue.

Whoever can best implement the new knowledge of the brain's central role in disease and wellness will make huge profits

Consequently, much of the arsenal of current medical treatments are not optimally effective, resulting in billions of dollars being wasted annually on unsuccessful treatments, which are the logical consequences of the incomplete medical model. Most treatment has been palliative—directed toward suppressing or eliminating the symptoms of disease—and very little has been done to cure and remove the basic causes.

Another source of misdirected treatment comes from the urgent need to contain health care costs. In attempting to solve Medicine's current economic crisis, current efforts are directed primarily at reducing costs, rather than producing effective outcomes. Soon people will realize that producing effective outcomes is the best way to reduce costs in both the short and the long term. There are vast monetary implications here because of the many billions of dollars currently misdirected in the health care system. Whoever can best implement the new knowledge of the brain's central role in disease and wellness will make huge profits while simultaneously lowering the total amount of money spent on health care in our society, and will also provide more effective outcomes for people seeking health care.

Disease is not so much the effect of external forces as it is the faulty efforts (reactions) of a person's mind and body to deal with them. Microbes already reside in our bodies. We are born with our genetic strengths and weaknesses. When our

responses to apparent problems in life are excessive or deficient, the central nervous system and hormones act on our immune defenses in such a way that "germs" and genetic weaknesses aid and abet disease rather than cause it. These disorders are the result of normal natural processes of the body going awry by too much or too little stimulation as a result of an autonomic nervous system stress reaction.

Antiquated medical practice draws the incomplete conclusion that the brain's and the body's autonomic responses are autonomous, i.e. that they are not available to our conscious control and direction. Consequently, the powerful and ultimately determinant role played by cortical activity is largely ignored. And more importantly, "standard" medical practice does not, and can not, account for the role of intention, of will, and of awareness in the control and regulation of the autonomic systems of the brain and body. Thus, under the old bio-mechanical/disease model, stress and the resultant illnesses and addictive behaviors are either simply unavoidable consequences of life or attempts are made to deal with this situation symptomatically by prescribing tranquilizers and the like for the amelioration of stress. Psychologists typically attempt to treat the stress problem through the teaching of coping mechanisms, which is likewise symptomatic because it attempts to reduce the effects of stress without eliminating the stress reaction right from the start.

Both approaches are premised upon the incomplete idea that the stress responses of the autonomic nervous system, i.e. its sympathetic and parasympathetic responses, are unavoidable, because of a false belief that we innately do not have the ability to control the brain activity that affects those responses. Whereas the truth is that WE DO INNATELY HAVE THE ABILITIES TO CONTROL BRAIN ACTIVITY, but that we are taught, through cultural conditioning, not to use them. Dr. Willis Harman has described the cultural conditioning we give our children (the process of acculturation) as meeting the classical definition of hypnosis, so perhaps most of us are hypnotized in our early years into accepting a rigid and limited view of our own mental abilities. Exceptional and gifted people have simply learned how to adopt additional viewpoints, new mind perspectives, which require only that they can control their brain activity in new ways. Any experience you have requires specific underlying brain activity. Choosing and controlling what you will experience is as easy as choosing and controlling your brain activity.

Most people can control their brain activity sufficiently to go to sleep and to wake up

as needed. Those who have exceptional mental abilities simply have additional subtleties of brain self-regulation available to them. Learning to understand and control the subtleties of one's own brain function opens up vast new areas of skills, abilities, and experiential fulfillment. It is simply learning to operate one's bio-computer more effectively, and the rewards are beyond your current ability to imagine, just as a 2 dimensional person could not imagine life in a 3 dimensional world. You first need to make the shift into a new mind perspective, a new point of view, to understand the implications of having that new point of view.

Choosing or controlling what you will experience is as easy as choosing and controlling your brain activity. Brain wave feedback has both the benefits of being faster than meditation and of being more nearly culturally neutral.

And then there are additional benefits of having multiple perspectives. For example depth perception requires at least two eyes, spaced some distance apart. With three perspectives, it is possible to triangulate and find the location of a signal source anywhere in three dimensions. As we will see later in this article, creative people have the natural ability to adopt a different [high alpha] brain state when they are working on a problem. This ability to step into a different brain state gives them a new mind state, and one that is ideal for being creative. Thus they are completely interconnected. Without this ability to change the brain activity, the person is non-creative.

Some people have been using meditation to control their own brain activity. Substantial evidence now exists about meditation's beneficial effects on the brain wave components of the stress reactions of the autonomic nervous system. Consider for example, Dr. Dean Ornish's report on successfully reversing coronary artery disease through a program emphasizing meditation, mild exercise, and dietary changes. For the first time someone has shown that the internal blockage of arteries can be reduced, and Dr. Ornish suggests that the meditation component may play the most important role.

Another means that increasing numbers of people are using to gain control their

own brain activity is brain wave feedback training, which is at the core of the Biocybernaut Process which I have developed. Brain wave feedback is a recently developed technology for learning control of the activity of one's own brain waves. Moreover, brain wave feedback has recently been shown—in research I describe later in this article—to be faster and more effective than meditation in producing beneficial learned changes in the brain waves. Another important consideration is that brain wave feedback is effective without the quasi-religious overtone or Eastern cultural overlays often associated with meditation training. Thus brain wave feedback has both the benefits of being faster than meditation and of being more nearly culturally neutral, so that it is free of the cultural resistance many people have to meditation. There are many benefits to having a clear, clean mind, and it is not necessary to spend your whole life to find the keys to a few subtleties of shifting your brain waves. Meditation is a slow process requiring patience, persistence, and lots of time. Brain wave feedback training can provide virtually the same insights and much faster access to those insights and to the underlying control of one's brain activity.

Part Two

HISTORY OF MY OWN WORK ON BRAIN WAVE FEEDBACK

In order to go beyond the treatment of symptoms, which is all the peripheral modality biofeedback training can accomplish, it is necessary to have access to the signals of the central nervous system—the electrical signals of the brain. Brain wave feedback is more powerful because it operates at the source of problems, in the brain and the mind, rather than with peripheral symptomatic expressions of those underlying (central) problems.

I recognized the importance of making this central vs. peripheral distinction at the beginning of my career in 1968 during the deep transpersonal experience described above. This experience was so profound that I have dedicated my entire professional life to the quest of creating the technology to most effectively transmit this experience to others, and studying this process scientifically so that it can be understood, evaluated and, ultimately, accepted by the professional scientific communities. This quest has led me on a course over the last 25 years to first establish that individuals do have an innate ability to control their own brain waves, and then secondly to develop and to optimize a technology and methodology with which to obtain the

profound and wide ranging benefits which result from voluntary control of central nervous system activity.

Prompted by my original experience, I first (in the late 1960s) conducted extensive literature reviews and searches, reading and absorbing everything available in the prior history of EEG research. Out of this study I gained an understanding of the natural reactivity of the brain waves to various sensory stimulation, an area known as psychophysics. Because of my undergraduate background in physics, I recognized that competence in the design of EEG feedback equipment required mastery of this classical literature in the psychophysics of the EEG.

Aided by this knowledge, from 1971-1973 I constructed and tested EEG feedback equipment as well as designed formal academic research trials of the alpha/anxiety relationship, first at Carnegie-Mellon in Pittsburgh and then at the laboratory of Dr. Joe Kamiya at Langley Porter Psychiatric Institute of the University of California Medical Center. These studies initiated the construction of a large multi-parameter psychophysiological data base, which has been of extraordinary value. In those pioneering early years, data analysis was quite a challenge. At that time there were no computers on the West Coast which had Analysis of Covariance programs for multiple groups with repeated measures, so I undertook to write one for the Kamiya lab's DEC PDP-15 minicomputer. I verified my ANACOVA computer program by comparing its results with a hand analysis, done on an HP-35 pocket calculator. I then used the resulting program to confirm that alpha trainees could significantly increase their alpha scores over time. The whole process was something like selecting the seeds to grow the trees from which mill the lumber with which to build a ship with which to voyage into discovery.

By 1974 I had established that successful replication of learning in brain wave training studies was dependent upon how alpha activity was quantified and fed back to the trainee. This work was the first to recognize that the alpha enhancement failures being published by other alpha researchers of that era all employed a percent time feedback and measurement technique. On the other hand, the small number of successful reports of positive learning results typically used amplitude integration for scoring and feedback. In spite of the publication of this finding in the charter issue (1976) of *Biofeedback and Self Regulation*, many researchers attempting brain wave training today still do not see the implications of this finding, if they know of it at all. Without utilization of

amplitude integration for scores and feedback signals, the effectiveness of the training is greatly reduced, and the ability to standardize protocols with predictive outcomes becomes very doubtful and open to question. Even the ability to report meaningful data, which can be compared between different subjects, or between different days of training for the same subject, is impossible with percent time measures. Percent time measures are like a rubber ruler in that they suffer from both ceiling and floor effects and they also suffer from gauge variance.

By 1978 my research had conclusively linked alpha increases with reductions of both trait anxiety and state anxiety.

ALPHA RELIEVES ANXIETY. By 1978 my research had conclusively linked alpha increases with reductions of both trait anxiety and state anxiety. This study (published in *Science*, 7/7/78) subsumed previous negative reports on this topic as special cases of low anxiety subjects, which were shown to be irrelevant to the treatment of high anxiety people. This was the first report in a world class scientific journal that personality traits were linked (possibly causally linked) with brain wave activity.

In earlier research I had found a correlation of changes in the MMPI's clinical scales with changes in EEG alpha activity at three different locations on the head. But this paper had been published first in a conference Proceedings and was then abstracted in a specialty journal (*Biofeedback and Self-Regulation*), so that little or no attention was paid to this finding by the Psychiatric and Psychological communities. However, with the 1978 report in *Science* showing both that people could learn to increase their alpha brain waves with EEG feedback training, AND that such learned alpha increases resulted in significant decreases in both State and Trait Anxiety, the scientific establishment was put on notice of a new paradigm for medical and psychological research. However, it would still be more than 11 years before Peniston and Kulkosky (1989) published their landmark study, which confirmed my 1976 and 1978 reports of personality changes following learned control of EEG activity with EEG feedback, and added the report that alco-

MEGABRAIN REPORT

hol addiction was effectively treated (80% success rate) with EEG feedback of both alpha and theta activity.

It may be that the high anxiety people were self-medicating [with marijuana] to lower their anxiety. She described “falling into a pool of alpha,” which forever changed her life.

ALPHA, DRUGS AND ALCOHOL. Drug and alcohol studies have been one of the sub-themes of my research since 1966, when I was still an undergraduate in the Physics department. Then I was the statistician and computer programmer for the Campus-Wide Drug Use Survey at Carnegie-Mellon University in Pittsburgh, PA. In this role I got an early and very complete look at the developing patterns of drug use in a University setting. When I started doing formal academic research studies on alpha feedback I always included drug use histories and daily surveys of the daily drug use of my alpha research subjects. In 1972 I continued this drug use and drug history research in San Francisco at UCSF with alpha feedback volunteers drawn from San Francisco State College. At that time average daily marijuana use of low anxiety subjects was 0.1 marijuana cigarettes per day, whereas high anxiety subjects were averaging 1.1 marijuana cigarettes per day. Given that alpha levels are depressed in high anxiety subjects, and given that published studies of the brain wave effects of marijuana show that it increases alpha brain activity, especially in the occipital region, it may be that the high anxiety people were self-medicating to lower their anxiety.

In 1979 I had the opportunity to provide alpha training to a woman who I later discovered to be a multiple-drug user and a drug dealer. I did not know that she and her husband (also a dealer) were consuming almost an ounce of cocaine per day, between the two of them. She was drinking a fifth of hard liquor to take the edge off the cocaine, and she smoked tobacco daily, and took LSD, psilocybin, mescaline, and marijuana on a regular basis. She also took tranquilizers and stimulants to change her mind state whenever she wanted and in whatever direction she wished. Her personal motto was, “Excess is not enough!” I did not know she was using drugs during her

training. On the fifth day of her alpha training she described “falling into a pool of alpha,” which forever changed her life. Although she had no intention of reducing or stopping her drug use when she started alpha training, and in spite of the fact that she liked her drug use lifestyle and thought her life “was working well,” her drug use began to fall away. Within six weeks of the end of her alpha training, she was not using any drugs. Even the tobacco smoking had stopped. And now she found that she could no longer live with her husband, who had not done the alpha training, and who continued to use and deal. I had the opportunity to follow up with this woman for the next nine years and she continued her drug abstinence to the extent of usually avoiding even caffeine beverages.

When my laboratory moved off the UCSF campus in 1983 and relocated to the San Jose campus of the Agnews State Hospital, I began training people specifically to treat drug addiction, sometimes working with several members of the same family simultaneously. Word of this success spread locally so that a local judge gave alcohol offenders the option of jail or my alpha training program. One of the most interesting success stories in a court referral shows the extremely broad range of chemically dependent people treatable with EEG feedback. This man was an alcohol and cocaine user. He was a farm hand adopted into a wealthy family and was unschooled and averse to learning. Referred by a court, he showed up for the first day's training in the company of his step brother with both of them late, drunk, and hungry, so they excused themselves to go out and eat (and drink more alcohol). However, the next morning he had sobered up enough to begin the training, though his drug abusing step brother did not join him. He did not understand any of the transpersonal themes typically discussed in the training, but he did know what he liked. He liked fixing farm equipment down in the shed, and he began to describe his moments of highest alpha like the visualizations of a born mechanic. His alpha scores went higher each day, and he became calmer and more patient and more sober. Several months later he called to express a surprisingly complex mixture of deep sadness and deep gratitude on the occasion of his step brother's death in a drug-related auto accident. He wished that his step brother had done the training, and he was so grateful that he had done it. Two years later he was still clean and sober.

However successful these various drug treatment studies were, I saw them as only one of the many applications of the technology I was developing. Other significant

adventures of discovery, included two trips to India to study brain waves and other physiological functions on Yogis of many different traditions, some of whom could profoundly alter cardiac functions, walk on hot coals, and even eat broken glass and razor blades. Some had been meditating for over 50 years and combined a beatific radiance with the ability to sustain monotonic increases in their alpha activity for over an hour during meditation.

I was learning that brain waves relate to everything, and that control of brain waves had life and death implications . . .

ALPHA AND LONGEVITY. The 1978 *Science* paper on the inverse correlation between alpha and anxiety supported the award of an NIMH Grant with the title *Anxiety & Aging: Intervention with EEG Alpha Feedback*. Prior research (Gurin, Veroff, & Feld, 1960) had shown that anxiety increases with age, in both men and women, and anxiety goes up faster in women. In addition, at every age, anxiety is higher in women than in men. So I undertook to study alpha EEG training in the people most at risk for anxiety: women over 60. I found that alpha activity declines as arteriosclerosis advances. Abundant alpha in the elderly was a marker for cardiovascular health. Many of the age-related losses of mental and physical function had accompanying brain wave changes which could be explained by reduced blood flow to the brain. Clogging of arteries and reduced elasticity of the blood vessels were both implicated. I also recognized the possibility of a connection between learned alpha increases and increased blood flow to the brain. It had already been shown, by others, that hand temperature feedback succeeded in warming the hands through the mechanism of learned dilation of the peripheral blood vessels, and I speculated that people might be learning cerebrovascular dilation as part of the underlying mechanism of increasing their alpha brain waves.

I began to formulate the hypothesis, and to collect evidence, that part of the mechanism of learning increases in alpha activity could be a learned dilation of cortical blood vessels, resulting in increased blood supply to the brain. Neuroscience recognizes that the brain works better when it is adequately supplied with blood, and thus glucose and oxygen. I recognized that the current population demographics

mandated that any effective geriatric applications of alpha feedback training would eventually assume increasing importance and value. One of my colleagues, Dr. Charles Yeager, had set up EEG labs in the California State Hospital system in the 1950s, and he visited these labs annually and did EEGs on the elderly residents of the State Hospitals. He commented to me that even if someone was 100 years old, if that person had good strong alpha waves in his or her EEG record, that he knew that person would still be around next year when he came to visit. On the other hand, if the elderly person had shifted into a non alpha record characterized by theta and beta activity, he would say a special good bye because he knew it was unlikely that person would be still be alive when he visited again next year.

ALPHA AND EVERYTHING. I was learning that brain waves relate to everything, and that control of brain waves had life and death implications, as well as implications for the quality of life. Any experience you can have has a specific underlying brain activity associated with it. If you can control your brain activity, then you can control your life and your experiences in life.

From 1982 to 1983 I took a leave of absence from UCSF for the specific purpose of developing patentable technology for both a portable EEG feedback unit and for a multi-user Training-Center version of the EEG feedback technology. In 1983 I founded the Biocybernet Institute, Inc., a for profit California Corporation to serve as the corporate arm of my Research and Development and Training programs. The Biocybernet Institute undertook the creation of new EEG feedback technology, both hardware and software.

In the Fall of 1983 I was awarded the first in a series of annual grants from the John E. Fetzer Foundation, and I went back on staff at Langley Porter, the Department of Psychiatry of the UCSF Medical Center, and I moved into a new laboratory on the campus of Agnews State Hospital. My time at the University was dedicated to conducting EEG feedback trainings with an ever widening client base to explore the range of applications effectively served by EEG feedback training. The balance of my time was devoted to work on technology R&D at the Biocybernet Institute, where I developed microprocessor-based EEG feedback instruments, including 2 and 4 channel portable units, and 8 channel laboratory training systems for single users and multiple simultaneous users.

ALPHA AND PEAK PERFORMANCE TRAINING. In late 1983 I provided several weeks of EEG feedback training to officers from Army Intelligence who were given the task of exploring new technologies to increase mili-

tary performance and effectiveness. This training laid the basis for later work with peak performance training for Army Special Forces (Green Berets). When the work with U.S. Army Intelligence expanded, it became part of a larger project and involved alpha training for two 12-man teams of Green Berets at a secret Army base. As part of a larger peak performance research project, one of the Biocybernet Institute's multi-user laboratory systems was installed at this army base—I had designed this Multi-User Lab System which as then built by the Biocybernet Institute was configured to train 6 people simultaneously. Consequently, I was able to demonstrate in a real application that significant economies of scale were possible in EEG feedback training.

The advent of IBM's AT class computers created the opportunity to upgrade the hardware platform of my brain wave feedback instruments. I undertook the redesign of all of the special purpose computer boards for the feedback function. The AT also proved a suitable hardware platform for large EEG data analysis programs I had begun in 1981. The largest such program was BIOCAL, a software post-training filter to the EEG data. BIOCAL incorporated pre- and post-training calibrations to produce adjusted scores of higher accuracy than the hardware could produce on its own. BIOCAL compensated for amplifier drift over time and for nonlinearities of gain across different amplitude ranges, and it automated the process of identifying and rejecting artifacts in the EEG data, through complex, heuristically developed algorithms involving simultaneous comparisons of many EEG channels and different filter bands. Using the highly purified data from BIOCAL, I was at last able map the dynamic brain patterns of specific experiences in what I called the "Cartography of Consciousness". The creation of these "Mercator Projections of Mind States" required the purest possible brain wave data for comparison with subjective measures of mind states. The ability to successfully relate brain states to mind states and to performance opens up new possibilities in implementing useful applications of EEG feedback.

I was able to come up with insights that seemed telepathic or psychic What does it mean to grow through an emotion like anger?

Other software development projects I undertook about this time were upgrades of the MOOD SCALE programs to administer

and score the three mood scales used every day in the brain wave training. I had discovered in the Green Beret study that my skills in memorizing every response made by a trainee to the hundreds of adjectives in the mood scale test batteries were overwhelmed by having 4 to 6 trainees simultaneously. The three individual mood scale programs were combined to automate and computerize both the administration and the scoring of the mood scales. In this way I only had to remember a few calculated dimensional scores for each trainee instead of hundreds of individual responses. Also, by computerizing the administration of the mood scales, it became possible to time each person's response to each item very accurately, in hundredths of a second. This data would prove extremely valuable in later developments.

ALPHA AND "GROWING THROUGH" EMOTION. One of those developments was a significant change in the computer programs administering and scoring the mood scales and a related significant change in the way the results of the mood scales were presented to the trainees. Response latency timing information on a trainee's responses to each of the mood scale items was already being collected with a precision of one hundredth of a second. To this software capability I added the calculation of descriptive statistics for each of the different responses. Suddenly it became possible for the trainee and the Trainer to know subtle details the trainee's response patterns. To this was added statistical significance testing on the responses. I soon recognized that some of these statistical patterns were pointers to an alternate part of the mind which was filled with unacknowledged (and thus buried) anger or fear or guilt or sadness or whatever else. Equipped with these new tools I was able to come up with insights that seemed telepathic or psychic, but with the added advantage that my insights were supported by measured data derived scientifically from the trainees' own responses.

Once the buried emotional blockages of a trainee had been identified by the new computerized mood scales, they often came very quickly to consciousness. And once the emotional blockage had come to consciousness, it then quickly became possible for the trainee to work through the "charge" or valence on the emotion in the next day's alpha training. Bringing to mind some highly charged emotional topic in the alpha training would, at first, block or suppress the alpha, and the feedback tones would shut off and the scores would drop. But then the challenge for the trainees would be to discover new ways of relating to their own experiences of that emotion and the events behind

it. The trainees would grow through their fear or anger or guilt or sadness much faster than believed possible. What does it mean to grow through an emotion like anger? We all know suppressing anger does not work. That leads to heart attacks, ulcers, unhappiness, and occasional violent outbursts of anger. On the other hand “expressing” anger does not work very well either. If someone practices expressing anger, then they usually develop the habit of expressing anger, they become too good at it, and it becomes a form of public littering. What is needed is to get to the source of the experience of anger in the mind and to learn how to adopt a new point of view about that experience.

ALPHA AND THE WITNESS. This is one of the key growth experiences of the present Biocybernaut Process—trainees have daily assessment of their emotions by computerized mood scales together with in depth interviews by highly skilled trainers to help them become aware of hidden, buried, and latent emotions. Once the awareness of these emotions has been raised to the level of conscious self awareness, then the trainee can begin to use the brain wave training process to gain control of his or her emotional processes. By exploring their emotions during brain wave feedback training, people learn how their emotions develop and change. In the process people learn how to take the perspective of an outside observer or Witness in looking at their own emotions. This gives them objectivity about their subjective experience, which is the key to understanding and controlling all aspects of subjective experience, including emotions. Thus the person is no longer subject to his or her emotions, but rather develops mastery over them. Again the brain waves are the key to any experience. If you can control your brain waves, then you can control your experiences, including your emotional experiences.

THREE ESSENTIAL COMPONENTS OF EEG TRAINING.

Over more than 15 years, I have been able to conceive and implement a highly optimized methodology and technology for rapidly producing learned control of brain waves. As a result of my discoveries and conceptualizations, I have been able to write broadly based U.S. and International patents, which now have been granted and provide protection on both the training methodologies and the feedback technologies. This technology and methodology is in a standardized form that can be readily replicated in a manner which produces consistent and predictable beneficial results.

Since it is somewhat unusual to be granted patent protection on both a technology and the methods of applying that technology, it would be useful and infor-

mative to consider what is unique about the Biocybernaut Process, and how it evolved. Early on I realized that there were three essential components of an optimal EEG feedback training: [1] An ergonomic technology, which includes the training environment, [2] An optimized training procedure or protocol, and [3] A transformational perspective on the part of the Trainer. Let us consider these one at a time.

Massed practice is better than distributed practice, and hours of training is more effective than minutes....

An ergonomic technology. To be most effective, any bio-feedback must be (1) Accurate, (2) Immediate, and (3) Aesthetic or comfortable. In addition, the physical environment and the feedback itself must be designed with a deep understanding of the “natural reactivity” of the alpha [or other EEG activity]. For example, alpha is reduced or eliminated by light or any visual processing, so those early feedback devices which caused a light to get brighter in response to increased alpha were very badly designed. Even devices which required a trainee to look at a swinging meter were non-ergonomic. Optimizing the amount of alpha produced requires eyes closed training or at the very least minimizing the information content of the stimulus. Auditory tones are a more ergonomic feedback stimuli for alpha training than are lights or visual displays. Many subtleties apply, including the loudness and the pitch of the tones.

The quality of the brain wave filters is also very important. The filters separate the different frequencies of brain waves [delta, theta, alpha, beta, and sub-bands within these]. If the filters are not sharp enough, or do not have enough decibels of attenuation in the stop band region(s), then they will not exclude other kinds of brain waves from the one kind the filter is allegedly tuned for. If you are doing theta feedback, and the theta filter allows in some alpha energy on one side and some delta energy on the other side, you are being deceived by the technology and learning is slowed or even prevented. Feedback must be accurate in order to be effective, and if 60% of the feedback is false feedback due to a deficient filter, then the feedback is not accurate. This finding also casts doubt on the validity of any EEG scores derived from such inaccurate filters, and the typically smaller theta EEG scores are more vulnerable to

this contamination than the larger alpha scores. It could also raise questions about any data analysis performed on such scores and about any conclusions reached based on such data analyses. The contamination could be larger than the “real” theta signal present under reasonable assumptions of the true alpha and theta amplitudes. It is impossible to do good science or good EEG training or to replicate results with such inaccurate technology.

The physical environment is also an important consideration. In the Kamiya lab, I used to see my trainees’ alpha diminish when water was used three floors below, because the sound traveled up the water pipes. Sound, light, temperature, humidity, ionization, fragrances, all must be carefully understood in their effects on the brain activity one is trying to control. For example, the smell of musk has been shown to reduce alpha, whereas the smell of lavender has been shown to increase alpha.

My System and Method patent has 37 separate claims—too many to describe here. However, one of those claims is so general and so useful that it should be mentioned. I have patented the idea and the practice of using multiple simultaneous channels of EEG feedback. I was the first person to do multiple channel EEG feedback, and was able to show the patent examiner that there are significant advantages of multiple simultaneous channels of EEG feedback. Included among these advantages are the prevention of localization of control, which can occur within a few hours of EEG feedback training.

An optimized training procedure or protocol. Back in the 1970s when most published alpha studies were reporting “No learning of alpha control”, it was standard practice to provide very little feedback training time. Meanwhile, I was learning that the more training time was provided, the greater was the percentage of people learning to increase their alpha above an initial baseline level. How much is enough? One of my typical 7 day protocols allows people to accumulate between 12 and 20 hours of actual feedback time during their first 7 consecutive day training. For most people, this is sufficient. I have found this amount of training to be adequate for treating many types of chemical dependency. However, some strong addictions, like nicotine, often require a second 7 day training in order for withdrawal to be effective and lasting. The basic principle here is that *massed practice is better than distributed practice, and hours of training time is more effective than minutes of training time.* This may soon seem obvious to people in the field, but even very recently people scoffed in disbelief when I explained that one of the reasons they could not obtain

EEG learning was their use of too little training time, and too many (or too long) interruptions of that training.

A *transformational perspective on the part of the Trainer*. When I came out of my own break-through experience in alpha feedback, there was a crowd of people eager to hear about my experiences. All of them understood something about meditation and were supportive of my report about my elevated states of consciousness. Their comments and questions helped to validate and contextualize my unusual experiences. If these people had been hostile, skeptical, or fearful, then my life may have had a different direction. It would have been possible to take a critical and culturally limited view of these experiences and to label them with the language used to describe psychiatric disorders.

The brain wave feedback process can produce experiences so profound and so outside the competence of most educated people in the West that great care must be taken to screen and train Trainers . . .

If the Kamiya laboratory staff had wanted to be critical, they could have suggested I was delusional for reporting out-of-body experiences [taking a perspective from out-

side of myself] or that I was risking psychosis by having an ego disintegration. Such interpretations of my experiences would have been culturally sanctioned, and might have stunted my growth into this new field by creating fear of new awareness states, and I might have remained a physicist. Therefore, the end of each training session in the Biocybernaut Process, a skilled Trainer conducts an in depth interview with the trainees. Each trainee is asked to describe his or her subjective experiences. Then the Trainer asks questions to clarify key points and to elevate significant aspects of that trainee's experience into prominence, so that all elements of the trainee's mind, including the rational mind, can begin to accept and integrate the insights born in deep reflection. Later the Trainer reviews the objective results of EEG scores and mood scale scores with each trainee, and together the Trainer and all trainees look through the polygraph record of the entire session, which may be hundreds of polygraph pages. This enables the minds of the trainees to correlate their new insights and altered states of consciousness with the actual graphical images of the brain waves which enabled those breakthroughs in consciousness. Inner and outer experience are united. Subjective and objective experiences are fused into a coherent whole. If the Trainer can look at the trainee and see endless possibilities of growth and transformation, then that Trainer has a transformational perspective. And if the Trainer has the compassion and intuition and love and understanding of both Virgil and Beatrice, who guided Dante's explorations, then that Trainer has a transformational perspective.

This deep metaphysical comparison is not whimsical, but eminently practical.

