Case Study

SIMULTANEOUS PSYCHOPHYSIOLOGICAL ASSESSMENTS OF A HAWAIIAN HEALER AND CLIENT DURING HEALING

Thomas S. Bearden, M.A.

ABSTRACT

This controlled case study was performed to investigate whether within and between subject physiological changes might occur during a healing experience that would differentiate healing from baseline and control conditions. Simultaneous measurements of EEG absolute power and coherence, heart rate, skin conductance, and hand temperature were performed on two subjects during five periods: two baselines, healing, a meditation or relaxation control condition, and photic stimulation. Each subject demonstrated significant physiological changes during healing that allowed differentiation of healing from their control and baseline conditions. Both EEG and somatic physiological measures indicated that the healer became more aroused during healing and the client more relaxed. The healer had a drop in frontal to occipital interhemispheric coherence during healing as well as increased heart rate and skin conductance. The client had a drop in frontal beta power and a drop in skin conductance during healing. The client also exhibited a strong trend toward increased parietal interhemispheric alpha band coherence during healing. No meaningful increase in covariance of EEG or other physiological measures occurred between the subjects during healing. A statistical method for the analysis of many EEG variables across several experimental conditions for individuals and between two subjects was modeled.

KEYWORDS: EEG, healing, coherence, psychophysiology, paired *t*-tests.

INTRODUCTION

Nontraditional methods of healing have recently begun to be evaluated by the scientific community. To date no studies have conclusively demonstrated a physical mechanism by which a possibly healing transfer of energy between individuals might occur. Nevertheless, there is a growing body of evidence that people can, without physical contact, influence other biological systems in a variety of ways. However, many healing research studies utilizing human subjects have been criticized because of possible placebo effects due to the expectations of the subjects.

Benor concluded that 56 out of 131 controlled trials of healing and psychokinesis (mental effects on biological systems) with enzymes, fungus, yeast, cancer cells, plants, animals, and humans had significant positive results.1 He stated, "if healing were a drug, I believe it would be accepted as effective on the basis of this evidence. Healing is certainly more than a placebo, unless enzymes, yeasts, bacteria, plants and mice are subject to suggestion"[1, p. 30]

Most psychokinetic studies have measured a change in a target group. Very few researchers have actually attempted to measure a wide range of both the purported healer and their clients' physiological indices during a healing session.

Fahrion, Wirkus and Pooley conducted a case study that simultaneously recorded both the healer's and the client's EEGs.[2] The healer exhibited an increase in right frontal high amplitude high frequency activity during all three of the experimental healing conditions, suggestive of an activation of his right hemisphere. Sugano, Uchida and Kuramoto also reported some changes in healers' and receivers' blood pressures, heart rates, electrical meridian activity and EEGs during healing.[3]

A study that investigated the possibility of intersubject EEG synchrony changes was conducted by Grinberg-Zylberbaum and Ramos in 1987.[4] Using 13 pairs of subjects, they recorded fluctuations in the pair's interhemispheric correlations as they attempted to non-verbally communicate. The researchers found that 70% of the pairs of subjects had closer fluctuations in their patterns of interhemispheric correlations during non-verbal communication than during isolated rest. Another study reported increased intersubject EEG coherence between three TM meditators on days when a group of 2,500 meditators 1,000 miles away were meditating.[5]

Braud and Schlitz conducted numerous studies that examined the ability of individuals (influencers) to cause changes in subjects' electrodermal activity.[6] In 11 studies utilizing 174 subjects they reported an overall statistical significance of p = .000034. Results were achieved for both reducing and increasing the subjects' electrodermal activity.

Green, Parks, Guyer, Fahrion and Coyne created an electrically isolated environment utilizing copper walls resting on glass blocks.[7] During healing sessions with the healers and normal subjects in the boxes together the healers demonstrated frequent high voltage electrostatic surges up to 221 volts. Such large voltage surges have never previously been measured from healers or anyone else. The authors cautioned that the electrostatic charges were probably a correlate of healing and not the actual healing itself. Indeed, it might not be possible to measure the undoubtedly subtle mechanisms that may be directly responsible for interpersonal healing.

