Experimental

A DOUBLE BLIND STUDY OF THE "BIOCIRCUIT," A PUTATIVE SUBTLE-ENERGY-BASED RELAXATION DEVICE

Julian Isaacs, Ph.D. and Terry Patten

ABSTRACT

Biocircuits are passive devices which are reported to cause relaxation in users, supposedly by facilitation of bodily subtle energy flow. A repeated-measures, within-subjects control, double-blind study was performed to test whether a "relaxation" biocircuit would produce more relaxation than a placebo-control biocircuit. The study design controlled for expectation, order effects, first-time effects and ultradian rhythms. Dependent measures included four physiological variables relating to arousal and relaxation (frontalis muscle tension, one monopolar channel of EEG monitored for theta episodes, finger temperature, finger skin conductance) and a ten-item comparative questionnaire used to rank subjective experiences relating to relaxation in session. Twelve subjects completed four sessions each. The first session for all subjects was used only for familiarization and its data were not analyzed. Subjects then completed three more sessions each, treatment order being counterbalanced and randomly assigned across subjects. The three sessions exposed subjects to a "relaxation" biocircuit, a placebo-control "dummy" biocircuit and a "tension" biocircuit.

The EEG theta measure showed significantly more theta episodes associated with the relaxation device than with the placebo control (Wilcoxon signed ranks test: $p \leq .025$ one-tailed). The frontalis muscle tension measure showed significantly lower tension levels associated with the relaxation device than with the placebo control (Wilcoxon signed ranks test: $p \leq .01$ one tailed). The skin conductivity and temperature measures did not reach significance in any direction across any pair of treatments. Five of the ten questionnaire items comparing the relaxation device with the placebo-control significantly favored the relaxation device (all by Sign test with *a priori* probability of .5): subjective estimate of relaxation ($p \leq .0002$), sensations of warmth ($p \leq .03$), non-ordinariness of experience ($p \leq .02$), perceived effectiveness ($p \leq .02$), perceived benefit ($p \leq .02$). No questionnaire items at the .05 significance level favored the placebo control over the relaxation device. The findings of the study demonstrate the superiority of the relaxation biocircuit over a placebo control for producing relaxation under fully controlled double- blind conditions.

KEYWORDS: "Biocircuit," psychophysiology, brainwaves, experiential, relaxation, physiology, placebo, polarity

INTRODUCTION

THE RATIONALE FOR THE STUDY

The present study was conceived as an attempt to investigate a relaxation device, the biocircuit, which is construed by its originators and users[1,2] as operating by means of a mechanism involving subtle energy. Since subtle energy cannot at present be detected, nor is it included within the current theoretical formulations of physics, any claims regarding the biocircuit's mechanism of operation which invoke subtle energy must be contentious. We review the subtle energy mechanisms postulated by the biocircuit's originators, developers and users (see Theories of Operation of Biocircuits below) but we wish to emphasize at the outset that we remain neutral with respect to mechanisms and theories of operation of the biocircuit. Our purpose in this study was restricted to evaluating some of the claimed physiological and experiential effects of the biocircuit in the most carefully controlled way that our resources would allow. In particular we wished to investigate whether the biocircuit's effects could be explained as being due to placebo responses. We suspect that our study may be the first fully-controlled double-blind study of a subtle energy device so far performed.[3] Certainly the present study is known to be the first fully-controlled investigation of the biocircuit, and subtle energy device manufacturers and investigators are invited to follow this lead. We would be happy to assist other investigators.

WHAT BIOCIRCUITS ARE

A biocircuit can be defined as a passive connection, or combination of passive connections between two or more points on the surface of the skin of the human body, which, taken together with the postulated capacity of the body to conduct subtle energy, or electricity, forms a circuit. The biocircuit used in the present study derives from the "relaxation circuit" invented in 1919 by the English Therapeutic Touch practitioner, Leon E. Eeman.[1,4]

Physically, a biocircuit is a rather simple passive device which is available in a number of variants.[5] In its least complex form it comprises two identical units which are each composed of a rectangular copper gauze screen connected to

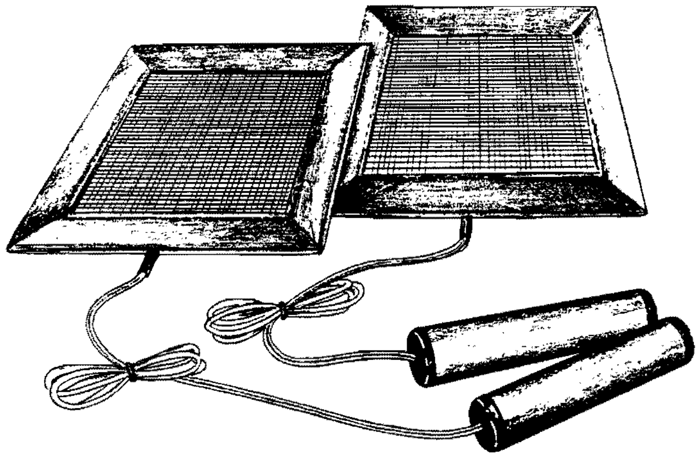

Figure 1. Standard Copper Biocircuuit.

an insulated copper wire terminated in a copper handle (Figure 1). The user assumes a reclining or prone position during the session, which may last from ten minutes to several hours but which is typically thirty minutes long. One gauze pad is placed under the tailbone (sacrum), with its attached handle being held by the right hand. The other gauze pad is placed under the back of the neck, with its attached handle being held in the left hand (Figure 2). The legs are crossed at the ankles, or an extra biocircuit segment is used to connect the soles of the feet, via two extra copper gauze screens connected with copper wire.

THEORIES OF OPERATION OF BIOCIRCUITS

Four mechanisms might feasibly be proposed to explain the reported effects of biocircuits. The first, and skeptical explanation is that the biocircuit's reported effects are due to suggestion, the biocircuit serving merely as a placebo device to create expectation in users. This hypothesis was tested in the present study by inclusion of the dummy placebo-control biocircuit.