Alpha and the Mystical Experience. Why practical? The mystical experience and the alpha feedback experience share basic dimensions. For example Dr. Arthur Deikman surveyed the mystical literature and identified five hallmarks of the mystical experience: (1) Intense Realness, (2) Unusual Sensations, (3) The Experience of Unity or Oneness with all things, (4) Trans-Sensate Phenomena, which come to the person from beyond the realm of the senses, and (5) Ineffability, or the difficulty or impossibility of describing the experience in words (Deikman, 1966). Some or all of these phenomena attend the profound alpha and theta EEG feedback training experiences. If the Trainer has personal experience with both culturally ordinary and mystical realms, then that Trainer can exemplify wisdom, self-understanding, self-honesty, and love for the trainee. This is practical because it is most effective in aiding the growth of the trainee. Exemplification teaches and guides far better than mere words or technical knowledge. If EEG feedback trainees begin to grow in their abilities of insight and perception and they see that the Trainer is insecure, opinionated, doctrinaire, or is struggling to suppress latent anger or fear, the trainee may be afraid to grow in the presence of such a Trainer, and will almost certainly not confide in such a Trainer about the details of his or her experience. Such a limited Trainer will thus never be told about the ecstatic experiences of the trainee, but even worse, such a Trainer may actually tarnish or even inhibit such experiences.

THE BIOCYBERNAUT TRAINING PROCESS

Trainees complete extensive *personal* logs and batteries of personality tests before and after their 7 consecutive *days* of EEG feedback training. Electrodes are placed over at least 8 different locations on the head, at least 4 over each brain hemisphere. EEG activity at each site is amplified and filtered into 8 different brain wave frequency bands. The feedback system provides up to 16 different channels of auditory *feedback* from 16 different speakers, each with a *different* pitch and spatially separated to mimic the brain locations of the electrodes. Moreover, each auditory channel can contain linear combinations of up to 8 different types of brain activity.

For best results, there are 7 consecutive days in the *introductory* Alpha One training, with 1 to 2 hours spent in auditory brain wave feedback during each day's session, which can last from 6 to 8 hours. Suitable *baselines* determine the starting point of learning control of this ability to increase and to reduce the target brain waves. Training in bi-directional control is essential for mental flexibility, and it accelerates the learning process. Each day of training includes computerized mood scales to reveal unconscious emotional blocks (fear, sadness, anger, guilt, etc.), which can literally "block" a person's alpha, thus slowing or preventing the person from *learning* alpha or theta, or whatever other target brain wave(s) there may be.

Breakthrough experiences depend on the percentage of increases in brain wave changes that trainees are able to accomplish. For *example*, a 15% increase in alpha amplitude over the initial day's baselines brings useful insights, increased self-understanding and self-acceptance, and *reduced* anxiety/stress. A *doubling* or tripling brings transcendent illumination, massive insight, revelations about one's deeper purposes in life, and can bring profound changes in life direction and acceleration of growth. At the end of each feedback session, there is a daily depth interview with the Trainer to explore these experiences, to review and synthesize the brain wave data with the mood scale data, and to explore and assess the implications of all that has happened and all that has become known.

Trainers must be intuitively gifted and possess a Transformational Perspective which sees unlimited potential within each trainee. After two months of very specialized *training*, Trainers are ready to assist trainees in expanding their choices in life and in seeing more clearly the implications of their actions or inaction. Trainers *provide* clues, specially tailored to each individual's *perceptual* and cognitive processes, in how to achieve transcendental *merging* and how to recognize it in the feedback process when it begins to occur, and Trainers provide compassion and understanding during the process of *awakening* into the discovery that one's mind is ever so much larger than one had previously imagined.

The brain wave feedback process can produce experiences so profound and so outside the competence of most educated people in the West, that great care must be taken to screen, select, and train Trainers for this new field. My training process for Trainers, which has been evolving over 15 years, requires two full months of training to learn the basics of this profound process, and only about half of the candidates I have been asked to train have achieved the necessary transformational perspective of a Trainer. Yes any nurse, or psychiatrist, or teacher can buy an EEG feedback machine and start training volunteers. But there may be some unexpected, even disagreeable, surprises in store for the Trainer and the trainees, and surely valuable opportunities will be missed. Optimizing the training process and the results seldom occurs by chance. It is not necessary to reinvent the wheel or to make the early learning mistakes alone and unaided.

COMPARISON OF BRAINWAVE TRAINING AND MEDITATION

Two of the themes which I have found most intriguing over the years have been (1) The relationship between meditation on one hand and alpha and other types of EEG feedback training on the other hand, and (2) How EEG feedback training could be used to accelerate and enhance the development of gifts of the mind. Creativity is one familiar and useful type of mental giftedness, and I was very interested to study the relationship between alpha feedback training and increases in creativity among a group of scientists. Before describing the details of studies done on these two topics, it could be useful to share with you the results of a thoughtful comparison between meditation and EEG feedback embedded in the procedural context I have developed and refined over 25 years, the Biocybernaut Process.

In meditation, the signal is a subtle mind state and there is lots of noise.

Brain wave feedback training has been shown to be effective on its own in a variety of application areas. There are also a number of studies, which have been conducted with meditators, that show health and other benefits. Any such benefits of meditation which stand up to careful scientific scrutiny can probably be explained by and reproduced with the Biocybernaut Process because of the close similarity of the that process and meditation.

Both procedures encourage the intervention of our higher cortical activities in controlling the autonomic response. Both are founded on the understanding of how changes in the body are brought about and both realize that the mind and body are intimately interconnected. Practitioners trained in each of these processes experience significant reductions in the physiological parameters of stress and increased psychological maturity.

Both processes create a sense in the practitioners that peace, tranquillity, and calmness come from within. Both processes lead to another complete level of consciousness, in which awareness is systematically expanded or increased under one's direct control. At a process level both are, or ideally should be, a continuous stream of awareness, which is one-pointed, in that the mind does not wander or shift around to different topics.

However, it is in the subject and the method of the one-pointedness of the concentration that there are major differences between meditation and brainwave feedback training. In meditation, that which is the subject of attention and concentration is not reliably related to one's mind state or to one's consciousness. Some meditation methods instruct by directing the student's attention to a mantra—a word or phrase which is repeated endlessly. Alternatively, attention may be directed to the breath, to the sensory impressions, or there is an effort to attend to one's thoughts without judgment or emotion. All of these methods can be useful, but they are difficult for most people, and they are usually very slow processes, requiring long periods of constant mental attention, and offer very little internal feedback about how well one is doing. This lack of internal feedback in meditation is especially problematical in the important early stages of learning.

Brain wave feedback is the key. In the Biocybernaut Process the trainee concentrates on his or her actual brain waves. These brain waves underlie all types of awareness, both those which are conveyed by thoughts, and those processes of awareness which do not proceed through the use of thoughts. With brain wave feedback the trainee learns not only how to calm the mind, but equally or more importantly, the trainee also learns how to control those brain waves which underlie all mind states. With this deep control comes the ability to regulate one's response to sensory stimulation and stimulation by words and concepts, so that the brain wave trainee can defuse a stressor or a stressful situation from the outset, immediately and flowingly. One of the differences between the two processes is that in meditation one attempts, without the aid of any feedback,

to witness one's thought patterns, whereas in the Biocybernaut Process one is aided by feedback of the exact brain waves that underlie and enable the thought processes.

SIGNAL TO NOISE RATIOS. Both meditation and brain wave feedback can be usefully compared using a signal detection analogy. In any signal detection application, the challenge is one of distinguishing the signal from the surrounding noise. Experts speak of the signal-to-noise ratio. If the signal is weak and there is a lot of noise, the signal is very hard to detect. This is the case in meditation, where the signal is a subtle mind state (a weak signal), and there is lots of noise. The noise in meditation can be acoustic noise like telephones, jets flying overhead, traffic rumbling by, people talking, even birds singing, and wind in the trees. But noise can also be the chatter of one's internal dialog, the urgings of one's desires or the reactions to one's aversions, or sensory distractions like itching of the skin, aching of a muscle, or joint, or the churning of one's stomach. All these distractions, taken together, are the "noise" which makes it difficult to pay uninterrupted attention to one's mind state (or one's breathing, or mantra).

Through brain wave feedback, the mind is forced into awareness of its subtle techniques for avoiding the calmness of the one-pointedness-of-mind.

To assist in the process of meditation, instructions are usually given to reduce this noise. Meditation instructions typically include (especially for beginners) retreating to a quiet place, turning down the lights, turning off the radio or television, and sitting very still. There are also instructions in meditation of how to pay attention to one's thoughts and feelings, to try and still these sources of "noise". But the instructions are often vague and difficult to follow, even if one understands them. The mind is extraordinarily elusive, especially when one tries to pin it down. Try not thinking of, say a hippopotamus, for one minute. Even though you may not have thought of one for months, the moment you try not to think of hippos, they stampede or do ballets through your mind with unsuppressable vigor. This is a problem when trying to still the mind in meditation. Thoughts erupt like volcanoes and flow in unstoppable torrents of words, concepts, and ideas.

However, in brain wave feedback the same subtle signal is electronically detected as the electrical brain activity underlying the calm mind state. This subtle signal is then electronically amplified, or boosted, 100,000 to 1,000,000 times and then used to control the loudness of feedback tones. In the Biocybernaut Process an effort is also made to reduce the noise by conducting this training in light controlled and sound proof rooms, so that the signal-to-noise ratio is enhanced from both ends. Both the signal is boosted and the noise is reduced. Every time the mind enters a calm state, even for a fraction of a second, the technology detects this shift and instantly turns on a tone. Thus the person is notified of his or her success in that moment (immediacy of feedback). With such feedback, there is a rapid increase in the probability of the mind entering, and staying longer in, the desired state. Since trainees get feedback on how well they are doing, they rapidly become better at entering the desired mind state, by learning how to control the underlying brain wave state out of which their experience [the mind state] arises.

Unfortunately, in meditation, there is very little feedback. And at the beginning of meditation there is virtually NO FEEDBACK. Only when meditation is done very well are there shifts in one's subjective experience. These shifts are often subtle and are not noticed until one has sustained the desired mind state for a long time. This is difficult or impossible for most beginners. As any teacher knows, students need the most guidance at the beginning of their learning. In meditation, one's guidance (or subjective feedback) occurs mostly at the end of the process, after one has become skilled at the process. This is one of the reasons why meditation has such a high drop out rate and why the learning process can take many decades.

Most meditation also fails to acknowledge or to assist people with overcoming the mental and emotional blockages which prevent the mind from entering into deep states of calmness. It is hoped that meditation itself will do the necessary mental housecleaning. And (with 20, 30, or 40 years of regular daily practice) meditation will sometimes do this. But many of the people in greatest need of the benefits will not persist long enough to gain these benefits, especially without much feedback on their progress. Even many normal, well-adjusted, busy people will not persist in such a slow process, with such a long delayed payoff.

The mental obstacles which stand between each of us and a transcendent consciousness include our attitudes, attachments, aversions, self conceptions, and our thought processes which have been trained

from childhood on to be compulsively active. These obstacles are hard to overcome by repeating a mantra, or attending to one's breathing, or even trying to pay attention to one's ever shifting thoughts.

The Biocybernaut Process includes computerized mood scales and depth interviews, on a daily basis, to bring the trainee into a clear awareness those inner obstacles of anger, fear, guilt, sadness, and all the attachments and aversions and posturing of one's ego. This information is then combined with the brain wave feedback process to focus the trainee's efforts in exactly those areas which are in the greatest need of conscious attention. The feedback signals are provided on those brain activities which are most intimately related to the thought processes and the attachments which must be worked on if one is to move toward discovery of a larger conscious awareness. Compulsive thinking, like choppy waves upon a lake, prevents one's awareness from penetrating into the depths. Thinking, at least at the level of ego-based conceptual thought, is an antagonist of one's alpha brain activity. This natural antagonism enables brain wave feedback to provide an accurate assessment (feedback) of one's increasing mental calmness and control, as one's alpha waves increase in prevalence and strength.

The Zen acceptance of sensory input... would seem more compatible with the sensory processing requirements of the alpha feedback setting.

LEARNING LIBERATION. In learning to still the mind, the feedback presentation of alpha activity provides an unambiguous record of, and spur to, one's progress. In the brain wave feedback situation, the mind is thrown back in on itself by having its strongest sensory input (the feedback tones) being controlled by the brain activity itself. All sensory distractions unrelated to the brain's own activity have been so reduced or eliminated that the only thing for the mind to attend to is itself, as indexed by the brain waves. Thus the mind is thrown back in upon itself and becomes its own object, thereby blurring the line between subject and object of consciousness (ie. merging), and dissolving the dualistic mind state which puts people "at the effect of" events of change (stressors). By thus freeing the mind, there are no longer over-reactions (sympathetic responses) and under-reactions (para-sympathetic responses)

es) of the central nervous system, and the person then enjoys the benefits of an uninterrupted natural state of health and well being (homeostasis).

Through brain wave feedback, the mind is forced into awareness of its subtle techniques for avoiding the calmness of the one-pointedness-of-mind. But there is no requirement or compulsion to change, because the trainee can choose either to ignore or to develop the insights thereby obtained. If the trainee chooses to ignore, then the alpha scores stop increasing and he or she may give the excuse of being bored (one of the Five Hindrances: drowsiness, distractibility, doubt, boredom, and laziness). If the trainee chooses development and growth, then the alpha continues to increase and the dualistic state wanes as the trainee learns the calmness and the one-pointedness of mind which leads toward liberation.

Liberation can mean freedom from the automatic stress response. It can also mean liberation from addiction, chronic pain, eating disorders, high blood pressure, stress and anxiety, psychoses and neuroses, learning disabilities, and age-related limitations on cognitive and physical functions. All of these benefits are really byproducts of learned improvements in central nervous system functioning. All of the benefits shown by scientifically accepted meditation studies are also likely to be available through the Biocybernaut Process; however they are likely to be available faster and easier and for a much greater range of people, who would never try or persist long enough at meditation.

Alpha Feedback Training May be a Closer Parallel to Zen Than to Yoga

Any comparison of alpha feedback training to meditation must take note of the differences between Zen and Yoga meditation. Yoga meditation has long been known to increase alpha activity (Wenger & Bagchi, 1961; Anand, Chhina, & Singh, 1961). The same is true of Zen meditation (Kasamatsu & Hirai, 1966; Hardt, Timmons, Yeager, & Kamiya, 1976). Advanced meditators showed the patterns of beginners and intermediate meditators but also showed a third pattern, which appeared in the deepest portion of their meditations: the emergence of rhythmic theta waves, unlike the theta of drowsiness. These rhythmic theta waves alternated with slowed down alpha waves. It was as though the slow alpha had slowed in frequency sufficiently to be considered theta activity (which is 4-7 Hz), because the

MEGABRAIN REPORT

rhythmic theta waves had the morphology of alpha waves: they occurred in spindles of successive waves and waxed and waned in amplitude just like the spindles or wave packets of alpha waves.

ALPHA BLOCKING. One important insight into differences between Zen and Yoga meditation is what happens to the alpha waves in the brain of the meditator when you disturb the meditator. In a non-meditator with alpha present, a disturbance causes the alpha to "block" or to disappear. After a short while the alpha comes back. If you make the same disturbance (say a click sound) again and again, eventually the alpha of the non-meditator does not block any more. It has *habituated* to that particular disturbance.

Only advanced Zen meditators showed theta activity... and yet the seven-day alpha feedback trainees showed the same result.

There are substantial differences between Zen and Yoga in the alpha blocking response to stimulation, which have been known for a long time (Anand, et al. 1961, and Kasamatsu & Hirai 1966). These EEG differences (no alpha blocking in Yogic Samadhi, and continued blocking without habituation in zazen) suggest comparisons with differences in Zen and Yoga philosophies. Yoga philosophy is more likely to deny or devalue external reality in favor of the "real" or superior reality within. The external world has little or no effect on the Yogi's EEG. This is consistent with the beliefs of Yogic philosophy, in which the external world is held to be mere illusion, or maya in Sanskrit.

Zen philosophy, on the other hand, seeks to bridge the inner and outer worlds, neither denying nor asserting the reality of either the inner or outer worlds. Yoga meditation is done eyes closed in most traditions, and the mind is fully absorbed with inner events, to the exclusion of the outer world of the senses. On the other hand, Zen is typically done with the eyes half open, downcast, with soft focus (ie. blurred or defocused vision). This visual strategy could help Zen bridge the gulf between inner and outer worlds. These are important clues in determining which of these two meditation traditions is more like alpha feedback training. The Yogic absorption into inner experience would tend to ignore stimuli from the world of

the senses, including even feedback sounds (and scores) which are used to signal or give feedback about presence of alpha waves. On the other hand, the Zen acceptance of sensory input (even distractions), and their integration into a steady inner awareness, would seem more compatible with the sensory processing requirements of the alpha feedback setting. It would therefore seem more suitable to compare the alpha feedback changes to those seen in Zen meditation.

When taken together, the studies of Kasamatsu and Hirai (1966) and Hardt, et al. (1976), show four significant features of Zen EEG changes:

- [1] Control subjects show no alpha increases,
- [2] Beginner Zen subjects show increased alpha amplitude mainly at the back of the head (occipitals),
- [3] Intermediate Zen subjects show increased alpha amplitudes which spread forward on the head, and which slow in frequency,
- [4] In the Zen studies, beginners showed increases of alpha activity, primarily at the back of the head. Intermediate meditators showed the beginners changes plus increases of slow alpha and a forward spreading of alpha from the alpha origin at the back of the head. These rhythmic trains of theta EEG, which are morphologically different from the individual wicket shaped theta waves seen in drowsiness. The theta wave criterion is a stringent one for alpha feedback to meet, since *only advanced Zen meditators with 21-40 years of meditation practice showed these theta waves.*

To obtain an alpha feedback group for comparison with the Zen meditators, the records of 17 alpha feedback subjects were selected at random from my University data base of EEG alpha feedback training. Selection criteria included right handedness and at least 7 days of alpha feedback training. Both men and women were represented. All subjects were volunteers, who did not have any prior meditative practice, Zen, Yoga, or otherwise. Their group results are shown in the following figure, which shows all eight head sites and the eight EEG filters employed at each site.

All 8 head sites (O1, O2, C3, C4, T3, T4, F3, F4) showed significant [$p < .05$] increases of both broad band alpha and slow alpha. In addition, there were significant increases of both fast theta and slow theta at the two Frontal sites (F3 & F4), and the levels of significance of the theta increases were all higher than $p < .01$, with the highest levels of

significance ($p < .0025$) seen in the fast theta, which is closer to the alpha frequencies.

It is quite remarkable that all 8 head sites showed significant increases of both broad band alpha and of slow alpha activity. Remarkable for two reasons:

- (1) Only 4 of the 8 sites were feedback sites (O1, O2, C3, C4), so only half of the head sites provided feedback signals to the subjects, suggesting extensive generalization of the feedback increases of alpha, and showing that the use of four channel feedback was preventing the development of localization-of-control to those head sites near the feedback sites. This is a predicted result of using multiple simultaneous feedback sites (Hardt, 1974, 1990).
- (2) In Zen meditation it took 6-20 years of practice to reach the stage of increases in slow alpha and of the alpha spreading forward toward the frontals. Zen Beginners with 0-5 years of experience did not show either the slowing or anterior spreading alpha activity.

TWENTY YEARS OF MEDITATION IN SEVEN DAYS OF BRAINWAVE TRAINING?

Technology speeds things up, and EEG feedback may accelerate the processes of intense concentration, inner focus, and self control seen in Zen meditation. One further consideration: the subjects' frontal theta increases. Only those advanced Zen meditators with 21-40 years of experience showed theta activity in their meditation records (this theta alternated with their slowed alpha activity), and yet the 7 day alpha feedback trainees showed this same result.

GETTING INTO THE ZONE. Future alpha and theta feedback studies may well see benefits in design, execution, interpretation, and application from greater understanding of Zen philosophy, Zen practice, and the Zen progression of mind states from Beginner's mind, through kensho, culminating in satori. There are many practical applications of such skillful control of one's mind. For example, Allman (1992) has shown how peak performance in sports is preceded by an increase in alpha brain waves, especially in the left hemisphere. Learning to extend one's moments of peak performance (what athletes call staying in the "Zone") through properly designed programs of EEG feedback training is now a realistic goal of alpha feedback training. Slightly more difficult, is the goal of learning how to enter the "Zone" whenever peak performance is required. Attainment of these goals promises the rewards of peak performance for sports, business, science, education, the arts, and perhaps in every area of human

endeavor where people are in search of excellence and are striving for mastery.

Creativity Increases Linked To Alpha Feedback Training

Creativity is an area of personal excellence, mental giftedness, and mental mastery, and it is of profound importance culturally, figuring as a principle component of international competitiveness and economic success for countries and for individuals. The key question is whether learning alpha increases through feedback training will increase creativity.

The creative process has four stages: *Application* (learning the information and problems in a field), *Incubation* (letting acquired knowledge gel), *Inspiration* (flash of insight, creative synthesis, Aha experience), and *Elaboration* (polishing and testing). I believe that alpha feedback training is most relevant to the Incubation and Inspiration stages of the creative process. Colin Martindale and his associates have provided both good and bad writings on alpha and creativity. The good is found in enlightening background reports (1973, 1977, 1978, 1984), and the bad is found in confusing and badly designed alpha feedback studies of creativity (1974, 1975).

CREATIVE VERSUS NON-CREATIVE ALPHA. Martindale's excellent background reports show that highly creative people differ remarkably from normal people in their EEG alpha activity. When told to rest (baselines), the minds of creative subjects remained activated. At rest they actually showed less alpha than non creative subjects, who did relax and whose brains deactivated, in resting conditions. On the other hand, when given creative problems to solve, creative subjects shifted their brains into high alpha in order to solve the problems quickly and creatively. Non-creative subjects made no such upward shifts in alpha, and actually decreased their alpha if they concentrated. Non-creative subjects blocked alpha (meaning alpha went away) on all types of cognitive tasks, but creative subjects blocked only on tasks not allowing for creativity, and actually increased alpha during tasks calling for or allowing creativity. Creative subjects showed higher alpha during the Inspiration phase of the creative process than they did during the following Elaboration phase. During creative performance tasks, creative right handed subjects showed increases of left hemisphere alpha. Non-creative right handed subjects did not show this shift to left hemisphere alpha during these creative performance tasks. Intriguingly, this increase of left

brain alpha is also reported prior to peak performance in golfers putting, archers and gunners shooting, and basketball players at free throw (Allman, 1992).

ALPHA AND CREATIVITY: A CONTROLLED STUDY. Given these remarkable alpha differences between creative and non-creative people, it is natural to ask, "Does alpha EEG feedback improve creative performance?" To answer this question, I conducted a study which used a control group in addition to Pre- and Post- feedback tests of creativity to see if creativity could be increased through alpha feedback training. Both the alpha feedback and the control groups were also given Pre- and Post- tests of subjective stress, and were also monitored Pre- and Post- for stress responses using the peripheral physiological modalities of EMG, EDR, heart rate, skin temperature, and respiration rate. There were seven experimental subjects who were all scientists at the Stanford Research Institute (SRI), who volunteered for a pilot program of EEG alpha feedback training. There were also six control subjects who were corporate professionals, also from Silicon Valley, approximately age matched, who volunteered for biofeedback training. All subjects were volunteers, who had two physiological stress tests, one at the beginning of the week [pre-training for the alpha group] and a second one at the end of the week [post training for the alpha group]. Between their two stress tests the control subjects simply did their normal daily routines.

On the first day of alpha training, one of the scientists experienced a breakthrough insight on a difficult problem in his research.

There were some remarkable results. On the first day of alpha training, during the alpha enhancement feedback, one of the 7 SRI scientists experienced a breakthrough insight on a difficult problem in his research. In fact, he had been struggling with this problem for several years. He was so eager to apply his new insights to his research immediately (Elaboration), that he dropped out of training at the end of the first day, leaving only 6 SRI experimental alpha feedback subjects. He had gotten the benefit he wanted in just one day of alpha feedback training, even though he was thereafter lost to the research study.

The first step of data analysis compared experimental and control groups on their

Pre-tests to see how well the two groups were matched (significance is $p < .05$). The two groups were very well matched on all three types of Pre-tests (Creativity, Subjective stress, the Signals of Stress Inventory [SOSI], and Physiological stress measures).

The second step of data analysis compared experimental and control groups on the Post training-tests to detect possible influences of alpha feedback training through changes in creativity of ideas, verbal fluency, subjective stress, and physiological measures of stress.

CREATIVITY RESULTS. Creativity scores (Ideational Fluency) in the alpha feedback group increased dramatically after 5 days of alpha training. This increase was highly significant (paired $t=5.3057$, $df=5$, $p < .004$). The control group had no significant changes up or down.

SUBJECTIVE STRESS RESULTS. Stress scores on the SOSI decreased an average of 57.6% for the alpha feedback group in the course of their alpha training. This alpha-related stress reduction was very highly significant (paired $t=6.636$, $df=5$, $p < .001$). The control group, after just waiting for a week, had an average 5% increase in SOSI scores, which was not significant.

PHYSIOLOGICAL STRESS TEST RESULTS. Electro-Dermal Response (EDR) was selected for analysis, as it discriminated most clearly. The alpha group and the control group showed significantly different EDR reactions after the intervening week. In four different conditions the alpha group showed declines in EDR stress responses, while the control group showed increases. These distinguishing conditions were: Emotional stress ($t=2.8037$, $df=10$, $p < .02$), Auditory Startle stress ($t=2.4024$, $df=10$, $p < .05$), and both of the rest conditions in the stress test, First Rest condition ($t=3.0578$, $df=10$, $p < .02$), and Final Rest condition ($t=2.8603$, $df=10$, $p < .02$).

This study, by itself, suggests that there are at least two different categories of beneficial results from feedback training to increase EEG alpha: increased creativity and reduced anxiety.

CONCLUSIONS. How do we interpret these remarkable findings? The highly significant increase in creativity of ideas (Ideational Fluency) in the alpha feedback group suggests that it may be possible for a wide range of people to become more creative.

If supported by further studies, this finding could have exciting implications for the conduct of daily life, and the development of human culture. The U.S. Congress has designated the 1990s as "The Decade of the Brain", recognizing that the brain, and the development of the mind, have become the new frontier of human exploration. Some societies, like Germany

MEGABRAIN REPORT

and Japan, are quick to adopt new processes that promise better performance and greater perfection. They will certainly recognize the potential of this EEG feedback process to improve their most valuable resource, the minds of their people. Other societies may suffer competitive disadvantages and economic decline to the degree that they lack the resources and the vision to make this technology and process broadly available to their citizens.

We now have the opportunity and the responsibility to integrate four significant recent discoveries regarding EEG training. These four findings will figure significantly in our future success at all levels ranging from our individual success to our national and cultural success and our success as a species confronting problems of global change, which require responses which are rapid, creative, and wise. They are:

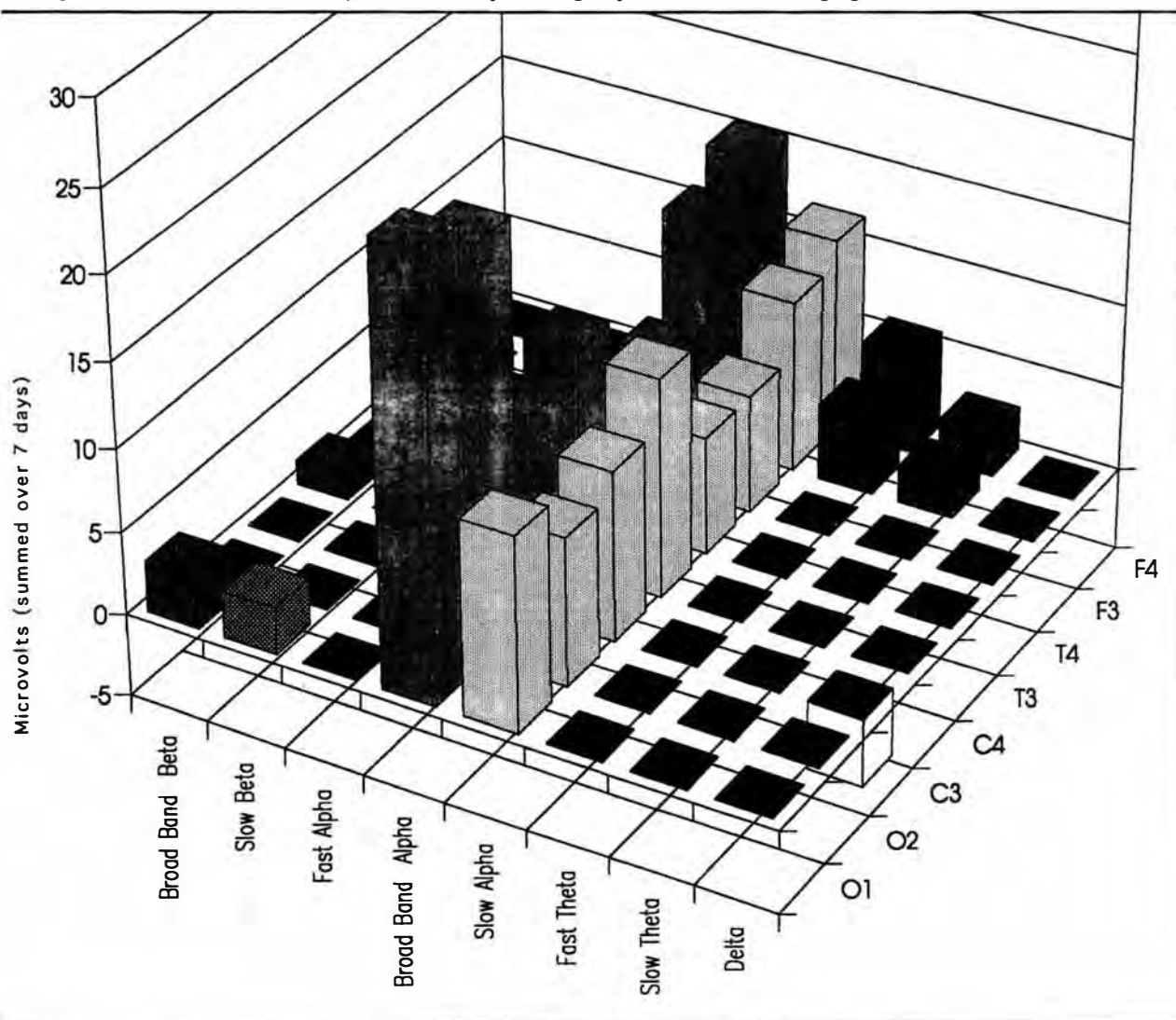
1. Hardt & Kamiya's (1978) alpha feedback report that learned increases in alpha will reduce stress and anxiety.

