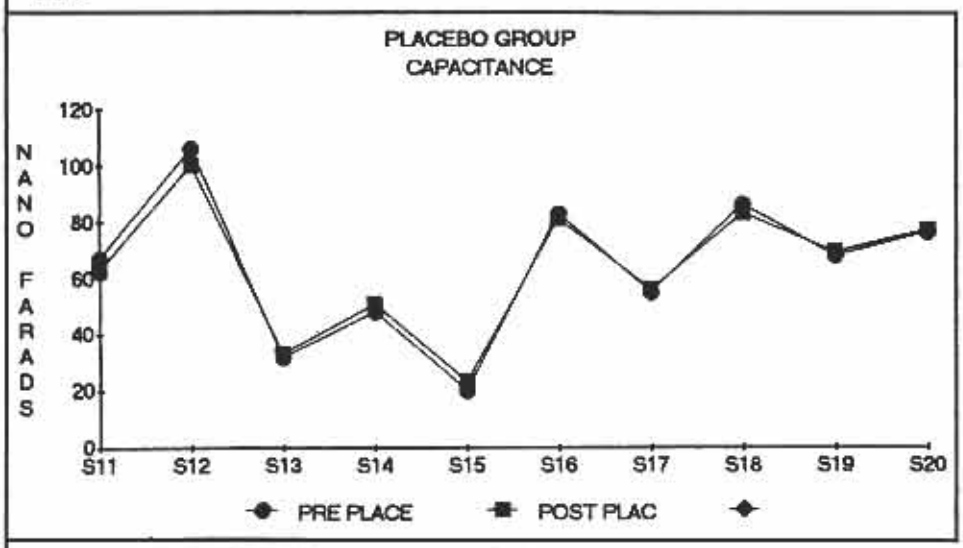
– Original Research –

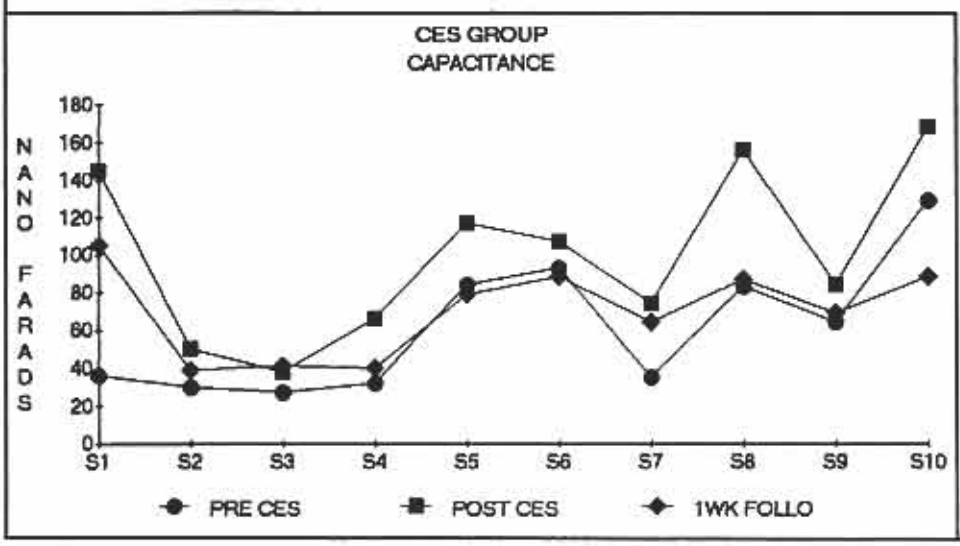
The Effect of a Single Cranial Electrotherapy Stimulation on Multiple Stress Measures

by Michael Heffernan, Ph.D.
Rockport, Texas USA

Abstract

To assess the post-treatment effects of cranial electrostimulation (CES) on basic psychophysiologic measures of stress response, 20 subjects were selected from a clinical treatment population of people seeking help for two common stress problems. 0.5 Hz CES was used for muscle tension with pain and essential hypertension made worse by stress. Because few CES studies utilize the common biofeedback measures of finger temperature, heart rate and trapezius electromyogram, these were selected to be studied before, after, and at one week follow-up from CES. Also measured as a dependent variable was capacitance to assess brain circuit paralleling. All dependent measures were found to change significantly when compared to a placebo group. The author strongly recommends CES researchers use more psychophysiologic measures of treatment effects and that some effort be made to understand neuronal path changes resulting from CES.