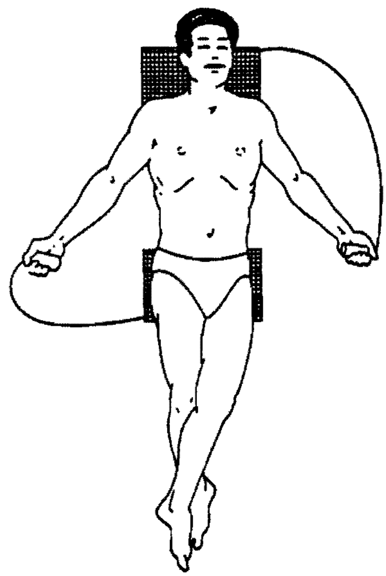

Figure 2. Standard Copper Biocircuit in use.

The second and third mechanisms could be proposed as electrical hypotheses. These postulate that biocircuits cause the reported effects physiologically, rather than through their effects on users' expectations, but that the mechanisms of action are conventional electrical, biophysical mechanisms, not a mechanism involving subtle energy flow. It is well-established that small electrical potential differences (of a few millivolts magnitude) exist between separated regions of human skin[6,7] and that these potentials might theoretically drive a current flow through electrical conductors if these were applied externally to the skin surface. The biocircuit's action in this mode could be likened to a form of low-current electrical stimulation, endogenously driven, and it is known that weak electrical currents have various biological effects.[8,9] The biocircuit's action may therefore be explicable in terms of providing electrical paths between body parts of differing electrical potential. Equally, it is well known that the placement of metal contacts onto skin surfaces can under some conditions produce contact potentials and such contact potentials could be expected to interact with endogenous surface potentials, modulating electrical current flow through the biocircuit.[10] The action of biocircuits may therefore be explicable by one or the other or both of these electrical mechanisms, rather than by reference to subtle energy.

Eeman's central postulate was that the bodily energy flow can be augmented by connecting copper wires to oppositely polarized body parts. Biocircuits are said to achieve their various reported effects by improving the circulation of subtle energy. As readers of this journal are aware, many non-western cultures have developed models of the human body which include "subtle energies" (e.g. "Chi") and extensive patterns of subtle energy flow, such as the meridians of Chinese and Japanese medicine.[11] In India the yogic system of chakras and nadis fulfilled similar functions.[12] Eeman claimed that there is a definite pattern of natural subtle energy flow in the body which is the same for the majority of the population, although a small fraction of the population has "reversed" energy flow.[13] The theory of Shen therapy[14] postulates a similar pattern of flow. It has been hypothesized that this energy flow may relate to acupuncture meridians and their postulated flow of "Chi." Eeman's central postulate was that the bodily energy flow can be augmented by connecting copper wires to oppositely polarized body parts. Since Eeman's theory contributed some constraints to our study, and identifies and shapes biocircuit use, we feel that it is useful to briefly articulate his theory.

According to Eeman's theory,[1] parts of the body where the postulated subtle energy naturally flows *out* (the "positively" polarized parts) should be connected to the parts of the body where the energy naturally flows *in* (the "negatively" polarized parts). "Tension" configuration biocircuits which link body points of like polarity were claimed by Eeman to obstruct the flow of energy (Figure 3). Tension biocircuits are reported by Eeman to produce irritation, tension, negative mood changes and in extreme cases strong avoidant behavior in individuals exposed to them.[1] Users do not customarily expose themselves to tension circuits.

Eeman claimed that most people are "polarized" so that energy flows *out* of the right hand and the sole of the right foot and *out* from the top of the spine. At the same time energy flows *in* through the left hand and sole of the left foot and into the bottom of the spine. Standard biocircuits connect the right hand with the bottom of the spine and the left hand with the top of the spine,

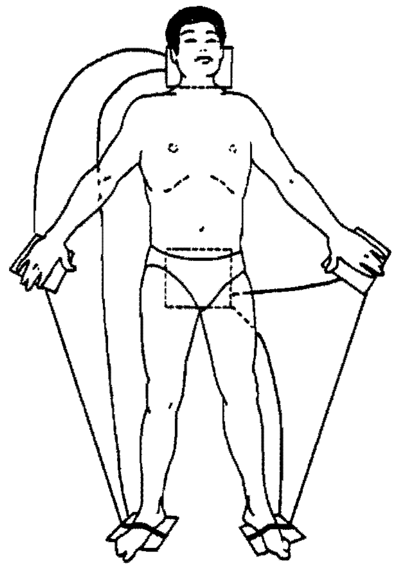

Figure 3. Tension Biocircuit in use.

facilitating energy flow from the right hand to the base of the spine, up the spine and then into the left hand (Figure 4). The legs are supposed to be crossed in use, or an extra biocircuit segment used to connect together the soles of the feet, facilitating flow between the right and left sides of the body. Biocircuits are supposed to balance the subtle energy flows in the user's body, from right to left direction and from top to bottom.[2] However, standard relaxation biocircuits connect only some of the unlike poles together.

By contrast "super" biocircuits connect together all oppositely polarized body parts—the left hand and foot with the right hand and foot, the top of the spine with left hand and left foot, the base of the spine with the right hand and right foot (Figure 5). For this reason they are supposed to be more powerful than the standard biocircuit. Since it was desired to maximize the possible effects, super biocircuits were used in this study.