2. Allman's (1992) report that certain patterns of increased alpha (and sometimes theta) precede, and appear to enable, moments of peak performance.
3. Hardt's recent (1993) findings that 7 consecutive days of alpha feedback can produce patterns of EEG changes seen in the most advanced Zen meditators (both alpha and theta changes).
4. Hardt & Gale's (1993) report that creativity can be increased in scientists through alpha feedback training.

Societies that rapidly adopt such techniques for their people, will clearly have great advantages over those that do not. But brain wave feedback process also has larger transpersonal benefits, and the growth and development of consciousness will immeasurably enrich both the individual and society at large. The evolution of our species has become the evolution of our consciousness, as individuals and as cooperative groups of individuals ranging

in size from the family to the nation states and the global community of humanity. The technology of brain wave feedback has the potential to become the nervous system of a Global Brain, in which each of us are akin to the neurons of our own brains. We are on an evolutionary journey, a quest for higher orders of functionality and a greater degree of oneness with other beings and with our planetary ecosystem, and with the whole of the manifested and unmanifested universe. Brain wave feedback technology accelerates our journey and empowers our quest to understand and exemplify this Oneness.▲■●

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Cumulative EEG Change Scores (Feedback—baseline), in microvolts, summed across 7 days of alpha feedback, representing the average trainee's EEG changes as a function of frequency and head site. Only statistically significant change are shown ($p < .05$).

Alpha-Theta Brainwave Biofeedback

by Jonathan D. Cowan, Ph.D.

The Many Possible Theoretical Reasons for Its Success

ABSTRACT

A new neurotherapy, employing alpha-theta brainwave biofeedback preceded by imagery of desired personal changes, has been reported to produce profound personality and mood changes in substance abusers and other patients. This has raised questions about the theoretical mechanism(s) underlying the clinical improvements: Why should the new therapy be beneficial? What is the relationship of these brain rhythms to substance abuse? This paper includes an annotated list of a number of possible theoretical reasons for these clinical gains, as well as a discussion of recent experimental evidence linking these brain rhythms to alcohol and other drug abuse.

The rediscovery of brainwave biofeedback, particularly in its new application as alpha-theta training, has left many practitioners and researchers puzzled about its reputed power. Just a few years ago, the training of the EEG was restricted to a few diehards who knew its potential. The recent explosion of interest in this field, spearheaded by the work of Drs. Eugene Peniston and Paul Kulkosky (1989, 1990, 1991), has produced a rapidly expanding group of practitioners claiming remarkable results in treating a number of disorders: chemical dependence, post-traumatic stress disorder, depression, anxiety, multiple personality, panic, and eating disorders, to name a few. In a recent article in the *Association for Applied Psychophysiology and Biofeedback's* newsmagazine, *Biofeedback*, Dr. J. Peter Rosenfeld (1992) raised the question of "the conceptual foundation of brainwave training effects", as well as other issues. To restate his questions more clearly:

1. Why should alpha-theta brainwave biofeedback have a positive effect on alcoholism and other forms of substance abuse?
2. What is the relationship of the alpha and theta rhythms to substance abuse?

Although I can see the remarkable success of this therapy in my own clinical work, from a scientific perspective, I can also understand why Dr. Rosenfeld and others are justifiably puzzled. I am also keenly aware that others postpone thinking about these issues at all, waiting for a larger number of controlled outcome studies. Although

it is clear that additional clinical trials are very necessary, further consideration of Dr. Rosenfeld's questions will add to our understanding and thereby refine these studies. I have been thinking about these questions since I first read Peniston and Kulkosky's paper in May, 1989, and visited Dr. Peniston that September. Since then, I have had a number of illuminating discussions about this with many others in the field, including Dr. Lester Fehmi, Dr. Joe Kamiya, Dr. Scott Lukas, and Dr. Peniston.

The ideas and references that they suggested have helped me to understand that there are a large number of possible reasons for the success of this therapy. While it is clearly too early to decide about the relative importance of these reasons, I feel that it is important to put forward an annotated list of possible explanations, in the hope that it will stimulate dialogue, research, and improved therapeutic approaches. I would certainly welcome comments and discussion from others.

PROGRAMMING THE UNCONSCIOUSNESS. This new neurotherapy—known as either alpha-theta training, Imagery and Attention Control Training, or (perhaps too vaguely) as neurofeedback, EEG or brainwave biofeedback—actually goes back quite a long time. The use of imagery and biofeedback involving both the alpha and theta states was first explored in the late 1960s by Dr. Elmer Green and his colleagues at the Menninger Foundation, who termed it "programming the unconscious" (Green & Green, 1986). Conversations with Dr. Green revealed that he had modified an approach to changing life patterns that he had excerpted from the ancient Yoga sutras: Hold the image of change firmly in mind as you quiet down both physiology and thought processes, and then release it without attachment. Dr. Green has discussed this approach at many Menninger Foundation courses on brainwave biofeedback, including one that Dr. Peniston attended.

The results of the therapy have been remarkably positive and robust . . .

The essentials of alpha-theta training have been covered in detail by Dr. Len Ochs (Ochs, 1992). As originally performed by Dr.

IEGABRAIN REPORT

niston, the nucleus of the training consisted of 6-8 sessions of thermal biofeedback and autogenic training, followed by 30 sessions of evoked images (of personal age) and alpha-theta EEG biofeedback. The sessions were typically performed once a day, five days a week, on Veterans

Administration Hospital inpatients. The training in hand warming, which was taken to a criterion of 94 degrees, was used to create an experience of mastery, as well as a state of relaxation that evidence suggests will also produce an enhancement of the patient's theta rhythm. Dr. Peniston used a

standardized set of imagery instructions, which he varied slightly for different diagnoses (alcoholism, drug, abuse, post-traumatic stress disorder, chronic pain, etc.). He then told the patient to "sink down" into a state just above sleep, keeping his mind quiet and his body still, while listen-

Varieties of Alpha-Theta Biofeedback Training

When a major innovation such as alpha-theta training is initially discovered, the first clinicians who begin to use it are usually an original and pioneering group. It's not surprising that each of them gives the approach his or her own twist, and that these variations gradually evolve over time. Differences in therapist training and patient population give rise to further innovations. As a result, there is already a wide spectrum of approaches which overlap to differing degrees. The common factor is that they all use brainwave biofeedback designed to increase the output of the alpha and theta frequency ranges.

EQUIPMENT. The first papers by Drs. Green, Peniston, and Kulkosky all used the REI biofeedback instrument, which had only one channel of input and very limited capabilities. It is set up to sound a specific tone when the patient's alpha output goes over a pre-defined threshold level of voltage, and different tones when the theta or beta levels exceed their thresholds. (The beta tone was not used for alpha-theta training.) Setting the appropriate threshold levels for each patient is very tricky, and monitoring progress is complicated by changing thresholds. There is an alternative approach—proportional biofeedback—in which the volume (or the pitch) of the sound is set to vary with the alpha or theta voltage output. It contains more information than a simple on or off signal, and generally produces quicker training. Some of the early EEG biofeedback machines had this option. Dr. Les Fehmi's BioFeedback Computers Model 5000 ingeniously combines both approaches to produce proportional feedback above a user-variable threshold. The information from this type of feedback is far less affected by changing threshold, but still retains the encouragement that the patient derives from turning the tone on. More recently, highly flexible computer-based EEG biofeedback instruments, such as the Lexicor, have made an even wider variety of approaches possible. Some clinicians, myself included, now customize the feedback to the patient, by adjusting proportions, thresholds, and frequency ranges. These adjustments can be based on the Brainmap, a multi-channel full-color display based on the quantitative analysis of the EEG. These sophisticated instruments can also be set to reject movement artifacts, and/or to produce one feedback sound, based on a linear combination of alpha and theta output. They may also be programmed to base the feedback on the ratio of two bands—such as alpha to beta, or theta to beta.

IMAGERY. The instructions to produce the images are read to the patient before asking him to "sink down" into the theta state and turning on the alpha-theta biofeedback. Although Dr. Peniston developed a set of imagery instructions for substance abuse treatment, he did not publish them in any of his articles, choosing instead to encourage clinicians to attend training classes concerning the entire protocol before divulging these "magic words". Perhaps because of Dr. Peniston's reluctance, there are various versions of these instructions for substance abuse. For other diagnoses, such as multiple personality disorder and post-traumatic stress disorder, a number of clinicians have written different imagery instructions. Some clinicians don't use any imagery instructions at all.

Obviously, there have also been variations in the number of sessions for each patient, ranging from 20 to 50 or more. Some therapists have used sessions with more than a half hour of biofeedback.

PROCESSING EXPERIENCES. The biofeedback training at the Menninger Foundation, in which Dr. Elmer Green taught the original version of the technique, also featured a method for helping clients to process any abreactive material that surfaced during the session. The method encourages the patients to free associate and to seek their own meaning for the images that surfaced. Many therapists have remarked that patients are far more able to do this kind of integrative work after the alpha-theta training than with other therapy. Clinicians such as Tom Allen have extended this approach to a more complete, very slowly paced conversation with the patient, while they are doing the brainwave biofeedback. By monitoring the patient's electrodermal responses and the EEG, these clinicians can detect when the patient is encountering difficult material and work with them to integrate the experience.

LIGHT—SOUND ENTRAINMENT/DISENTRAINMENT. Most of the remaining variations began by combining other modalities with alpha-theta training. One of the obvious additions to an EEG biofeedback protocol, light/sound (LS) therapy, actually preceded the wave of interest in alpha-theta by many years. Dr. Fehmi's BioFeedback Computers 5000 produces pulsating sounds and triggers a strobe unit to flash in synchrony with the filtered brainwave output. The LS output was designed with the proper phase delay to reinforce the brain's output during the next wave cycle, and keep the brain firing at the same frequency. Dr. Fehmi typically sets the center frequency for his filter at 7.8

ing to the biofeedback tones. The two tones were triggered if the occipital (O1) alpha or theta amplitudes went above a preset threshold. Alpha and theta were trained simultaneously, not sequentially, as Ochs (1992) stated. The simultaneous training, in combination with the instructions, results in the production of alpha rhythms that are primarily at the lower end of the alpha frequency range. A trainee will typically spend several minutes producing predomi-

cycles per second, right at the crossover point between alpha and theta, during his Open Focus Training. Dr. Fehmi indicates that he has consistently obtained very positive changes from this method in 10-15 sessions, by substituting the images of Open Focus Training, performed during the biofeedback, for the pre-feedback imagery of the patient's new intentions. Other clinicians, notably Dr. Len Ochs, have devised brainwave biofeedback systems in which they attempt to use LS, pulsating at slightly below the dominant EEG frequency, to gradually slow the brain state to the theta frequency range.

After I changed from using the BioFeedback Computers 5000 to the more flexible Lexicor, I added LS to my alpha-theta protocol by programming a DAVID Paradise to gradually decrease its stimulation frequency. I start the LS stimulation during the autogenic training phase that (in my procedure) precedes the alpha-theta training. I turn off the sound during the imagery portion. After the instructions, I replace the DAVID's audio with a tape featuring music and binaural beats, mixed with the feedback sounds. Other clinicians have also preceded the imagery instructions with various types of deep breathing, relaxation, sensory awareness, and autogenic training.

SUGGESTIONS. There are a number of ways to include hypnotic techniques in the alpha-theta training. I have embedded hypnotic suggestions in the music that the patient hears while he is doing the feedback, encouraging him to remember the new intentions and images. In collaboration with a hypnotist, I developed a brief (three session) therapy called "hypnoneurofeedback" for weight loss and other problems. After some deep breathing and relaxation training, the hypnotist uses a 20-30 minute script designed around the patient's problem, while the patient is also stimulated by LS. This is followed by the alpha-theta biofeedback and the tape I previously described.

All of these creative approaches are very intriguing, and many are quite promising, when combined with the proper therapist and patient population. However, none of these variations have as yet withstood the tests of time and scientific rigor. I certainly hope that a group of interested clinician/researchers will put together the time, patients, and resources to properly test these new neurotherapies.

Jonathan D. Cowan

nantly low alpha rhythms, before this drops out and somewhat increased theta amplitudes supervene. From there, the course of the 30 minute biofeedback experience is highly variable, as are the subjective reports. As Dr. Ochs indicated, each clinician who has employed this protocol has added his or her own variations. Some of them are described in the accompanying sidebar.

REMARKABLE EFFECTS. Despite this inconsistency, the results of the therapy have been remarkably positive and robust among patients who have completed the recommended number of sessions. Some of the evidence for its effectiveness was put forward at a symposium at the recent AAPB meeting in Colorado Springs. An informal meeting of practitioners at the same conference produced reports of about 80% short-term effectiveness with over 300 patients in the wide variety of conditions listed above. Dr. Peniston's efforts accounted for about 180 of these patients, whose success has been followed up for 2-4 years. The network of therapists that I have talked with about this particular technique reports a similar pattern in a much larger number of patients. There is also a partial overlap with other successful methods of EEG biofeedback therapy with a much longer track record, including the numerous practitioners trained over the years by Dr. Lester Fehmi, Dr. Thomas Budzynski, the Menninger Foundation, and several others. On balance, I should also point out that there are real practical difficulties in providing enough encouragement for patients to complete this therapy in an outpatient setting, as Dr. Ochs discussed in great detail. However, there are modifications and additions to the therapy that produce major gains in the first few sessions and thereby improve compliance.

To start the list of reasons where the therapy begins, with thermal biofeedback, is to review territory familiar to most biofeedback clinicians. Clearly, thermal biofeedback, coupled with autogenic phrases, can be very relaxing, thereby relieving stress that the trainee has accumulated. Teaching the student how to achieve this relaxed state does create a perception of self-mastery over stress, which can be healing in itself. It is probable that if the 6-8 sessions of this training were extended by 30 more, additional gains in relaxation and mastery would be forthcoming. Would these gains be sufficient to account for the effectiveness of Peniston's approach? This is a researchable question. To confound the issue, these reasons for success should also apply to learning control of the low alpha and theta brain rhythms, but perhaps the latter task produces an even more profound experience of relaxation and mastery.

MENTAL REHEARSAL: IMAGES OF CHANGE. In an Association devoted to biofeedback and psychophysiology, it is easy to overlook the importance of the imagery instructions given prior to the EEG biofeedback in each session. In private conversations, Dr. Peniston has consistently emphasized the importance of evoking these images of personal change. The imagery instructions used here provide mental rehearsal of new intentions and images of positive alternatives to unwanted responses, such as drinking alcohol. The instructions are repeated without variation in each of the 30 sessions. This degree of massed practice and rehearsal may be very valuable in healing, in and of itself.

The power of alpha-theta training may be partly due to inputting images and suggestions in such a way that they bypass the conscious mind....

From the viewpoint of learning and memory, the repetition of intentional images or visualizations is quite different from a series of guided imagery experiences. It is much more likely to reinforce

learning and produce the over-learning of the particular response that is important in creating personal change. In fact, finding ways to evoke the same images several times in each session may be very useful in decreasing the number of sessions necessary for successful alpha-theta therapy. Adapting some of the characteristics of effective visualization discussed by Dr. Patricia Norris (1989) to this therapy should also increase its effectiveness. To achieve this, I make sure that each of my students is deeply involved in writing his or her own script to evoke imagery.

These images of personal change are experienced in a relaxed state, followed closely by the affect induced by alpha-theta biofeedback, which is usually very pleasant. This forms an association between the images and pleasant affect which is repeated 30 times throughout the course of therapy; the well-learned association between the two should make the new intentions and behaviors seem more desirable.

The power of alpha-theta training may be partly due to inputting images and suggestions in such a way that they bypass the conscious mind, thereby benefiting from the lack of interference from adult disbelief and disempowerment.

Before setting forth the rest of the reasons associated with the feedback of the alpha and theta rhythms, it is important to clearly establish the distinction between brain rhythms and brain states. The underlying configuration of psychological, neurological and biochemical activity, which may shift from moment to moment, is the brain state, state of consciousness, or, more precisely, *state-context* (Kiefer and Cowan, 1979). I prefer our terminology because it emphasizes the fact that elements of context, particularly cognitive patterns, also influence the neural background on which experiences are encoded and stored in the brain. The impairments of retrieval produced by changes in state and cognitive context are both consequences of the shift in neuronal background in effect at storage and retrieval, and are therefore nearly impossible to separate. I believe the term *state-context-dependent retrieval* is a more accurate description of the phenomenon than the original term, *state-dependent learning*.

The EEG is but one of a number of multiple converging indicators of state-context, as Dr. Joe Kamiya is fond of pointing out. The multiple rhythms of the EEG are often overlaid on one another at the same time; the amplitudes, frequencies, and phase relationships of these rhythms presumably have some connections to the underlying brain state-context. However, comments such as those indicating that a student is "in the theta state" when he is practicing the augmentation of his theta rhythm grossly oversimplify a highly complex reality. There are a number of problems with this all too convenient approach:

1. The theta rhythm itself is not a unitary phenomenon. Undoubtedly, there are important distinctions relating to the meaning of different frequencies, waveforms, and electrode sites, especially if pathological EEGs are also considered.
2. There probably are multiple underlying state contexts which characteristically produce large amounts of theta activity at a particular electrode site. These state-contexts have evolved differently in each person, shaped by many factors in the individual's developmental history. More on this later.
3. One should not confuse the rhythm that the therapist is attempting to train with the pattern of rhythms that the student is producing at the moment. This is particularly troublesome if he is being trained by turning on a sound when he is above an arbitrary threshold, which the therapist can change at whim. Without looking at the whole pattern, it is impossible to assign a meaning to producing a certain percentage of theta above threshold. It is often difficult even if you can see the whole pattern.

It is probably more accurate to state that EEG rhythms roughly reflect one or several dimensions of the focusing and deployment of the student's attention, ranging from the relatively narrow focus associated with some predominantly beta rhythms to the more open or even diffuse attention, divided among multiple objects, characteristic of low alpha dominance (Fritz & Fehmi, 1982).

By training the student to produce more or less of these brain rhythms, we are actually doing something far more complex: Teaching him to perceive and control a number of different transitions among his own unique state-contexts, which differ among themselves in the amounts of each of these rhythms that they produce. We are training the student to activate certain of these state-contexts by instructing him to emphasize certain rhythms. In some cases, we are also teaching him new state-contexts, and their distinction from other previously learned ones.

Patients report a greater ability to "let go" of unwanted thoughts and feelings.

One possible reason for the success of this therapy is that we are training the student to better control many of his transitions between his unique state-contexts, by teaching him how to control the way he focuses and deploys his attention. Certain types of state-contexts may only be activated if attention is focused and deployed among possible objects in a characteristic manner, one associated with the predominance of certain brain rhythms. For example, it may be easier to activate or stabilize a state-context in which one is narrowly focusing on anxious thoughts and feelings, as well as the associated events and memories, if the predominant brainwave rhythm is beta.

Parenthetically, there may be a more direct way of measuring the student's ability to produce appropriate transitions between brain rhythms. One problem with current approaches is that we rarely train complete control, in that we omit teaching them how to turn off these rhythms. Dr. Kamiya did this in his early work with alpha training, in which he alternated between two minutes of alpha enhancement and two minutes of suppression. With our current technological riches, it would be a simple matter to devise a program that measured how quickly an individual could make transitions back and forth between predominant rhythms. By quantifying this latency, we may be able to develop a training outcome measure with greater validity. By training the student to produce quick transitions between brain rhythms, we may also be able to train them to improve their ability to transit between some of their underlying state-contexts—those that typically produce the changes in brain rhythm and the consequent biofeedback.

Dr. Martin Wuttke's article (1992) sets forth a related reason for the success of alpha-theta therapy—the development of the "witness" consciousness through training these transitions. "With training you eventually develop the ability to consciously observe and witness internal and external stimuli, without judging or thinking...This skill brings with it a new volition in regard to cognitive processing." (1992, p. 21) This increased ability to choose between experiencing a state-context containing unpleasant thoughts, feelings, and associated memories, or a more pleasant one, can clearly improve anyone's mental health. During and after this therapy, patients regularly report increased control of their state-contexts.

Patients also report a greater ability to "let go" of unwanted thoughts and feelings. In view of the alpha rhythm training, this is not at all surprising. For many years, Dr. Lester Fehmi has been teaching clients and therapists to use low alpha, in combination with certain images, to open the focus of their attention and include more of the sensory/perceptual field surrounding each experienced event (Fritz & Fehmi, 1982). Dr. Karl Pribram has uncovered a

number of systems within the brain which allow it to vary between a narrow focus on one aspect of experience and dividing attention more equally among multiple, narrow bandwidth input channels (Pribram, 1971). By broadening the focus of attention to include many sensory input channels, it becomes more difficult to narrowly focus on one repetitive "tape" or "conversation" or a "vicious cycle" involving unpleasant thoughts, feelings, and memories, each intensifying the other. If the attentional focus is diffuse, as it is in many state-contexts characterized by large low alpha output, these thoughts can be "let go" more easily, since they represent only a small portion of the totality of experience at the moment. If they recur, or other unpleasant thoughts come up, it is easier to watch them dissolve again without attachment. By developing the ability to allow the "witness" to control this Open Focus of attention, the student can learn to experience and accept all events equally without attachment, transcending pleasure and displeasure (Fritz & Fehmi, 1982) *[For more on this technique see the interview with Dr. Fehmi elsewhere in this issue—Ed.]*

During alpha-theta therapy, the subconscious becomes more accessible to alteration or "programming"

GETTING TO THE "INNER CHILD". Is there something unique about state-contexts with predominant theta rhythms that can account for some of the treatment's effectiveness? There is a fact that may have immense implications here: As we mature, our average brainwave frequencies get faster. During the important formative period from one to six years old, the predominant brain rhythms fall in the theta range, but the waveforms of the posterior dominant rhythm look more like alpha spindles (Duffy, Iyer, & Surwillo, 1989). Older children's frequencies are in the alpha range until puberty, when the faster adult pattern supervenes (Kooi, Tucker & Marshall, 1978). The implications of this shift are fascinating, especially when combined with the principle of state (or state-context) dependent learning and retrieval. The highly emotional experiences of early childhood, and the (often mistaken) decisions which stem from them, are learned and stored as modifications of the slower background frequencies that were activated at the time. These initial associations between the cortex and the limbic system—the emotional brain—are formed in individualized state-

contexts characterized by cortical theta rhythms, and strongly consolidated in memory by the actions of neurohormones (such as epinephrine and vasopressin) released during emotional experiences. Over the years, as brainwave rhythms move to faster and faster frequencies, access to these original memories is gradually lost due to the state-context change and state-context dependent retrieval. Newer experiences which are connected to the original ones by cognitive or emotional similarities are stored in association with them, but at faster frequencies, generally easier to retrieve at a later time. The part of this matrix of associated memories which is hidden from consciousness by state dependence can be considered to be the subconscious. A subset of these subconscious memories—particularly those related to sexuality and aggression—are further modified and obscured by psychodynamic memory processes to form the unconscious, in the sense used by Freud and his followers. However, Green and Green's (1986) use of the word "unconscious" appears to be closer to the broader subconscious I am describing, with an emphasis on the clear links to the control of psychophysiological functions.

During the alpha-theta therapy, the subconscious becomes more accessible to alteration or "programming" (as Dr. Green puts it) by new images, as well as the release of old images. As I suggested in a remark at the end of the alpha-theta EEG biofeedback seminar at the 1990 AAPB meeting in Washington, the images generated by the student are being stored in a variety of state-contexts, each characterized by predominant slow EEG frequencies. In each session, after the images are evoked, they remain in short term memory as the student "sinks down" into a series of these state-contexts. It is likely that in this unusual attempt to relax deeply without falling asleep, the student reactivates a number of state-contexts that have been largely dormant since childhood, since his adult experience with state-contexts of deep relaxation is typically very limited. He will permanently store the new images in each state-context that he reactivates. Although each new memory increment may be weak, over the 30 sessions the student will generalize these repeated images from his adult state-contexts to a number of those initially learned in childhood at predominantly lower frequencies. Each training session may reactivate a different selection of state-contexts, and the consolidation of memory in them will be probabilistic and cumulative. This is one of the few ways in which adults can store new information in the subconscious—in state-contexts dominated by theta and low alpha rhythms, with their well learned but state

dependent connections to the limbic system and early emotional memories. Hypnosis and NLP may offer other approaches. If this therapy does offer a powerful method to reprogram the subconscious, by overlaying images of new intentions and positive alternatives, this is clearly a reason for its success.

The release of old images—that is, the integration of subconscious, possibly repressed material into conscious awareness during this therapy—may form the basis of another reason for the success of the alpha-theta training. As Wuttke (1992, p. 21) states "A goal of psychotherapy is the integration of repressed material into conscious awareness. This self-integrative process occurs quite often during brainwave training sessions as the individual maintains a semi-conscious awareness (referred to as reverie) . . . The result is a natural integration of repressed material, usually through symbolic mini-dreams." This integration may have a basis in the brainwave changes seen in alpha-theta training, according to an upcoming paper by Dr. Peniston. He reports that repressed, abreactive material is most likely to surface when the student learns to slow down the predominant alpha frequency to the point where it is below eight cycles per second, technically within the theta range. At these frequencies, the posterior dominant rhythm resembles that of childhood. The emergence of subconscious memories, stored during childhood and reinforced by other highly emotional experiences which reactivate the associations between the limbic system and cortical theta rhythms, becomes more understandable as an effect of state-context dependent retrieval.

...Material is most likely to surface when the student learns to slow down the alpha frequency below 8 cycles per second.

SYNCHRONY. Dr. Peniston also noted a large amount of synchrony between electrode sites during these abreactive episodes. Brainwave synchrony indicates that the portions of the cerebral cortex sensed by the electrodes in question are firing in phase with one another. The origin of this coordinated cerebral rhythmic activity is now thought to be in the reticular nucleus of the thalamus (Steriade et al., 1990), a network of neurons that surrounds the centrally located thalamus like

an eggshell. Although many of the more widespread, synchronous rhythms do appear at times when the cerebral cortex is arguably doing nothing more than idling (e.g., the alpha rhythms of relaxed wakefulness, the delta rhythms of deep sleep), other information supports the idea that some synchronized rhythms (and even some forms of idling) coincide with profoundly altered state-contexts that may produce integration and healing. There are several studies that indicate that long-term meditators show increased amplitudes and synchrony (and decreased frequency) of their low alpha rhythms, particularly in the frontal lobes.

For over 18 years, Dr. Lester Fehmi has used a five channel EEG biofeedback instrument that trains people to increase both the amplitude and synchrony of the selected brain rhythms. His approach, which combines this training with the images of Open Focus, has become accepted as a treatment for a wide variety of conditions, including chronic pain and anxiety. Dr. Fehmi, Dr. Jean Millay and others have reported that brainwave synchrony between individuals results in increased rapport and reports of remarkably similar experiences. Others, such as Dr. Edgar Wilson, have found synchrony between healer and patient at the time of peak effectiveness. I have suggested a mechanism for this type of synchrony-induced information transfer (See "Mind as the Projection and Reception of Electroholographic Fields by the Brain," in *Megabrain Report*, Vol. 2, No. 2 [1994], pp. 23-30, and Cowan, 1991). I mention all of this in support of the suggestion that the development of synchrony during alpha-theta brainwave training may be an important reason for its success on neuropsychological, psychological and transcendental levels.

Once individuals have been thoroughly trained using this protocol for alcohol or other drug abuse, if they transgress by using these substances again, they have a good chance of developing the "bone sick flu". This unexplained illness, which has frequently been described as "the worst flu I have ever had in my life" (Peniston, personal communication) may constitute a reason for therapeutic success with some patients. Rather than getting high from his drug of choice, the user experiences bone, joint, and muscle aches, as well as fever and malaise, for about two days before the symptoms resolve spontaneously. It should be noted that Peniston was using this method with success long before he uncovered this reaction and therapists became obligated to inform their patients, thereby establishing an expectation which reinforces abstinence.

"A goal of psychotherapy is the integration of repressed material into conscious awareness.

This self-integrative process occurs quite often during brainwave training sessions. . . ."

There have been some speculations involving the possible role of the hippocampus. I strongly doubt that the hippocampal theta rhythm has anything to do with alpha-theta training, since Winslow (1985, pg. 185), who has done a considerable amount of work in the area, states "In all probability there is no such rhythm in any primate". It

is true, however, that the hippocampus is desynchronized at many times when large portions of the cortex are in synchrony. The significance of this finding for the alpha-theta training has not yet been clarified.