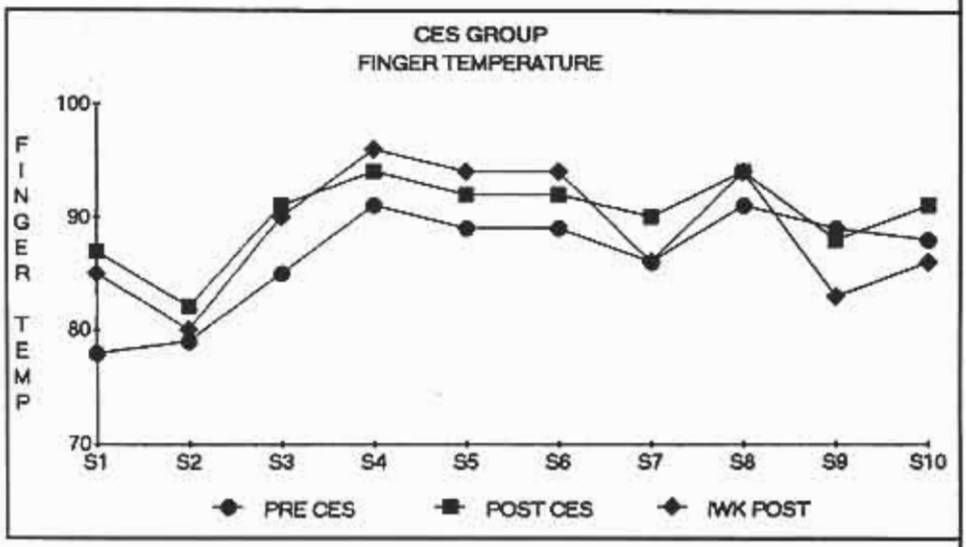
A large percentage of patient complaints stem from the somatization of patient-perceived or experienced, stress. Stress often produces an alteration in autonomic para-sympathetic, sympathetic balance, resulting in elevations in blood pressure, pulse rate, vasoconstriction in peripheral blood vessels, and increased outputs of stress hormones. In the stress response, skeletal muscle tension may rise along with central nervous system shifts toward increased EEG desynchrony, sleep disturbance, reduced brain serotonin, and eventual declines in cognitive performance (Seely, Stephens, Tate, 1989).

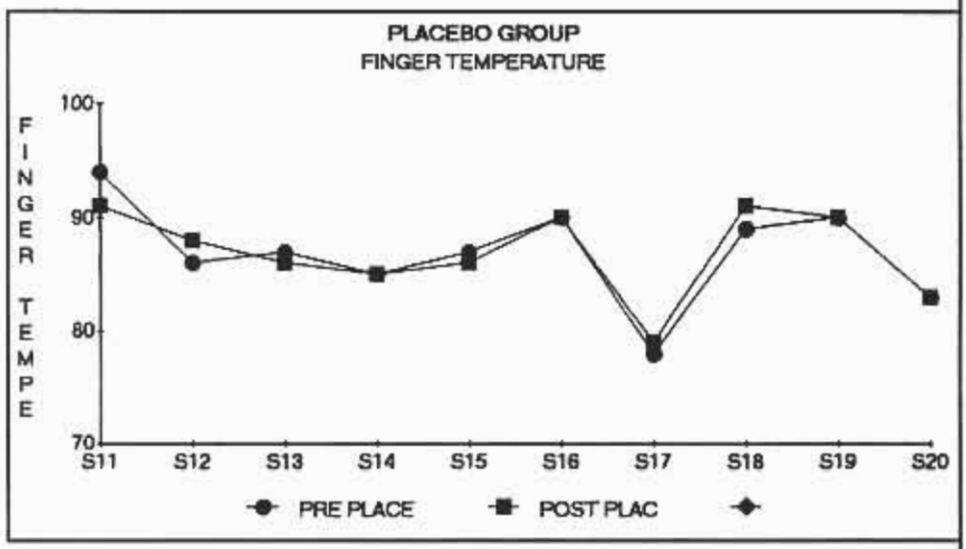
Prior work by Zimmerman and Lerner (1989) using cranial electrotherapy (CES) at 0.5 Hz, random low repetition rate, biphasic square waves, demonstrated CES lowered one component of the stress response beyond that achieved by biofeedback. Specifically, the combined use of CES and EMG feedback was demonstrated to produce a synergistic effect in lowering muscle tension levels in chronic pain patients. Other investigations using EMG measures to assess CES on stress arousal are less conclusive. Weingarten (1981) found that 15, 40-minute CES treatments lowered standardized anxiety scale scores but failed to uniformly lower frontalis EMG without feedback training. Viewing data from limited studies of autonomic variables shows some support for CES lowering sympathetic arousal. Brotman (1989), conducting one of the few double blind studies of CES effects on vasomotor tone, found CES to synergize the vasodilatory response produced by biofeedback. The study evaluated treatment effects of CES and/or finger temperature feedback in lowering vasoconstriction in a group of migraine patients. Eight sessions of each alone, and combined, demonstrated the greatest significant improvement in the combined use of both CES and biofeedback.