However, Becker reported that extremely low frequency electromagnetic fluctuations of very low intensity can have profound effects on human bone healing rates, cancer rates, the rate of developmental defects in chicken embryos and even the results of a number of extra-sensory performance tasks.8 He postulated that a healer's magnetic field in conjunction with the earth's magnetic field might produce a resonance effect in a patient's body part allowing the detection and correction of a pathological electromagnetic field.

The present study entails the simultaneous collection of data from a large number of EEG scalp electrodes from each subject as well as their heart rates, skin conductances and hand temperatures. These comprehensive physiological measures were utilized to attempt to delineate any state-specific physiological changes that occurred in either subject during the healing experimental condition. The study was also designed to assess whether any between-subject covariance of physiological activity might occur during healing. It was hypothesized that the subjects would display an increased similarity of physiological activity during healing versus the control conditions. If an increased similarity of physiological activity occurred during healing, it could possibly be reflective of a direct by-product of, or a mechanism for, interpersonal healing.

METHOD

SUBJECTS

The subjects were a middle-aged Hawaiian couple whom had both practiced ancient Hawaiian healing arts for approximately 20 years. The healer practices a form of spiritual healing that involves the detection of putative energy blockages and the sending of "mana" or life force to release the client's blockages. Subjects who were familiar to each other were used to reduce anxiety-related artifacts (such as increased EMG) that would be likely to occur with unfamiliar subjects.

PROCEDURE

The healer and client were seated next to each other in a quiet dimly lit EEG laboratory. The full complement of 19 active silver EEG scalp electrodes were applied both to the healer and to the client according to the international 10-20 electrode system with conductive electrode paste. The electrodes were referenced to linked ears and impedances were below 10 kohms. EOG was monitored via electrodes below the left eye and above the right eye.

A Model 9000 quantitative neurophysiological system from Quantified Signal Imaging was utilized to record the healer's 19 channel EEG and EOG. The amplified analog EEG waveforms were filtered with a bandpass of 1–51 Hz and digitized with a 12 bit A/D converter at 102.4 samples/sec and stored in 2.5 second epochs.

A 17–channel Grass model 8–D electroencephalograph was utilized to record the client's EEG and EOG. The amplified analog signals were filtered with a 6 db/octave 1 Hz high pass filter and a low pass rapid roll off filter that attenuated 100% of 60 Hz and higher activity. The analog signals were digitized using Rhythm Software from Stellate Systems with a 12 bit A/D converter at 128 samples/sec. A conversion program allowed the Grass-Rhythm EEG data to be assessed by the QSI 9000 as if it were generated by the QSI system. An interpolation procedure was utilized to create data for the client's midline electrodes (Fz, Cz & Pz) to allow the creation of full-scalp power topographic maps.

Both subjects' EKGs, right-index-finger hand temperatures and left hand (second and third digits) skin conductances were recorded with silver-silver chloride electrodes. The room temperature varied from 76 to 77 degrees Fahrenheit from the beginning to the end of the experiment. The subjects' somatic physiological signals were recorded with an eight channel Thought Technology biofeedback system. The analog waveforms were digitized at various sampling rates, displayed on the computer screen and saved to a file.

The experimental protocol included two-minute reading periods (of self-selected literature) before each experimental condition to minimize any carry over effects and to begin each experimental condition with a similar state of alertness. All recordings during the experimental periods were conducted simultaneously.

The experimental protocol for the healer consisted of a two-minute reading period followed by a four-minute eyes closed baseline. Then another two-minute reading period followed by a four-minute meditation period occurred. Meditation has previously been used as a control condition in a healing experiment.[2] During the meditation period the healer's chair was turned toward the client's recliner and his right arm was supported at the elbow and extended toward the client. This position was very similar to the position the healer used during the healing period. After another 2 minutes of reading, a twelve-minute healing session occurred. During the first three and a half minutes of the healing session, the healer had his eyes open as he scanned the client's energy field for "energy blockages." A four-minute data sample was used as the healing period beginning thirty seconds after the healer closed his eyes and running to the nine-minute mark. During this four minutes the healer reported actively attempting to transfer healing energy to the client's heart area where he had earlier detected an energy blockage. Shortly after the nine-minute mark, the healer ended the active portion of the attempted healing.