BEWARE OF PHYSICS ENVY. I am also cautious about suggesting that the reasons for effectiveness are primarily based at the neurochemical or endocrine level. Although it is fashionable to seek explanations that attempt to root neuropsychological phenomena in supposedly deeper bedrock, I find that I must agree with Dr. Siegfried Othmer, a physicist who has turned his attention to EEG biofeedback, in wryly terming this type of reductionist approach "physics envy". While there is no doubt that any therapy that produces changes in the central nervous system as profound as this one does will produce many secondary changes in neurochemistry, to jump to the conclusion that any one (or even a few) of these changes cause the transformation of the individual that we see clinically is to put the cart in front of the horse. This situation is quite different from that involved in administering a drug, where it is thought that the drug must bind to a receptor, thereby leading to changes at the biochemical level that cause its psychological effects. With our current state of knowledge, there is simply no reason to assume that any one change in biochemistry or endocrinology is the primary event, eventually causing all the other changes. Although Peniston and Kulkosky (1989) did find that this training prevented a rise in beta-endorphin levels that was seen in the control group just before release, they admitted that this change could very well be due to the increased stress experienced by the control group in anticipation of their release from the hos-

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pital. Presumably, the brainwave training helped the experimental group to minimize this stress.

Recent studies by Dr. Scott Lukas and Dr. Jack Mendelson have cast considerable light on the second question, concerning the relationships of these alpha and theta rhythms to substance abuse. They provide support for the assertion that the euphoria produced by many drugs is associated with increases in the output of low alpha waves. One study (Lukas & Mendelson, 1988) demonstrated that the euphoria and the alpha wave output of normal subjects drinking alcohol both peaked almost simultaneously, about a half hour after starting a fifteen minute drinking period. The blood levels of ACTH and corticosteroids also peaked at about the same time. In contrast, the blood alcohol concentrations continued to rise over the next half hour or more. In this and other studies, they have found a consistent relationship between momentary experiences of euphoria and very short term increases in alpha wave output due to alcohol, marijuana, or cocaine (Lukas, 1991).

NEGATIVE EUPHORIA. These findings reminded me that during my tenure at the National Institute on Drug Abuse Addiction Research Center, I had learned about the concept of "negative euphoria" put forth by Dr. Clifton K. Himmelsbach, the first Director, over 50 years ago. He hypothesized that many addicts used drugs not to feel good, but to forget that they felt badly. I performed a study which showed that alcohol could help normals to forget their feelings, whether positive or negative (Cowan, 1983), and demonstrated that this was a specific effect. This data supports the hypothesis that the euphoria produced by alcohol and perhaps some other drugs of abuse could be largely a negative one—that by helping individuals to achieve a particular low alpha state, the drugs may also help them to "let go" or forget a variety of unwanted, intrusive thoughts and feelings. The alpha-theta training may very well be teaching these drug-dependent individuals, who are usually troubled by a variety of unfavorable feelings and attitudes (particularly towards themselves), how to naturally achieve this escape, when it is beneficial to do so, by producing a state-context with an increased, and perhaps more synchronous, low alpha rhythm. Learning to enhance the theta rhythm may lead them to produce state-contexts of even deeper serenity and peace.

There is a lot to think about here. There are few answers, but perhaps these hypothesized mechanisms will help in framing better questions. The immense promise of the alpha-theta technique and its many variants deserve a great deal of further attention both from researchers, intent on demonstrating its effectiveness and answering some of these questions, and from clinicians interested in refining this highly beneficial approach to personal change.▲■●

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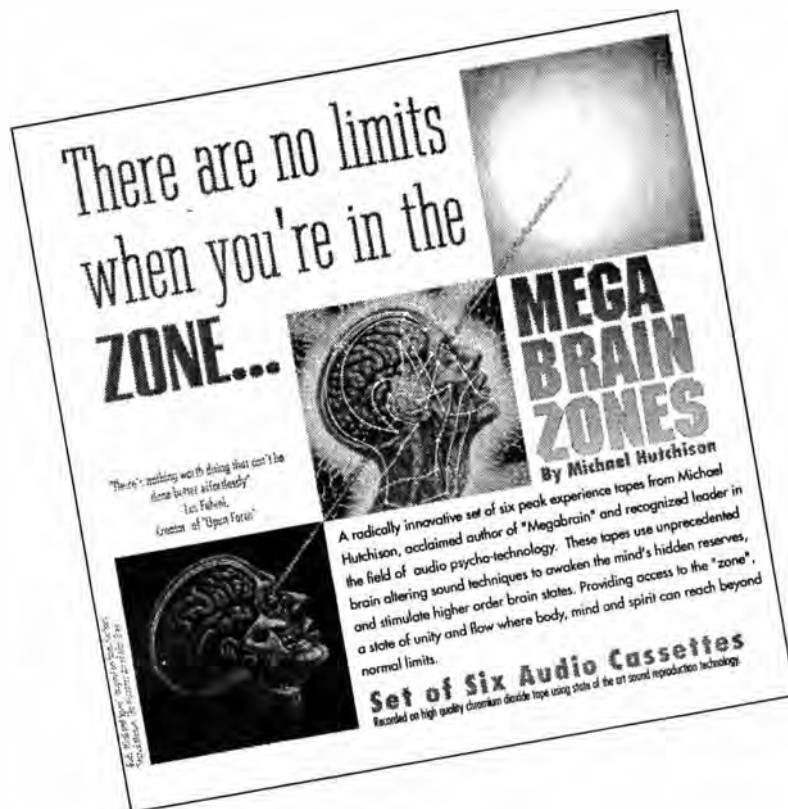
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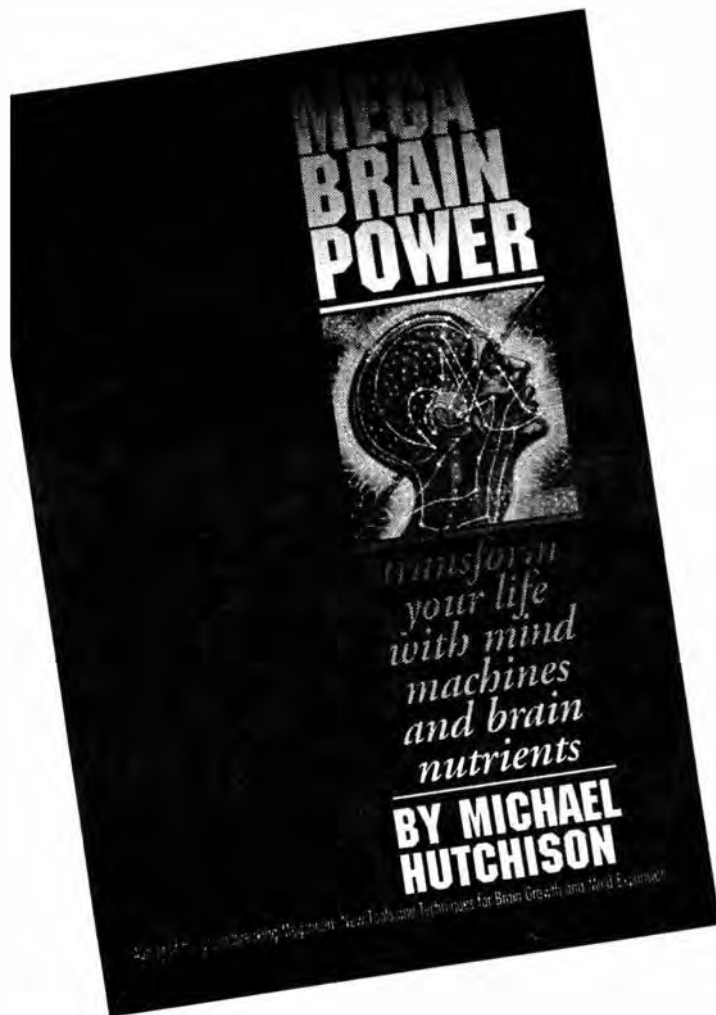
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by Julian Isaacs, Ph.D.

Theta What?

BEING AN ACCOUNT OF JULIAN'S ADVENTURES IN THETA-LAND

So What's So Wonderful About Theta Anyway?

Theta brainwaves have gained an almost legendary mystique in the psycho-technology community. It seems that everyone wants to own equipment for getting into theta, and there are high expectations that theta brainwaves provide all sorts of wonderful benefits for their experiencers.

Well yes, there is good evidence for this, and it's interesting stuff. But as usual, things are a bit more complicated than they appear at first sight. This issue of *Megabrain Report* dealing with EEG is the ideal place for me to relate the story of my long involvement with theta brainwaves and the lengthy if somewhat informal research I conducted into theta state induction. My research took place in the context of my working with a group that intended to open a chain of mind-spas devoted to human potential. The focus of this group radically changed after I left it. The mind-spa chain idea was dropped because the group could not work out favorable operational economics. I did not sign any non-disclosure agreements or make verbal promises of non-disclosure to this group, so *Megabrain Report* readers can benefit from my explorations.

TWILIGHT LEARNING. My brief was to find hitherto neglected techniques that provide powerful potentials for transformation of the individual. For a couple of years I researched all the techniques and whole libraries of books relating to exotic transformational techniques. I happened upon the "twilight training" technique developed by Dr Thomas Budzynski and also independently developed by Jay Gunkelman. Probably others have developed twilight training techniques independently. It's an idea whose time has come. Twilight training involves giving a relaxation stimulus (if that isn't an oxymoron) to the trainee until he or she lapses into stage one sleep, where usually alpha brainwaves are abruptly inhibited and replaced by theta brainwaves. If the trainee goes further into the sleep state, the theta amplitude increases, slows, and is accompanied by K-complexes etc, moving through stage two to stage three sleep, delta sleep.

The trick in twilight training is to monitor the change by EEG and then after the theta state is achieved, play suggestions to the trainee. Rita Sullivan created a variant by using subliminal tapes for her dissertation research into twilight training with alcoholics. If the trainee gets too deep, a gentle wake-up stimulus is given to push them back up to the alpha state. Then they are relaxed again back down into theta. The idea is for the trainee to "cruise" the alpha/theta switchover point. And this is exactly what the Peniston protocol alpha/theta training regime does.

The evidence for the effectiveness of this technique is legion, even if most of it is informal. In addition to the work of Budzynski, Sullivan, Gunkelman, Peniston, etc, and a massive literature on the usefulness of the hypnogogic state for intuition and creativity, it includes the abundant Eastern European research into "sleep learning." The stimulus for Budzynski's original work was T.H. Barber's dissertation research wherein he showed that individuals at the borderline of sleep were equally as suggestible as individuals in deep trance. Not very many people can be trained rapidly to enter deep trance, but nearly everyone sleeps! So the concept is really "benefits of deep trance for everyone."

Why Does It Work?

There are many theories propounded to explain the results of twilight training. These are not necessarily mutually exclusive. Barber's theory is that individuals in the hypnogogic state may hear the suggestions, but are unable to resist accepting them. Budzynski's theory is closely allied but different. He sees twilight training as producing a state where the person cannot consciously hear the suggestions, so that they are unable to muster the normal conscious resistance to them, even though he thinks that there may be other levels of the psyche which still resist to some extent. This implies that Barber's model of the twilight state does not preclude consciousness of the stimulus, whereas Budzynski's experience is that nearly all trainees in the theta state are unaware of the suggestions. We may

be talking about different depths of hypnogogic state. There are probably fine gradations of state, reflected in different alpha/beta/theta ratios. Budzynski thinks that trainees will be conscious if they have both theta and significant alpha or beta EEG content. The reports of users of the Peniston protocol also clearly imply consciousness, at least at times.

WINDOW BETWEEN CONSCIOUS AND UNCONSCIOUS. But a major characteristic of the hypnogogic state is the occurrence of bizarre imagery, often stranger than ordinary dream images, indicating primary process operation, the functioning of the unconscious mind (NOT necessarily the Freudian unconscious or “unconscious” as proposed by psychoanalysis). Theta cortical pacing derives from the limbic system, a relatively “primitive” area of the brain and it has been speculated that twilight training opens the theta “window” between conscious and unconscious realms, allowing two-way traffic. *Twilight training represents the process of putting information into the person, whereas the hypnogogic state has also been used for output of creative or intuitive information—more on this below.* So the “window” hypothesis is that material can be input directly into the unconscious core-beliefs held by the trainee.

WINDOW TO CHILDHOOD. Finally, the “evocation of childhood EEG” hypothesis proposes that since EEG brainwave frequencies are much slower in childhood, getting into theta allows access to beliefs and states experienced in childhood, when most of our deepest core beliefs are laid down. This could be seen as an elaboration of the “window” thesis.

WINDOW TO CREATIVITY. Finally, for output functions, theta state induction has been used by psychotherapists to access repressed material, by occultists for doing ESP and “astral traveling”, for induction of out-of-body experiences and most notably for creative process by many, including famous inventors, artists, writers etc. This evidence is most impressive because although informal it is massive and very consistent.

A COMPLICATION: VARIETIES OF THETA

BAD THETA. “Theta” is not simply one thing. First, in contrast to the good theta we’ve been discussing, there is “bad theta”! Individuals with varying degrees of minimal brain dysfunction frequently have elevated theta levels in the eyes-open waking state. Excessive low frequency EEG output is usually diagnostic that something is wrong—could be attention deficit disorder, tendency towards epilepsy, closed head injury, and brain dysfunction of many sorts. If they are bad enough, then waking state delta EEG outputs are fre-

quently generated by areas of damaged brain tissue. So theta is not automatically good, nor is beta bad. In the 60’s, beta brainwaves got a bad rap, being labeled as indicative of stress. But now in the 90s we have learned that in the eyes open, waking state, beta is good—indicating ability to focus attention and get the job done. Much remedial neurofeedback now involves training the inhibition of low frequencies and enhancement of beta. A “fully desynchronized EEG” is the target here, where focused states of absorption in mental activity are desired. [See Dr. Seigfried Othmer’s article on beta training elsewhere in this issue—Ed.]

Barber’s research showed that individuals at the borderline of sleep were equally as suggestible as individuals in deep trance.

THETA AND BREATHING. There is an intriguing connection between theta and breathing which is creating a developing field of research. Robert Fried, in his trenchantly argued and important 1993 book on breathing [*The Psychology and Physiology of Breathing in Behavioral Medicine, Clinical Psychology, and Psychiatry*] argues that waking state theta is frequently caused by unconscious hyperventilation. He cites research showing that, paradoxically, hyperventilation constricts the cerebral blood supply, reducing cerebral oxygen levels and creating excessive theta brainwave outputs, with all the possibilities for lower level functioning reviewed above. This is important stuff, because his thesis is that *breathing leads EEG, rather than the EEG state dictating breathing*. Probably both causal directions are possible. Fried argues for the breathing always being dominant, but only further research will really pin this down.

One of the most effective means of inducing hypnogogic theta is through feedback of breathing.

I find this research important and fascinating, especially in the context of my own work in developing a breathing feedback system for relaxation. Somehow, feedback

of breathing seems very effective in inducing deep relaxation. The reasons for this will be discussed below. I hope my new device will be available to *Megabrain Report* readers in the early summer. The idea that breathing alone can regulate EEG is not a new one—alternate nostril breathing is already well established as modulating hemispheric dominance. And according to some German research and the anecdotal reports of users of breathing feedback systems, one of the most effective means of inducing hypnogogic theta is through feedback of breathing. I will report more on this as my investigations proceed.

SYNCHRONY. Then there are the special “hypersynchronous” high amplitude theta brainwaves which seem to be generated in special states of altered consciousness, which very definitely do not indicate sleep. Some meditation research has found these large amplitude, smooth sine-wave like theta waves occurring as accompaniments to slowed alpha. These look almost like alpha in their morphology. Only one subject in my research routinely showed these big sine-wave like theta outputs, and interestingly, he was a young very brilliant laser physicist working at UC Berkeley. Are these outputs indicative of intelligence or creativity?

Dr Edgar Wilson now, alas, deceased—there was a consciousness pioneer if ever there was one—and Skip Atwater at the Monroe Institute have both reported that individuals undergoing profound altered states can show large synchronous theta and delta outputs in the central brain regions, simultaneously with high beta being present in the temporal lobes. The problem is that this research is informal and uncontrolled and the nature of the states evoked is not really well defined. Again, very interesting preliminary findings but more controlled research is needed.

Emotions are also well known to cause temporary theta outputs. Many researchers have reported this. Since the limbic system is intimately involved in emotional responses, this is not surprising.

Finally, there is the hypnogogic theta. This tends to be rather irregular, unlike the well-formed hypersynchronous theta. It is also low-voltage, again, unlike the hypersynchronous theta or the theta found in meditative states. How are all these different thetas related? Only more research will show. Meanwhile we can use theta as a “magical technology”, where we use the techniques before we fully understand them.

OK, So How Do We Get There?

The primary focus of my research was to evaluate methods for inducing theta dominant brain states. We wanted to know the time to onset of theta and the percent-time

MEGABRAIN REPORT

of our 30 minute sessions during which theta was dominant. We used a Lexicor NRS 24 brain-mapper for EEG data collection, and took the output from the Pz position (center line in the parietal region), although in sleep research the Cz position (center line of the central region) is usually used. I used Pz because I thought it was a tougher test site for theta, since theta usually emerges first in the frontal regions. What we found first puzzled us, then suddenly created a simple no-nonsense formula which demystified so much of the theta-induction technology and techniques.

We tried audio tapes from many sources, various light and sound machines, ganzfeld devices and biofeedback approaches. At first, it appeared that results varied across the various devices and tapes in a meaningless and puzzling way. We found that a *Megabrain Sync* tape from Michael Hutchison's company, Megabrain, was very effective in inducing theta, for most subjects, but not all. Maybe sound was the answer. Then we found that for some people the Mind's Eye Plus light-sound (LS) device was effective, and that the Dreamwave I LS system was, if anything, even more effective. But not all subjects found LS relaxing. We found the Theta One ganzfeld somewhat effective for some subjects. We tried a prototype model of the Tranquilite ganzfeld, but it was incredibly uncomfortable to wear. We tried Dr. Lloyd Glauberman's HPP tapes. They were almost universally effective—except for one lady who had been gypped by someone having a similar New York accent as Dr. Glauberman! Then we tried the Changeworks "Natural Self Confidence" and "Self Hypnosis" tapes, which worked very well. Clearly, all sorts of treatments could elicit theta. Then came a blow. Just leaving a subject lying down waiting for treatment seemed to induce relaxation and I realized that our subjects, who we were running for many sessions each, had become conditioned to zonking out as soon as they hit the recliner we used! So what did I conclude?

THE SECRET OF THETA

The secret of theta is simple, yet profound (if you want to do theta training). Choose a stimulus which does the following things:

- (1) distracts the person's thought processes so that they no longer think of their everyday concerns,
- (2) is non-threatening and comforting,
- (3) is very very MONOTONOUS, consistent with
- (4) is as PLEASANT as possible, and

- (5) excludes normal vision and hearing, shutting down the trainee's normal monitoring of his or her environment.

In brief, monotonous, immersive, pleasant stimuli create theta because they shut down the normal vigilance sustaining systems and elicit the sleep process—easy!

Most of us are somewhat sleep deprived anyway, so given a chance to rest, the body will try to recuperate. So now the problem becomes that of stopping the trainee from crashing straight down to delta brainwaves and sleep and keeping them cruising the alpha/theta borderline. The number of sessions for effective reprogramming are variable but range from about a dozen to thirty or more, depending on the individual. So everything works—light & sound, tapes, binaural beats, hot tubs (careful not to drown!), ganzfeld, biofeedback, flotation tanks, etc. The issue is to find what works best for you.

The theta recipe is easy for self-activating folks like *Megabrain Report* readers to utilize, because you already know your preferences. Knowing your preferences, you can set up conditions that are right for you. *Mega Brain Power*, Michael Hutchison's new book on applications of psychotechnology covers a variety of these theta approaches. But it is very difficult for brain gym or mind spa owners to provide reliable theta experiences to clients, since to do so they must successfully predict what the tastes and preferences of their clients are, virtually as soon as they walk through the door. Developing methods of predicting which treatments will fit which individuals is both a science and also quite an art. This is what prospective mind spa owners pay for in their consulting with psychotechnology professionals. There also needs to be much more research done in this area.

Monotonous, immersive, pleasant stimuli create theta...

Are there any down-sides to theta training? *Theta training* is **POWERFUL**. If you have a past history of any kind of heavy trauma or abuse, be warned that flashbacks may occur. Second, for a very few people, theta training may disturb their normal sleep pattern. We had one subject like this. And not everyone is able to release their vigilance sufficiently to get to theta. Strangely, the two subjects in my research who had most trouble getting to theta were both raised in Germany.

Finally, how could we stop that crash into delta? This is a tricky one. The surest

way is to buy a real twilight trainer. True twilight trainers have to at least detect the onset of theta. A timer can then be used to provide a period of theta, at the end of which a stimulus can be applied to bump the person gently into alpha. The best (and most expensive) way of doing this is to get an EEG to do the detection and control, as with Budzynski's *Twilight Trainer*. This system will allow the maximum use of theta while providing a certain way of avoiding too much depth of state. The research into sleep and learning clearly indicates that deep sleep is useless for learning purposes. Detection of theta onset using characteristics of breathing are also possible, and there are three techniques which have been used. I hope to incorporate this kind of theta detection system in my new breathing feedback device.

Many other methods of detecting theta onset have used muscle tension, which drops at theta onset, but although useful for most people these are not totally reliable for everyone. Perhaps it's worth outlining these techniques. Maxwell Cade used a simple device—the trainee presses a spring-loaded switch and when the sudden loss of muscle tone occurs at theta onset a buzzer sounds. The loss of muscle tone at theta onset is the cause of (literally) "nodding-off"—the forward head roll happens as muscle tone is suddenly lost at theta onset (lectures seem great theta induction devices, specially after a big lunch!). Charles Tart devised a clever device where the trainee's head roll, as they laid down with their head on a special platform, switched a system for timed wake-up to alpha. There is also the simple trick of balancing an arm in upright position—when it falls it wakes you up. It is said that Thomas Edison held steel balls in his hand and on theta entry would drop them, waking himself.

So finally I have at last briefly related my adventures in Thetaland. This is a magic country and we will doubtless hear even more about this area in the future. Meanwhile I can recommend this area to the intrepid explorers who read *Megabrain Report*. It's worth exploring.▲●●

Julian Isaacs, Ph.D.

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EEG Biofeedback Training

THE OLD AND THE NEW

by Siegfried Othmer, Ph.D.

THE HISTORICAL BACKGROUND. During the sixties, Joe Kamiya explored his earlier finding that EEG activity could be altered deliberately by means of feedback of EEG information to the subject. Alpha wave activity was trained while the subject's eyes were closed. In this manner, a more relaxed state could be facilitated and different experiential states explored.

In the late sixties, M. Barry Sterman of the UCLA School of Medicine was doing sleep studies on cats, and finding that a certain rhythmic activity, at 14 Hz, was present in both the sleeping and waking state. He was successful in training that activity as well, with manifest consequences for sleep in these cats. Fortuitously, at that time NASA approached Sterman about a problem they were having with their rocket fuel: it appeared to be inducing seizures in their personnel out on the test range. Would he be willing to test the rocket fuel? He was. The rocket fuel did indeed induce seizures in cats, but there was a wide variation in seizure threshold. As it turned out, those cats which had undergone the brainwave training had a significantly higher seizure threshold than the others. Apparently, brainwave training could change behavior!

This little experiment launched a lengthy period of research in which it was rigorously demonstrated that seizure incidence, intensity, and duration, could be reduced in humans with EEG training in the same spectral band, about 12-15 Hz. Human brains did not usually show a 14-Hz rhythm (called *sensorimotor rhythm*, or SMR, for its appearance at sensorimotor cortex) in the waking state. However, some controlling mechanism appears to operate in that frequency range.

In the meantime, "alpha training" using EEG biofeedback became popular in the culture of the sixties and seventies—which of course rendered it unfit for serious study by most university researchers. In

that climate, Sterman was careful to distinguish his own work with SMR training from the "popular" version of EEG biofeedback. The work was sound; it was replicated by a number of other groups; but the technique remained obscure. The training took a long time in most subjects; the training was provided by Ph.D.'s, so it was expensive; and Sterman depended in his clinical work on referrals from neurologists. Hence, the training was received mostly by very severe cases of seizure disorder. Hardly front-page stuff.

During the course of this work with epileptics, it was observed that *hyperactivity* also seemed to subside with the SMR training. One of Sterman's associates, Joel Lubar, pursued the matter further with rigorous studies. Over the years it was established that the technique could be helpful not only with hyperactivity but also with attention deficit disorder in the absence of hyperactivity, as well as with learning disabilities.

Things grew from there: We are now finding in our own clinical work that the technique can be helpful with a much broader range of conditions. Just as the attention deficit hyperactivity disorder (ADHD) work grew out of epilepsy studies, these insights and findings accrue incrementally. ADHD can, for example, be looked upon as an *underarousal* condition. This may seem paradoxical; however, it is consistent with the fact that stimulant or anti-depressant medication helps the condition. One may ask: Can EEG training help other conditions which respond to anti-depressant medication, in particular pure depression? Clinical evidence suggests that this is indeed the case, although this finding has not been subjected to controlled study.

THE LARGER CONTEXT

Since EEG training is effective in treating epilepsy, and epilepsy mostly results

from cases of head injury, one may also ask: Does EEG training help other symptoms of head injury besides seizures—symptoms such as cognitive deficits, chronic pain, visual disturbances, extreme fatigue, mood swings, irritability, and sleep disturbances? The answer is that it does. Profound recoveries have been induced with EEG training in persons who have been stable for years after head injury, where further spontaneous recovery would not have been expected.

A third area where improvements have been observed with EEG training is in sleep disorders. Insomnia, sleep onset problems, bedwetting, night terrors, and even sleep apnea have responded to the training in clinical settings.

With these new findings, and aided by new computerized instrumentation and a proliferation of centers where the training is offered, EEG training in the 12-19 Hz (or low beta) frequency range is experiencing a growth in clinical application. The alpha training remained (until recently) under a cloud of its unfulfilled early promise and “indiscriminate popularization”. In the past three years, however, alpha training has been shown to be very effective as part of a multi-faceted program for severe alcoholics, so it is experiencing a renaissance as well. Ironically, this is also in the context of remediation and rehabilitation of dysfunction.

What are the larger implications of these new findings? First of all, a connection suggests itself among the various conditions which ostensibly respond to this training. Firstly, attention deficit disorder is correlated with sleep problems such as bedwetting and night terrors. More than half of all seizures occur at night, suggesting an intimate connection of seizures with disordered sleep. There is a high correlation of attention deficit disorder with birth trauma, a kind of head injury. And many of the deficits resulting from head injury in the mature person look like attention deficit disorder. Also, depression is a common symptom resulting from head injury. Finally, other underarousal conditions, such as depression and chronic fatigue syndrome, also manifest in sleep disorders and cognitive deficits such as we see in ADHD. Perhaps a common neurological substrate or pathway underlies the attention problems, sleep problems, depression, and head injury deficits which respond to the training. If so, it must be very basic to be common to such a variety of observables.

A DISCUSSION OF MECHANISMS

In our work, we distinguish between training at higher frequencies (15-18 Hz, which we refer to as “beta”) and at lower frequencies (12-15 Hz, or “SMR” training)

within the overall beta range of frequencies. These have vastly different effects. In beta training we appear to be dealing with conditions of underarousal, either induced by trauma of some kind, or of genetic origin. In SMR or high alpha training, we appear to be dealing with conditions of overarousal, of anxiety, of hypervigilance, of heightened stress susceptibility. Taken together, the training appears to help normalize physiological arousal, i.e. to restore normal modulation and control of arousal level. The increase in seizure threshold with training suggests that the training confers increasing stability in the face of cortical hyperexcitability. The training appears to enhance self-regulation of fundamental arousal mechanisms where these are deficient.

Physiological arousal is under the management of the brain stem, which also regulates the sleep-wake cycle and modulates the pain response. The regulation of cortical function is mediated by the thalamus which, among other things, modulates inputs to the sensorimotor cortex where our (beta) training conventionally takes place. A distribution of frequencies within the low beta range of 12-19 Hz appears to be operative in regulating a variety of cortical functions. Training those specific frequency bands can then be used to elicit certain effects. Among these are regulation of sleep cycles, improved cognitive function, modulation of attention, and increased stability of mood.

As suggested above, if one modality has such diverse effects, it must be true that a very central and basic function such as arousal control is being affected by the training. If brainstem function and arousal level are being trained, certain predictions would follow. In particular, we might expect effects on pain mechanisms. We have observed a profound effect on headache syndromes and chronic pain.

Another piece of corroborative evidence is the finding that the human brain is peculiarly sensitive to whiplash injury. Even a minor car accident, involving no loss of consciousness but involving whiplash, can leave lingering deficits of the type mentioned above. In whiplash it is the brainstem that is being impacted, yet cortical function suffers! Likewise in birth injury it is frequently the spinal cord and brain stem which take the brunt.

A final straw in the wind is that PET (positron emission tomography) studies show the thalamus and the sensorimotor cortex to be in a stage of rapid growth and organization, their most vulnerable period, right at the time of birth. A mutually consistent view is that the EEG is the “window in” to the functioning of the cortex, as it is regulated by subcortical structures such as

the brainstem/midbrain, which structures are vulnerable to injury. The EEG training renormalizes this regulatory mechanism.