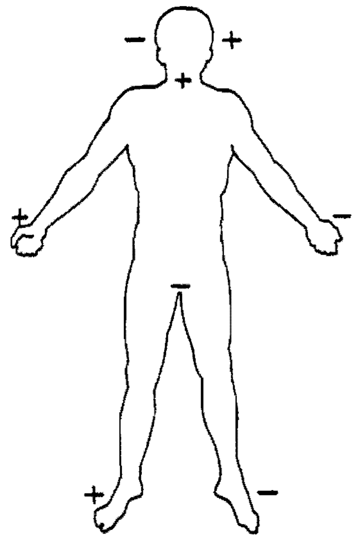

Figure 4. *Polar Diagram of Body.*

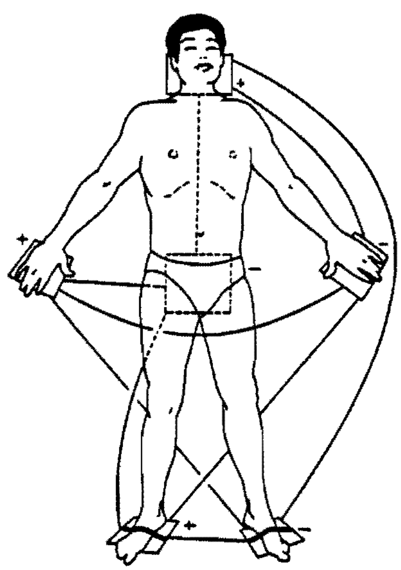

Figure 5. *Super Biocircuit Diagram.*

Reported Psychological and Physiological Effects of Biocircuits

The principal effect reported by biocircuit users is that it promotes states of deep relaxation, and even sleep, facilitating stress reduction and integrative experiences. Sensations of unusual warmth and of moving subtle energy are also frequently reported by regular users who usually express the belief that the beneficial effects from biocircuit sessions are not limited to those due to normal relaxation. Users feel that "non-ordinary" energetic processes sometimes take place in sessions. A recent book by Patten and Patten[2] documents the reported effects of various types of biocircuit in some detail and includes reports suggesting that biocircuits appear to facilitate conscious access to previously unconscious attitudes, memories and emotions.

The existing biocircuit literature reports that sessions with biocircuits usually follow a specific pattern. The session might start with the individual feeling stressed or fatigued. A few minutes after starting the session, unusual warmth in the hands and/or feet may be sensed, together with deepening relaxation. Waves of "energy" may be felt to flow through the body, reaching peaks of intensity then dying away. The user may lapse into sleep, and if so usually sleeps for 10 to 15 minutes, then awakens, seemingly in response to the biocircuit itself. If the user does not actually sleep, he or she may go into a state of deep relaxation similar to trance, self-terminated after 10 to 20 minutes. After returning to normal wakefulness users often report feeling relaxed, de-stressed, clear-headed, refreshed and relieved of fatigue. These are the most commonly reported benefits which motivate biocircuit usage.

HYPOTHESES TESTED

The Relaxation Hypothesis

The general hypothesis tested was that the relaxation biocircuit would relax subjects more effectively than a dummy placebo-control biocircuit. This was the primary hypothesis because it supports the use of the biocircuit as a relaxation tool and directly relates to biocircuit usage. This hypothesis predicted that on all measures of relaxation, the relaxation biocircuit would produce statistically significant enhancement of relaxation compared to the data from the same measures obtained with the dummy placebo-control biocircuit.

Predictions Concerning Dependent Variables

In specific terms the experimental hypotheses as they related to the dependent variable measures and their statistical evaluation are listed below.

1. The EMG (Electromyographic muscle-tension measure) figure-of-merit described below would show higher levels (lower muscle tension) with the relaxation biocircuit than with the placebo-control dummy biocircuit. The planned statistical evaluation was by Wilcoxon signed ranks test for paired related measures.

2. The EDR (Electrodermal Response, a skin conductivity measure, see Choice of Physiological Indices below) minimum value would be lower with the relaxation biocircuit than with the placebo-control dummy biocircuit. The planned statistical evaluation was by Wilcoxon signed ranks test for paired related measures.

3. The TEMP (finger temperature) maximum value reached would be higher with the relaxation biocircuit than with the placebo-control dummy biocircuit. The planned statistical evaluation was by Wilcoxon signed ranks test for paired related measures.

4. The number of trials showing EEG theta dominance would be greater with the relaxation biocircuit than with the placebo-control dummy biocircuit. The planned statistical evaluation was by Wilcoxon signed ranks test for paired related measures.

5. The ranking of each of the 10 comparative measures in the experiential questionnaire would favor the relaxation biocircuit compared to the dummy biocircuit. The planned statistical evaluation was by Sign test based on 12 rankings each having an *a priori* probability of .5.

We included a treatment with a "tension" biocircuit in the study because Eeman had claimed that if individuals used a biocircuit which circulated energy in the opposite direction to the individual's normal flow it would create tension rather than relaxation. However, since no one deliberately uses a tension circuit, our interest in this question was purely academic. We expected to find that the tension device would generate less relaxation than the placebo-control dummy device, but we did not treat this as a formal hypothesis.

METHODOLOGY

The Decision to Measure Subtle Energy Secondary Effects

Western science and medicine accept only directly observable or instrumentally detectable phenomena. But no purely mechanical instruments for detection of bodily subtle energy have been developed as yet. Consequently, the present study used conventional instrumentation, which detects only the side effects or secondary effects of subtle energy flow—measurable changes in bodily functioning presumed to have been caused by the as-yet-undetectable subtle energy flows. A detection system was used, combining physiological measurements and a self-report questionnaire.

Overall Study Design

A double-blind design was essential, to eliminate the effects of suggestion. The double blind protocol was created by the use of biocircuits with concealed connections, prepared by the assistant experimenter. A within-subjects-control design was selected, employing repeated measures made on the same group. To minimize transfer effects between treatments with different biocircuits, treatment order with the concealed super biocircuits was counter-balanced across subjects and treatment order was randomly assigned to subjects. Pilot runs were conducted with an independent subject group prior to the formal study to facilitate questionnaire construction (see Questionnaire Measures below) and refine the protocol.

Choice of Physiological Indices

Based on the relaxation phenomena claimed to accompany biocircuit use,[2] the physiological measures utilized in the study were selected to detect physiological concomitants of relaxation.[15] Forehead muscle tension (EMG) was monitored because it is an accepted indicator of bodily muscular tension. Electrodermal Response (EDR) was monitored because this is known to reflect emotional arousal. Finger temperature (TEMP) was monitored because an increase in skin temperature is known to indicate relaxation.

