The following is a chapter from the book entitled: *"The Rediscovery of Audio-Visual Entrainment"* by Dave Siever, C.E.T. copyright 1997

Most people believe that brainwave entrainment (BWE) brought about by the repetitive pulsing of light and sound (audio-visual entrainment) is a new technology, however the history of brainwave entrainment through photic or visual can be traced as far back as the dawn of man. When our ancestors made a fire to keep warm, they enjoyed watching the flickering flames which led them into reverie and spiritual or mystical experiences. Michael Hutchison, author of "Megabrain", summed it up well by stating that "the knowledge that a flickering light can cause mysterious visual hallucinations and alterations in consciousness is something that humans have known since the discovery of fire." Early scientists used the comforting, mesmerizing light of the fires in their fireplaces to draw them into lucid states of mind, then commonly referred to as "reverie." They would use reverie to help them solve many of their puzzling questions regarding science, life, and the universe. Even today, people enjoy sitting by a fire, not for the warmth so much, but mostly for the relaxing effect we feel from the flickering flames. With the development of modernized home heating, few of us get the chance to gaze absent-mindedly into a fire. Only a few urbanites manage to retreat to the woods to enjoy the warmth and relaxing dance of the flames upon the logs while feelings of peace, safety and tranquility fill their minds, separating them from the hectic lifestyle of the city.

Another way BWE can be experienced naturally is from driving a car down a long straight highway at sunrise or sunset with the roadside trees casting shadows across the road. The flickering sunlight may bring about an altered state of consciousness, making it difficult to focus on the task of driving. We can also experience BWE by cruising down a highway at 60 miles per hour at night. As the bright lines flicker past us at a theta frequency, we slowly drift into a dream state and before we know it, we spot a pink elephant or other apparition standing on the road in front of us. With a quick flash of panic, we grab the wheel and hit the brakes. In the blink of an eye, we are now wide awake and quite startled and the apparition has vanished. The highway induced BWE is gone.

BWE research has been difficult to collect because of the many terms used to describe photic stimulation because there was no standardized terminology within the medical community. Brainwave entrainment, which is the term most often used today, has been known in the past as *flicker stimulation, photic driving, cortical evoked response, visual evoked response, afferent sensory stimulation, variable frequency photo-stimulation, repetitive sensory response and brainwave synchronization*. As a result, collecting all of the research relating to BWE has been difficult and time consuming.

It is important that I clarify the distinction between "cortical evoked response" (CER), and brainwave entrainment. The CER is the brain's response related to its processing a single stimulus. This "kick" of the brain occurs approximately 100 milliseconds (msec) following the stimulus, and the CER usually occurs only once, until the next stimulus. The evoked response is generally mixed with other brain activity. However, when the stimulus is repeated continuously above four Hz, the brain begins to "resonate" with the stream of stimuli and the resultant brainwave response is of the same frequency as the stimuli. The entraining brainwave occurs best at one's own natural alpha frequency (between 9 and 11 Hz). This leaves the brain little time to inject its own activity in between the continuous evoked responses, causing a decrease in all other brainwave frequencies. Depending on the waveform of the stimuli, a second or third harmonic may be seen on an EEG.

It is equally important that I clarify the distinctions between brainwave entrainment (BWE), audio-visual entrainment (AVE) and light and sound (L&S) stimulation. An L&S device flashes lights and makes sounds of some sort. The stimuli isn't designed to follow the rules of entrainment, so outside of a great light show, there may not be any neurological effects and benefits at all, just fun entertainment. AVE produces BWE by delivering pulses of light and sound in accordance with the rules of BWE. BWE as mentioned above can also be produced by nerve and kinesthetic (tactile) stimulation as well as visual and auditory stimulation, which is used in an AVE device.