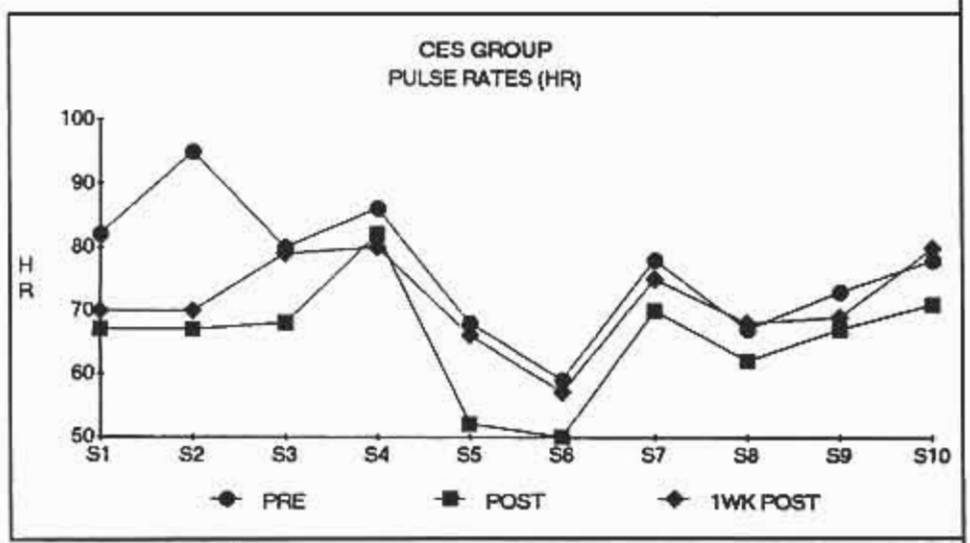
A review of CES literature shows that most double blind, well-controlled studies look at only one measure of the stress response, often in conjunction with some personality or cognitive psychometric measure. This type of research ignores the obvious clinical reality of symptom substitution and individual physiologic variability in stress responding. Each individual responds differently to stress, indeed some persons are classified as musculoskeletal responders, whereas others are seen as autonomic responders. Patients are known to often shift the target organ or system under stress at differing times. For this reason the current study will view the effect of CES simultaneously on two autonomic measures (heart rate, and finger temperature), and on EMG as a musculoskeletal component of stress.

Another shortcoming of current psychophysiology investigations of CES is the failure to assess a single trial treatment effect of CES. The majority of CES studies use several regularly spaced multiple treatments with CES. This study design fails to control for either learned habituation or neural adaptation to the CES as a repetitive simple stimulus. Learned habituation in the phylogenically complex nervous system of a human is obvious since this behavioral capability has been established in simple planarian. Considering the myriad of complex incoming neural signals and the internal complex, chaotic EEG signal, a simple CES signal of little biologic or reinforcement value is a prime candidate for learned habituation. For this reason the current study evaluates a single 30-minute treatment rather than a multitude of repetitious treatments which might in effect be reversing or canceling single treatment effects.

