EDITORIAL COMMENT: The following contribution was originally scheduled to appear in Volume 30, No. 4 of this journal, in which not widely understood but powerful physiological influences were described. The topics concerned two long-neglected hormones, melatonin (Russel Reiter) and Dehydroepiandrosterone (C. Norman Shealy); forces other than genetic that govern cellular tissue development (Richard C. Strohman); and energy sources that govern ion traffic across vascular and cell membranes (Richard L. Veech).

Physiological and Therapeutic Effects of High Frequency Electrical Pulses

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Abstract—The results of stimulating human subjects with the LISS Cranial Stimulator (LCS) and the LISS Body Stimulator (LBS) include an increase or decrease in the activities of certain neurotransmitters and neurohormones and the reduction of associated pain, insomnia, depression, and spasticity. The effects were documented in human subjects with measurements of the serum concentration of the various agents and assessments of the symptoms being performed before and after stimulation. The stimulators had a carrier frequency of 15,000 hz, which utilizes the bulk capacitance of the body, and a 15 hz modulating bioactive frequency. The second modulating frequency presently used, 500 hz, reduces the energy input to the patient by half. Significant increases in levels of CSF serotonin and beta endorphin were recorded post stimulation. There were also elevations in the levels of plasma serotonin, beta endorphin, GABA and DHEA together with diminished levels of cortisol and tryptophan. Concomitant with these changes were significant improvements in the symptoms of pain, insomnia, spasticity, depression, and headache.

Background

THE STIMULATORS WERE developed with a view to matching the dynamic electrical impedance of the body. Oscillographic recordings in humans following stimulation by the monopolar modulated energy stimulators gave evidence of stored energy in minuscule amounts (less than 1 milliampere equivalent direct current in each work phase), indicating that internal currents are generated. The hypothesis emerging from this work states that the mechanism by which the neurotransmitter levels change includes an internal current, which is caused by the modulated energy of the stimulator acting on the stimulated tissue.

The experiments were based on the assumption that it takes a certain amount of energy for a nerve signal to cross the synapse. When there is less than the required amount of energy present at the junction of whatever nerves are under study, no signal will cross the synapse. When such a dysfunction occurs in a motor circuit the affected muscle will not function. Similarly in a sensory nerve or memory system there will be no consequent

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change in perception or transference of the memory information. The disturbance can also occur in the emotional systems of the brain and mind, thus bringing a cloud over the individual's whole thought processes or behavior. Sufficient energy at the synapse, therefore, appears to be essential for neurons that are involved in adaptive physiological mechanisms to function effectively and achieve homeostatic balance.

A research team at the Max Planck Institute of Biochemistry in Martinsried, Germany, have built a new type of junction between a microscopic spot on a silicon chip and a corresponding spot on the neuron of a leech and have demonstrated that "An electric voltage applied to the interior of the chip produces an electric field that induces a charge inside the cell. They showed furthermore that when this charge reaches a certain level, the cell fires, initiating the electrochemical sequence by which nerve cells communicate with their neighbors."

The apparent requirement of an increment of "triggering energy" to be present for an event to transpire is well known in nature. In chemistry, for example, reactants must reach a "temperature of reaction" for an effect to take place. Similarly, in mechanics, "stiction" (static friction) must be overcome for motion to take place.

We hypothesize that in physiology, while the factors for an action may be present, if the "triggering energy" is absent or insufficient, no action will occur. We suggest that, in some cases, introducing the current of the LCS or the LBS facilitates the physiologic action. Whether the facilitation is directly involved in the action or is catalytic thereto is presently unknown.

Demodulation is the process of separating the audio frequency or the video signal from the "carrier" waveform in radio and television transmission, respectively. There is a circuit in radio and television that includes the lumped constant equivalent of resistors, capacitors, and semiconductors. Such a circuit separates the modulating frequency (or information) from the carrier frequency that transmits the signals through the atmosphere. We dial the radio to carrier frequency (~500,000 to 1,600,000 hz), but we listen to the radio transmitted audio frequency (~15 to 15,000 hz) and we see the video results of frequencies (~100,000 hz), while the television carrier frequencies can be 88,000,000 to 108,000,000 hz.

Granbard (1987) reported that the electrical characteristic of a lobster stomatogastric ganglion includes the property of "demodulation," normally the property of a semiconductor circuit in a "communication device." Thus, system or circuit rectification, which is necessary in "demodulation," appears to be present in certain neural systems.