EEG is the “window in” to the functioning of the cortex . . .

Many of the above findings of efficacy of EEG training are only clinical, and remain to be confirmed in systematic research. Because of the usual disdain of the neurological community for behavioral management techniques, however, these exciting possibilities find no resonance within medical research. Partly, this is because behavioral techniques really belong to the field of psychology, not medicine. And partly it is because finding a physiological basis for the above conditions has been so elusive. Objective findings supporting the major head injury symptoms listed above are often lacking. MRI and CAT scans are frequently negative. As was recently pointed out even in *Newsweek*, however, such tests are not even able to distinguish a live brain from a dead one. Perhaps they should not be expected to discriminate functional deficits. Tests which measure function rather than morphology, such as quantitative EEG, PET scans, and evoked response measurements, do show up such deficits.

Putting it crudely, I believe we have a small, elusive “hardware error” leading to prominent and obtrusive “software errors” in the human brain. The EEG training appears to be able to reinforce the control codes in our “fuzzy-logic” brain and thus remediate functional deficits.

**I believe we have a small,
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in the human brain.**

Two recent findings promise to shift attention to the claims of EEG biofeedback. The first is the report by Alan Zametkin of the NIMH that the brains of hyperactive adults show lowered glucose uptake in the sensorimotor and frontal regions. That is, there is a discernible functional distinction and it is consistent with underarousal. Secondly, we have the recent report by Lewis Baxter of UCLA that behavior therapy for obsessive-compulsive behavior results in activity level changes in the caudate

nucleus similar to those elicited by medication for this condition. Finally, we have the recent confirmation by Chris Mann of what had already been well-established, namely that the EEG statistics of ADHD children are significantly different from those of normals, and in line with the underarousal hypothesis. These results may begin to draw the attention of a reluctant medical community to this promising new field.

One key reason for the lack of interest by the medical research community is that the current focus in neurophysiology is on neurotransmitter mechanisms and interactions at the molecular level. The phenomenology we are concerned with cannot yet be described in those terms. ADHD may involve observable differences in serotonin, norepinephrine, and dopamine function, but these may be effects rather than causes. To understand "disorder," we must look at how the brain maintains "order." We must look at the brain as a control and feedback mechanism. A functioning serotonin system is a necessary but insufficient condition for maintenance of "order."

AN EMERGING SYNTHESIS

When one considers how the brain must organize sequential processing activity, or how it must recognize a particular visual image, splayed across the visual cortex, as belonging together, we realize that an incredible amount of parallel processing must occur, and nearly simultaneous or synchronous communication between different parts of the brain. It is belaboring the obvious to say that timing, and the coherence of timed events over a larger interval, are important for the completion of sequential processing tasks. Various parts of the brain must be successively alerted to play their role in the completion of the task. This is called activation. This is the business of the brain stem, of the midbrain, and of the thalamus in particular. And this process is out to lunch in the head-injured, the depressed, the over-anxious, the sleep-deprived, and the ADHD child or adult.

Sterman long ago postulated that the mechanism being affected by EEG training is that by which the thalamus regulates and stabilizes the intrinsically hyperexcitable cortex. This mechanism is presumed to act rhythmically in the 12-19 Hz domain. The thalamus has both specific and non-specific nuclei. The specific nuclei project to localized regions of the brain, whereas the non-specific ones project to broad regions of the cortex. By varying the training frequency within the band, and by varying electrode location, we are able to elicit highly specific effects, in addition to the general benefit of training activation. In this we are guided by what neuropsychologists and neu-

roanatomists have learned with respect to localization of function. The specific effects confirm that we are able to train both the specific and the nonspecific thalamic nuclei. They also prove that we are not simply dealing with placebo effects.

NIMH stopped funding the epilepsy research in 1985, arguing that the field had been plumbed. In fact, the field had just begun. One of the most promising findings in this decade of the brain is how amenable the brain is to effecting change in its own function, if only it is given appropriate cues. One of these days all this will be considered obvious. Why shouldn't the brain be able to adapt to new information about itself? It is called learning. That's what our brain does well.

What the brain is known to be capable of randomly, we may be able to elicit systematically.

Just as in agriculture a slow transition is taking place from the pesticide war against nature to using more biological means of control, we will emerge from a singular focus on pharmacotherapy and surgery to recognizing the brain's own potential for healing. We know it exists. Probably many startling recoveries now routinely ascribed to the placebo effect are in fact examples of the power of self-healing. We all know of the phenomenon of "spontaneous remission" of tumors. This term pre-dates the scientific era. In fact, of course, tumors do not disappear in the absence of agency. We have allowed this term to survive to this day because we have not been interested in the mechanisms underlying spontaneous remission. Somehow the body, or more specifically the brain, precipitated the aggression against the tumor. It is another example of self-healing. What the brain is known to be capable of randomly, we may be able to elicit systematically.

SOME CONCRETE EXAMPLES

Science in general, and in particular medical science, is not impressed by individual case histories, which are routinely dismissed as "anecdotal data". However, they can nevertheless be useful in the present context to calibrate the reader's expectations of what this new technique may be used to accomplish. They are also useful scientifically, by forcing our attention on new phenomena which have simply not yet been studied extensively, but point the way to the future. The astonishing 29-foot long jump by Bob Beamon in the Mexico City Olympics was a singular event, but it

could not be dismissed in terms of what it said about human potential.

TRAUMATIC BRAIN INJURY.

In the case of major head injuries, significant spontaneous recovery has never been reported in the literature more than a couple of years post-injury. After such an interval, significant recovery would be as exceptional and noteworthy as an amputee starting to regrow a limb. The following are some representative case histories:

A professional woman in her thirties was referred for EEG biofeedback training more than four years post-injury, an automobile accident in which she suffered whiplash. At the time she came for training, she was unable to live independently. She had to be brought to the office because she could neither find the way nor remember her appointments. She could no longer read, and even the simple act of boiling water at home could get her into trouble. She was extremely fatigued, and was not sleeping well. She was emotionally volatile, and suffered from frequent crying spells. All therapies to help her had terminated long before she came to EEG biofeedback training.

At the third training session, she reported sleeping better. At session five, she reported having more energy. By session 11, she was reading newspaper ads. At session 15, she declared: "I am becoming the woman I was before". By session 30, she was able to read her whole legal file at one sitting. At session 47 she reported "feeling 100% human again for the first time." The training continued on to session 80. Subsequently, she reentered professional life and was remarried.

A second case involved a woman in her thirties who was three years post-injury, a car accident in which she had suffered whiplash, and was unconscious for a period of time. Her spine was fractured. When she came for EEG biofeedback training she was still totally disabled due to a variety of problems: chronic pain behind one eye; vision problems (central area gray, periphery fuzzy); dragging left leg; slurred speech; diminished memory function. She had continuous digestive complaints; headaches; dyslexia; and mental confusion. All therapies had been terminated except that she was still visiting her chiropractor, who referred her for biofeedback.

The digestive problems she reported were 75% improved by the fourth session, and completely eliminated by the eighth. Sleep was reported improved by session ten. By the time of completion of training at session 24, the pain behind the eye had been remediated, and her vision significantly improved. Her speech was no longer slurred; she was no longer dragging

MEGABRAIN REPORT

her foot; and there was no more uncontrolled crying. She was able to return promptly to a full-time occupation.

After EEG training his IQ was 112, an increase of 42.

A third case involved a man in his fifties. After an automobile accident he was brought into the hospital DOA. His family was summoned. A family member observed the body to move under the blanket on the gurney, and drew attention to it. "Oh, bodies do that," she was told. The movements continued, and the medical staff thereupon resumed attempts to resuscitate the man. After weeks in coma, he subsequently made a major recovery, and came to us years later after his condition had stabilized. With the training, his mood became more elevated, and his memory gradually returned. He had studied some seven languages in his youth, and this language ability was gradually recovered. He also improved in terms of balance and gait. Members of his head injury support group pronounced him "a changed man."

STROKE

A woman in her fifties came to us for EEG training 19 months post-stroke, and after all other therapies had been terminated. She was having difficulty with concentration, with speech, and with word retrieval. There was some loss in fine motor control, and symptoms of depression. She came from out of town and could only obtain six training sessions during her stay. Nevertheless, it was reported upon her return home that she resumed writing correspondence; that she was again playing the piano; and that she was much more verbal, once again bossing everyone around in her household. Her original vitality had returned.

Another case: A man came to us some three years post-stroke, having suffered extensive damage to left-side speech and motor areas. His speech consisted of only partial words—often the wrong ones—and some consonants were still lacking. He was on a cane, and had limited use of his right hand. He was depressed and withdrawn. All therapies had ended with the exception of speech therapy, which was just about to end.

The training effected first a remediation of the depression. He became much more active and interested in the life of his family. His speech therapist observed a sudden burst of improvement in speech (within two weeks of start of training for the speech deficit). By session 27 he was

speaking again in simple but complete sentences. By session 46 he had given up his cane; by session 60 he was using his right hand again to shake hands. By session 90 he trusted himself to go skiing again, and was picking up newspapers to read. Speech is still halting and slow; but he is fully engaged again in the life of the family.

DRUG BABY

A three-year-old girl was referred to one of our offices for reasons of behavioral dyscontrol. She had screaming episodes lasting for hours. These were so common that it was impossible to find foster care placement for the girl. She was hospitalized at the time of the training. Within three sessions, the crying episodes were reduced to three minutes, and after ten sessions the case worker pronounced that the girl was functioning like a normal three-year-old.

FETAL ALCOHOL SYNDROME

A five-year old adopted boy was starting to develop severe behavior problems at home. Fetal alcohol syndrome was then diagnosed. The child so fractured the family life that the mother thought her only option was to "put the child back into the system." The boy was totally resistant to doing the training. He announced "I don't have a brain." Nevertheless, after a few training sessions, the boy mellowed. His anger diminished, and it became possible to reason with him. After 32 training sessions total, he was winning "student of the week" awards at his school. His intrinsic charm was now showing.

MILDLY MENTALLY RETARDED BOY

An adopted boy with an IQ score of 70 underwent EEG training with another practitioner. He was retested a year later, and his IQ score was 112, an increase of 42. By itself, this result may appear startling. However, it is quite consistent with our own findings of increases in IQ test scores of more than thirty points when the children start at values less than 90. The training clearly facilitates the organization of mental functioning so that the child can exhibit his native intelligence. The results are so striking that they must compel us to revisit the whole issue of whom we are calling mentally retarded.

ATTENTION DEFICIT DISORDER; CONDUCT DISORDER

A twelve-year-old boy was referred to us for EEG training because of conduct problems. He had been kicked out of seven schools, the last a school for severely emotionally disturbed children. He was being home-schooled at the time. He had suffered a birth injury, and a subsequent

head injury at two years. He had significant sleep problems when he came to us.

After the first EEG session, he stopped talking in his sleep at night. After session nine, he reported that he did not get in as much trouble. He completed training at 29 sessions. Within a few months, he returned to regular public school. No one would call him emotionally disturbed any more. Also, his IQ score increased 34 points (WISC-R), and he improved four grade levels in reading, and more than two in spelling, according to the Wide Range Achievement Test.

SEVERELY EMOTIONALLY DISTURBED BOY

An eleven-year-old boy at a group foster home had a history of aggression, oppositional behavior, and ADHD. He was also suicidal. He had math and language disabilities. He was reluctant to undertake the training, and rarely did more than twenty-minute sessions. After twenty such sessions, he made a breakthrough. He came to the next session enthusiastic about the training, declaring that he was a "new man." He was calmer, and much more cooperative.

His aberrant behavior subsided. He was no longer suicidal. The staff psychologist said she had never seen a more dramatic change in a person in ten years of psychotherapy. After ten more sessions to consolidate his gains, the boy was released from the group home back to his closest living relative, an aunt.

DEPRESSION

A woman in her forties came to us with a long history of depression, of eating disorders, of chronic pain, and bruxism (teeth-grinding). As part of the intake session, she took the TOVA test, which measures attentional variables. She was in the 5th percentile in terms of reaction time, and in terms of inattention and variability in response time. After only twenty training sessions, her TOVA scores were all better than her age-appropriate norms, a simply staggering improvement. We rejoiced. She was wistful. "You are taking my disability away," she said. "I've lived with that all of my life." Change, though positive, can be somewhat frightening because of the uncertainty it brings. She is in the continuing care of her psychotherapist to manage these changes.

DEMENTIA

An elderly man came to us diagnosed with "diffuse cortical atrophy". He had been a highly verbal, intellectual man—Rhodes scholar, company president, and public official. Now he was falling silent because he was losing himself in para-

graphs and sentences, and he found that was too embarrassing for him. After nine training sessions in one week, his disorderly EEG was normalized (reduced in amplitude) by a factor of three. He became more verbal, and more animated. His wife said, "You have given me my husband back." He came for booster sessions a year later. Subsequently he suffered an ischemic attack, leaving him with symptoms of disorientation and paranoia. These symptoms persisted for some months until he could come back to the training, at which time they were promptly remediated. As the organic deterioration continued its relentless course, he eventually needed the booster sessions more frequently.

Ultimately, he benefited from the training for more than five years, until he succumbed to progressive supranuclear palsy.

BRUXISM (TEETH GRINDING)

A woman came to us after having had a \$10,000 dental restoration for bruxism. She was a hyperactive adult with poor body awareness. She undertook the training for more than thirty sessions. By session six, she became aware of clenching her teeth during the day. By session twenty, the cessation of night-time bruxing behavior was indicated by remediation of the pain associated with it. Training continued to thirty sessions to consolidate the gains.

ANXIETY AND PANIC ATTACKS

A woman came to us with a history of frequent panic attacks, migraine headaches, poor sleep patterns, and fatigue. She could not handle the stress of a job. Training in the SMR band helped her to relax; then training in the beta band (15-18 Hz) helped her mental functioning (concentration, focus). Followup after 32 training sessions showed that she still felt somewhat anxious, but her panic attacks had been completely eliminated.

TEMPORAL LOBE EPILEPSY

A seventeen-year-old boy was trained for temporal lobe epilepsy, for which he was medicated with Tegretol and Dilantin. He was doing poorly academically, and was exhibiting many signs of psychological disturbance and instability. He was emotionally volatile, even explosive. He was depressed and angry. He exhibited self-mutilating behavior and suicidal ideation. This behavior pattern had been observed for nine years prior to the onset of EEG training. After the training was initiated, the boy became friendly and talkative. His academic performance began to soar. The volatile emotions subsided. The suicidal thoughts vanished. He began to set long-term goals for himself: getting into

college, choosing a curriculum. He was able to eliminate the need for Dilantin entirely, and to significantly reduce his dose of Tegretol.

After a year of intensive training at two sessions per week, he succeeded in getting into college on the basis of his obvious change in performance, which made his prior record unrepresentative. By the end of the first year, he was near the top of his class in his chosen field of computer science. The biofeedback gave him a sense of control over his epilepsy, and over his brain. He began to take charge of his own training. He came to know his own brain very well. He could predict what the EEG instrument would show on a given day based on what he knew about himself. Eventually, he came to need the instrument less and less. He also learned other skills (breathing, yoga, meditation) which many other persons with seizure disorder have found to be helpful as well in managing their seizure threshold.

We have now managed over 1000 persons in EEG training in our own office, and our techniques are now in use with well over fifty other professionals who are getting similar results.

SUMMARY AND AN INTIMATION OF THE FUTURE

The results described above portend many new developments in terms of taking advantage of the ability of the brain to remediate itself. We are surely just at the beginning of discovering how this new tool of EEG training can be best applied in a particular individual. The boundary of our knowledge horizon is increasing rapidly, like ripples on a pond, raising more questions than we have so far answered.

The results bespeak a general property of the human brain, which is LEARNING. All parts of the brain are intrinsically responsive to information. That is the essential function of a nervous system. It is similarly obvious that the brain routinely responds to information about itself. The new findings indicate that it can also respond to information about itself which is provided externally, by biofeedback. The implications of this appear quite boundless at this point.

We see the impact of this training particularly strongly in the most severe conditions with which brains are afflicted: epilepsy, traumatic brain injury, cerebral palsy, and the dementia of the aged. We see it impacting also on the largest issues confronting the field of mental health: depression and anxiety disorders. We see it helping with some of our society's most vexing problems: irrational violence, criminal behavior, and addictive behavior. And we see it dealing with so many of the

learning problems which lead to unproductive lives. The efficacy of the training for some of the most disturbing behaviors we see in our fellow man (irrational aggressive behavior; sociopathy) implies that these behaviors are brain-based. They do not come from a deficient force of "will". In fact, the more extreme the behavior, the more likely it is that we are dealing with a neurological impairment. Fortunately, these impairments don't appear to be hard-wired.

In the last year we have seen a surge of interest by mental health professionals in this technique. We will soon see it available in many different settings. The impact of our emerging ability to train the brain is incalculable for our society. Clearly, this will have to be part of any national health plan which meaningfully addresses the problems people actually have. EEG biofeedback could lead to significant reduction in health care costs, as we address the underlying problems rather than the physical symptoms they give rise to. The frontier of health is, in large part, the frontier of the brain.▲■●

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New Light on Lights, Sounds, and the Brain

by Len Ochs, Ph.D.

Light and sound machines—devices that combine rhythmic photic and auditory stimulation and seem to alter or “entrain” brain wave activity—have been available as consumer products for years now. These devices have been used to explore consciousness, relax, enhance performance and learning, explore altered states, and enhance sleep and energy, to name but a small selection of goals.

I am not aware of any reasonable scientific studies, much less controlled studies, of the therapeutic effectiveness of light and sound stimulation devices. However, if there's fire where there's smoke, formal studies or no, these devices must be doing enough to warrant their sharply increasing sales over the past few years. Reliable reports of significant benefit are few, but they are clearly frequent enough to sell increasing numbers of these devices in the context of enhanced functioning, as well as widespread desires to stay away from both drugs and the relatively poor efficacy of medical treatment for some chronic conditions. I have, on occasion, heard second hand stories of these devices producing effects that seem nothing less than miraculous.

My negative bias and disposition toward these devices showed clearly, even in the face of Marion Diamond's and W. Grey Walter's pioneering work on stimulation. So it is with a distinct sense of embarrassment that I must report my own observations of a light and sound device that produces reliable and important results within certain domains of problems.

EEG Entrainment Feedback. In the process of working on one technical problem, I designed a sound and light system that would customize itself to the user's brain waves on a moment to moment basis. By using the individual's EEG to set and reset the stimulation frequency, the stimulation would always, then, be customized to the user's brain wave states. This system, which I called EEG Entrainment Feedback (EEF) would, I thought, constitute a non-directive psychotechnology whose course would be set by the person's brain, but which in turn would be influenced by the stimulation.

I had the biofeedback J&J I-330 EEG and the Synergizer light/sound device from Syntec Systems. EEG software was designed to link these two devices allowing the person's EEG to change the frequency of the lights and sounds, and the stimulation, in turn, to change the EEG. That covers the electronics and computer side of the system.

The clinical effects of this system were entirely unpredictable to me. This link had not been attempted before to my knowledge. There was certainly nothing in the literature which described the EEG-stimulation link, what the effects of it might be, what problems might be encountered, and how it might be used.

I tried out the EEF system and found it much more visually beautiful than I found the traditional sound and light stimulation. It seemed more alive and responsive to my brain waves than was the fixed-frequency or pre-programmed slowly ramping stimulation I had previously tried. Although only red LEDs were used at that time, the visible patterns and rich colors varied closely with the measured EEG frequencies.

CLEARER, FASTER PSYCHOTHERAPY. Interested, but not especially aware of any unusual ability of the system, I introduced it to some patients who had a great deal of psychotherapy, biofeedback, and even EEG brainwave biofeedback, but who needed results that were clearer, faster, and more

meaningful than brought about by these procedures. One man had 20 years of rages, many of which lasted two weeks at a time. The family was threatened with divorce because of the unacceptability of his explosiveness. He was unable to work because of his temper. Another patient was a woman who worked for a major retail chain as an upper-level manager and had been exposed to increasing work pressure over the past few years, capped by threats of bodily harm to her and her family by employees. She had been unable to go to work and was extremely depressed and anxious. Both of these individuals were very highly motivated, and very bright. Both wanted to work again; and both felt the shame of being out of work. The man highly valued his family and wanted to continue in it. What follows are lessons I learned using EEF to work with these two individuals and others.

I found it much more visually beautiful than traditional sound and light stimulation. It seemed more alive and responsive to my brain waves...

LESSON ONE: People can be hypersensitive to their own brain waves. Within two minutes of feeding back EEG-driven sound and lights the woman began to complain of back, neck, and head pain. I had set the system to lower her EEG by flashing the lights a little slower than her dominant frequency. Increasingly in the biofeedback field, brain wave biofeedback was being used to teach people with post-traumatic stress disorders to voluntarily lower their average brain wave frequencies. But this woman clearly experienced tension and muscle contraction pain when her brain wave frequencies lowered. If lowering her EEG produced pain, I wondered if increasing her EEG by flashing the lights slightly faster than her dominant frequency would keep her from pain. Contrary to the wisdom of conventional EEG biofeedback, it did.

Her responses suggested to me that she was *hypersensitive* to lower frequencies. So the strategy I next adopted was to gradually re-expose her to her lower frequencies, but to do it so gradually that she would desensitize to them and be able to be comfortable with them. So I alternately reduced and sped up the stimulation by changing the polarity of the difference between her dominant frequency and the stimulation. The lights alternately flashed at slightly faster than her dominant frequency (thus entraining her brainwaves upward) for one minute, then slightly slower for the next minute, and so on, reversing the polarity or direction over the course of a five minute session, at first, and gradually lengthening the session to 30 minutes.

As I continued exploring this non-directive psychotechnology, psychologist Jon Cowan's objection to the name EEF began to stimulate me to fit a new model to the phenomenon I was witnessing. EEG Entrainment Feedback still made sense in that the brain was indeed being entrained by the stimulation (as James Gleick writes in *Chaos: Making of a New Science*, “This phenomenon, in which one regular cycle locks into another, is now called entrainment, or mode locking.”) However, in the larger sense this

entrainment was being used to *disentrain* the brain from being stuck in a destructive reaction pattern.

Disentrainment refers to the disruption of entrained patterns, patterns which have become in some way locked. Disentrainment is more a process which leads to the re-establishment of biological systems flexibility. As critical as the ability of a system in its ability to withstand shocks is, in Gleick's words, "how well a system can function over a range of frequencies. A locking-in to a single mode can be enslavement, preventing a system from adapting to change.... No heartbeat or respiratory rhythm can be locked into the strict periodicities of the simplest physical models, and the same is true of the subtler rhythms of the rest of the body" [italics mine].

The linked EEG and LS system I had developed had the effect of making more flexible a range of neurological and neurochemical systems from the largest to the scale, and consequently improve conditions of patients once thought to be largely hopeless. The success of this system rests on the integrity and ingenuity of the research toward this end. Thus I changed the original name EEG Entrainment Feedback to the more accurate *EEG Disentrainment Feedback (EDF)*.

This entrainment was being used to disentrain the brain from being stuck in a destructive reaction pattern.

The previously mentioned man afflicted with uncontrollable rages, a Viet Nam veteran, had suffered these explosive episodes since his tour of duty. His temper had decreased ever so slightly over the course of 40 EEG biofeedback sessions, but clearly not enough to change his wife's mind about divorcing him. His sixteen year-old son was giving the parents increasing problems with temper, manipulateness, and mixing with the "wrong crowd" at school. The mother was especially concerned that the son was beginning to imitate "big time" the father's temper, which was too much for her to handle, and which added to her sense of urgency. Over a span of two weeks of daily EEG-driven LS stimulation sessions, tears would show over the man's cheeks; he felt thermal hallucinations ("It's as hot as Nam... whoops, it's gone."); he experienced auditory hallucinations ("I hear the choppers."). In each of these instances, and in others like them, my only verbal intervention was a non-technical acknowledgment of what he said: "Uh-huh," or "Yup." In each of these instances he reassured me that he was all right.

The protocol I used with this patient was the same that I used with the woman: if the patient looked uncomfortable or sounded uncomfortable, I reversed the polarity of the leading frequency, i.e., alternating between slightly faster and slightly slower than the dominant brain wave frequency.

Over the course of two weeks not only did the father's temper recede, but the son could no longer trigger the father's temper outbursts (which dazed and confused the son the first times it happened). In addition, the father became a stable aid to the mother in the son's management, and exercised good judgment in the management of his own time so that the mother could at last depend on the father to show up for appointments, for example, even when things didn't go his way, or when traffic was especially bad.

With the progressively lengthening exposures to specific frequencies that made these individuals uncomfortable, their comfort with the presence of these frequencies in their spectrum increased, and their symptomatology decreased.

LESSON TWO: Those with psychological and physical trauma are much more frequently hypersensitive than normals are to stimulation. According to Robert Austin, the president of Synetic Systems of

Seattle—a manufacturer of consumer sound and light stimulation devices—approximately 5% of their customers have complained about the brightness of the lights and the loudness of the sounds (even though the stimulation could be lowered to non-visible and non-audible levels). However, my continuing work with a heterogeneous head-injury and mixed psychopathology patient sample has shown over 80% to be hypersensitive to the light stimulation to significant degrees.

The linked EEG and LS system had the effect of making more flexible a range of neurological and neurochemical systems ...

"Hypersensitive" to stimulation means that the patients showed or expressed some degree of discomfort when the stimulation was present. Often the sensitivity was so great that the lowest levels of illumination of the lights were too bright. Non-verbal signs of over stimulation were tightening of the chest, restriction of chest motility, lifting or rounding of the shoulders, flexion of the neck, or tightening of the jaw. There were verbal expressions as well, ranging from "too bright" to "too much flicker" to "too much red" to cries and grunts of discomfort. In some cases I needed to mask the red LEDs embedded on the inside of the glasses with a sheet or two of manila file folder material in order to decrease the brightness of the lights low enough so that the patients could be comfortable with the stimulation.

One woman was so sensitive that she found the lights too bright even when they were shielded with file folder material and placed on her lap. Individuals may not even be able to see the lights when they are so dim; some can, however, feel that the lights are on, and feel this as apparent changes in blood flow inside their head, in their scalp, or in their eye lids. If they are sensitive to vascular pain, stimulation at the lowest levels may begin to elicit vascular pain as a fraction of that which they usually experience—and rarely pain of their usual full intensity, although full intensity pain has been known to occur and the patient should be prepared medically to manage it with the cooperation of his or her physician.

LESSON THREE: The people with the worst symptoms are the most hypersensitive to LS stimulation. It is astonishing to link sound and light sensitivity to symptom intensity. It is astonishing because we are not used to documenting central nervous system status with peripheral problems, or brain irritability with consciousness, motivation, mood and energy problems. It is much more typical to think of psychological reasons for these problems. Examples of those with extreme hypersensitivity problems are people unable to tolerate the flashing at all, even with the lights taped over with black electrical tape; they may object to the brightness, the flicker or the color. These people may not begin to respond for 20 sessions, while most of those with less sensitivity can begin to respond with symptom relief after the first session.

LESSON FOUR: The people who desensitize get better. Not all patients show hypersensitivity. However, of those that do show hypersensitivity, 100% of the over 50 patients I have worked with showed a decrease in symptoms as they desensitized. Examples of this hypersensitivity are someone saying that the lights, colors, or flickering are making them uncomfortable. Several kinds of symptoms reliably improve for those that have suffered psychological or mechanical head trauma: lack of clarity, lack of energy during the day, sleeping problems at night, depression, irritability, temper, and explosive episodes, inability to absorb information auditorily or visually, difficulty prioritizing, poor short-term memory, difficulty making decisions related to focused and directed activity, and obsessive thinking.

MEGABRAIN REPORT

A 24-year old man with a pre-birth family history of alcohol abuse and physical violence, multiple head injuries as a young child and a long history of psychotherapy (along with continued family addictions, violence, and parental psychiatric hospitalizations), came in to me for treatment on the referral of his therapist. He complained of a life-long history of depression, suicidality (thoughts and attempts), obsessive thinking, sleeping problems, and the shooting of a family member. His skepticism about the possibility of change was immense, as was his distrust of me as a psychologist and therapist. Within the first 10 daily half-hour treatments (given in 1-hour sessions) he noticed a decrease obsessions and suicidality. At his 22nd session he was in his own words "90%" free of depression, irritability, temper, and obsession. He declared himself to be reliably not suicidal, and was focused on how he might mobilize himself vocationally to move out of social security disability. At this time he has completed 45 daily sessions and his work, energy, productivity and attention have stabilized. He will begin once weekly sessions for about six weeks to taper from treatment.

There was a clear direct relation between the amount of light stimulation he could comfortably tolerate and his sense of well being. It took him twenty sessions to be able to comfortably tolerate full light intensity. To someone hypersensitive to stimulation it seems impossible that they will ever be able to be comfortable with strongly bright lights. However if the desensitization is managed carefully, skillfully, and with patience, patients are able to be comfortable with brightness levels they once thought impossible.

LESSON FIVE: After desensitization, the lower the intensity of the stimulation, the more reliable the improvement. After a woman who had been doing well suffered another trauma she relapsed. And after the trauma she appeared to be making no progress toward recovering the gains she had made, although she did not appear to be uncomfortable with bright stimulation. Since she was showing large amounts of very low frequency activity, I wondered if the strong stimulation was itself mimicking the effects of trauma and perpetuating her problems.