Few CES investigators measure pre- and post-circuit characteristics in the ear to ear CES circuit. One in-depth investigation of an epileptic patient did confirm electrical parameter changes in the brain during and following CES. A measured decline in resistance was found between electrodes displaced by 1.1 cm., implanted in the posterior to anterior hippocampus following application of CES. This finding shows the importance of circuit monitoring and suggests a resistance drop from





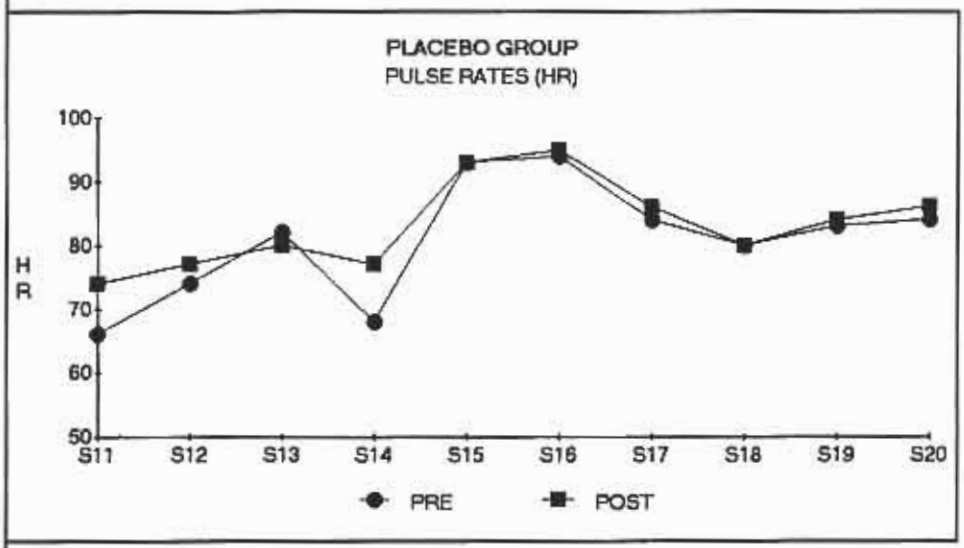


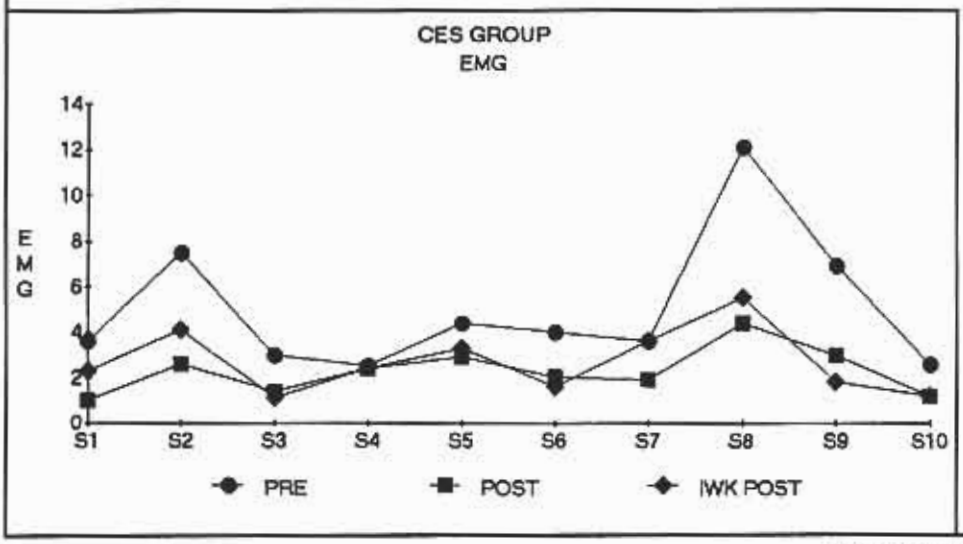
disinhibition or parallel circuiting of neuronal cell assemblies. Given the constant resistance, capacitance product (RC=K), CES would be predicted to increase parallel neural paths, and ear to ear capacitance. To test this prediction the author measured capacitance pre-and post-CES while maintaining skin impedance at a constant of 5K.

Method

Subjects

Twenty subjects (Ss) were selected from the author's private practice. Selection was based on three criteria: 1) persistence of complaint for one year or more, 2) failure of the patient's condition to respond to medication or other medical intervention, and 3) report by the patient that the symptom was made noticeably worse when the patient was under "stress" or was "emotionally upset." The patient sample consisted of subjects half (50%) with hypertension, and half (50%) with 50% muscle spasm with pain. All Ss consented to participate in the study that was described to "evaluate the effects of a microcurrent stimulator on muscle tension, pulse rate, and finger temperature." Ss were divided randomly into two groups: 1) a treatment group who would receive active CES stimulation and 2) a placebo group who were given sham treatment. Neither Ss nor the experimenter had knowledge of which instrument was a placebo or CES active stimulator, and therefore the study was designed to be double-blind. After data collection the manufacturer released the code for which unit was active and which was placebo. Ss were told the CES treatment uses a minuscule current and they therefore may or may not feel the CES treatment. Ss were asked after all treatment and placebo sessions if they felt any sensations during the session.