The modulated energy of the present and predecessor devices can be utilized in a variety of sites on the human head and body to provide the signal for the nervous system to "demodulate" the stimulator energy into the information that the organism needs to help alter the neurochemical levels of certain substances. Having learned how to bring energy into the anatomy, the real challenge lies in how to utilize it to enhance the body's ability to reduce its own symptoms. Hence, contact placement, the combination of contacts, and the integration into a complete treatment regimen may need to be applied at a particular time of day in the circadian cycle of the substance being targeted. Moreover, the sequence of treatments must be adapted to the disorder being treated.

Table 1 contains a list of targeted substances and effects observed.

TABLE 1
Neurochemicals Measured To Date

Substance	Alteration	Plasma	CSF
A. Serotonin (5HT) -------------------	Increases	X	X
B. Beta Endorphin --------------------	Increases	X	X
C. Tryptophan ------------------------	Decreases	X	
D. Cortisol --------------------------	Decreases	X	
E. A C T H ----------------------------	Increases	X	
F. G A B A ----------------------------	Increases	X	
G. D H E A ----------------------------	Increases	X	

The implications of these substances are:

Substance	Implications
A. Serotonin	1. Mood management
	2. Pain Tolerance
	3. Insomnia Symptom Reduction
	4. Cardiovascular Control
B. Beta Endorphin-Morphine-like biochemical	
C. Tryptophan ---------------	Precursor to serotonin
D. Cortisol (decrease) -------	Systemic Relaxation
E. ACTH ---------------------	H/P/A-Axis & Homeostasis
F. GABA ---------------------	Neural Inhibitor & Spasticity Red.
G. DHEA ---------------------	Aging Biochem. & enhance Immune Sys.

Experiments

Subjects

The authors, a colleague, and thirteen volunteers—seven women and six men—ranging in age from 22 to 70, with a mean of 46—participated in the study.

Objective

To evaluate the difference in neurobiochemical level changes following transcranial stimulation for 20 minutes with different stimulators: monopolar, bipolar, and placebo devices.

Procedure

The devices were set to function at only one milliampere (peak)—less than the volunteers could perceive when the contacts were placed transcranially on their heads. When the placebo device (which had had its output short-circuited so that no current was conducted), was used, there was no sensation felt by the subjects. The intensity of 1 milliampere of the active devices was also insufficient for the volunteers to perceive any sensation.

All tests were made at regulated times for each of the participants in this study to prevent diurnal changes from altering the results. Two of the subjects were treated at the same time of day (5–7P.M.), a third was treated at 8:00 A.M. each morning, and the remaining ten volunteers were processed at 10A.M.–12 noon each morning. Thereby, diurnal

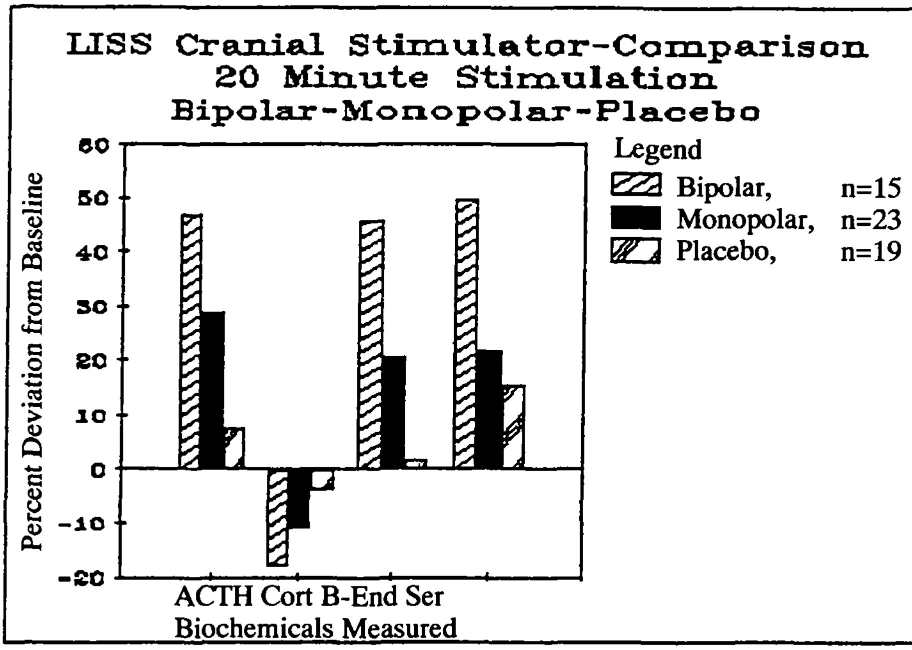

FIG. 1. Biochemical changes following 20-minute transcranial treatment with the LISS Stimulators—monopolar, bipolar and placebo.

changes that might have confounded the measurements were nullified. The bipolar instrument was used on 18 subjects and the monopolar on 23, while there were 13 sham stimulation episodes.