I decided to lower the lights to levels barely visible to her, and once I did, she began making progress again. Others using EDF have found the same improvement effects in work with stroke victims: those who appeared to have plateaued once again made progress once the stimulation levels were lowered.

The advisability of lowering the stimulation levels also flies in the face of the way many use commercial sound and light devices. People seem hungry for experience and sensation, and often speak of "blasting" themselves with light and sound stimulation. In fact,

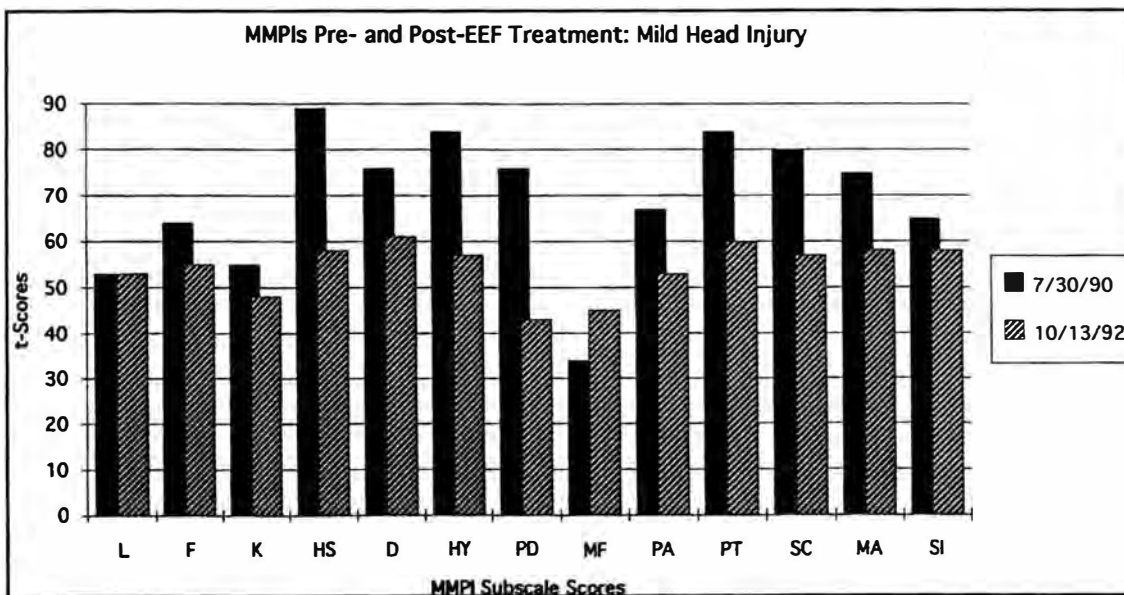
patients frequently ask me to raise the brightness of the lights in the belief that more is better; if they can just "take" a little more, they may get through the treatment faster. Unfortunately this may provoke a relapse and overdose, and lengthen their treatment. At best, it can lead to no improvement.

It may be that gradually raising the lights in intensity serves to reorganize the brain in some way. However while many of the symptoms do decrease as this happens, as noted above, some others, typically the finer thinking, organizing, memory, and sequencing skills seem to need something else. It may also be that lowering the intensity of the stimulation produces a much milder local stimulation at the site of the EEG electrode without the global brain reorganization. Keeping the stimulus intensity high may interfere with the return of function by overloading the cortex, an effect seen by large amounts of low frequency activity and a failure of the cortex to inhibit that activity and integrate it so that the person can function at "higher" levels. This cortical overload may serve as a model by which trauma can be studied. (This also suggests that there may be two phases to EDF treatment: global and local. Global reorganization appears to require desensitization to bright stimulation, while local reorganization, responsible for the recovery of specific skills, seems to require dim light.)

LESSON SIX: There is more than one kind of hypersensitivity. Although the woman I mentioned above appeared comfortable with brighter lights she did not resume making progress until their brightness was lowered significantly. This implies that she was still hypersensitive to the lights even though she felt no need to complain. The loss of the sense of hypersensitivity in the midst of continued impairment suggests that the brain is capable of reacting differentially.

Because her sense of hypersensitivity was lost, there has been a need to develop other objective ways to alert the clinician that the patient is hypersensitive. This remains a problem today, and one that is receiving top attention.

LESSON SEVEN: *There appears to be such a thing as optimization of one's EEG.* As a patient becomes progressively more functional—that is mood, energy, motivation, memory, attention, sequencing, prioritizing, etc., become more present and reliable—there are predictable changes that appear in the patient's EEG patterns. As the patient learns to "cruise the frequencies" and do "nothing" under the stimulation of the lights and/or sounds, i.e., gets better at not directing or processing consciousness but instead lets go and permits it be pulled however it goes, the activity observed in each of the bands becomes minimized, equalized, and reduced in variability.



A typical MMPI personality test graph for a woman who was extremely competent before her head injury and unable to work afterward. Shading difference show results before and after a 6-session treatment. Any of the t-score bars above 65 are considered abnormal. Not only are the after-treatment (shaded) bars much lower, on the whole, which means reduction in symptoms, but the patterns among the bars are different, indicating that her personality has, in effect, changed. The initial readings indicate both personality and thought disorders, whereas the after-treatment results are within the normal range and co respond to much greater functional ability.

While there initially appears relatively enormous amounts of high amplitude EEG in the lower frequency bands, this activity is minimized and stabilized in response to properly applied stimulation.

I have seen no instance in which symptoms were worsened or even fixed at high levels as these patterns became more prominent. The opposite is true, in fact: I have only seen improvement as the “idling” EEG was minimized and stabilized when measured from the front of the head.

As these EEG patterns become increasingly prominent, the EEG will increasingly follow (or be entrained by) the stimulation if it is deliberately varied. EEG following has not been evident early in the treatment when the EEG appears disorganized. In addition, movement artifact, often a consideration in EEG measurement, becomes much less prominent as the treatment progresses, and may almost be another indication of discomfort which improves with treatment.

LESSON EIGHT: We appear to have subcortical as well as cortical intelligence, fortunately. Once our functioning begins to deteriorate, our ability to be ourselves also deteriorates. We begin to experience the frustration that we can no longer do the things we used to do. We have trouble reading, following conversations, following (understanding), remembering and executing sequences of instructions; remembering what we need to do, what belongs to whom, and what still needs to be done (whether it was already done, or whether we or someone else needed to do it). We often have problems driving or riding in the car, fuming at apparent slights and stupidities of others and the impossibility of arriving at the intended destination on time (especially if we are having troubles admitting we can't remember where we are going or how to get there). The frustration and shame of not being who we were in our former competence is pervasive in nearly everything we do, and nobody can really understand why we can't “snap out of it” and “grow up.” We fake normalcy the best we can.

If we try to use regular EEG biofeedback, which follows a conscious learning model, our incompetencies interfere with our ability to learn brain wave discrimination, association, and control. EEG biofeedback, that is, sometimes places us in a Catch 22 situation in which the very skills we have lost are those which are required to expeditiously learn brain wave control!

Fortunately EDF does not require conscious learning—except for the need to learn to “idle” and drift with the stimulation patterns, as we both influence and are influenced by the lights. In fact, any attempts to “help” the stimulation, engage in constructive thinking, meditate, and so on, usually *lengthen* the treatment process, at least in its initial stages.

EDF does not require conscious learning — except for the need to learn to “idle” and drift with the stimulation patterns.

We are used to thinking of our intelligence as an attribute associated with focused attention, discrimination, associative linking, memory, sorting, and discerning our way through sequences of possibilities and problems. The application of intellectual skills is often associated with effort. Those receiving EDF treatment, however, are asked to do as little effortful focusing as they are able. They are asked to drift, or let their minds wander as much as possible without direction. Patients often spontaneously report at the end of the treatment that they no longer resist the stimulation, that they just watch the colors and patterns and let them take them wherever they go—which is largely a reflection of what their brain activity is inclined to do.

Those who were brightest consciously before their trauma often do the best, as if their intelligence is a quality that permeates the brain subcortically as well as cortically. While they often feel stupid in the conscious world of complex tasks, instructions, and cues, watching and listening to the stimulation seems to allow it to work without the need to overcome what are apparently useless efforts to direct their consciousness.

It has been apparent that more than just the visual or auditory parts of the brain are involved in this treatment process. Reports of “a golden globe slowly rotating before my eyes,” “strange smells that I can't place,” “smelling the horses on screen at the movie,” or “my God it's hot! as if I'm back in Nam,” are not uncommon. These appear to be signs of the brain's interconnectedness, intelligence that is at work to automatically heal the individual.

The floating relationship between stimulation and brain activity becomes the program.

It is important to say that except for the skills involved in desensitizing the individual and remaining comfortably present and yet unobtrusive, it is the interaction between the EDF system and the individual's brain that is most intelligent. That is, *the therapist does not need to pick out helpful frequency stimulation strategies*:

The floating relationship between stimulation and brain activity becomes the program.

LESSON NINE: High functioning people who are truly injured and handicapped will do almost anything to get better if there is a reasonable chance that they will show relatively rapid significant improvement. People who are used to high functioning are intolerant of impaired functioning, even if there is secondary gain to be had from their impairment. They will travel hours each way each day; they will pay cash regardless of whether insurance will pay; they will keep their appointments except in unusually difficult circumstances at which times they will call to keep the connection; they will ask questions about their experience; they will ask for reading material if there is some reasonable assurance that what is being offered to them will make a real difference in their lives. Formerly high functioning individuals who have been financially impoverished, who are living on disability and welfare, will stop at nothing to obtain and accept free treatment and will get well if possible, and go back to work or back to school. These people hate their lives.

LESSON TEN: Research, Research, Research. It is sometimes difficult to tell the difference between wishes for dramatic breakthroughs in medicine and knowledge of the mind, and actual discoveries that change our knowledge and our lives. Research starts with observation and moves on to controlled testing of hypotheses with increasing degrees of stringency, all to make sure we are not fooling ourselves and each other. In case the reader thinks I am advocating stodgy academic publishing to enhance a knowledge of basic science, the reader is only partly correct. I am as well concerned with marketing and being able to make the grandest justifiable claims. However, these claims should acknowledge the product's limitations as well as its areas of applicability. The makers of the claims need to recognize the desperation of those afflicted with head injuries, strokes, spinal cord problems, depression, obsessions, rages, enormous fatigue, emotional and environmental hypersensitivity. Only research can define a product's limitations and capabilities.

It has taken us three years to study how EDF might be studied, and to begin to develop tools so that neuroscientists can begin to evaluate its safety, efficacy and mechanism. Research is the only way to ascertain the system's assets and liabilities.

Furthermore, there is no reason not to subject even the standard light and sound technologies to controlled studies. They lend

themselves perfectly to such investigations. The programs may be changed inside them without the knowledge of either the study personnel or the subjects under some conditions, and then changed again to be sure that each subject receives the real and placebo programs at specific times during the study. Fully informing both staff and subjects that such switching will be taking place, and reassuring them that each will receive the best treatment known at the time will safeguard the interests of all. I believe that the extent to which the manufacturers of these devices have confidence that they are useful will be seen in their willingness to conduct good research on them. Again, this is not just research, but potentially superb marketing.

Many questions remain to be answered, such as:

- Is the inclusion of the EEG really necessary? I suspect so, otherwise there would have been much more frequently reported successes from the already existing LS stimulation devices. However this really needs to be tested methodically.
- Is the desensitization to the stimulation all that is necessary?
- Are there particular protocols that are much more effective than others?

Only research will advance our knowledge of the potential here.

LESSON ELEVEN: Move to other sites to monitor the EEG. One site most probably won't be enough. An individual's EEG may be optimized at one site and problems still remain. It is possible that the job may not be completed satisfactorily until the EEG from the entire scalp is examined for high signal levels and great variability. The therapist may proceed systematically around the head following the standard 10-20 electrode site system, or look for electrode sites on the basis of neuropsychological research. One patient was doing rather well throughout the sites on the left side of his head. However when electrodes were placed toward the back of the scalp on the left, and working around the back of the scalp from left to right, and again across sites on the right side of his scale, he began to have emotional reactions, powerful dreams, and changed from not feeling bad to feeling occasional clear happiness. His inner life has become unstable, but extremely intriguing and satisfying in its diversity.

LESSON TWELVE: Trauma, both psychological and physical, may be a lot more treatable than formerly thought. A great deal of pain has been endured by the traumatized; a great deal of human resource has been lost as well. Trauma's impact on someone's life can convert it from exciting, satisfying, and productive, to one that is empty of hope, or financial and social independence in a second.

LESSON THIRTEEN: Dead may not be so dead. The traditional wisdom is that head injury symptoms are the result of dead or destroyed brain tissue. While there is undoubtedly structural and tissue damage in head injury, including stroke and spinal cord injury, the inevitable linking of that damage with the subsequent loss of function may be premature and largely based on the treatment resistance of the subsequent problems using conventional methods. EDF has most certainly had its treatment failures. However in each case these failures are characterized by the patients being disappointed that the particular functions they wanted did not return, while other functions did. The functions that did return, such as the ability to remember without making notes all the time, or clarity of consciousness, were each devalued. One patient did not recover from her post-traumatic headache of five years when I was just beginning to understand the phenomenon of photic and auditory hypersensitivity. Her treatment may have been terminated prematurely.

Another, who suffered both a massive stroke and an attempt to surgically repair his cerebral circulation during a cardiac bypass operation had major portions of dead tissue removed from his brain. The clarity EDF brought him drove home to him even more the significance of his losses, which intensified his frustration.

However the range of problems that were helped, from mild traumatic closed head injury, to limbs paralyzed by stroke, to loss of emotional control, to depression, to loss of balance and equilibrium, to loss of sight, to fatigue in chronic fatigue, to arthritis, to allergic cracking of the skin (post head injury), etc., implies that finding a structural anomaly does not necessarily mean that the person won't recover. In fact, I have been increasingly dissatisfied with the medical (EEG, radiographic, nuclear medicine) ability to predict capacity for recovery once EDF is applied to problems, especially since most of the patients I have worked with have been better than two years since their injuries.

LESSON FOURTEEN: We ain't seen nothin' yet. Once more it appears that we really don't know what we thought we knew: former truths about human limitations to recovery from terrible trauma are beginning to show themselves as inadequate pictures of reality. There may be a good deal of institutional, personal, and professional resistance to the recognition that commercial LS stimulation technologies may have a valued place in the hallowed halls of medicine and psychology. Here are some of examples of resistance I have already encountered.

1. Congratulations from some medical and psychological professionals, followed by quickly walking away.
2. Accusations of cruel fraud and deception, offering false hope to the truly hopeless.
3. The attribution of success to either the personality of the therapist or the placebo response of the patient.
4. Expressed fears that therapists will lose their jobs due to the success of EDF.
5. Statements that the patients really didn't have the previously diagnosed problems, but psychological ones that were much more easily curable.

None of these forms of resistance are unusual. Certainly controlled studies, even double-blind studies, are required to offer the highest level of commonly-accepted evidence of efficacy and safety.

I have not speculated about how EDF works. It may be premature to do so. There is a great deal of research to do which will answer questions as it is conducted.

There is no telling what electronic miniaturization will bring, ranging from the possibility of widespread and rapid improvement to many "hopeless" patients, to performance enhancement to many less severely afflicted. Procedures need to be developed to automatically adjust the intensity of the lights so that those who believe in macho treatment don't make themselves or their patients too spacy to operate a motor vehicle or other heavy or potentially dangerous machinery. Of one thing I am certain, and I underscore it for those who think that everything has been discovered: as long as people are alive, creation has a chance of being a continuous process. Just as this EDF process couldn't have been anticipated and just as the beneficial consequences of this process couldn't have been concretely forecast (disregarding the slogans about the brain being only 10% used, and therefore capable of anything), openness to surprise has helped many who were condemned to a hopeless life.▲■●

Len Ochs, Ph.D. has applied the principles of simplicity, directness and obviousness to such diverse endeavors as the design and development of the Orion biofeedback system and its Apple II-based predecessor, psychiatric aftercare facility merger, psychotherapy issues and techniques, and behavioral medicine. He has worked extensively with the physically injured, teaching them to rapidly and purposefully direct their blood flow for pain control, and with the chemically dependent, to alter their brain rhythms to relieve addiction. He is a past president of the Biofeedback Society of New York, and was recognized by the AAPB for his pioneering contributions to biofeedback instrumentation. He has a private practice in northern California. Phone 510 -687-3203.

The Key West Conference

by Dennis Campbell

Before the “entrainment revolution” of the eighties and nineties, there was biofeedback. Beginning with Joe Kamiya’s pioneering work in the late 50’s and early 60’s demonstrating that subjects could gain control over their own alpha brain waves, EEG biofeedback took off at an incredible pace. And that was the problem. It moved too fast to be considered scientifically credible. Early on, claims of “instant meditation” and “all you need is alpha” were made and promptly rejected by the scientific mainstream, along with LSD and love-ins. It was not to be taken seriously again for another 25 years.

Very quickly, however, through the more peripheral (and less controversial) forms of self-regulation, such as temperature, pulse rate, blood pressure, EMG (Electro-myograph), and EDR (Electro-dermal response), biofeedback research clearly established that any physiological variable that can be accurately measured and “fed back” can be brought under conscious control. These “traditional” forms of biofeedback have long been accepted as useful tools for stress reduction, and the cost of treatment is readily covered by most insurance companies.

Quietly, meanwhile, in a few widely separated research labs around the country, work with brainwave self-regulation continued. And in recent years the perseverance of these EEG feedback researchers has paid off in a cluster of exciting breakthroughs. Today, EEG biofeedback (brainwave training, neuro-feedback) is seen by many researchers and practitioners in the field as the ultimate in biofeedback. Rather than teaching self-regulation of peripheral areas, like traditional biofeedback, it works by teaching self-regulation of the mediator of all behavior and awareness, the brain. But while it is simple, elegant and seemingly on a solid scientific footing, neurofeedback is still subject to as much derision as astrology by much of the medical/psychological establishment.

Many psychologists see EEG biofeedback as their best hope of catching up.

So it was with a sense of shared exploration and discovery that many of the leading figures in the world of EEG feedback came together for the second annual Key West EEG Conference, sponsored by Futurehealth, from January 21 through 26, 1994. Last year’s conference (now considered to be the “Woodstock” of the neurofeedback movement) attracted about 40 attendees. This year’s attracted about three times that many—a clear indicator of the growing interest in the field. Bob Kall, head of Futurehealth, began his work with EEG biofeedback in 1972, and stayed with it through the dark times because, he told *Megabrain Report*, “It’s the most exciting part of the entire consciousness and human potential field.” He explained that his goal has been to pull together all the diverse elements and ideas in the field; to get the proponents of various conceptual models to overcome their sometimes strong disagreements and share their knowledge and experience—to create a situation where the strictly scientific can be transcended in the creative atmosphere of an anything-goes think tank.

And so the hallways at Key West buzzed with the energy and excitement inherent in finding oneself out on the cutting edge, along with many other like-minded explorers who are all eager to share information and speculation. More than once, in the excitement of free flowing, after-session conversations, assertions were made that might have remained proprietary or conjectural until a little more research was completed. But what the hell, was the general attitude, at this point the field is wide open and ripe for discovery, and each new finding creates the energy to fuel the next.

The charged atmosphere was tempered somewhat by the overriding concern for possible near-term actions by the FDA. In terms of regulation, EEG biofeedback systems are considered medical devices, and are subject to FDA scrutiny. Warnings have been sent out to several manufacturers, demanding that they refrain from making any claims about the efficacy of neurotherapy, even if it is supported by research, unless that research has been accepted by the FDA.

The drug companies, which have a lot to lose if the claims of the neurofeedback community are proven true, have insisted that such benign self-regulation devices be subjected to the same rigors of proof as are new drugs—a process that can take over \$100 million dollars and many years (see “The Problem with the FDA” in *Megabrain Report*, Vol. 2 #1). FDA enforcement agents have already confiscated one instrument in Texas and performed some structural alterations with an ax. (For more information, see “A Silver Lining” by Adam Crane on the next page.)

FOUNDATIONS

Many of the first day’s attendees were new to the field of EEG biofeedback. By some estimates, the number of practitioners of neurofeedback increased by 300 to 500 percent in 1993, and is increasing exponentially. And little wonder. After all, neurofeedback researchers have made some staggering claims recently about its capacity to remediate a number of conditions—such as addictive behavior, the effects of traumatic brain injury,

A Silver Lining: EEG Biofeedback Manufacturers Must Comply with FDA Regulations

By R. Adam Crane,
Chairman of the Technology Developers and
Support Section of the Association for Applied
Psychophysiology and Biofeedback

Neurofeedback (EEG Biofeedback) is falling under much closer FDA scrutiny than has been the case historically. EEG biofeedback manufacturers including our own company are lamenting the enormous expense that is required in order to fully comply with the incredibly complex FDA statutes.

However, in my opinion there is no choice but to meet a more aggressive FDA with an equally aggressive program to come into full compliance.

There is much speculation about why the FDA focus on the biofeedback field in general and neurofeedback in particular. I believe the fundamental reason is the EEG biofeedback's estimated 500% per year growth is moving it from a promising new biofeedback strategy to the mainstream of mental health. This means research is exploding in many areas. This leads to claims that are considered by the FDA to be unproved.

Therefore, it is critically important that any manufacturers of EEG biofeedback equipment be "purer than Caesar's wife" when it comes to claims. After all, neurofeedback speaks for itself in the hands of the appropriate health care practitioner. Eventually the research will satisfy FDA requirements for specific claims as it already has in EMG biofeedback (neuromuscular rehabilitation, etc.).

The FDA considers EEG biofeedback instruments to be class II medical devices. This means that all companies manufacturing these devices must register with the FDA and receive a 510K pre-market clearance before marketing. Instruments that do not satisfy FDA requirement may be seized without recourse (except to the manufacturer). Companies that try to avoid FDA compliance may be subject to huge fines.

EEG biofeedback is coming of age. Growing pains are inevitable but they are also essentially good news.

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and learning disorders such as attention deficit hyperactivity disorder—which have heretofore been relegated to long-term maintenance treatment with various drugs, and little or no real hope of significant improvement. Preliminary research seems to have validated most of the claims, and suddenly EEG feedback's the hot topic among progressive therapists. A large percentage of these would-be practitioners are psychologists, a field that has nurtured a bad case of technology envy since the rival field of psychiatry pulled ahead of the pack with the introduction of behavior modification drugs. Many psychologists appear to see EEG biofeedback as their best hope of catching up.

A central mystery of EEG feedback is how it works—how does the process of learning to self-regulate the brain produce the striking changes in behavior and performance that have been observed so consistently? On the opening day, veteran researcher Joel Lubar Ph.D., University of Tennessee, presented a detailed theoretical model of the brainwave self-regulation process. According to Lubar, any changes in behavior and performance produced by a program of neurofeedback must be detectable as changes in the structure of the EEG. After all, if the training parameters for the treatment of attention deficit disorder, for example, call for the inhibition of theta and the enhancement of beta in order to get the feedback "reward" (and the subsequent cognitive improvement), then a change in the theta/beta ratio of his attention deficit disorder patients should be detectable on a brain map. He went so far as to say that "...if no change in theta/beta ratio is seen, then no learning is taking place."

Lubar presented an impressive array of brain maps and statistics indicating that EEG does change commensurate with increased cognitive performance. His work provides the kind of quantitative data that lend credibility to the argument for neurofeedback that eventually must be put before the FDA, insurance companies, medical skeptics and others. After all, the most widely accepted assumption is still that consciousness is an epiphenomenon of the brain's electro-chemical processes; that the whole question can be reduced to simple cause and effect relationships of measurable phenomena.

There are, however, other opinions, including the view that on the contrary, the brain's electro-chemical activities may emerge out of consciousness. In his lecture and workshop Siegfried Othmer, Ph.D., President of EEG Spectrum, supported a less quantitative and less mechanistic view of what happens in the brain when it learns to self-regulate. "What we want," he asserted, "is efficient, appropriate behavior. To do this, the functional brain requires the flexibility to change states of consciousness and levels of arousal, as is appropriate to the situation at hand, and it requires the stability to stay in that state as long as is necessary. There are a large number of individuals with manifest deficits whose brainwave spectra fall well within the norm." Othmer reported that only about half the clients at his Encino, California, office show significant changes in their theta/beta ratio over the course of their brainwave training, while fully 80 to 90% of them show significant changes in test-measured performance.

Sterman's work with jet aircraft pilots has led him to identify alpha amplitude as a key indicator of peak performance.

So, what is "beta" neurofeedback training the brain to do? "Of course we see a reduction in slow brain waves in some of our clients," Othmer pointed out, "principally those who come in with a preponderance of slow brain waves. Because they have very high amplitude theta they can't attend to the outside world effectively; they tend to drift off into dreamland or bounce off the walls to stay awake. So we train them to inhibit theta and enhance frequencies in the low to mid-beta range, which is associated with externalized cognitive states. The net result of this training, however, is likely to be a decreased amplitude in the target beta region—a small, low-amplitude, desynchronized EEG being characteristic of the mature, thinking brain." *For and in-depth description of beta training, see Siegfried Othmer's "EEG Biofeedback Training" on page xx of this issue.*

YOU CAN DO IT BETTER EFFORTLESSLY

Barry Sterman, Ph.D., of the Sepulveda, California VA Hospital and UCLA, has been studying EEGs for 25 years or more. His name is in most of the books written about EEG during the past two decades for his discovery of the sensory motor rhythm (SMR). He found the SMR dominant during the "relaxed but focused" state exhibited by cats as they alertly withhold response just before pouncing. Subsequently Sterman had great success using the SMR to treat epilepsy in humans by training the subject to suppress theta and enhance SMR (in the 12 to 15 Hz frequency range). Along with Lubar, Othmer and other EEG researchers, Sterman has found that high amplitude, rhythmic theta ("bad theta") is not conducive to efficient, externalized cognitive functioning.

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Sterman's latest work, which he described at Key West, has been not with those suffering brain function deficits, but rather with some of the world's most highly functional individuals, jet aircraft pilots. His research has led him to identify alpha amplitude as a key indicator of peak performance. In monitoring the EEG of pilots, he found that while there was little change in either theta or beta (initially) in high stress situations, the presence of alpha (7 to 11 Hz) had a high degree of correlation to successful execution of complex tasks in those situations. This linked directly to his early work with cats, in which he discovered that the brain exhibits a need for "post reinforcement synchrony" (PRS)—an alpha state in which the brain momentarily rests after completion of a stressful activity. Continued stress in a person's environment, Sterman found, tends to lengthen this PRS period, lower the frequency of the dominant alpha, and produce increasing amplitude rhythmic theta (bad theta), as the individual requires increasingly longer and longer PRS periods to recharge and be ready for a new task. As the PRS continues to lengthen, it interferes with response to the next stimulus, until the individual becomes non-functional and drifts off into theta.

"Practice a task until you can do it in alpha" — Les Fehmi.

Sterman concluded that peak performance under conditions of sustained vigilance can only be maintained by training one's ability to maintain alpha under fire, which inhibits excessive post reinforcement synchrony. During the glory days of the Russian space program, he pointed out, the inability to maintain one's alpha was grounds for dismissal from the astronaut corps. Sterman also found that low to moderate work loads, even in stressful surroundings, yield a gradual mastery of the work (with mastery being defined as the ability to maintain alpha); but high work loads (especially with high variability and high stress) result in a gradual deterioration of alpha and an eventual overt stress reaction (burnout). Thus level of effort becomes in itself the most critical measure of peak performance.

This view was strongly supported at Key West by Les Fehmi, Ph.D. For more than 20 years, Fehmi has been using phase sensitive multiple electrode EEG feedback in a process of "attention training." The training, which he calls "Open Focus," entails learning to maintain high amplitude, in-phase (i.e. synchronous) alpha, which produces a Zen-like, detached awareness of oneself and one's surroundings—the Open Focus state, quite different from the stressful, straining narrow focus of attention cultivated and rewarded by our culture. His proverb for this process—"If it's worth doing, it's worth doing effortlessly"—has its application in his advice to "practice a task until you can do it in alpha." He has worked successfully with world class athletes and others who are required to attain peak performance under pressure.

His further insistence (echoing ancient Zen masters) that "all sensory experience necessarily arises out of emptiness," corresponds quite well with Sterman's observation that maintaining alpha reduces the need for Post Reinforcement Synchronization, so that it does not interfere with reception of the next bit of sensory input data. While in this alpha-dominated state of the "Open Focus," according to Fehmi's research, we can rapidly process rich experience without either overloading and drifting off into theta, or getting hung up in a narrowly focused, hypervigilant, state of excess desynchronized beta.

In the light of Sterman and Fehmi's findings about the benefits of alpha, what is the explanation for the extraordinary success in training attention deficit disorder children (and others) with so called "beta protocols?" Siegfried and Susan Othmer believe that ADD is a problem resulting from underarousal, and that the key to treating it

is to (A) inhibit theta, (B) improve (narrow) focus by enhancing beta, resulting in a lower amplitude, less synchronized EEG, and most important, (C) teach the subject an increased level of control and flexibility of response for both arousal level and concentration.