Materials

Alpha-Stim 100 CES stimulators were purchased from Electromedical Products International Inc., Mineral Wells, Texas. CES stimulation was adjusted to minimal intensity level "1." This level produces about a 100 microampere, 14 volt ac, random biphasic square waveform. Pilot studies by the author show this level of intensity is seldom felt by most patients. The placebo and active units were identical in appearance and LCD timer characteristics.

Dependent measures of pulse rate (HR), finger temperature (temp), electromyogram (EMG), and capacitance (nF) were taken in sets of four readings spaced five minutes apart. To give more stable and reliable data these sets of readings were converted into averages. HR was measured by using a standard electronic blood pressure cuff placed over the left brachial artery. Finger temperature was obtained from a one-second response time, biofeedback monitoring probe, placed over the right index fingertip. EMG was measured by using a scanning surface. EMG made by J&J Electronics placed over the right trapezius muscle at muscle midpoint. Capacitance was measured ear to ear through the CES electrodes by a low current Sperry capacitance meter set on nano farad (nF) range. The current and voltage parameters of this instrument are very low, making its use on the body safe. CES electrodes were gold-plated, cotton-padded, constant spring tension ear clip electrodes. Skin was prepared with newprep EEG paste prior to electrode placement. Cotton padded, CES electrode tips were kept moist with a saline solution. This procedure insured a constant skin impedance of about 5K.

Both placebo and CES groups were given 30-minute sessions with equal pre- and post-measurement protocols. Both groups were treated identically. After pre- and post-measures were collected, the CES and placebo groups were determined, and a one week follow up of all dependent variables was then performed on the CES group.

Table 1

	t-statistic	one tailed P
Pre and Post CES		
EMG	2.35	P< .025*
HR	2.55	P< .025*
Temp	2.62	P< .025*
nF	2.14	P< .05*
Pre and Post Placebo		
EMG	1.29	P> .05
HR	1.51	P< .05
Temp	1.28	P> .05
nF	0.71	P< .05
1 Wk Follow-up CES Group		
EMG	1.89	P< .05*
HR	1.83	P= .05*
Temp	1.76	P> .05
nF	1.24	P> .05

Results

An analysis of pre- and post-CES and pre- and post-placebo was preformed on each of the dependent variables using the paired t-test. The results of these tests is shown above in Table 1.

None of the Ss reported any sensations being felt at any time during stimulation, in either the CES or placebo group. All Ss in the CES treatment group (Ss 1-10) showed immediate declines in EMG and pulse rates with simultaneous increases in capacitance and finger temperature. These changes were all significant at the .05 level of confidence with confirmation of experimental hypothesis that CES would reduce stress physiologic measures. The results with CES on EMG, HR, and finger temperature were significant at the .025 level. The results in the placebo group (Ss 11-20) showed no such patterns, but rather showed small insignificant fluctuations up and down in all dependent measures. The results by subject are displayed in graphic form, graphs 1-8.

One week follow-up measures in the CES group showed consistent carryover effects in EMG and HR, but were not significant at the .05 level for finger temperature or capacitance.

Discussion

The current study suggests the immediate effects of low level 0.5 Hz, random, 100 microampere currents, delivered to earlobes, will be observed in several physiologic functions normally synonymous with stress responding. There are many reasons for