With the development of sophisticated electronic physiological measuring equipment, scientists now conduct and record research to show the effects that photic stimulation has on humans. There have been countless research articles printed in scientific and medical journals on the effects of BWE since the discovery of photic driving in 1934. In efforts to better understand the brain, most

early research only observed of the physiological effects of BWE directly and not the clinical benefits of BWE. It has only been more recently that clinical research has been conducted. Listed below, is a brief summary of some of the most significant observations and discoveries that are available at the time of writing. However, continued research is being conducted on this amazing technology. For instance, since 1988, Comptronic Devices Limited has been involved in several clinical studies including dentistry, ADD, insomnia fibromyalgia and chronic pain.

Few people had considered the effects of BWE on one's perceptions, feelings, health, performance, stress levels or consciousness until the 1960's when behavior research became regarded as a recognized approach to maintaining good health. This new paradigm was brought about in part by the psychedelic drug revolution and, more importantly, the application of biofeedback which proved beyond any doubt that we could control all aspects of our visceral functioning such as muscle and arterial tone, stomach acid excretion, brainwave activity and emotions. Biofeedback soon expanded to basically anything that could be measured, and where those measurements could be "fed" back to the subject. This was a blow to the credibility of the dogmatic medical model which presumed that people could not control much bodily functioning and that pharmaceutical agents and surgical interventions were the only panacea for illnesses. Biofeedback was also of paramount importance in not only proving our control over our bodies, but it also proved that WE ARE OFTEN THE CAUSE of most of our illnesses. Hence biofeedback, psychological counselling, healthy eating, exercise, BWE and a plethora of non-drug approaches that focused on prevention rather than correction started making inroads into people's lifestyles.

BWE, although not a new concept, has been recently receiving a lot of media attention and hype. However, even today, most people have not yet heard of BWE, even though it has been around for nearly a century and it is only recently that BWE, through the use of AVE machines is making a comeback in a scientific way.

Over the years, there have been many different manufacturers of these brainwave entrainment devices available all over the world. These devices have evolved from large expensive "science fiction" looking devices to compact, easy-to-use, portable units. More and more we hear of "spas" and "Brain Gyms" and various holistic centres that are offering this technology to their clientele.

We have also documented other milestones in the development of BWE technology. We hope you will find traveling through the evolution of this amazing technology both fascinating and enlightening.

RESEARCH

The first known documented experimentation with photic stimulation was by Ptolemy, in approximately 200 AD. While spinning a spoked wheel into the sun, he noticed the apparent immobility of the wheel radius above a certain speed. He also noted that the flickering light caused patterns and colors to appear before his eyes.

It wasn't until the seventeenth century before research involving flicker stimulation commenced once again. This research examined the frequency at which individual flickering light began to "fuse" into a steady light. This ***flicker fusion phenomenon*** was first established in 1834 - 1835 by the Englishman, Talbot and by the Belgian named Plateau, whose thesis at Leige is described as a landmark in the field. They noted that healthy people could notice the flickering of light at a higher frequency than persons experiencing ill health. Twentieth century research has shown that meditators notice higher frequencies of flickering light than non-meditators.

Research into photic stimulation was of little consequence until 1895 when the illusion of colors produced by flickering light were demonstrated by Benham through his invention - the "artificial spectrum top."

A few years later, the French psychologist, Pierre Janet, at the Salpetriere Hospital noted a reduction in hysteria and an increase in relaxation when he exposed patients to flickering light delivered by a rotating strobe-wheel illuminated by a lantern from behind. The patient would stare into the strobe-wheel to receive treatment. This was the first known clinical application using BWE as a treatment tool.

In 1929, with the invention of vacuum-tube amplifiers, Hans Berger, a German psychiatrist, working in Jena, began to publish strange little pictures consisting of nothing but wavy lines showing the electrical activity made by the human brain.

The voltage of these signals ranged from 50 to 100 micro volts and at a frequency near 10 cycles per second (Hz). This was called the Berger rhythm (later termed the *alpha rhythm*). The signals appeared when the subject was at rest with the eyes closed and disappeared when the eyes were opened or during a task that involved attention. Berger's colleagues were not interested and no one took these wavy little lines seriously. And for a number of years no one even bothered repeating his experiments. Berger naturally felt hurt and disappointed.