Results

The biochemical changes achieved by the bipolar device were significantly greater than those caused by the monopolar LCS. The placebo device produced only changes in the level of serotonin in the blood of the authors. These effects may be suspect because the authors hope for results from the electrical modulation. Perhaps because of their interest in the subject, they displayed a "real" placebo effect on serotonin levels.

The changes in the blood levels of the biochemicals resulting from these experiments are shown in Figure 1.

Experiment

In order to evaluate the difference in the levels of blood plasma serotonin, tryptophan, cortisol, ACTH, beta-endorphin, and GABA, following stimulation, a group of 15 volunteers, 6 women and 9 men, aged 22 to 38, with an average age of 30 years, were stimulated on 45 occasions. The testing was done on Monday, Wednesday, and Friday of the same week at 10 A.M. to 12 noon in order to eliminate diurnal changes as a confounding factor.

Measurements of the serum concentration of each of the agents listed in Table 2 were made before stimulation and 10 minutes after conclusion of a 20-minute treatment with different stimulators according to the following schedule:

TABLE 2
Neurobiochemical Levels—Pre- and Post-Stim. with Stimulators of Differing Frequencies

Neurobiochem.	*Conv. TENS Peripherally*		*Pain Supp. Peripherally*		*Pain Supp. Transcranial*	
	Before	*After*	*Before*	*After*	*Before*	*After*
Seroton. ng/ml	54.40	55.27	63.27	86.13	45.00	76.00
Tryptoph.Rel%	50.13	49.47	55.40	45.20	51.10	37.20
Cortisl-ng/dl	13.27	12.17	12.73	10.99	15.35	13.71
A CT H-pg/ml	19.61	19.43	18.82	24.42	7.42	12.52
B-End.pg/.1ml	9.38	8.78	10.60	12.54	12.29	16.73

- Monday—Conventional TENS device set at 80 pulses per second, in control burst mode with one contact placed at the right side of the neck at the C-2/C-3 level, and the second contact at the web of the right hand for twenty minutes.
- Wednesday—Pain Suppressor (which contains the monopolar carrier frequency of 15,000 hz and the asymmetrical modulating frequency of 15 hz-(50 milliseconds "on" and 16.7 milliseconds "off") with contacts placed, as above, with the red contact at the right side of the neck, and the black contact on the web of the right hand for twenty minutes, at subthreshold settings.
- Friday—Pain Suppressor, as in step two above, but with the contacts placed transcranially (red contact, front of the top tip of the right ear; black contact, front of the top tip of the left ear) for twenty minutes, at subthreshold settings.

In this manner, the biochemical alterations affected by the conventional TENS stimulator could be compared to that of the Pain Suppressor (forerunner to today's LCS and LBS) with the same placement of contacts on the same volunteers at the same time of day.

Results

The largest changes in the circulating chemical agents were achieved by the Pain Suppressor unit with the electrodes placed transcranially (as shown in Table 2) (Closson et al. 1988).

Discussion

Whether or not the results achieved by direct stimulation of serotonergic neurons in the central nervous system (CNS), which could act directly on the hypothalamus, causing release of hypothalamic releasing hormones and subsequent stimulation of the pituitary and adrenals remains to be studied. An evaluation of the kinetic effects of stimulation on the levels of neurotransmitters—serotonin, cortisol, ACTH, and beta endorphin—following 20 minutes transcranial stimulation with the monopolar LCS was evaluated by Closson et al. (1993). Blood samples drawn periodically for two hours following the stimulation yielded the results shown in Figure 2. Two subjects, one female and one male had transcranial stimulation for 20 minutes with the LCS model. Their blood samples were drawn at the following periods:

- Immediately post stimulation

- + 5 minutes
- + 20 minutes
- + 60 minutes
- +120 minutes

Cortisol levels did not change in the first 5-minute period post-stimulation. ACTH rose an average 75% over baseline, after which it receded to 25% over baseline by the end of two hours. Subsequent to the 5-minute post-stimulation period, the cortisol readings diminished to -18% of baseline by the end of 120 minutes post-stimulation, a change compatible with relaxation. ACTH rose sharply above baseline as cortisol diminished. The significance of this effect is not clear. Serotonin rose to its maximum of 50% over baseline by 20 minutes and remained there for the rest of the 2-hour period. Beta-endorphin rose progressively from its baseline throughout the entire 2-hour period.