One monopolar channel of EEG (P3)[16] was used to detect the onset of Stage 1 sleep—the switch-over from alpha brainwave dominance to dominance of theta brainwaves, a sign that relaxation has reached sufficient depth for sleep to set in. When an individual moves from wakefulness into Stage 1 sleep (the hypnagogic state), the EEG usually shows alternating dominance of alpha (8 to 12 Hz) and theta (4 to 8 Hz), with increasing periods of theta dominance as Stage 1 deepens to Stage 2 sleep.[17] The standard placements used in sleep research are the C3 and C4.[18] However the principal investigator, in unpublished pilot research, using a 24 channel topographic EEG, found that the more posterior P3 and P4 placements appeared to give marginally more sensitive indications of alpha-theta transition than C3 and C4 placements, and were also less likely to be subject to artifact due to eye movements. The limitation of having only one EEG channel led to the decision to monitor left hemisphere activity via the P3 placement. The theta measure was selected to detect Stage 1 sleep and was scored by counting the number of trials in the session in which the amplitude of the theta component of the EEG equalled or exceeded the alpha amplitude.

Electrode Assemblies

Silver/silver chloride electrodes of 3/8" diameter were used for the EDR, EMG and EEG sensors. Electrode sites were de-greased with isopropyl alcohol and then cleaned and abraded with abrasive cleaner used for electrophysiological applications. Electrode cream was used to provide low-resistance skin contact. Three EMG electrodes were set into 3/4" outside-diameter plastic cup electrode assemblies, filled with electrode cream and used with adhesive double-sided plastic film collars which held the electrodes to the subjects' forehead. Two EDR electrodes were mounted within plastic fabric strips terminated with Velcro which were wrapped around the subjects' fingers (see Skin Electrical Conductance below). The active EEG sensor was equipped with a 1-inch diameter cup, 1/4" deep, inside of which an expanded plastic fiber spacer was placed. The cup was then filled with electrode cream and secured to the prepared P3 placement site by an elastic headband. The reference EEG electrode was identical to an EMG electrode and was secured to the prepared mastoid site by an adhesive plastic film collar. A ground electrode was secured to a site above the left clavicle.

The Computerized Data Collection System

Physiological data were collected by a J&J Type I-330 computerized multichannel physiological data-recording system.[19] This system is the current standard data-collection system in the biofeedback community and has been widely used in recent psychophysiological research. The system included an IBM 286 computer and two external control units. The master control unit contained four physiological monitoring modules (2 EMG, 2 EDR/TEMP) to which the cables for EDR, TEMP and EMG measurement were interfaced. The second control unit contained the EEG module to which the EEG cables were interfaced and an unused EDR/TEMP module. Inside the master control unit the outputs from all the modules were input to an analog-to-digital converter. The digitized output was then converted to serial form within the master control unit and conveyed via shielded cable to the RS232 serial input of the computer. J&J "USE" data-collection software was used to collect, display, print and store data. All 4 channels were continuously monitored during data collection.

For each physiological channel, the following data-collection routine was automatically performed by the system. Data samples were digitized and averaged at 5-second intervals. Six of these averages were then averaged to create a score for each trial of 30 seconds duration. In each 30-minute session 60 trials were collected. The 60 trial scores for each of the 4 channels constituted the basic data collected in each session.

Treatment of Data

Collected data were stored on the computer's hard drive during the session and backed up on floppy disks after each session. Immediately after each session the data from that session were printed and the printed hard copy was stored. The hard copy was later retrieved and subjected to manual data reduction by an assistant. Data reduction was checked by the assistant and by the principal experimenter. After data collection had ended, summary data were statistically analyzed on a blind basis by the senior author.

Temperature Measurement

Temperature (TEMP) was measured by attaching a miniature bead thermistor to the inside proximal pad of the middle finger of the subject's left hand with tape. The subjects' temperature would typically reach a maximum in the session and then drift down again. The peak temperature was therefore selected as the TEMP score for analysis.

Electromyographic Measurement

The EMG electrodes were applied with adhesive collars to cleaned and de-greased sites on the forehead. The EMG measure selected was a figure-of-merit derived from both lowness of EMG amplitude (representing depth of muscular relaxation) and consistency of low EMG amplitude trials in sessions, showing persistence of a relaxed state. This measure was chosen after pilot sessions demonstrated that it is a more sensitive measure of relaxation than EMG mean values. The use of figures-of-merit is relatively commonplace in electro-physiological research.[20]

Skin Electrical Conductance Measurement

The EDR channel measured electrical conductivity between the first and third fingers of the right hand. The electrodes were applied to the outside surfaces of the middle phalanx of the first and third fingers, although the standard EDR placement is on the inside surfaces of the fingers. This may have reduced the effectiveness of the EDR measurements in detecting relaxation and may have been responsible for the non-significance of the EDR measure (see following sections). However, the electrodes could not be applied to the inside surfaces of the fingers because during sessions subjects held the electrically conductive copper biocircuit handles. Placing electrodes on the inside surfaces of the fingers would have risked their being bridged by the copper biocircuit handles, either partially through flesh, or completely, by both EDR electrodes being touched by the copper biocircuit handle.

Testing during the pilot phase decisively demonstrated that when EDR electrodes were placed on the outside surfaces of the two fingers, no bridging action occurred as a result of subjects holding the handles. The J & J equipment measured skin conductivity in micromhos to one decimal place. In extensive tests no changes in conductivity reading could be produced by subjects moving the copper handles over the inside surfaces of their hands and fingers, or by alternately holding and then releasing the handles. Pilot sessions revealed that EDR values usually reached a minimum and then drifted up from this value. The EDR measure used was the minimum value in the session.

Electroencephalographic Measurement

As previously mentioned, monitoring of EEG was performed by one monopolar EEG channel. The active electrode was placed in the left parietal (P3) position. The reference electrode was secured to the left mastoid. The ground electrode was placed just above the left clavicle. EEG was monitored for alpha, beta and theta frequencies.