In 1934, the researchers, Adrian and Matthews confirmed many of Berger's observations but disagreed with the origin of the Berger rhythm. They were the first to use a balanced amplifier, known today as a bipolar or differential amplifier (used widely in biofeedback). They also postulated, as did Tonnies in 1933, that this rhythm was associated with mental processes and involved a large number of neurons. (Today there is a much greater understanding of the visual cortex which is thought to consist of approximately 300 million neurons.) This was the first research showing that the Berger rhythm could be driven beyond its natural frequency by photic driving.

By 1940, James Toman performed a number of simple studies into the effects of flicker stimulation on the flicker potentials of the brain. He noted several observations and his work provided the foundation to understanding the physiological properties of BWE. He studied and recorded the percentage of time that alpha was produced with the eyes closed and the range that BWE or photic driving could be achieved above and below one's natural alpha (where BWE occurs best). Toman confirmed the work of Loomis, Harvey and Hobart (1936) which showed that people with strong alpha rhythms had a poor range of entrainment and those with little or no alpha rhythms could be entrained to a wider range of frequencies. Toman noted the BWE effects of the percentage of "on time" (duty cycle) of the stimulus and its effect on the visual evoked response. Toman also noted the importance of stimulating the eyes with a large, evenly illuminated visual field. Lastly, he observed that the cerebral frequency of stimulation seemed to maintain itself for a period of time following the end of flicker stimulation and he hypothesized that this was due to the mutual interaction of neurons. Toman also noted that stimulating in a wide, uniform visual field produced the best photic driving. Refer to Chapter 7 - *Rules of Brainwave Entrainment* for more details of Toman's work.

During the 1940's, animal BWE research was conducted by the brain researchers,

Adrian and Bartley by implanting electrodes into the brains of animals. He concluded that the system of neurons which generate the alpha rhythm is different from those involved in the evoked response (BWE).

Dempsey and Morison (1942) observed the "repetitive sensory response" in response to stimulation of the sciatic nerve (the nerve going to the legs). This proved that tactile stimulation also produced BWE.

In 1946, Walter, Dovey and Shipton introduced the electronic stroboscope to provide highly accurate information about the latency of the evoked response. They also noted some perceived psychological effects. They exposed thousands of subjects to intense flickering white light, who all reported sensations of pattern, movement and color. The descriptions varied greatly from subject to subject. For some, the impressions were particularly intense only at certain frequencies. Several subjects who had full normal color vision with steady light showed "color blind" responses (such as the red-green response seen on a color card) usually at frequencies between five and ten Hz.

In 1959, Dr. William Kroger and Sidney Schneider reported on the unusual effects of the rhythmic flashing of the dot on radar screens of ships and submarines. On several occasions the radar operators readily entered into a relaxed state of mind and others fell into deep hypnotic states while watching signals on the radar screen. They believed that these men were being visually stimulated at a frequency near the frequency the brain was producing. This prompted the construction of the "Brain Wave Synchronizer" by Sidney Schneider of the Schneider Instrument Company. Kroger stated that between 1957 and 1958, the Synchronizer had been tested on approximately 2,500 patients and subjects, some in groups and some individually. Of the 200 female subjects, they received prenatal training for childbirth under hypnosis by Dr. Kroger at the Edgewater Hospital in Chicago. Whenever the Brain Wave Synchronizer was used to induce hypnosis during the group training program, considerable time was saved. Kroger and Schneider's study also determined the percentage of subjects who entered a hypnotic state based on their level of expectation and experience with hypnosis.

In 1959, John Barrow, MD, from MIT, studied the effects of random photic stimulation on the EEG of his subjects. Barrow confirmed Bartley's earlier observations. He hypothesized that the "after-discharge," or sustained rhythm of the entrainment frequency is brought about by the brain's system which also

generates the alpha rhythm and not the system responsible for the visual evoked response.

Also in 1959, Robert Ellingson, PhD, of the Nebraska Psychiatric Institute, examined the effects of photic stimulation on 700 babies. In his study, he placed a strobe light ten inches from the babies' faces. He noted that premature babies had response times (latencies) as long as 220 milliseconds (msec). Babies born at term had latencies of about 190 msec. These fell to nearly 100 msec by 15 weeks of age with very little change into adulthood. The amplitude of the evoked response in the babies was best when their eyes were closed and probably sleeping.