After the healing session, another baseline was recorded. The last experimental condition consisted of four minutes of photic stimulation at a nine-Hz flash rate. The photic stimulation was conducted with a Grass model PS33 photic stimulator flashing at nine flashes per second. It was placed at the midline between the subjects, four feet from their faces. Photic stimulation is known to elicit an alpha-band dominant frequency-following or driving response in a majority of subjects. The photic stimulation period was performed to evaluate the ability of the various analytical techniques to detect EEG changes that actually occurred.

The client's experimental protocol differed only in that instead of a meditation control period, there was a relaxation period. As with the healer, a four-minute period running from the fourth to ninth minute of the healing session was utilized for analysis. At the conclusion of the experiment both subjects filled out an assessment of the depth of their states of relaxation or meditation and the intensity of their healing session.

Data Analysis

The EEG absolute power (rms amplitude squared) from 16 scalp electrodes referenced to linked ears and four bipolar electrode pairs (T3–O1, T4–O2, F3–O1 & F4–O2) was calculated for each edited 2.5 second epoch of each condition. The frequency analysis was performed using a fast Fourier transform (FFT). The .4 Hz wide increments were then combined into delta (1.6–4.0 Hz), theta (4.0–8.0 Hz), alpha (8.0–12.8 Hz), beta 1 (12.8–30.0 Hz) and beta 2 (30.0–50.0 Hz) frequency bands. The resultant power values from each epoch were log-transformed to achieve a normal distribution.[9]

All power- and coherence-paired *t*-tests were conducted only between pairs of 2.5 second epochs that matched up temporally across the different conditions. Due to the editing of the various samples, some epochs from one subject were matched with edited epochs that occurred at the same time from the other subject. These mismatched epochs could not be tested. This resulted in a reduction of the data sets available for testing. The subjects' power data sets were also randomly reduced in size so that the number of cases accorded with the test-retest EEG amplitude and power literature.[9-11] These studies proved that 50-60 seconds of power data is more than adequate to delineate an individual's power spectrum for individual test-retest and group testing purposes. The resultant within-subject power paired *t*-tests had 21-29 cases with an average of 23 cases (57.5 seconds) for the healer and 27 cases (67.5 seconds) for the client.

Coherence values were also calculated from select electrode pairs (F3–F4, T3–T4, P3–P4, O1–O2, F3–C3, F4–C4, F3–P3, F4–P4, F3–O1 vs. F4–O2 & T3–O1 vs. T4–O2) for each edited 2.5 second epoch of each condition. The coherence values from each epoch were transformed to a more normal distribution using Fisher's Z transform on the square root of each value.[12] Coherence may be thought of as a measure of the functional coupling of two brain regions. Its calculation involves the assessment of the variability of frequency specific power and phase values and is expressed as a correlation coefficient ranging from 0–1.

The coherence-paired *t*-tests utilized the original larger data sets that existed before the random data reduction was performed. An average of 48 cases (120 sec) were available for the healer's within subject coherence comparisons. An average of 40 cases (100 sec) were available for the client's within subject comparisons.

Data Editing

In general the recordings from both subjects were edited to eliminate epochs that contained EMG and EOG artifacts as well as drowsiness. Both the polygraph recordings and the digital representation of the waveforms on the QSI video monitor were scanned for editing purposes.

The client's EEG reflected high levels of slow eye movements across all the experimental periods. It was impossible to eliminate all of this EOG artifact by editing. Therefore, her delta band absolute power and coherence values could not be utilized for any statistical analyses. Otherwise, her EEG had very little EMG artifact and she maintained a very consistent state of consciousness with minimal drowsiness.

The healer's level of alertness fluctuated slightly across the different periods, however, he had few outright drowsy epochs. His EEG reflected only minimal eye movements.

However, preliminary analysis of the healer's delta band absolute power and coherence data showed few positive differences across the five conditions. The ones that were positive were all from the frontal electrodes, probably indicating an EOG influence as well. Consequently, no delta band power or coherence data from the healer is presented either.

The healer also demonstrated moderate amounts of left hemispheric dominant scalp EMG artifact during both the meditation and healing periods. This EMG artifact was partially induced by the physical effort required to keep his right arm somewhat extended during these two periods. It was especially prevalent during the healing period and it affected all nineteen of the active electrodes to some extent and could not be totally eliminated by editing. Therefore, the healer's beta absolute power and coherence values from the meditation and healing periods could not be utilized for any statistical analyses.