The EEG record was carefully examined as it was collected and in each session was checked for freedom from artifact due to bad electrode contact prior to initiating formal data collection. The electrode site was re-cleaned if bad contact was suspected. All trials in which EEG artifact was detected were excluded from data analysis. For EEG artifact control, the EMG channel provided an additional means of detecting head movements, since these would create noticeable signals. Subjects performed all sessions with eyes closed so that eyeblink artifacts did not tend to occur. The following acceptance criterion was also applied in order to reduce the possibility of contamination of the EEG data by artifact. For theta-dominant trial periods to be counted for a subject, he or she had to produce at least 2 consecutive 30-second trials of theta-dominant EEG during the session. The intention was to prevent the occurrence of false-positive theta-dominant trials.

Some individuals do not have a dominant alpha rhythm, and alpha dominance is necessary in order for the theta detection method to operate correctly. All subjects were therefore checked in their first session for the occurrence of dominant alpha when resting with eyes closed. All subjects produced satisfactory alpha rhythm.

Questionnaire Measures

After all sessions except the first, subjects completed a 10-item experiential questionnaire comparing the effects of the experimental biocircuit treatments. The rationale for repeated administration of the questionnaire was to assist subjects to consolidate their memories of prior experimental biocircuit sessions. However, scoring was performed only for the questionnaire administered after each subject's *final* session. The list of questions is shown in Table I.

Location and Setup of Experimental Room

All sessions were held in the same room (Figure 6), located at the top of a quiet house in Sausalito, California. During sessions, subjects were seated in a comfortable reclining chair. The principal experimenter (JI) conducted experimental sessions, and after wiring subjects to the electrophysiological monitoring equipment monitored the computer system, which was situated about 7 feet from the subject.

Construction of the Concealed Super Biocircuits

Unlike the standard biocircuit, the wire connections of super biocircuits are normally sewn inside a padded blanket which is doubled over and sewn

Table I

Comparative Questionnaire Questions

1. **Pleasantness:** Please rank your biocircuit experiences in order of their pleasantness.
2. **Energy:** Please rank your biocircuit experiences in order of the amount of energy you felt during the session.
3. **Warming:** Please rank your biocircuit experiences in order of the amount of warming or warmth you felt.
4. **Non-ordinariness:** Was there a quality to your experiences during any of your biocircuit sessions that you would describe as "non-ordinary," "unusual" or "special," compared to ordinary relaxation. If so, please rank your sessions below.
5. **Depth of Relaxation:** Please rank your biocircuit experiences in order of the depth of relaxation you reached.
6. **Tension or Irritation:** If you did feel irritation or tension in any session, please rank the sessions in order of these characteristics.
7. **Arousing Quality of Energy:** Some people experience being awakened or aroused by the biocircuit's energy after initially relaxing or sleeping in the biocircuit. If this happened to you, please rank the sessions in order of the strength or intensity of this feature (the energy waking you up).
8. **Beneficial After-Effects:** If some or all of the biocircuit sessions had beneficial after-effects, please rank them for this characteristic.
9. **Increases in Clarity:** If your biocircuit sessions resulted in your feeling mentally or emotionally clearer after your sessions, please rank them in order of strength of this effect.
10. **Overall Effectiveness:** Please rank the sessions in order of their general effectiveness in providing a beneficial experience of relaxation and/or a rebalancing of your energies.

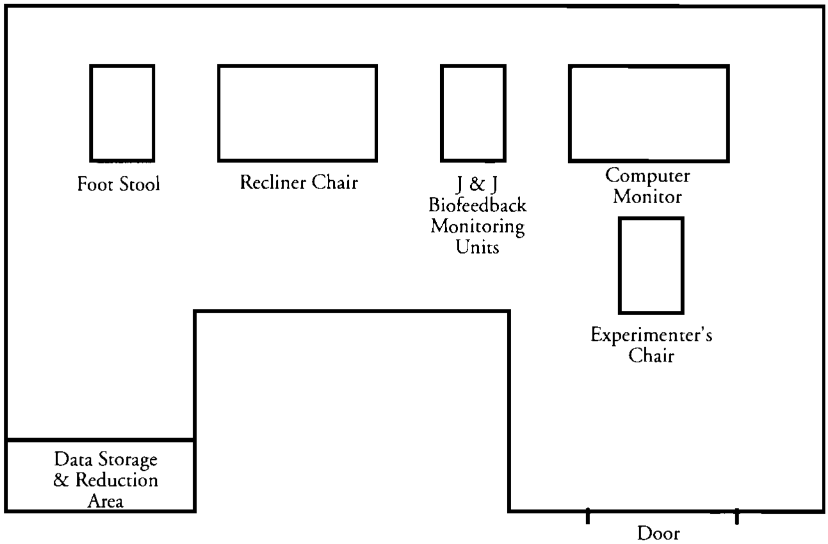

Figure 6. Laboratory Room Layout.

together, providing an inner space for location of the connecting wires, and support and fastening for the copper gauze pads and handles. Super biocircuits provide a copper handle for each hand and copper gauze pads for the neck, sacrum, and soles of the feet. The normal construction of the super biocircuit, hidden inside a double-layered and padded blanket, was therefore ideal for concealing the experimental devices' identity, since it was the connections between the wires which defined the functional status of the biocircuits. The blanket padding was thick enough to prevent the experimenter and subjects from feeling the wires inside the blanket assembly.

Three super biocircuits were constructed for the study: (1) a relaxation type with all unlike poles connected, (2) a tension device with all like poles connected, and (3) a dummy placebo-control type with wires cut, preventing electrical (and presumably subtle energy) connection between the gauze pads and copper handles. Aside from cut wires, the dummy components were identical in length, design and composition to those of the relaxation biocircuit.

The functional super biocircuits and dummy were manufactured and then conveyed to the principal experimenter (JI) by the assistant experimenter (TP). The assistant knew the identity of the circuits on delivery, but the devices were concealed by packaging and not unpacked until after the assistant left the laboratory suite. After departure of the assistant, the principal experimenter opened the packaging and blindly assigned three labels, "A," "B" and "C" to the biocircuits. Since the assistant experimenter could not afterwards visually distinguish between the three biocircuits except by their labels, the study was performed with both the experimenters and all the subjects kept blind to the identity of the biocircuits until after statistical analysis had been performed. It should also be noted that the assistant experimenter did not run subjects, nor was he present at the experimental site during sessions. Sessions were identified as using device A, B or C. The experimenter did not guess the identity of the concealed biocircuits, nor did any of the subjects identify the biocircuits nor did any of them appear to suspect that a dummy biocircuit was used. Subjects appeared to accept the explanation given them that various "different" biocircuits were being tried out (see Participant Selection and Orientation below) without questioning the exact nature of the differences involved.