In 1959, Chatrian and his colleagues at the Rochester State Hospital, utilized depth-electrode recordings to observe the brain's response to clicks in either or both ears. They observed an auditory evoked response to clicks at three hertz (Hz) or less. At click rates of 15 Hz, they observed definite auditory driving. They also noted a 10% decrease in response when only the opposite ear was stimulated. There was an 85% reduction in driving in the brain on the same side as the stimulus. This study definitely showed that most of the auditory driving was on the opposite side of the stimulus.

In 1963, M.S. Sadove, MD, Director of Anaesthesiology at the University of Illinois, reported that by using the Brain Wave Synchronizer, photic stimulation put over 90% of his patients into a trance, which reduced the amount of anaesthesia needed for surgery. Sadove believed that some day many of our drugs may be forgotten, but that there would always be a human need for hypnosis.

In 1963, C. Lewerenz, the editor of Hypnosis Quarterly describes his experience of a live demonstration of the Brain Wave Synchronizer by its developer, Sidney Schneider. He describes the setting of the Brain Wave Synchronizer facing the audience with a subject placed in front of it. Mr. Schneider conducted a six minute induction of the subject while the synchronizer was producing photic stimulation. At the end of his induction, the subject and four others in the first row near the synchronizer became deeply hypnotized. Of those four, one person was considered to be completely non-hypnotizable, but under the influence of the synchronizer, he ended up in a deep stage-four state of hypnosis.

In 1964, Van der Tweel, a researcher at the University of Amsterdam, noted that rapid on/off transitions in the visual stimulus produced harmonics of the

fundamental frequency of the stimulator as could be shown in spectral analysis. His paper demonstrated the effects of sine-wave stimulation at various depths of modulation. He reported that, in some individuals, a modulation depth too low for one's subjective awareness also produced a cortical evoked response. He also verified some of Toman's work regarding the span of frequencies that could generate photic driving.

In 1966, Bernard Margolis, DDS, published an article using the Brain Wave Synchronizer to induce hypnosis during dental procedures. He noted several advantages of BWE over the conventional dental practices. Most important, the patients required less anaesthesia, had greater control of gagging, less bleeding, and their fear and anxiety was sharply reduced during the dental procedure.

In 1972, Richard Townsend developed a laboratory device which produced sine-wave modulation of the lamps in that the lamps were turned on and off slowly of light instead of the instantaneous flashes of light that conventional BWE devices were using. He presented the problems with instantaneous on/off flashing and supported Van der Tweel's findings that sine-wave modulation of the lamps eliminated the second harmonic of brainwave EEG activity. This may be the first record of a BWE system using "goggles" with light bulbs in them.

Gerald Oster published an excellent article on the effects of binaural beats (BB) in Scientific American (1973). He showed the difference between monaural beats (MB) and binaural beats and they are perceived with respect to each other and when mixed with other tones. He demonstrated that binaural beats produced much smaller evoked potentials than that of monaural beats and concluded that binaural beats have almost no BWE value but could be beneficial in diagnosing certain neurological disorders such as Parkinson's Disease.

Also in 1973, Jo Ann Kinney and her colleagues, at the Naval Submarine Research Laboratory in Connecticut, developed a mathematical model to determine the visual evoked response (VER) at frequencies of 4 Hz and higher. They concluded that the VER was the linear addition of a single VER and its tail, based on when the next flash would occur. They demonstrated their mathematical model with a fair degree of accuracy.

In 1975, Williams and West, at the University Hospital in Wales, Great Britain, studied the effects of BWE on meditators and non-meditators. They noted that the

meditators entered a BWE induced meditative state more quickly than the non-meditators, and following BWE, were less drowsy than the non-meditators. They hypothesized that these results may be due to the fact that alpha induction was related to the neurological changes resulting from the attention skills learned by the meditators.