Experimental data by Cady (1991) indicated that there were also significant increases in the post-stimulation cerebrospinal fluid levels of both serotonin and beta-endorphin in a group of five normal volunteers. The monopolar LCS was used transcranially for twenty minutes on each volunteer.

The experimental data by Shealy et al. on the rise in DHEA (dehydroepiandrosterone) via electrical stimulation was recently reported by Rosch (1995) in the American Institute of Stress Newsletter.

Clinical Data

Clinical effects of these stimulators have been reported to be safe (Walker, 1987) and effective in dental and other pain control, reduction of depression, and spasticity of cerebral palsy and Closed Head Injury.

Reports of the beneficial results in clinical studies with the modulated energy stimulators have been published by Shealy with respect to the effects on mood and serotonin production (Shealy, 1979), the treatment of depression (1989, 1994) and on the alterations of neurochemistry (1992). Other studies of the effects on headache have been published by Solomon et al. (1985, 1989), on headache in Fibromyalgia by Romano (1993). Favorable effects on pain in general were reported by Cassuto (1993) and Konzelman (1985). On dental pain control during restoration, Clark (1987) and Hochman (1988) reported benefit while temporomandibular pain management was noted by Terezhalmy (1982) and Gelb (1977).

Reports of the relief of the spasticity of cerebral palsy, improvement of learning disabilities, and reduction of symptoms from closed head injury have been reported by Malden (1985), Hunt (1986), Sornson (1985), Reilly (1990), Okoye (1989), Childs (1993). In these studies on 1,100 patients and volunteers, highly beneficial results were achieved following treatment with modulated energies.

To interpret the data from these studies, one might propose that the release of energy by the modulated carrier technique can be converted in the body into an internal current via energy stored and facilitated by the bulk capacitance of the head and body.

Modulated carrier wave form stimulators like the LCS and LBS and their predecessor are able to alter the levels of the neurochemicals: serotonin, cortisol, tryptophan, beta-endorphin, and GABA to a greater degree than those by conventional TENS stimulators when used at 80 PPS frequency and CB mode. It further appears that transcranial stimulation is more successful in altering the levels of these neurochemicals than periph-

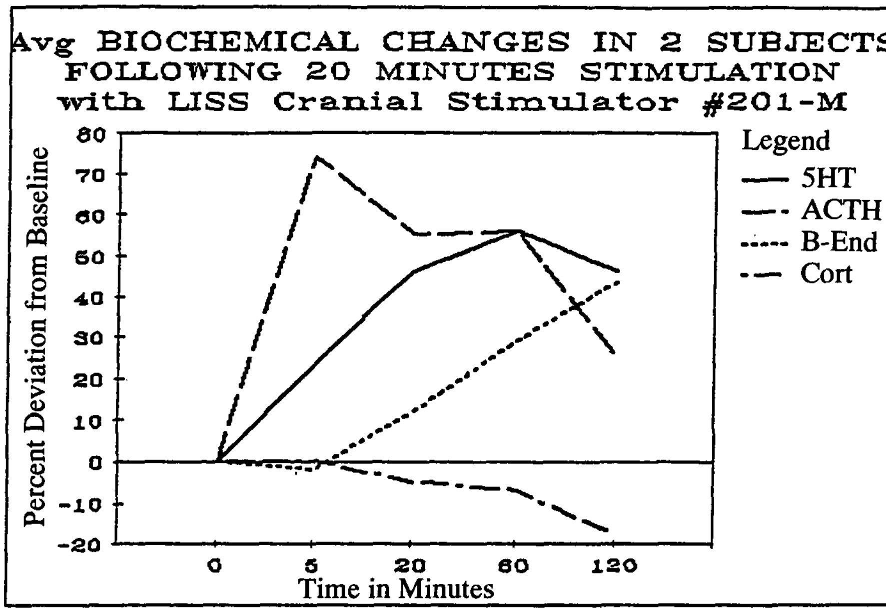

FIG. 2. Preliminary kinetic, average biochemical effects following 20 minutes transcranial treatment with the monopolar LCS.

eral stimulation. However, it must also be noted that peripheral stimulation with the modulated energy stimulators is also capable of altering the neurochemicals to a great degree.

Conclusion

The LISS stimulators LBS and LCS appear to be safe devices to use on a patient's body or head and appear to be capable of relieving pain, muscle tension (stress), depression, and peripheral vascular insufficiency (secondary to diabetic neuropathy) by way of modulated energy of very low currents.

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