The copper gauze pads utilized were 5" wide by 5 3/4" long and were approximately 1/16" thick, with 30 gauge (American Wire Gauge) solid copper wires placed 20 to the inch in the gauze. The copper handles consisted of copper pipe of 7/8" outside diameter, 1/16" thick, 3" long. The copper wire used to interconnect the super biocircuit elements consisted of a multi-stranded core insulated with pink tinted transparent PVC of 1.1 mm thickness, giving a total nominal outside diameter of 3.3 mm. The 34 gauge core consisted of 26 strands of non-tinned 99.9% pure copper wire.

In order to further amplify the effect of the super-circuit configuration, the gauze-pad assemblies were reinforced with two extra sheets of copper gauze and they and the handles were connected by three wires, instead of one wire, to the remainder of the super-biocircuit assembly. The gauze-pad assemblies consisted of three layers of the copper gauze, the central layer being connected to the three wires, the other two pads being used to sandwich the central layer. The pad assemblies were taped together with PVC electrical tape.

Application of the Biocircuit to Subjects

In each session the super biocircuit was placed on the recliner chair, prior to the subject entering the room. In use, the top gauze pad of each biocircuit was gently pushed into the gap between the back of the subject's neck and their collar, ensuring skin contact. The bottom pad was slid by the subject between their clothing and their sacrum, ensuring skin contact. Subjects removed their shoes, socks or pantyhose before the biocircuit pads for the feet were placed centrally on the soles of the feet and secured there by elasticized cotton bands. A light cotton blanket was then placed over the subject's feet and ankles and drawn up to their chest. The same blanket was placed in the same way on all subjects.

Participant Selection and Orientation

All subjects (2 males and 10 females) were adult residents of Marin County, California. They spanned an age range between 24 and 56, with a mean of approximately 38. The subject group was largely inexperienced with respect to use of the standard biocircuit. Only 4 subjects had slight to moderate experience of standard biocircuit use, 8 subjects had had no previous experience of biocircuit use. None of the subjects had previously used a super biocircuit.

Subject recruitment was determined mainly by availability. The experienced group was recruited through use of a contact list of local purchasers of biocircuits. The non-experienced group was recruited through the principal experimenter's prior contact with them as subjects in previous studies of other relaxation treatments.

Subjects were told that the disguised devices were three newly-developed variants of the original biocircuit. They were told that these devices were being compared with each other in a double-blind study in order to assess their relative effectiveness as part of a product development project. All subjects accepted this explanation without apparent difficulty. All subjects read and signed a consent form regarding their participation in the study. The consent form was a standard version of the consent form used for behavioral research at John F. Kennedy University. Subjects consented to not being fully informed regarding some aspects of the study.

PROCEDURE

INTRODUCTION

The twelve subjects each participated in four experimental sessions of 30 minutes duration while resting in a recliner chair and listening to the same quiet music in each session via headphones to mask background noise. Subjects adjusted headphone volume to their own preference.

THE FIRST SESSION

First sessions were run using a regular undisguised copper biocircuit, and were regarded as familiarization sessions only. Data from these sessions were not analyzed. The first session had several purposes. First, it included an intake procedure whereby subjects were informed about the study, asked questions, read and signed the consent form and familiarized themselves with the ambience and layout of the experimental room.

The first session required subjects to perform several novel tasks including completion of questionnaires, using a biocircuit, being hooked up to the physiological monitoring system and remaining as still as possible for 30 minutes, then completing a further questionnaire and being debriefed by the experimenter. For 8 of the 12 subjects who were new to the biocircuit, it also provided an opportunity for them to experience the action of a biocircuit in order to provide a basis for comparison with the concealed devices to be used in the three following sessions. Another reason for treating the first session as a familiarization exercise was that in psychological studies the first session can sometimes elicit extreme or paradoxical responses,[21] substantially contributing to the error variance of the study.

SUBSEQUENT SESSIONS

The procedure for the three sessions using the concealed super biocircuits was always the same. The subject would arrive, be greeted and then hooked up to the monitoring equipment, the output of the system was checked for artifact, then the subject would be run for 30 minutes of data-collection time. After release from the monitoring equipment, subjects completed the questionnaire and were then briefly interviewed by the experimenter regarding their experiences in the session. The data were printed and backed up to floppy disk, and then the electrode assemblies were cleaned. Finally, the successful completion of the subject's session was marked off in the sessions log for the study.

CONTROLS AGAINST ARTIFACT IN THE EXPERIMENTAL DESIGN

Care was taken to provide maximum control against artifact in the study design. The controls are briefly reviewed below.

1. DOUBLE BLIND DESIGN. The study was conducted double blind. Neither subjects nor experimenter knew the identity of the three biocircuits under test until data analysis was concluded. The beliefs and expectations of subjects and experimenter could not therefore affect the outcome, since the identity of the disguised biocircuits was concealed.

2. USE OF OBJECTIVE PHYSIOLOGICAL MEASURES. Objective physiological measures were used as well as self-report experiential measures, providing a convergent technique to characterize shifts in state caused by the biocircuits. We chose not to use applied kinesiology or any other form of dowsing as a measuring technique because of the lack of double-blind evidence of accuracy under test conditions. Our measurements are therefore fully comparable to those used in conventional experimental psychology, psychophysiology and medical studies.

3. AVOIDANCE OF ERROR VARIANCE DUE TO FIRST SESSION EFFECTS. First-session effects were avoided by using the first session as a familiarization session and rejecting its data.