In 1976, Takahashi and Tsukahara, at the Tohoku University School of Medicine in Japan, published their findings on the influence of color on the photo-convulsive response (PCR). They measured the effects of white, red, yellow, blue and green photic-stimulation on the PCR. They noted that the color red at a frequency of 15 Hz was most likely to cause a PCR. They also noted that a PCR elicited by red stimulation could be inhibited by introducing low levels of blue light at the same time.

In the 1980's, Norman Shealy and his colleagues studied the effects of 30 minute sessions of 10 Hz photic stimulation. They measured blood levels of serotonin, endorphin, melatonin and norepinephrine. They noted a drop in the daytime level of melatonin and substantial increases in the levels of endorphin, serotonin and norepinephrine. Shealy's group suggested that an increase in beta endorphins is associated with a sense of well being and decreased pain. The increase in norepinephrine and serotonin and the decrease in melatonin suggested an increase in alertness. They also noted that people had better relaxation responses to AVE than from using self hypnosis, cranio-electro stimulation or "Hemi-Sync" tapes.

During the mid 1980's, Glen Solomon, MD, used a most unusual BWE approach for reducing tension headache using a Dzidra Glass. The Dzidra Glass is consisted of two liquid crystals which cast shadows on the eyes momentarily blocking light from an external light source. The maximum "flash" frequency was 3 Hz. Almost all of the muscle tension headache subjects reported complete relief of their symptoms. None of the sinusitis or migraine subjects reported any relief.

Although research on the subjective effects of audio stimulation had continued, it received little attention. This was probably because the visual evoked response could be reliably observed and recorded which was useful in providing a better understanding of the brain. This interest may also have been a result of the fascination with the visual hallucinations associated with BWE.

In 1981, Arturo Manns, et. al. published a study showing the effectiveness of "isochronic" (evenly-spaced) tones. They examined several subjects experiencing facial pain and jaw tension (TMJ dysfunction). The subjects were given isochronic tones for 15 minutes, followed by 15 minutes of EMG biofeedback (sounds of muscle electrical discharge) on masseter muscle tension, then isochronic tones combined with the biofeedback. When the subjects used isochronic tone stimulation, they experienced deeper muscular relaxation than when they practised relaxation with biofeedback. The simultaneous use of both biofeedback and isochronic tones produced the deepest relaxation. There was an overall improvement in their mandibular movements. Facial pain, insomnia and emotional tension were reduced considerably.

During the 1980's, the flood of so many different BWE devices into the market prompted a case study in Neurology by Ruuskanen-Uoti and Salmi. They documented a case of a woman with no history of seizures, who experienced a photically-induced seizure while using an "Inner Quest" brainwave synchronizer that used red LEDs. After the seizure, the woman continued to have a normal EEG. She experienced no unusual side effects and continued her life as usual. But AVE devices aren't the only products causing seizures. Children playing video games were found to be experiencing seizures, as well. A 1983 article in the Archives of Neurology by Glista and his colleagues discussed two cases of teenage boys developing seizures while playing video games. They both had normal EEGs with no history of seizures or continued problems after they quit playing video games.

In 1986, Joseph Glicksohn at the University of Tel Aviv studied the effects of photic dribing on generating altered states of consciousness (ASC). Glicksohn concluded that (1) if a driving response is not observed, and ASC will not be experienced; (2) visual imagery is not necessary to produce and ASC; and (3) the increase in alpha activity from photic driving may bring about an ASC, visual imagery or both.

In 1988, D. Siever and Dr. N. Thomas, of the University of Alberta, published research showing that persons with TMJ or chiropractic and muscle tension pain would actually unconsciously increase their muscle tension when asked to relax. This effect is known as ***dysponetic activity*** or ***bracing habits***. When given BWE stimulation using the DAVID 1, developed by Comptronic Devices Limited, their muscles relaxed deeply and finger temperature increased, suggesting that subjects

entered a meditative or alpha state. Refer to *Appendix A.*

In 1989, D. J. Anderson, of Queen Elizabeth Military Hospital, performed work on the treatment of migraine headaches. All seven subjects in the experiment experienced one or more migraine related symptoms such as: aura, photophobia or periodic vomiting. No subject had satisfactory results using drugs. The subjects were instructed to use BWE at the onset of a migraine. Of the 50 migraines recorded, 49 were rated by the subjects as being helped and 36 of the 49 were rated as being "stopped." Pre-treatment migraines lasted an average of six hours while post-treatment migraines lasted an average of 35 minutes.