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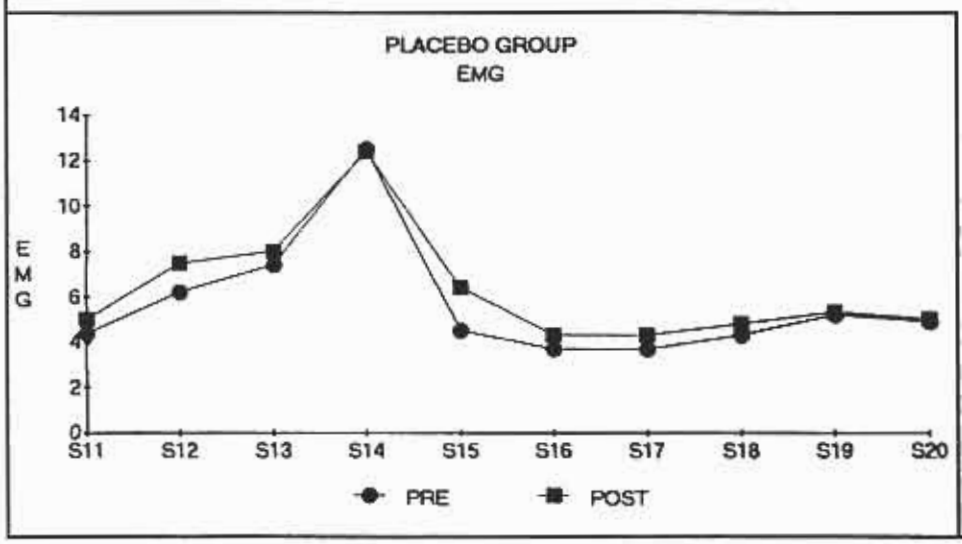
the clear and consistent results that the current study produced. The type of CES stimulus used in the nervous system may be crucial. This study used a stimulus which is compatible with brain frequencies that are associated with parasympathetic response, sleep, and relaxation. Many of the prior studies using 100 Hz frequencies may in the short-term, elicit stress, and although the literature suggests some relaxation and anti-anxiety effects from 100 Hz, these results may be due to inefficient harmonic elicitation of low frequency brainwaves after the treatment ends. This may also explain the reason more treatments are needed to see effects due to inefficient 100 Hz stimulation.

There is another reason involving safety that may contraindicate 100 Hz CES. Some research indicates frequencies above 14 Hz may cause cyclotronic resonance, and consequent efflux of major ions (Becker, 1989). Becker discusses the importance of low frequency, low amperage, direct current shifting while presenting evidence of the detrimental health effects of 30-100 Hz, ELF. The author has measured and observed EEG spectra during low intensity CES at frequencies, 0.5, 1.5, and 100 Hz. CES at the lower frequencies produce an increase in 8-12 Hz EEG amplitudes with an increase in the area under the spectral curve (amplitude x frequency bandwidth) power output. CES at 100 Hz does little to produce these parasympathetic CNS states in the EEG record. Indeed during stimulation, 100 Hz may be causing sympathetic response and stress.

Another reason for this study's significant change in EMG, pulse rate, and finger temperature is due to the measurement of infrequently studied CES dependent measures, and selection of reliable EMG recording sites. A review of CES literature shows a paucity of studies focusing on psychophysiologic measures of stress, and only two studies on finger temperature and pulse rates. This oversight is particularly surprising since there is a massive literature on these variables in the biofeedback. EMG in CES studies is often inappropriately studied at unreliable recording sites like the frontalis and submental muscle. These localities are full of movement artifact from eye blinking, jaw movement, and are rather small muscle groups often not reflective of total body tension.

The psychophysiologic reduction in stress response found in this study may be the probable correlate and necessary preconditions for noted anxiety reduction found frequently in the CES literature. A meta-analysis by Klawansky, et al. (in press) reveals a positive treatment effect for anxiety when poorly controlled and inadequate sample size CES studies are eliminated. Klawansky's pooling of smaller sample studies, with weighting of dependent anxiety scale measures shows significance at the .05 level for the use of CES in anxiety management. Prior to personality change there is bound to exist some psychophysiologic correlates of lowered anxiety. The logical choice of these underlying physiological correlates appears to be muscle tension, peripheral blood flow, heart rate, and other classical psychophysiologic correlates of stress.

Results of the current study suggest that reductions in stress physiology are associated with some basic neural changes in brain tissue. The capacitance increase found in this study supports an increase in neural and behavioral flexibility that occurs with increasing use and the opening of new parallel neural circuits. The increased capacitance and resistance drop in brain tissue following CES would substantiate the probable basis for cognitive and IQ test improvement often found in CES.



Correspondence:
Michael Heffernan, Ph.D.
1807 Hwy 35 North
Rockport, Texas 78382 USA
512-729-0817

The author is in private practice specializing in neuropsychology and biofeedback. He is a National Health Service Provider in Psychology.

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