Most of the so called "beta protocols," as Sterman pointed out, conspicuously ignore alpha altogether, concentrating on the suppression of theta, and (in the case of the Lubar protocol) reducing the theta/beta ratio. Sterman observed that in all the studies of EEG biofeedback's cognition enhancing effects that he was able to examine, not one actually showed an increase in beta, even though beta was the "reward" frequency. What apparently happens in these beta protocols is that excessive theta is reduced in amplitude, and beta is stabilized or even reduced, in relation to some healthy level of alpha. Of course, this begs the questions of what is a healthy level of alpha, and what value there is, if any, in training (or entraining) theta. What brainwaves are conducive to what type of activity?

ALPHA, BETA OR THETA

In Saturday night's feature presentation Robert Fried, M.D., Ph.D. offered a wealth of evidence suggesting that EEG is an epiphenomenon of the respiratory process. In analyzing EEG research conducted over the last 50 years, he demonstrated a clear relationship between blood CO₂ content and dominant EEG frequency. The most interesting aspect of his research was his observation that deep rhythmic breathing enhances the "good theta," also observed in Hirai's classic EEG studies of Zen meditators over thirty years ago.

What is the difference between the "bad theta" produced by opiates and the "good theta" produced by Zen meditators?

One wished that Fried would take the conceptual leap to a hypothesis that perhaps both breath and EEG may be epiphenomena of consciousness. Most clinicians present did agree, though, that proper breathing would potentiate any of the protocols. Does this mean that the good theta produced by deep breathing was somehow buried in or displaced by the bad theta seen in dysfunctional EEGs?

Neuropsychological Associate Tom Allen, Ph.D., of Winter Park, Florida, delivered two compelling presentations on his alpha/theta work for the treatment of addictive behavior and post traumatic stress disorder (PTSD). Alpha/theta protocols are in many ways the most intriguing and sensational of the recent developments in neurofeedback, and have emerged from the research of Drs. Eugene Peniston and Paul Kulkosky and their influential papers on the successful treatment of alcoholics and PTSD subjects at a Colorado VA hospital. Peniston and Kulkosky's subjects underwent a series of neurofeedback assisted descents through alpha, into deep, internalized, theta states, during which they programmed themselves with visualizations and silent mantras which described the abstinent behavior they desired to exhibit in the future. In the first study, all ten subjects were successfully remediated. In comparison, all ten controls were rehospitalized for alcoholism within 18 months. This resulted in an unprecedented 80% "cure" rate (one returned to controlled, social drinking; one died)—a success rate that has been maintained through numerous subsequent studies—and established that the behavioral/emotional side of "mind" was at least as amenable to alpha/theta neurofeedback as the rational/logical side was to the beta protocols for ADD and such.

Allen, a recovered addict himself, concluded that the alpha/theta protocol works because it shuns the traditional "shaming" process and confrontation that form the mainstay of most traditional 12 Step programs. Instead, the EEG feedback helps create a relaxed, safe and

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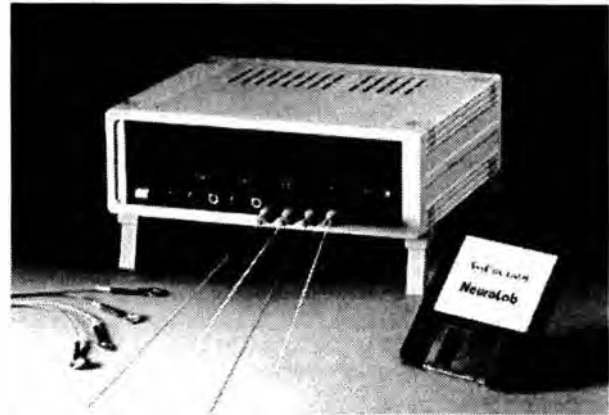
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highly internalized state that allows the addict to examine the aspects of his life which lead to the addiction in the first place, and to reprogram his behavior through use of the visualizations.

One of the keys to Allen's success is his use of traditional biofeedback along with the EEG feedback. He uses a combination of temperature, EDR and EMG to detect deep-felt responses of the entire body-mind to the ongoing therapy. It is well established that decreasing temperature and increasing EDR (conductance through increased sweating of the palms) is an accurate indicator of stress, and the reverse an indicator of relaxation. Some of his patients, however, have managed to defeat this detection system, saying they are comfortable with some aspect of the therapy when they actually aren't. So Allen has added the EMG measurement at the left forearm flexor muscle to detect tension that would be associated with the right (emotional) side of the brain, as determined by cross lateralization.

Allen described how he uses this combination of biofeedback with EEG feedback to deviate from the Peniston protocol in another important and controversial way, by taking a more active psychotherapeutic approach to the session. Upon monitoring any striking trends in the various physiological measurements, Allen asks the client to note what is going on in his thoughts at that time, and even carries on a slow-paced dialogue with the client during the session. After the session is completed, Allen then goes over the various reactive incidents with the client in an effort to identify which specific aspects of the client's life are the most deeply rooted in the body-mind.

Many purists, such as Nancy White of the Neurotherapy Center in Houston, blanch at the thought of altering the Peniston formula. White speaks of the almost magical properties of the theta state, which allow the "inner healer" to do the work of changing behavior "at its own speed." She hints that verbal intervention may be more of a necessity for the therapist (as entertainment or benign desire to control the course of the session) than for the patient.

Both Allen and White have good success with their individual versions of the alpha/theta protocol. One reason may be that clients tend to self-select therapists who bring to bear a degree of intervention that feels right to them. However, it should be noted that therapists using the more interventionist protocols seemed to engender more overt releases (abreactions) in their clients. In any case, the theta state seems to be of great value in both approaches, for its power to "unblock" memories and feelings, and allow the patient to get in touch with alienated parts of himself which he can then lead out of the darkness and confront in the "safe space" of the session.

An interesting aspect of Allen's presentation was a reference to Dr. Scott Lukas' recent work in defining the effects of various addictive substances in terms of their effects on the EEG ("Brain Electrical Activity as a Tool for Studying Drugs of Abuse," *Advances in Substance Abuse*, 4:1-88). To summarize those effects:

Alcohol:

- A) Low to moderate dosages cause an increase in alpha
- B) High doses result in an increase in theta and delta

Marijuana:

- A) Initial increase in beta and drop in alpha
- B) After about 40 minutes, alpha begins to increase

Cocaine:

- A) Initial increase in alpha, followed by a big drop

Opiates:

- A) Lower the frequency of resting state alpha
- B) Increases theta and delta
- C) Increases synchrony

Allen observed that alpha/theta training is extremely effective with all of these drugs except opiate addiction, which is seldom helped by alpha/theta training. It's easy to see why. The other three seem to be ways of self-medicating to enhance alpha, especially in the cases of alcohol and marijuana, perennial favorites as tension

relievers, because they are able to transport the user into a relaxed alpha state over and over again. Cocaine seems to be doing the same thing, for the first few minutes after consumption, but the euphoric state is quickly replaced by a noticeable absence of alpha, and the agitated need to use more to regain the initial state (which is then unavailable to the user until he runs out of the drug, allows his body to brain to "reset", and the process begins all over again).

Opiates, on the other hand, are a descent into a much deeper, less externalized state to begin with, in which the pain of the world is not just relaxed, but blotted out by heavy theta/delta.

Tom Budzynski, Ph.D. has been working for many years on a variety of alpha/theta training he calls "twilight learning." In his pioneering version of alpha/theta training (which he first developed over a decade before Peniston's alpha/theta work), the client learns to enter the "twilight" (theta) state, which has the characteristic of producing a state of hypersuggestibility and hyperreceptivity during which statements, information and imagery bypass the critical "censor" and pass into the unconscious mind. Budzynski uses an EEG system that monitors dominant brainwave frequency, and when the subject is in alpha, turns on a tape recorder delivering relaxation messages; when the subject enters theta, the alpha recorder turns off and a theta tape recorder turns on, delivering theta messages—those having to do with personal change, or other information or imagery that are intended to bypass the critical censor and pass into the unconscious. These theta affirmations and visualizations are recorded in the client's voice.

So what is the difference between the "bad theta" produced by an opiate high and the "good theta" produced by Hirai's Zen meditators? More than anything, it seems, it depends on how you get there. If nothing else, theta is a state of minimal control. The ancient meditative and yogic disciplines went to great lengths to insure that this highly volatile state would be reached by way of a path of "mindfulness." Though many artists and musicians may claim that drugs are a valuable source of creative insight, addictive drugs are not primarily used in a mindful way, but rather to eradicate the mind. Clearly, meditation too may be used as a means of avoidance rather than a path to wholeness. Let this be a guide to us in our uses of mind technology. As the philosopher Gregory Bateson so often urged, let us look for "the pattern that connects."

EEG AND ALTERNATIVE THERAPIES

It was evident that even within the select group of experimenters at Key West, some theories were considered further off the beaten path—many times for their inclusion of entrainment technologies such as light and sound (LS) devices, or so called "alternative therapies" in their experimental protocols.

One stroke victim recovered some 50 IQ points using Russell's LS protocol.

Harold Russell, Ph.D., of the University of Houston, has been cited in *Megabrain Report* on several occasions for his innovative clinical work with LS devices in treating ADD. His Key West presentation, however, focused on his work with three stroke victims, as part of his continuing research into the clinical effectiveness of entrainment devices. He has also hybridized his research by introducing EEG biofeedback into the protocol. While some of the patients he has worked with were started on neurofeedback, he eventually found he had greater success using a sound/light entrainment system. The protocol he developed for treating stroke victims (similar to that which he uses for treatment of ADD) consists of an alternating cycle of 10 Hz and 18 Hz stimulation, for two minutes each. His patients showed remarkable improvement, including regaining of

lost motor function and restoration of lost IQ (one stroke victim recovered some 50 IQ points). He believes that change is easier to see with entrainment therapy, but will continue to introduce neurofeedback into his protocol because he believes that some optimal combination of the two must exist. In the end, he echoed a common concern that entrainment is a passive process, and that more study needs to be done to determine if it “sticks”.

“After all,” said Wise, “do we really want to normalize everybody?”

Do subliminal suggestions work? Paul Swingle, Ph.D., Coordinator of Clinical Psychophysiology of McLean Hospital, Belmont, Mass., a division of Harvard Medical School, having worked with subliminals for several years, has a great deal of research data to contribute to the debate. He has found strong evidence that subliminals are powerfully effective when presented at appropriate sound levels and in appropriate forms. His work has centered around developing detailed protocols and optimizing the volume level and verbal content of subliminals to achieve maximum effect. The results of his study were quite striking, and will be presented in detail in an upcoming issue of *Megabrain Report*.

Therapist Anna Wise approached the subject of EEG feedback from a unique perspective, and aroused much interest with her heartfelt presentation describing her work with the Mind Mirror, an EEG that provides a complex image of brainwave activity in both hemispheres throughout a spectrum from delta to beta. Continuing along the path first explored by biofeedback researcher C. Maxwell Cade (with whom she studied for 8 years in England), Wise has examined the EEG patterns of healers, holy men and other high achievers in an effort to document similarities in complex patterns of relative brainwave amplitudes which are thought to accompany high levels of consciousness.

Barry Stermann and other hardcore scientists voiced a good deal of concern over the seemingly arbitrary nature of Cade's archetypal patterns. Wise, who attests to their accuracy as predictors of a person's state of awareness, also cited numerous examples of clients who have learned to change their brainwaves to the desired structure, and have gained a sort of enlightenment or “awakened mind” from the experience. The main objection from the scientific contingent was that the Cade's structures are geometric and seemingly arbitrary rather than being based on hard quantitative evidence. However, the quantitative view itself has already begun to reveal inadequacies. Our growing dependence on computers has caused us to bias research towards the quantitative measurement and comparison of data which they do so well, at the expense of pattern recognition, which even the most advanced of expert systems can't attain. Wise's technique, on the other hand, emphasizes pattern recognition and interpretation—and the trainer's intuition—rather than raw quantitative measurement. In guiding clients toward desired brain states by encouraging optimal and appropriate brainwave patterns rather than simple amplitude or synchrony at specific frequencies, the Mind Mirror training may be a more personalized technique. “After all,” said Wise, “do we really want to normalize everybody?”

One of the final presentations was by Gary Schwartz, a researcher from the University of Arizona. He is one of a growing number of professionals who are using brain mapping to verify changes brought about by traditional healing methods—in his case, aromatherapy. Our sense of smell, he pointed out, is processed by the most primitive portion of our brain, an area fully developed even before sight and hearing. Since then, we've lost a great deal of our olfactory ability, or at least that's what science had thought up until Schwartz's research became public. What he

actually found was that even the most minute dilutions of various odors, which none of the subjects reported they could consciously smell, registered immediately in the brainmaps of those exposed. One attendee suggested that our diminished awareness of smell is a result of evolutionary biology: in becoming “civilized” and suppressing “animal” reactions, humans have had to stifle our sense of smell because its direct tie to primitive emotions and emotional reaction is no longer a viable survival trait in the modern world.

Having established that infinitesimal odors altered brain waves, Schwartz then designed an elaborate series of studies (which may go on for years) to determine whether specific odors had generally the same effect on a majority of people. Are there relaxing smells and activating smells, as aroma therapy claims? The answer, Schwartz discovered, was an unqualified yes. For example, brainmaps of 23 subjects showed conclusively that rosemary was “energizing” and jasmine produced significant increases in alpha. Bad odors, on the other hand produced alpha suppression.

WHERE DO WE GO FROM HERE?

A forum on the future of mind technology was held near the end of the conference. Below are some of the suggestions made by the panel:

Gary Schwartz: “The technology will become as common as personal computers are today. This will make it possible for everyone to achieve peak performance and increase the possibilities available to the entire human race.”

Siegfried Othmer: “Our ability to use this process to remediate pathology will change the rules about who can seek self-actualization”

Joe Kamiya: “Biofeedback can be used to remediate the problems of our entire social system.”

Others suggested group biofeedback for the remediation of social conflict. Work with the prisons. Work with the President. One sober individual had the gall to ask (amid all the blue sky utopianism), “Is society ready for us to all function at a peak level?” What will happen if we short circuit existing social compensation mechanisms based on inequality?

The clearest impression I have of the Key West conference is an amazement at the power of EEG biofeedback as both a clinical tool and a path to human evolution. All the bickering about model and method reminds me of the joke about the three blind men trying to describe an elephant. *Everything seems to work.* Each one of the many dedicated researchers and clinicians in attendance have a piece of the puzzle. We are literally only scratching the surface. Everything seems to work, I suspect, because we are all exploring the shape of something whose dimensions are so vast they are still largely unknown. What will we achieve when we can economically map the brain's activity with more sophisticated depth scans, capable of microscopic resolution of interior brain structures? Pair that with virtual reality biofeedback, and who knows what the brain might be capable of. Neurologists have already confirmed that there are more possible variations of neuronal interconnection in one human brain than there are atoms in the universe. And all these connections have proven to be intrinsically capable of learning. It's clear that not only have we just scratched the surface of an unprecedented tool for learning—as we develop and perfect this tool, we're going to have to decide what our species wants—and needs—to learn. This is something we will have to learn as we learn how to use the tools.

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BRAINWAVES ON MY MIND:

A Review of Personal EEG Equipment

PART ONE

by Julian Isaacs Ph.D.

EEG IS BUSTING OUT ALL OVER

With our culture's increasing interest in states of consciousness and psychotechnology to modify consciousness, more of us are thinking about buying EEG equipment to study our internal states. Low-end computer-based EEG equipment has never been so inexpensive and with the advent of cheap powerful personal computers the stage is set for an explosion of new EEG technology. Already there are some good systems available at (comparatively) modest prices and many explorers are venturing into this technology. Here, I will review and compare the *Mind Pyramid*, the *Mind Mirror*, the *BrainTracer*, the *Brain Exerciser 300*, the *Neurodata* and the *Interactive Brainwave Visual Analyser* (IBVA) systems, all available for less than \$4000. In a future companion article to this, I will to look at some more expensive multichannel systems, suitable for more demanding research or professional applications.

SOME WORDS OF ADVICE FOR THE NOVICE IN EEG

While I do not wish to deter readers from using EEG, because it is possible for intelligent lay folks to use EEG satisfactorily, there are some pitfalls which have already become apparent. It is only fair and responsible to outline these pitfalls to those thinking about buying EEG equipment, to avoid disappointment. The good news is that doing EEG biofeedback is easiest, and is definitely within the reach of the beginner, and only a few of the considerations outlined below apply to biofeedback EEG. The kinds of uses of EEG which demand the higher level skills summarized below involve trying to detect changes in EEG due to changes in the brain's processing modes - typically, trying to detect EEG changes associated with altered states.

Often, reading *Megabrain Report* or other consciousness-oriented journals, the reader is given the impression that getting valid and meaningful EEG measurements is just an easy, routine affair. Papers glibly mention that certain treatments increased theta brainwaves, or stimulated alpha, or whatever. Left out of these accounts are the skills and training that were necessary to get these kinds of results.

Some lay purchasers of EEG equipment have become frustrated because they did not know enough about the art and science of EEG to be able to use it to their own satisfaction. The equipment is blamed, and gets returned to the retailer. But the real problem was that the user was not sufficiently educated in the technology, its limitations and its techniques of application - and did not realize it. Doing basic EEG, like feedback, requires you to have the patience and understanding to learn certain basic skills. And if you want to do sophisticated things, it demands sophisticated skills.

THE REAL SKINNY ON EEG SKILLS

First, if you are using a computer-based system, you need enough computer skills to be able to install and use the software and hardware. Some systems need fairly powerful host computers, so the computer requirements have to be understood.

Second, the selection of which scalp sites to monitor requires a smidgen of brain physiology to know what goes on where in the brain.

Third, actually getting good (i.e. low resistance) electrode contacts is a manual skill (some say an art) which sure'nuff has to be learned by trial and error, mostly error. Often EEG packages do not say enough about how to prepare electrode sites, nor enough about what the implications are of using different electrode setups (more on this later). Not all packages supply appropriate site-cleansing agents.

Fourth, to "read" by eyeball what the EEG waveform is saying about the state of the person is an art that has to be learned too, yet there is usually no information given about this with the EEG systems, and no reference to this taken-for-granted skill in the literature. The art depends upon knowing what the shapes and sizes of the waves mean and in interpreting them. There are many types of waveforms, not just the delta, theta, alpha and beta mentioned in the popular literature. The same waveform display may provide much information to the expert, but very little to the lay person. To the casual glance of someone uneducated in reading EEG, waveforms taken during a period in which the person monitored went into an altered state may show no meaningful change, even though there may be differences in the EEG waveforms discernible to the expert.

Fifth, there are many sources of *artifact* in taking EEG readings, any of which can render the data invalid. These include false signals due to eye movements, blinking, head movements, swallowing, yawning, speaking, cable movements, muscle tension in the jaw and head, shifting electrode positions, bad electrical contact, tremor etc.

Sixth, EEG data can be viewed in several ways, according to the features of the software in use, and some are more revealing than others. The lay user may select an unhelpful form of visual display with which to try to "eyeball" their results.

Seventh, the common impression is that EEG changes are usually clear and immediately obvious. Not so. For some transitions, like going to sleep, the changes may be eyeballable from either the raw EEG waveforms, or from several of the possible displays. For the transitions involved in EEG biofeedback the changes are also usually easily eyeballable. But for many other changes, including many changes of conscious state, no readily eyeballable differences between in-state and out-of-state may be obvious. Partly this may be because the cheaper systems use only a few electrodes, so that not enough scalp is monitored to catch relevant differences. But more often this is

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Besides the medical model of illness repair, there is a quietly but quickly growing group of clinicians, teachers, researchers and practitioners who are exploring what works, how to make people feel good feelings. The researchers study the biology of optimism, warm feelings, hope, of feeling good. People at all levels in the health care system are using the power of the heart to light up the strength and joy within people, helping to reach their full potential.

The medical model is a dinosaur which is on the verge of extinction because it has excluded the heart and spirit--the variables which don't pigeonhole comfortably into the double blind drug dose paradigm. But an art and science is beginning to develop so we now have the beginning of a language and set of tools for using our understanding of heart and spirit in a systematic, teachable way. This two day event will combine science with technique and experiential sharing. You will leave with a better knowledge of the science of heart and spirit, with specific tools and techniques you can use for yourself or your clients, and you will leave having laughed and cried and shared and filled your heart and linked with others. You'll have skills for teaching and motivating toward the positive, not from the negative. You will know how to coach people to tap into their spiritual resources regardless of their faith. You will have learned some specific skills to make your life happier and filled with more, richer, deeper positive experiences.

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because EEG changes can be very subtle and only statistical analysis of the data would reveal differences associated with the change in state. Human beings are bad at the kind of analysis that statistics can do very well. This brings us to the point that in order to really pin down relevant differences in EEG associated with state changes, statistical analysis is necessary. If one is trying to actually prove something scientifically, statistical analysis is essential, yet none of the consumer-oriented systems come with statistical packages and most folks are not statistics literate. To do proper EEG studies one also needs a modicum of experimental methodology too.

ARE YOU LISTENING, MANUFACTURERS?

What is needed to make consciousness state research more satisfying for the lay consciousness explorer would be very user-friendly statistical analysis software bundled with the EEG systems, together with some pre-configured experimental formats that the statistics fit. Let's hope the manufacturers are reading this article! Alternatively if a *Megabrain Report* reader wants to configure a public-domain stats package to do EEG analysis, be assured that a market is developing. To learn the morphology of EEG waveforms so that one can read EEG waveforms well, there are books available on EEG in university text book stores. My colleague Jay Gunkelman, an EEG expert, and myself, are developing a book and possibly a video to be an introduction to EEG techniques suitable for lay consciousness explorers. We hope this will be sold by Tools For Exploration, and we will keep readers informed of our progress.

THE MIND PYRAMID: EASY ALPHA/THETA TRAINING

Now to the hardware. I will first review the Mind Pyramid and the Mind Mirror III because they are both stand-alone systems, needing no computer. The Mind Pyramid (\$1395) is an alpha-theta feedback system. Very recognizable, its cabinet is shaped like a pyramid - Lord knows why. Professional users tell me its shape makes it hard to use with credibility in corporate settings. I believe it! That said, the system is a good one, with the easiest electrode setup of any EEG system anywhere. Power is delivered from an AC adapter, although one could configure a battery supply. The electrodes take the form of two strips of soft, woven stainless steel "cloth" embedded in a soft (real) cloth headband bearing one earclip. One simply dampens the two stainless strips with tap water, then gently wraps the headband around the head so as to position the two strips equally either side of the center line of the forehead, then rubs an earlobe with a damp napkin and applies the earclip. The back of the headband fastens with Velcro. This is VERY easy and takes about 10 seconds - wonderful.

Much deeper levels of surrender are necessary to obtain both the alpha and theta tones "on."

Equally easy is the selection of settings. The Mind Pyramid supplies one chirp or cricket tone for alpha above a predefined threshold and an additional chirp or locust tone for theta above a predefined threshold. There are three "difficulty" (amplitude) settings for the thresholds - from easy to hard - for both alpha and theta (they can't be adjusted separately). There are also three volume levels for the audio feedback. There is a miniature piezo speaker giving public audible feedback (not very loud but enough) and a headphone socket (mono). There are two vertical LED VU-meter type displays, lighting one column of red LEDs for alpha amplitude and one column of green LEDs for theta amplitude. Since it is impossible for beginning or even intermediate alpha trainees to do alpha with eyes open, the columns are more for public consumption than useful for trainee feedback. Much more useful are the pair of clock displays

giving the number of minutes and seconds the trainee was above threshold during the session. By dividing that time by the total session time a "percent time above threshold" figure is easily calculable, which is quite a good measure of facility at alpha production. The clocks are resettable.

Despite its simplicity in use, the Mind Pyramid is sufficiently full-featured to be counted a good machine. It has both EMG and bad electrode contact detection, good features in an EEG trainer. If the EEG electrode contact is bad, a special light is shown and feedback inhibited. If signals from the facial/scalp muscles are too high, another signal is given and the feedback signal is also inhibited. Thus the two bugaboos of EEG training are handled well. If you want a good alpha-theta feedback system which is very quick to set up, clean in use (no electrode gel) and a no-brainer to use, this is it. But in return for operational simplicity, as always, one loses flexibility. The filter characteristics to detect alpha and theta are fixed. Typically one would set the filters to pass successively lower frequency alpha as training progressed. But it is not possible to "shape" alpha response in this way with the Mind Pyramid.

Finally, is it really worth the \$1395 price, given that there are cheaper feedback systems on the market? In using the system it is clear that it achieves its purpose well. I have used it myself and have also run a number of people on this machine. The addition of feedback for theta makes it much more effective, because much deeper levels of surrender are necessary to obtain both the alpha and theta tones "on". This makes it MUCH better than a simple alpha trainer. None of the cheaper trainers have the theta-detect feature, and the cheapest trainers usually have very inadequate filters, making them almost useless. I have achieved powerfully altered states with this device, and so have many of the individuals I have run on it.

I have achieved powerfully altered states with this device.

Recently, I participated in an intuition training cruise where I was running psychotechnology workshops and demonstrations for Tools For Exploration. Given a free choice from the entire range of Tools' EEG systems, I chose the Mind Pyramid to take with me. Why? (A) I wanted a stand-alone system because I did not want the bother of toting a laptop computer with me; (B) I knew that in the hurried and stressful conditions of doing quick demonstrations the Mind Pyramid would be far quicker and easier to set up and demonstrate than any other system; and (C) I knew that it was capable (given the right instructions to the people run on it) of producing profoundly altered states in a few minutes of use per person. My sense is that if you want a high quality simple device which is supremely easy to use and are serious about alpha/theta training, the Mind Pyramid is a good choice, assuming you have the resources to invest in it.

THE MIND MIRROR—ESSENTIAL TOOL OF THE "AWAKENED MIND" TRADITION

The Mind Mirror III is an utterly different device, coming from a unique historical tradition. Perhaps some background would be interesting. Maxwell Cade in London during the 70's wanted a portable EEG to investigate the EEGs of meditation masters and spiritually evolved persons. Geoff Blundell, an audio electronics engineer, designed and manufactured the Mind Mirror I, then the Mind Mirror II for Cade. Cade believed that he had discovered that very evolved people shared an EEG profile which he dubbed the "Awakened Mind" EEG profile. He then set about developing methods to train ordinary people, over a period of months or more, to reach and stay in the awakened mind state. The development of this

training technique is documented, although in a very frustratingly incomplete way, in Cade's book "The Awakened Mind", written with Nona Coxhead. Cade died in the late 70's but he left behind a number of practitioners of the Awakened Mind training technique, and Geoff Blundell continued to make the Mind Mirror II. Then in the early 1990's an updated version of the Mind Mirror, the model three, was developed by Neil Hancock, now resident in Texas. Another stroke of luck for us in the US was that Cade's most experienced trainer Anna Wise now lives in Marin County, California, and gives Awakened Mind trainings privately, as well as leading Awakened Mind workshops at Esalen Institute. She is slated to publish a book about Awakened Mind Training in 1994. So the tradition is still alive—her Esalen workshops have been full to overflowing.

Evidence suggests there might be a generalized EEG profile associated with extremely healthy psychological functioning.

Use of the Mind Mirror is quite different from any of the other EEGs reviewed here, because it employs "biomonitoring", rather than biofeedback. Cade's method was founded on student-trainer pairs, with the trainer looking at the Mind Mirror display and giving verbal feedback and directions to the student. The Mind Mirror has never had audio feedback, and since all but very experienced eyes-open meditators cannot produce significant alpha output with eyes open, the Mind Mirror is of limited use if you are working alone. It will replay the last 30 minutes of an EEG session, but this is certainly not "immediate feedback". If you have a friend interested in doing the training, you could take turns at being student/trainer.

The Awakened Mind tradition specifies a developmental sequence of EEG profiles and specific meditational and other means for the student to progress up the hierarchy of states to the Awakened Mind. The Awakened Mind profile requires that the individual produce a certain ratio of beta, alpha and theta most of the time, that the beta not extend to high frequencies, and that the EEG should show fairly equal amplitude between the hemispheres for all frequencies. Conceptually, one could interpret the Awakened Mind profile to mean that the resources of the conscious, preconscious and unconscious minds are available at all times, together with a calm, non-anxious state.

This prescriptive schema poses the fascinating question of whether there are indeed reliable EEG correlates of "higher" overall functioning which apply validly to everyone. More research is needed to answer this question definitively. But, despite the large individual differences in EEGs of "normal" folks (some 25% of whom have no dominant alpha rhythm, by the way) we know that there are age-dependent EEG norms for the healthy population, and that these norms are different from those established for brain dysfunctional conditions (such as ADD, stroke, depression etc). Correcting the dysfunctional EEG profiles towards the norm is the principal goal of the discipline of remedial neurofeedback, which is now showing enormous promise. This evidence is thus suggestive that there might be a generalized EEG profile associated with extremely healthy psychological functioning.