In about 1990, the psychologists, Brucato and Abascal, at Mindworks International in Miami, conducted a study with the Metro-Dade Police department. They noted a reduction in the heart rate, and muscle tension. On the psychometric tests, the police showed an improvement in their coping ability and a reduction in their overall (state) and present (trait) anxiety.

In 1992, Fred Boersma, PhD, and Constance Gagnon, at the University of Alberta, published their study using DAVID Paradise devices to treat chronic pain involving three back injury subjects. They measured pain, medication used, suicide ideation, anxiety, self-esteem, hopefulness, coping ability and family stability. The results were very encouraging. Apparently, one person was taking up to 35 extra-strength Tylenol with codeine per day before treatment and experiencing a subjective pain level of "7" out of "9". After one year of BWE, he was down to two or less "Tylenol" daily and experienced a subjective pain level of "2." Refer to *Appendix B.*

In 1992, Siever conducted a study to determine the effectiveness of BWE on jaw relaxation while the jaw was opened. Siever noticed that dentists were sometimes causing damage to patients' Temporo-Mandibular Joints (TMJ) as a result of having the patients' jaws opened wide for extended periods of time during routine dental treatments. This TMJ Dysfunction can cause chronic and sometimes debilitating pain. And for many, it remains undetected and incurable. During the study, Siever measured masseter muscle tension and found it to be high during wide openings. When the jaw was opened wide while using a DAVID *Paradise* at an alpha frequency, the muscle relaxed shortly after opening and remained relaxed for the duration of the wide opening. This showed that BWE would reduce the risk of developing a TMJ problem during dental procedures.

A unique 1992 paper by Sappey-Mariner and his colleagues from the Department of Veterans Affairs Medical Centre in California on the effects of photic stimulation on cerebral blood flow and glucose metabolism as observed with magnetic resonance imaging. They used two hertz photic stimulation and observed increased cerebral blood flow. They also observed that the glucose uptake increased much more than the oxygen consumption, suggesting selective activation of anaerobic glycolysis (burning of glucose). They don't conclude if *anaerobic* (lactate) conversation of glucose is better or worse than *aerobic* conversation of glucose, only that it wasn't expected.

In 1993, Morse and Chow published the results of the effects of using a BWE device called the Shealy "Relaxmate" during endodontic (root-canal) procedures. Galvanic skin response, heart rate and anxiety levels were recorded during all aspects of the root-canal. Data was collected from three groups (1) a control group (no stimulation); (2) white light BWE only; and (3) white light BWE and music. The study concluded that using BWE during a root-canal procedure was an effective method of maintaining relaxation. Refer to *Appendix C*.

In 1993, Russell and Carter conducted a blind study on a group of learning disabled boys between 8 and 12 years of age. The children were given 40 sessions of AVE stimulation at 10 Hz and 18 Hz. The children showed an average IQ increase of 8 points on the Raven IQ test. They also showed significant improvements (<.01) in memory, reading and spelling.

In 1994, Siever conducted an informal pilot study of elementary-school-aged children with ADD. All of the children were rated by their parents, using a modified Conners rating scale, for changes in behavior and study habits. In all instances, the parents reported improvments on all of the questions asked in the study.

In 1995, Rosenfeld, Reinhart, and Srivastava at Northwestern University collected their research on BWE using red LED photic stimulation. They stimulated in the alpha band at 10 Hz and in the beta band at 22 Hz. They found that some persons entrained to the stimulus and others didn't. Whether or not the participants entrained depended on their natural baseline alpha and beta activity.