Other data problems involved the attempted log power and Fisher's Z coherence transforms to achieve more normal distributions. These transforms did not produce normal distributions of beta 2 power or coherence from either subject. Consequently, power and coherence paired t-tests could not be performed for the beta 2 band.

Statistical Procedures

Within-subject paired power and coherence t-tests were performed between each subject's five experimental periods. Between-subject independent t-tests were performed on the *differences* between the subjects' coherence values across the experimental periods.

Correlation coefficients have been utilized by a number of authors to test the variability of amplitude and power measurements from individual subjects over periods of time ranging from five minutes to sixteen weeks and longer.[9-11,13-15] It is imperative that an individual's EEG values from their pre and post treatment baselines be highly correlated. If the baselines are not highly correlated, any significant differences ascribed to the independent variable may simply be due to the intrinsic variability of the power and coherence measures over time. Therefore, within subject Pearson's correlation coefficients were calculated between each subject's Baseline 1 and Baseline 2 power and coherence values. In an effort to reduce the number of false positive (Type I) errors several *a* *priori* measures were selected based on the literature.[2,4,5] The within subject *a priori* values were as follows:

1. O1-O2 alpha coherence from both subjects.

2. O2 absolute beta power from the healer.

3. Fp2 absolute beta power from the healer.

4. F3-O1 vs. F4-O2 combined theta, alpha and beta coherence from both subjects.

However, due to the healer's EMG artifact during healing the O2 and Fp2 absolute beta power measures could not be used. Additionally, the beta coherence was dropped from both subjects' F3–O1 vs. F4–O2 combined coherence measure.

The single between-subject *a priori* value was F3–01–F4–O2 combined theta, alpha and beta coherence vs. F3–O1–F4–O2 combined theta, alpha and beta coherence. Again, the beta coherence was dropped from the combined coherence measure.

Within-subject one-way ANOVAs were conducted on the two *a priori* coherence measures across each experimental period for each subject. A one-way ANOVA was also performed on the single between-subject *a priori* coherence measure across all the periods.

RESULTS

HEALER'S BACKGROUND ACTIVITY

The healer's Baseline 1 total amplitudes (rms) from the left and right occipital head regions were 26 and 21 microvolts respectively. His absolute power maps divided into the delta, theta, alpha, beta and total power frequency bands are presented for each experimental period in Figure 1. As can be observed from Figure 1, the healer's highest power alpha activity occurred from the fronto-central head regions in all the periods except the healing period. He consis-

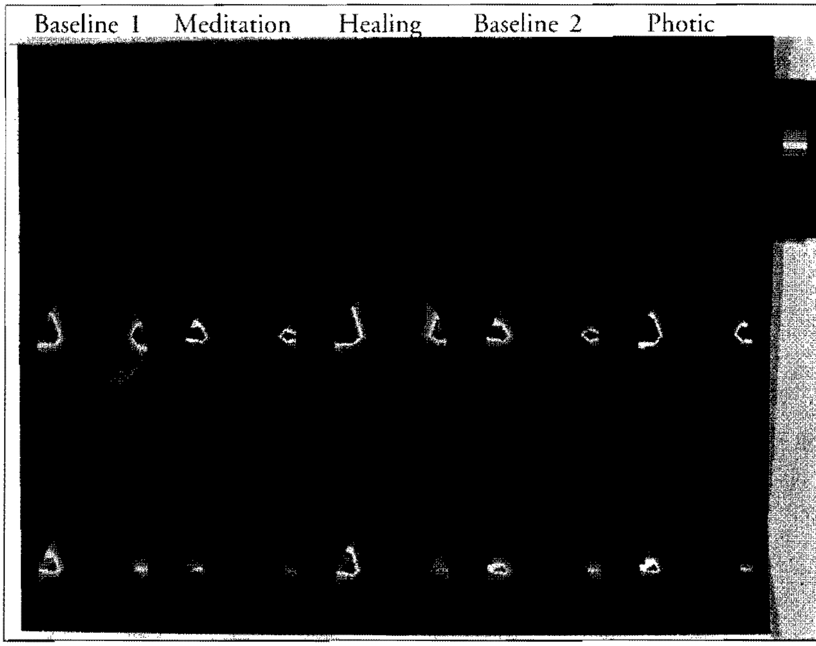

Figure 1. Healer's absolute power across periods divided into the delta, theta, alpha, beta and total power frequency bands. Darker shading corresponds to increased power.

tently displayed more alpha power in his left posterior head region than his right. His alpha band occipital centroid was 10.2 Hz.