4. TREATMENT ORDER COUNTERBALANCED. The order of treatments was counterbalanced across subjects, so that effects due to

order of treatments would be minimized. To illustrate the possible effect of order on results, if a particularly strong effect were encountered in one session and a weaker effect in the following session, subjects might under-estimate the second session. Equally, sessions with strong effects following sessions with weak effects may also distort subjects' judgements of the second session. Using the three super biocircuit treatments (relaxation, tension and dummy) there are six possible treatment orders, so each treatment order was utilized twice in running the twelve subjects. They were assigned randomly to a particular treatment order according to the date of their first session.

5. CONTROL FOR ULTRADIAN RHYTHMS. Effects due to "ultradian rhythms" were controlled. This is an important but frequently overlooked factor in research on relaxation procedures. Human arousal level (and hence likelihood of spontaneous sleep onset) seems to follow a roughly 100-minute cycle—the same cycle which controls dreaming. The arousal cycle produces a natural, endogenous alternation between sleepiness and wakefulness. In many studies,[22] it has been found that the ability to go to sleep during the day varies in step with this 100-minute ultradian rhythm. The strength of the cyclic liability to spontaneous sleep is quite strong in the morning, reaches a peak with the "mid afternoon droop," then becomes much weaker as bed-time approaches.

   When subjects are run at different times of the day on different days, they might be run at different sections of the 100 minute cycle and show differences in the ability to relax and sleep due purely to the ultradian rhythm, differences which are unrelated to the specific relaxation treatments they receive. In this study the ultradian rhythm factor was controlled by running subjects at the same time each day, and running all the sessions for any particular subject within 10 days, since the ultradian rhythm slowly changes phase over periods of several weeks.

6. CONTROL OF ENVIRONMENTAL FLUCTUATIONS. Environmental factors were kept as constant as possible. All sessions were conducted in the same chair in the same room with the same experi-

menter. Subjects listened to the same relaxing taped music, using headphones, with eyes closed. Room temperature was kept within a range of 70° to 75° Fahrenheit.

7. **AVOIDANCE OF ABSOLUTE JUDGEMENTS BY SUBJECTS.** In general, human subjects tend to produce less accurate judgements of the absolute magnitudes of stimuli than of the relative magnitudes of stimuli.[23] A questionnaire requesting comparative evaluation of the three concealed biocircuits was therefore utilized rather than an instrument requiring absolute ratings to be performed.

   In order to reinforce and stabilize subject's memories of the experiential aspects of their sessions, they were asked to fill out the comparative questionnaire, ranking experiential aspects of their session immediately after the session, from the second session onwards, and were then interviewed about experiences. However, the data used for analysis of comparisons were taken only from questionnaires filled out by subjects after the last session.

DATA ANALYSIS AND RESULTS

The 4 physiological measures were evaluated using a non-parametric statistic suitable for paired repeated measures, the Wilcoxon signed-ranks test.[24] While it is less powerful than MANOVA or dependent-measures *t*-tests it was felt to be more appropriate since the distribution of scores being analyzed could not be assumed to be normal.

Table II shows the results of statistical evaluation of the physiological measures. "R" represents the relaxation biocircuit and "D" represents the dummy placebo-control biocircuit. All cited statistics are one-tailed since the hypothesis under test was directional.

Table III shows the significant results obtained by comparing the rankings of the relaxation biocircuit with the ranking of the dummy placebo-control biocircuit in the data from the comparative questionnaire. The rankings were statistically evaluated by Sign test[24] with *a priori* probability of .5.

Table II
Physiological Measures

MEASURE	HYPOTHESIS	PROBABILITY (1 tailed)
EMG figure-of-merit	R > D	.01*
THETA dominant trials	R > D	.025*
EDR session minimum	R < D	.14
TEMP session maximum	R > D	.85

*significant at .05

Table III
Comparative Questionnaire Measures

MEASURE	HYPOTHESIS	PROBABILITY (1 tailed)
Subjective relaxation depth	R > D	.0002*
Sensations of warmth	R > D	.03*
Perceived non-ordinariness	R > D	.02*
Perceived benefit	R > D	.02*
Perceived effectiveness	R > D	.02*

*significant at .05

DISCUSSION OF RESULTS

As is seen in Table II, significantly more theta-dominant trials (indicating trance or light sleep) occurred with the relaxation biocircuit than with the placebo-control dummy biocircuit, with an associated chance probability of .025. Across the three conditions, approximately equal numbers of EEG trials were excluded from data analysis by artifact rejection and the acceptance criterion.

Significantly lower muscle tension occurred with the relaxation biocircuit than with the dummy, with an associated chance probability of .01. The temperature measure (TEMP) did not reach significance in any direction across any pair of treatments (relaxation-dummy, tension-dummy, relaxation-tension).

As will be seen from Table III, ranking the relaxation biocircuit against the placebo-control "dummy" biocircuit, five of the ten questions of the comparative questionnaire produced significant results favoring the relaxation device. No significant results were obtained favoring the placebo-control "dummy" over the relaxation device for any of the ten measures.

The significant experiential measures favoring the relaxation biocircuit compared to the dummy were: Perceived depth of relaxation—12 out of 12 subjects ranked the relaxation biocircuit above the dummy (chance probability of .0002). Perceived benefit from the treatment—10 out of 12 subjects ranked the relaxation biocircuit above the dummy (chance probability of .02). Perceived effectiveness of treatment—10 out of 12 subjects ranked the relaxation biocircuit above the dummy (chance probability of .02). Perceived non-ordinariness of the biocircuit experience (an attempt to get subjects to estimate the "energy" quality of their experience)—10 out of 12 subjects ranked the relaxation biocircuit above the dummy (chance probability of .02). Sensations of warmth (a frequently reported effect of biocircuit use)—9 out of 12 subjects ranked the relaxation biocircuit above the dummy (chance probability of .03).