In 1995 and 1996, at the annual conferences of the Association for Applied

Psychophysiology and Biofeedback, David Noton, PhD, presented the findings of the pre-menstrual syndrome study of Duncan Anderson from the Postgraduate Medical School in London. They note that PMS is a "slow brainwave" disorder and belongs in the group of disorders including Attention Deficit Disorder, Chronic Fatigue Syndrome, and Minor Head Injury. "Of the seventeen women who completed the study, 76% experienced a greater than 50% reduction in their PMS symptoms." Noton concluded that these results reflect that BWE may be acting mostly by increasing cerebral blood flow and not so much by simply speeding up the brainwaves.

In 1996, Leonard, Telch and Harrington, at the University of Texas observed that the DAVID 1 could easily and effectively generate disassociative states. The symptoms of a disassociative disorder are generally divided into five categories: amnesia, depersonalization, derealization, absorption, or imaginative involvement (Carlson & Putnam, 1993). It has been suggested that one approach to treating people with disassociative disorders would be to induce a dissociative state in a clinical setting and teach the client to control it (Leonard et al). To determine if disassociative states could, in fact, be induced in a laboratory and to determine which method of disassociation induction would produce the most disassociative symptomatology, Leonard, Telch & Harrington (1990, not published) sampled 78 college students and assigned them to one of two groups (high disassociators and low disassociators) based on their scores on the Disassociative Experiences Scale (Bernstein & Putnam, 1986). All of the participants were given three induction conditions: in the first condition participants stared at a two-inch dot on the wall; in the second condition participants received audio and visual stimulation at 12 Hz on the DAVID 1; in the third condition participants wore the DAVID 1 equipment, but no light or sound was emitted. The dependent measure was the Acute Disassociation Index (ADI; developed specifically for this study). The ADI was administered immediately before and after each experimental condition. These researchers found that it is indeed possible to induce disassociation, in a non-clinical population, in a laboratory. They also determined that the DAVID 1 produced the most disassociative symptomatology.

In 1996, Russell reported on the effectiveness of using visual and auditory stimulation in helphing rehabilitate a four-year postaneurysm hemiplegic. Improvements were noted in central tone and truncal motor control and both sensory and motor improvements in the hands and feet including fine motor improvements for drawing and writing. In light of these improvements, Russell

speculated that entrainment could be stimulating dendritic growth. Russell's study supports the results we have observed in people with brain injury. This promises to be an exciting area for AVE in the future and deserves a lot more research and study.

In 1997, Leonard, Telch and Harrington conducted another study - this time to observe the impact of the DAVID *Paradise* on anxiety produced with dissociation. They observed that after 12 minutes of Hemistep^{TM} stimulation, all 101 participants had a reduction in their dissociation anxiety sensitivity and heart rate. Contrary to their hypothesis, they found that anxiety sensitivity proved to be a better predictor of challenge and dissociation-induced anxiety than dissociation sensitivity.

Also in 1997, Siever and Twittey completed a preliminary study in treating chronic pain using the DAVID *Paradise*. Of the twelve participants who completed the study, most had pain due to fibromyalgia, lupus, arthritis, TMJ Dysfunction and/or motor vehicle accidents. After eight weeks of treatment, the Visual Analogue Pain scale showed a reduction in pain to the $p<0.005$ level and the Beck Depression Index showed improvements to the $p<0.05$ level. This study shows the benefit of using BWE in the treatment of chronic pain. Refer to Appendix D. A subsequent study is currently in process.

For 10 weeks in 1998, Michael Joyce stimulated 30 Attention Deficit Disorder and eight reading challenged, primary school children with BWE. He used a specially designed BWE session that stimulated a beta frequency into the left hemisphere of the brain and stimulated 12 Hz into the right side of the brain, by using a patented field-independent eyeset from Comptronic Devices Limited. Joyce was able to treat 10 children at a time using a multiple stimulation system also from Comptronic. He observed substantial improvements in attention and reaction time and a reduction in impulsivity and variability. In the reading group he observed an 18 month improvement in instructional reading level and a 1/2 year advancement in grade level.