THE MIND MIRROR: WHAT YOU GET

Now to the hardware. The Mind Mirror III (\$3500 plus S/H) comes with all electrodes, leads, gel, etc. and is packaged snugly inside a sturdy foam-lined aluminum carrying case. The electronics are mounted in a slope-fronted plastic box different from the two earlier models and the system uses an onboard computer for digital filtering and all other functions. It is powered with alkaline cells,

instead of the previously used rechargeable gel cells. The display is a small LCD screen of about 2.5" by 3.5," now backlit. This display is therefore completely different from the larger moving LED displays of earlier models, and not so good. While it is possible for one or two people to read the screen together, for display to a larger group it would be better to invest the additional \$395 to get the optional fiber optic link and software to interface to an IBM PC or compatible via a serial port (COM1 or COM2). The link and software permits the user to display the Mind Mirror pattern on a color monitor, unfortunately only in CGA resolution, even on VGA monitors. The display consists of 28 horizontal bars, 14 on each side of the display, each bar representing the amplitude of the EEG in a given frequency band. For each hemisphere there are 14 bands, starting at the low delta frequency of 0.75 Hz and ending at the beta frequency of 37.5 Hz. The crucial point to grasp about the Mind Mirror is that it presents a real-time spectral display, showing the distribution of EEG amplitude between frequencies for each hemisphere. The software with the optional fiber optic link allows EEG session data to be collected in IBM-compatible files which can be stored and replayed.

A bipolar electrode configuration will tend to greatly underestimate synchronous alpha amplitudes.

The electrode system is very similar to the original Mind Mirror setup, and deserves a word or two of comment because the issues it brings up are generic to EEG in general, and we will run into them in reviewing the BrainTracer and Neurodata systems, so these issues are usefully reviewed here. One of the confusing things to the lay user of EEG is the choice of electrode configuration and the choice of electrode placement. It is worth understanding these issues because they materially affect both data collection and the inferences which can be made from EEG data.

OF ELECTRODES AND PLACEMENTS - MONOPOLAR OR BIPOLAR?

EEG amplifiers have the enormously difficult task of extracting a few tens of microvolts of EEG signal from millions of microvolts of AC hum and electrical interference, etc. The signal sought can thus be hundreds of thousands of times smaller than the interference, requiring sophisticated electronic techniques—one of the reasons EEG devices are usually not cheap. To do this rescue job, nearly all EEGs employ a special kind of interference-canceling amplifier in their front end circuits. These are called differential amplifiers. These amplifiers have the characteristic that they each have two inputs and the signals on the two inputs are subtracted from each other. So if the EEG has two channels, as the Mind Mirror does, then there are a total of four inputs to consider. The way the interference canceling works is that for each amplifier, the AC hum on one input wire is subtracted from the AC hum on the other input wire, reducing the hum input by thousands or more, but amplifying signals which are different on the two input wires. So far, so good.

But there are two ways of configuring the resulting electrode system—one is the monopolar way, the other is the bipolar way. The monopolar way is to take one of the inputs and place its electrode over an electrically "neutral" place on the head—typically on an earlobe. This is then termed the "reference" electrode, because the input of the other electrode of the pair is then "referenced" to the earlobe electrically. The other electrode is then placed on the scalp over electrically active brain tissue, and is conventionally termed the "active" electrode—although "reference" and "active" really apply to the SITES, not to the amplifier inputs or electrodes, because these are identical, electronically speaking. If there are two channels in the

MEGABRAIN REPORT

EEG, for ease of use and simplicity, the reference electrodes from both channels are usually joined together and placed on the same earlobe. Often, a wire will then be used to link electrodes from both earlobes to the reference inputs. This produces the standard monopolar setup "referenced to linked earlobes", with both references joined and electrically tied to both earlobes, and the two free-ranging "active" electrodes being placed on two active scalp sites. This has an upside and a downside. The upside is that signals in each channel really are coming from the scalp site under the active electrodes, and we get true readings from this system, unlike the bipolar configuration described below. The downside is that for each channel of the EEG system, we only get input from one electrode site.

The combination of the physically small EEG hardware and a laptop computer gives you a physiology laboratory in a briefcase.

The bipolar system is different. With the bipolar system, BOTH electrodes from each EEG channel are put on active scalp surfaces. This has the upside that with a single EEG channel, because of the double input, two sites can be monitored. With the Mind Mirror, which uses the bipolar placement, the sites monitored are on the Occipital and Parietal lobes. This means that more scalp gets monitored than using a monopolar electrode configuration. But the downsides are significant. First, we can't tell which of the two electrode sites used for each channel are producing the observed output, which may be important. Second, because signals present on both electrodes get subtracted, any EEG signals common to both inputs will be removed, or greatly reduced in amplitude.

Now one of the treasured entities of EEG training is "synchronous alpha", where identical alpha brainwaves are present over all, or large regions, of the scalp. A bipolar electrode configuration will tend to greatly underestimate synchronous alpha amplitudes, because the inputs to each of the two electrodes of each channel are identical, or nearly so. So far, no-one has carefully compared the Mind Mirror's alpha amplitudes measured with its original bipolar electrode configuration with amplitudes obtained using a monopolar electrode setup. We do know from the EEG literature however, that alpha amplitudes do tend to be depressed when bipolar electrode setups are used, compared to monopolar. Alpha gets more synchronous as amplitudes increase, so the Mind Mirror probably does underestimate alpha, especially high amplitude alpha, but it will also underestimate any synchronous signal, whether theta, alpha or beta.

The Mind Mirror's electrode system is quite good, silver cup electrodes are embedded in plastic disks which are secured to a perforated headband by the snaps on the electrode lead wire terminations. The lead wires are woven into a nicely constructed braid. The cups have soft plastic foam cylinders put in them. In use the plastic foam cylinders are gelled and then the electrodes slipped into scalp contact. This system is relatively easy to use, with a little practice, and produces acceptably low resistance contact.

THE CONTROVERSY OVER DELTA AND THE MIND-MIRROR

Professionals in the field of EEG criticize electrodes mounted on headbands as liable to movement, which produces low frequency artifactual signals in the delta range. Professionals usually discount most delta EEG outputs, unless the monitored individual is asleep or has a brain injury or disease of some sort. Interestingly, the most controversial aspect of the Mind Mirror in use is that with some individuals it records very high levels of delta in the WAKING state, which are interpreted by practitioners of the Awakened Mind system as being evidence of psychic func-

tioning. In my session as the trainee with an Awakened Mind practitioner, substantial delta readings were obtained, much larger than with any other EEG system I have used. My signals were interpreted as being evidence of psychic functioning. I reckon I am as psychic as the next person, but I still remain unconvinced that the delta signals registered by the Mind Mirror are real and not artifacts. If the Mind Mirror allowed observation of the raw brainwaves, identification of artifacts would easily be possible. As things stand, only careful research will clarify this situation.

Despite the possible problems of interpreting its delta outputs, the Mind Mirror does have the advantage that it has a long history of use, and a "culture" of usage has grown among Mind Mirror practitioners in the US and England, scattered though they are. Undoubtedly it is an essential tool for the Awakened Mind training process. But if we try to use it for other purposes, the system has some very restrictive limitations. First, as mentioned above, it cannot display raw EEG waveforms. This is important because only by checking the waveforms can we be really certain that signals are not artifactual, and it is impossible to "read" the raw waveform to estimate the state of the person monitored.

Second, the software with the fiber optic link is primitive and very user-unfriendly. It crashes easily if the operator hits a wrong key. The instruction book is confusing and unclear and does not do a good job of describing the software functions either. The only way one can view past sessions saved as files is to page through the bar-graph screens one by one. This is a really limiting feature because there is no way of viewing the EEG data where a whole session, or a substantial part of a session, can be displayed on one screen. These limitations are partly a result of the device being developed before there was a reasonable market for it, so that the costs of development of better software could not be sustained. But they do limit its applications for serious research.

Why would one buy a Mind Mirror? It's more expensive than the other systems, yet it has none of the software sophistication of, say, the Neurodata. But if you need a battery-powered stand-alone system for use in the field, it is definitely a viable choice. In its stand-alone mode it is MUCH easier to use than a computerized system, and it does, after all, give the all-important EEG spectral information. If you want to do Awakened Mind training, as student or practitioner, it is THE system to use. It is the only EEG system to be developed specifically with self-improvement in mind, and the Awakened Mind training system does seem to work, although it has not been formally validated or even investigated. Finally, its manufacturers are really nice people and very willing to support their product and help in any way they can.

BYTE-ING THE EEG BULLET: COMPUTER-BASED EEGS

We now come to the computer-based systems. Using a computer to collect, store, display and analyze EEG data makes a lot of sense. The combination of the physically small EEG hardware and a laptop computer gives a lot of power in a small space—this way you can have a physiology laboratory in a briefcase. Laptops allow one to use the system away from the AC supply, and using supplementary large capacity rechargeable batteries to power the laptop greatly extends possible EEG run-time and is not difficult to arrange. All the systems reviewed use a serial port to input data (COM1 or COM2) and all are battery powered. All these EEGs have a ground electrode in addition to their active and reference input electrodes. The ground is not used for signal input but is used to tie the EEG electrically to the user's body. All the reviewed systems provide very low noise inputs and sufficient amplification to do the job properly.

THE BRAINTRACER: A LOW-PRICE HIGH QUALITY SYSTEM

The BrainTracer is a two channel system (for IBM and compatibles) manufactured in Holland and costs \$1099 plus S/H. It is the lowest priced computer-based EEG available. Apart from the electrode system, which may be upgraded soon, this is a very nice system for the price. The hardware consists of a small unit roughly 6" by 4" by 2"—about the size of a medium-sized paperback book. The electronics inside look good. The software is very easy to install, menu-driven and user-friendly. The graphics are well designed and have a very good visual appearance. There is an instruction book which covers the basics moderately well but leaves out some of the more detailed aspects of actually using the device, particularly details of setting up the biofeedback parameters. This system has modest computer requirements and will run on any IBM compatible from a 16 MHz 286 upwards. Only 1 megabyte of memory is needed, together with a VGA display and one serial port for data input. The BrainTracer's 8 internally located "AA" cells provide about 25 hours running time.

The basic display is of two streams of raw waveform. A third waveform can be displayed to show the coherence between the two channels. The fixed sampling rate is 128 samples/sec and resolution is 8-bit—this is not high precision but is good enough for most purposes. The time to write each screen of EEG waveform tracing can be selected from 2.5 seconds to 10 seconds. A software-selectable digital AC line-frequency filter is available to provide a final cleanup for the raw waveform. Amplification of the waveform is fully adjustable and provides a good clear waveform for visual inspection. For biofeedback purposes, biofeedback tones are only available when the "averager" display is shown. Two averages for each channel are displayed, one being the average for the last 10 seconds, the other being the average for the total run time in session. Two audio biofeedback options are given, one for a single user-selected frequency band, the other for two user-selected frequency bands. The audio options for feedback can be expanded from basic beep tones conveyed via the PC speaker to musical instrument tones if the user installs a SoundBlaster compatible card (8 or 16 bit) or MIDI card. All biofeedback options can be applied to either channel singly or both channels combined.

There is also a "Mind Mirror" type of spectral display available, so that mind mirror type readings can be taken. BUT here again we run into some of the technical considerations outlined earlier. The BrainTracer joins the two reference inputs of the two channels, so that if used in bipolar mode, it has only three input electrodes (a common reference and two separate active electrodes). This means that it cannot possibly measure exactly what the Mind Mirror measures, because the Mind Mirror, having two separate reference electrodes, can measure outputs from both occipital lobes independently, whereas if you try to use the BrainTracer in a mind mirror type of electrode configuration, the presence of only one reference electrode means that it must be placed in the center of the occipital area (PZ position), summing the outputs from both occipital lobes. This means that asymmetries in occipital lobe outputs between left and right hemispheres will not be detected, quite a significant limitation. As a monopolar device, the BrainTracer is fine, and the joined reference wire would then be connected to an earlobe electrode or linked earlobes.

WHAT YOU SEE IS WHAT YOU GET: VISUAL DISPLAYS FOR REVIEWING EEG DATA

There are several methods in common use to display recorded EEG data in ways so that visual inspection can be used to accurately assess changes in EEG over a recorded session. One way is to page through the raw waveform—helpful for expert eyes to "read" the state, but of limited use for the beginner and in its reliance on human memory to link earlier epochs with later ones. For the non-expert eye, a better display for longitudinal data is to show "trend

graphs"—graphical line representation of delta, theta, alpha and beta amplitudes during the EEG session. The third technique is to show the spectral output of each recorded epoch, or averaged epochs, as a "compressed spectral array" (CSA) or "waterfall display" as mentioned earlier. The CSA looks like a topological map of hilly terrain, the peaks representing the highest amplitudes. Frequency is usually measured left-to-right (low to high) whereas time is shown front (earlier) to back (later). The CSA can very clearly indicate state changes in arousal level. For example in the transition to sleep, the reduction in high frequencies and alpha, and the onset of theta, can be very clear. The CSA is also particularly useful for showing the effects of brainwave driving such as supplied by a light & sound device, the EEG peaks of the driven frequency trending across the frequency domain like an obliquely angled mountain range as the light and sound device's program slows the light flicker frequency.

The BrainTracer records data in RAM and this is written as a file to disk when the data is saved by the user. In reviewing the data, the raw EEG waveform can be viewed, page at a time, and a good CSA display is available, but only for recorded data, not in real time. There is no trend-graph display either. Maybe future software upgrades will include this feature. The BrainTracer will also export data files in a format which the spreadsheet program LOTUS 123 will read, which is a useful feature for serious researchers because it allows statistical analysis.

HOPE FOR THE FUTURE? A NEW ELECTRODE SYSTEM FOR THE BRAINTRACER?

The only really deficient feature of the current BrainTracer is its really bad electrode system. The manufacturer is very responsive to feedback, but so far he has not provided an adequate electrode system, although even now there ARE ways around this problem (which I will mention) and I am informed that the electrode system will be upgraded very soon. The current electrodes (March '94) are silver-plated pre-gelled stick-on plastic electrode strips. It is almost impossible to get adequately low resistance contact with these and the "bad contact" warning light on the BrainTracer shows this up. The manufacturer supplies a kind of Velcro "rasp" to clean the skin, but this is not very humane if you are doing much EEG on an individual. I have drawn blood using this thing on myself! Most restrictively, the present electrodes are only usable on non-hairy parts of the head so that it is recommended that the bare areas just above the ears be used for the active electrodes, with the reference on the forehead. This is a bad setup, because forehead electrode sites are subject to huge amounts of low frequency artifact from the facial muscles, eye movements etc, giving a confusingly artifacted EEG (the BrainTracer has no adjustable low frequency filter). Most EEGs using only a few electrodes place these in central or parietal positions to get a good idea of overall EEG. Neither of these positions are available using the electrode system as supplied, and the above the ears position is also subject to muscle artifacts.

The solution is to buy a supplementary electrode system and a proper EEG scalp cleanser such as "New Prep." Several purchasers of the BrainTracer have bought Mind Mirror III electrodes, headbands and cables. If you are at all handy with a soldering iron this is a very easy solution and not too expensive (about \$100). The interface for the electrode cables is very simple (small banana sockets). The Electrode Shop ((800) 537-1093) may also have some solutions. However, I have a sneaking suspicion that the BrainTracer will have its electrode system upgraded very soon, maybe even by the time you read this.

Finally, an overall evaluation. For low-price value, the BrainTracer cannot be beaten. A Mac version will be out in late Spring of this year. While it does not offer the fully professional features of the Neurodata, it sets a new standard in lowest price computer-based EEG. The manufacturer is constantly innovating and will be introducing new, non-EEG physiological systems soon. With its new soft-

MEGABRAIN REPORT

ware, out in March, it will be possible to run two BrainTracers together, giving four channels. This is a good EEG and the problems with the electrode system should not deter users from investing in it.

THE BRAIN EXERCISER 300: A HACKER'S SYSTEM

The BE 300 displays a curious combination of power and amateurishness. It is a four channel system. The BE 300 is packaged in an amateurish way. Its saltwater-using fiber electrodes have an ungainly appearance but they work quite well. There is no raw waveform display, a considerable weakness. The software is user-unfriendly and makes little attempt at graphical niceties. The instruction book, as it was during system review several months ago, leaves much to be desired. Yet here is a four channel system with a wealth of highly analytical displays, including detailed synchrony displays, and feedback, graphical representation of single hertz frequency slices and quite complex audio feedback possibilities, all for the modest price of \$1600. There is good data collection and ASCII file export for statistical analysis. The system is available from Adam Sundor (see address at end of article). If you are a computer-competent hacker with no fear of plowing through convoluted software and no care for physical appearance, but want functionality, then this is the cheapest solution to four channel EEG. If not, read on.

THE ROLLS-ROYCE OF SMALL EEGS: ENTER THE NEURODATA

The Neurodata is a wonderful machine. If you want to make your reviewer happy, buy me one right now! They are only \$2995. The secret of the Neurodata is that its functional design was created by a biofeedback clinician, Dr George Fuller Von Bozzay, rather than an engineer, so the design is oriented towards real clinical usage. And it shows—this machine blows away the competition. The hardware is manufactured by the J & J company—well known in the biofeedback world. Russian programmers created the software, written in machine code so it's very fast—one more product of the end of the cold war. It's IBM compatible only.

In addition to two EEG channels, the Neurodata sports two other physiological channels, EDR (GSR—skin electrical resistance) and TEMP (temperature). One EEG channel can even be used as a low frequency EMG (electromyograph—muscle tension monitor). While most EMGs monitor bands in the higher frequencies (in the range from 100 Hz to 1000 Hz, depending on the device), research has shown that in fact, peak EMG output of fatigued muscles is much lower, around 17 Hz in the beta range. Thus in one of its configurations we have a device which will monitor 1 channel of EEG, 1 channel of EMG, 1 channel of EDR and 1 channel of TEMP. These are the classic physiological measures used in biofeedback to monitor relaxation, and would be adequate to monitor the state of individuals undergoing a relaxation procedure—ideal for low-budget but serious consciousness research.

The Neurodata currently has an upper frequency limit of 35 Hz and a lower limit of 0.5 Hz, together with a software selectable low frequency filter which is normally set to remove all delta below 2 Hz. For the technophiles, the maximum sampling rate is currently 128 samples/sec although a new model will sample from 512 samples/sec to 4 samples/sec. It has 12 bit resolution and the Butterworth digital filters have slopes of 60 dB/octave. It is physically a bit smaller than the BrainTracer and its 9 volt battery lasts 100 hours. There is even a battery-reading feature so you can check the state of the battery. It comes with a complete set of electrodes, leads, electrode site cleaning agent and electrode gels etc. The instruction manual is the only deficient element, not being sufficiently complete. However, the user friendly menu system allows the user easily to work out undocumented aspects of the system and there is a free 800 number telephone support line if you're still puzzled.

Because the software is so powerful, the system is somewhat demanding of computer power and requires two serial ports (one

for a mouse, one for EEG data input), at least a 16 MHz 386DX with an installed math co-processor and at least 2 Megabytes of RAM (better 4 Megs), a VGA monitor, and a mouse. These days you can get a 386 mono VGA notebook with coprocessor for around \$900 in the Bay Area. The software looks prettier in color, but this is not necessary for operation. This system gives you a lab in a briefcase and is ideal for the professional, the serious amateur or the researcher. The software is very user friendly and the system uses a Mac or Windows-like GUI (Graphical User Interface). Operation is easy with a mouse, you just point and click on the pop-down menus. The graphics are excellent, the opening screen allows you to start an application within very few seconds of switching the system on. Recorded data can be viewed in a number of ways. Raw waveform is available, as are trend-line graphs and real time and recorded CSA. There is even a quasi-Mind Mirror type of spectral display.

EEG POWER TO THE PEOPLE! NEUROFEEDBACK FOR THE MASSES?

Best of all, the software comes loaded with a big variety of clinical protocols, including, among others, protocols for attention deficit disorder (ADD), hyperactivity (ADHD), epilepsy and the Peniston alpha theta training protocol for self development or treatment of alcoholism. The protocols are like preset clinical procedures which tell you what to do and how to do it. There are informational help screens for all the protocols. The ADD program comes with several games, so that treatment of children down to about 5 years of age becomes possible. This is a great little system for biofeedback professionals.

If I had a child with ADD, a relative with grand mal epilepsy, or a senior with stroke or with pre-dementia failing mental functions I would be very tempted to buy this system (maybe with the addition of dietary and CES treatment for the seniors). With appropriate reading and training it's possible to treat ADD and several other disorders very successfully with biofeedback, even some head injuries. In fact this is really the first system that puts the hitherto very expensive resources of neurofeedback into the realm of the consumer.

But if you are going to do this, make sure that you get enough training and support to be able to perform your task correctly. There are pitfalls that the professional will know how to avoid. The manufacturer holds training seminars. Other educational institutions such as the Menninger Foundation also run neurofeedback seminars. While neurofeedback is not a magic wand, I am certain that we will see many brain deficit conditions becoming successfully treated—Len Och's work in this area is an exciting portent of things to come. (see his article elsewhere in this issue—Ed.) Even for "normals", going through the Peniston protocol may be a rewarding experience.

The Neurodata is well set up for alpha training, alpha synchronization training, theta training etc, and of course can also be used for skin temperature training, muscle relaxation training and GSR relaxation training. The feedback contingencies can be specified by the user and complex feedback contingencies are possible. The system can drive an Adlib or SoundBlaster musical output and will export ASCII files for analysis. It can accommodate up to 6 active display windows at one time, and provides very good visual monitoring for the person using the system. The audio feedback allows use for biofeedback by a single person.

The electrode system is excellent. The basic electrode set consists of several modules. One unit is for hand attachment. This has two finger electrodes for EDR (electrodermal response-skin resistance), together with a thermistor temperature sensor and the ground lead. The other units provide EEG electrodes. The common reference (like the Brain Tracer the Neurodata puts both reference leads together as one wire) can be placed on the mastoid process (the bare bone behind the ear) and the two active electrodes are then applied to suitable

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Neurodata I

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IBVA

For Macintosh only, this unit provides a unique easy-to-use wireless headband transmitter that eliminates the inconvenience of being leashed to the base unit. Japanese-designed, it outputs information through Apple's Midi Manager to control other software or hardware with brainwaves. 2-channel system. (NT401) \$2295.00

Mind Mirror III

The latest generation of the legendary Mind Mirror is still a stand-alone device. The unique display enables rapid recognition of brain activity across a complex range of parameters -- R/L activity broken out clearly across 15 separate frequency bands including an EMG channel. LCD display, automatic recording of the most recent 30 minutes of data, and DOS computer communications in real time with optional fiberoptic cable. Comes with batteries, all leads, electrodes and carrying case. (NE610) \$3,500.00

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scalp sites. The electrodes are silver and New Prep skin cleanser is supplied, together with "10/20" adhesive electrode paste. This latter is a great product, much better than previous self-adhesive electrode pastes because it provides just the right amount of "stick" and yet cleans off easily. With this system, you can put electrodes anywhere on the scalp, with no headband to worry about.

Overall, the Neurodata is a great new tool for a myriad of different applications. It's easy to use, small, very powerful and very flexible. It's easy enough to use for beginners to employ it for self-improvement using biofeedback. Within the limitations of 2 EEG channels it's good for clinicians and researchers of all degrees of expertise. If you are looking for a really good system of professional quality that's incredibly convenient to use and very low price for the features, this is your system. Wish it was mine!

"LOOK NO WIRES MOM": RADIO-EEG FOR THE MACINTOSH FROM THE IBVA

The IBVA is the only Mac system reviewed here and your reviewer must confess to less experience of operating Mac systems than IBM. The IBVA's advertising literature makes much of its ability to control the Mac MIDI manager, giving musical outputs. Performing artists use the system and it is intended for use by a variety of users, including lay consciousness explorers, researchers and for simple biofeedback applications. The unit is relatively inexpensive, \$1295 for a single channel, \$2295 for a twin channel device. The twin has two single units on one headband. EEG data resolution is 8 bit and the sampling rate is 120 samples/sec. The upper EEG frequency measurable is about 50 Hz, lowest frequency is about 0.5 Hz. Minimum computer requirement for the single channel device is an LC3 with 5 Megabytes of RAM, and 80-Megabyte hard-drive. For two channels this rises to the Quadra 650 with 8 Megabytes of RAM and a 120-Megabyte hard-drive. The electronics and appearance are fully professional.

IBVA is very convenient to use because it is very small and has no EEG leads. The signal from the headband-mounted amplifier unit is sent to the computer by high frequency FM radio waves—the head-mounted unit is a miniature radio transmitter. A small receiver plugs into the Mac's modem or printer port. This avoids wires, but despite probably correct assurances by the manufacturer that the level of radio radiation is so low that it's harmless, with the recent opening of the can of worms relating to induction of brain cancer by exposure to radio frequency radiation, this reviewer would be cautious about prolonged exposure. However, a cable system can be supplied as an optional extra, through which the signal can be routed.

As supplied, the EEG electrodes are integral to the headband unit. They are actually mounted on the back of the unit which faces the head. Without the optional extra electrode setup it is only able to pick up EEG signals from the forehead. While this is ok for alpha training, for more general or broad-band analytical purposes where you wanted to read all frequency bands, this is a very restrictive limitation because the forehead is about the worst spot on the head for eye and muscle artifact, giving huge delta frequency artifacts, which were in fact observed during use. This system might generate beta artifact from muscle movements too. To be fair to the IBVA there is an eye-roll filter and if EMG outputs get too high there is warning. But since the IBVA Technology corporation will supply alternative electrode sets allowing pickup from any scalp site, if you do want that freedom, it is available. The very portable nature of the "look no wires" telemetry system does allow monitoring in situations which preclude normal EEG monitoring. It gives the person monitored a freedom of movement which must make this system attractive to many Mac users. This might also appeal to some researchers.

The primary displays are of the raw waveform and a real-time CSA, called "FFT" by IBVA. Somehow I was not impressed by either of these displays. Quite possibly it was the Mac system I used for the review, or maybe it's my eyesight, or maybe it's the IBVA, but the waveform display seemed somewhat dim and low contrast, giving

an impression of lack of clarity, although I suppose one could get used to it. To be frank, the CSA display was one of the worst I have seen. What surprised me was that although normally CSA gives one of the very best visual readouts for EEG, this display actually managed to obscure the data, with really bad graininess and a bad algorithm in use to smooth the surface displayed, making it seem fuzzy and very difficult to "read". If one contrasts this CSA display with either that given by the BrainTracer, the Neurodata or the Lexicor Neuro-search systems, it comes off a very poor worst. Why? I thought Mac systems were the wizards of graphics display and was very disappointed. Maybe it was the Mac system used for the review. If you are interested in the IBVA go see it for yourself, because perhaps other Mac systems give superior resolution, although it certainly looked as if the problem was with the software, not the monitor—which worked fine with other software. The real time CSA was also very slow, which is the fault of the Mac system I used. Faster machines will give superior speed for the displays.

The IBVA has no trend line graphs but it can produce a Mind-Mirror like bar-graph display, with up to 16 bars assignable to different frequency bands—a good feature. These same frequency bands can be used with the Mac MIDI manager to control 16 different MIDI functions. The control is flexible, with software-selectable complex feedback contingencies dependent on both frequency and magnitude information in the EEG data stream, a very nice feature. No wonder the system is popular with musicians. Simple MIDI synthesizers for Macs are fairly inexpensive—around \$100 or so, so that by purchasing the MIDI unit, the Mac owner can get a satisfyingly flexible audio feedback system for the IBVA. Without a MIDI card, there are 6 definable frequency bands each of which can be assigned one note. Whichever is the largest signal in the 6 bands will then trigger a note, so that in practice this system will play a stream of notes, the feedback task being to keep it playing just one of the 6 notes corresponding to the frequency of the desired EEG output.

The IBVA will export EEG data as ASCII files and in Excel compatible formats, allowing analysis. Overall, the IBVA has several useful features, the wireless signal transmission, good MIDI feedback control possibilities and relatively low price, although the Mac version of the BrainTracer will provide two channels cheaper than the IBVA, but without the complex MIDI control. For Mac users, the IBVA may be a very attractive option, and IBVA Technology are genuinely interested in helping users of their equipment. ▲■●

Brain Exerciser 300:

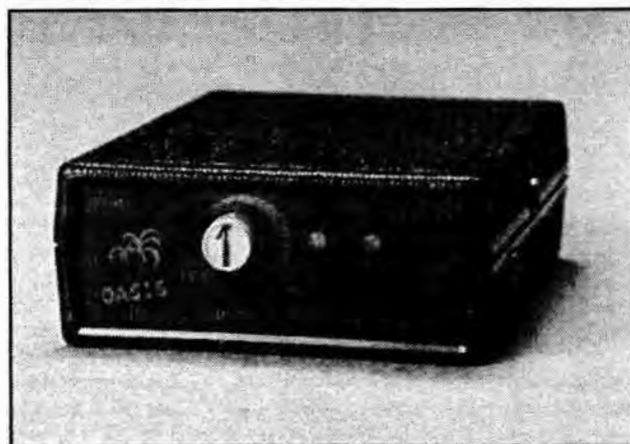
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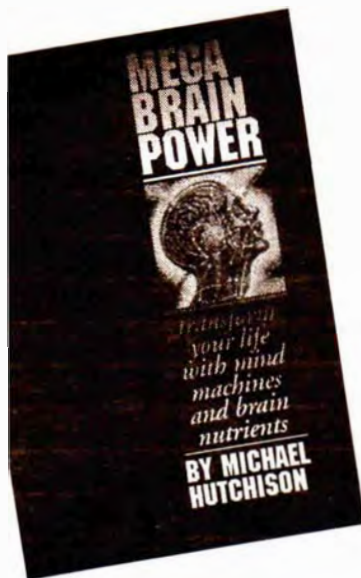
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