CONCLUSIONS

THE RELAXATION BIOCIRCUIT WAS MORE EFFECTIVE THAN THE PLACEBO

The results decisively demonstrate that the relaxation biocircuit produced deeper relaxation than the dummy biocircuit under double-blind conditions. The EEG measure indicates that significantly more sleep and trance state occurred with the relaxation biocircuit than with the dummy. The EMG results indicate that greater physical relaxation accompanied use of the relaxation biocircuit compared with the dummy. The fact that no less than 12 of 12 subjects ranked the real biocircuit above the dummy for relaxation in the experiential questionnaire strongly indicates that they perceived the real biocircuit as being more relaxing than the dummy. The other psychological measures tell the same story. Overall, results are surprisingly strong, especially in view of the fact that only twelve subjects were used—indicating a very large effect size.

THE "TENSION" BIOCIRCUIT DID NOT CAUSE TENSION

In contradiction to Eeman's anecdotal findings, the so-called "tension" biocircuit came out as intermediate between the relaxation biocircuit and the dummy in most measures of relaxation although it was not statistically superior to the dummy biocircuit on any measure of relaxation.

The relaxation biocircuit was scored significantly higher than the tension biocircuit on the psychological measures of "subtle energy sensations" (chance probability of .02) and "non-ordinary in-session experience" (chance probability of .02). The lack of obvious tension in the results from the "tension" biocircuit contradicted Eeman's claim,[1] since he relates stories of individuals seemingly almost driven temporarily mad by being exposed to tension biocircuits.

Our results suggested that Eeman's theory of "polarity" needs testing under double-blind conditions. Clearly the electrical hypotheses would also seem to be worth testing. We look forward to pursuing these inquiries further when our resources allow us to do so.

CORRESPONDENCE. Julian Isaacs, Ph.D. • Tools for Exploration • 4460 Redwood Highway, Suite 2 • San Rafael, CA 94903.

ACKNOWLEDGEMENTS: The authors thank Ron Gordon for his generous provision of laboratory space, Sunny Turner for her labors in data analysis, Dr. Jerry Solvfin and Dr. Ephraim Schechter for their statistical consultation and STENS corporation for excellent service during the hire of the monitoring equipment. Thanks are also due to James Spottiswoode for advice and suggestions.

REFERENCES AND NOTES

1. L.E. Eeman, *Cooperative Healing* (Frederick Muller, London, 1947, reprinted 1987 by Health Research, Mokelumne Hill, CA).
2. L. Patten & T. Patten, *Biocircuits: Amazing New Tools for Energy Health.* (H.J. Kramer, Tiburon, CA, 1988).
3. *The authors are aware of the limited nature of their search for controlled double blind studies of putative subtle energy devices. We would be glad to be informed of any such studies, whether published or not.*
4. D. Krieger, *Foundations of Holistic Health: Nursing Practices* (J.P. Lippincott Co., Philadelphia, PA, 1981).
5. *There are several variants of the basic biocircuit. One dimension of variability is in the material used for fabrication. So far, biocircuits have been constructed of copper, silk, and silver plate on copper. The second dimension of variability is in the circuit configurations used, of which there are several. The third dimension of variability is the choice whether or not to mix the putative subtle energy effects of various therapeutic substances into the postulated subtle energy flow through the biocircuit by means of a "substance" bottle placed in series with some section of the biocircuit. All of these variations are detailed in the book on biocircuits by Leslie and Terry Patten.*[2]
6. R. Pethig, Electrical Properties of Biological Tissue, In *Modern Bioelectricity* (A. A. Marino Ed., Marcek Dekker, New York, NY, 1988).
7. R.O. Becker & A.A. Marino, *Electromagnetism and Life* (SUNY Press, New York, NY, 1982).
8. D.B. Harrington, R. Meyer & R.M. Kline, Effects of Small Amounts of Electric Current at the Cellular Level. In *Electrically Mediated Growth Mechanisms in Living Systems (*A.R. Liboff & R.A. Rinaldi, Eds., *Annals of the New York Academy of Sciences* **238**, New York, NY, 1974), pp. 300-306.
9. M. Reichmanis, Electroacupuncture, In *Modern Bioelectricity (*A.A. Marino, Ed., Marcel Dekker, New York, NY, 1988).
10. I. Martin & P.H. Venables, Eds., *Techniques in Psychophysiology* (Wiley, New York, NY, 1980).
11. L. Gwei-Djen & J. Needham, *Celestial Lancets:L A History and Rationale of Acupuncture and Moxa* (Cambridge Universiry Press, Cambridge, England, 1980).
12. G. Feurstein, *Encyclopedic Dictionary of Yoga* (Paragon Press, New York, NY, 1990).
13. *Eeman estimated that perhaps up to 15% of the population is of "reversed" polarity.*
14. R. Pavek, *The Health Professional's Handbook of Shen: Physio-Emotional Release Therapy* (Shen Therapy Institute, Sausalito, CA, 1987).

15. M. Schwartz (Ed.) *Biofeedback: A Practitioner's Guide* (Guilford Press, New York, NY, 1987).
16. R. Sternbach & N. Greenfield, Eds., *Handbook of Psychophysiology* (Holt, Reinhart and Winston, New York, NY, 1973).
17. A.M. Arkin, J.S. Antrobus & S.J. Ellman, *The Mind in Sleep; Psychology & Psychophysiology* (Lawrence Erlbaum Associates, Hillsdale, NJ), 1978.
18. A. Rechtschaffen & A. Kales, Eds., *A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects* (National Institutes of Health Publication 204, Washington DC, US Govt. Printing Office, 1968).
19. J & J Inc., 22797 Holgar Court North East, Polsboro, WA 98370.
20. Cohen H.L. & J. Brunlik, *A Manual of Electromyography* (New York, Harper & Row, 1968).
21. S. Isaac & B. Michael, *Handbook in Research and Evaluation* (Robert R. Knapp, San Diego, CA, 1971).
22. P. Lavie, Ultradian Rhythms: Gates of Sleep and Wakefulness, In *Ultradian Rhythms in Physiology and Behavior* (H. Schulz & P. Lavie, Eds., Springer-Verlag, New York, NY, 1985), pp. 148-164.
23. S.H. Bartley, *Principles of Perception* (Harper & Row, London, 1969).
24. J.L. Bruning & B.L. Kintz, *Computational Handbook of Statistics* (Harper Collins, Glenview, ILL, 1987).