The healer had generally high alpha coherence measures (.62 - .94) for Baseline 1 from both the inter and intrahemispheric electrode pairs except for the mid-temporal interhemispheric pair (T3–T4) which had a value of .23. The frontal interhemispheric alpha band coherence (F3–F4) and the right frontocentral alpha band coherences were highest at .94.

HEALER'S COHERENCE BASELINE CORRELATIONS

To ascertain the stability of the healer's coherence measures across the baselines, his Baseline 1 to Baseline 2 coherence Pearson correlation coefficients were calculated from 10 electrode pairs from the theta, alpha and beta 1 bands. His mean correlation coefficients were .99, .98 and .99 ($p < .001$), respectively. All of the healer's individual electrode coherence correlations were $\geq .96$ ($p \leq .001$)

.

HEALER'S COHERENCE PAIRED T-TESTS

There were six experimental comparisons; Baseline 1 (B1) to Baseline 2 (B2), B1 to Meditation (Med), B1 to Heal, Med to Heal, B2 to Heal and B1 to Photic.

Because of the large number of paired two-tailed *t*-tests and the resultant high probability of false positive results, only significant changes that occurred in the same direction across all three comparisons to the healing period (B1, B2 and Med) were considered meaningful. Additionally, these changes were not considered meaningful if they also occurred between the B1 to B2 or B1 to Med control conditions.

The healer's significant ($p \leq .05$) coherence *t*-test results are presented in Table I. Ten electrode pairs were utilized for testing between the six comparisons. In addition to the usual theta, alpha and beta 1 frequency bands (except for the Med & Heal periods), a special combined theta + alpha band was utilized for the F3–01 versus F4–O2 electrode pairs.

The healer's control conditions of B1–B2 and B1–Med were well behaved with only 4 significant theta, alpha and theta + alpha band comparisons. In contrast his three B1–Heal, B2–Heal and Med–Heal comparisons yielded 25 significant theta, alpha and theta + alpha band coherence results.

Several trends are apparent. His frontal to occipital interhemispheric coherence (F3–O1 vs. F4–O2) dropped dramatically in the theta, alpha and theta + alpha frequency bands during healing. The alpha band and the theta + alpha band results met the criteria for reliability. They occurred across the three comparisons to Heal and not between the baselines or Med–Heal.

Another trend was an increase in frontal to parietal intrahemispheric coherence from F3–P3 and F4–P4. The increased F4–P4 alpha band coherence during

Table I

Healer's significant coherence *t*-tests between periods by frequency band.

Period	Electrode Pair F3-01 F4-02	T3-01 T4-02	F3-F4	T3-T4	P3-P4	01-02	F3-C3	F4-C4	F3-P3	F4-P4
B1–B2										
Theta + Alpha										
Theta										
Alpha		.039↑								.022↓
Beta 1	.015↑	.001↑	.001↑		.001↓	.001↓	.001↓	.001↑		
B1–Med										
Theta + AlPha										
Theta	.043↓					.017↓				
Alpha										
B1–Heal										
Theta + Alpha	.002↓[a]									
Theta										.036↑
Alpha	.002↓[a]	.001↑								.014↑
Med–Heal										
Theta + Alpha	.001↓[a]									
Theta	.001↓	.020↓	.001↓		.001↑				.016↑	
Alpha	.001↓[a]		.002↓						.001↑	.002↑
B2–Heal										
Theta + Alpha	.001↓[a]									
Theta	.001↓		.001↓		.001↑				.003↑	.001↑
Alpha	.001↓[a]		.001↓						.001↑	.001↑
B1–Photic										
Theta + Alpha										
Theta								.038↑		
Alpha							.006↑	.022↑	.050↑	.020↑
Beta 1							.001↓	.005↑	.001↑	

Note: Arrows denote the direction of the mean coherence changes (second period relative to first period).
Note: $p < .05$
[a]*Meet all criteria for reliability*

Heal versus B1, B2 and Med almost met the criteria for reliability except a significant B1–B2 alpha band change also occurred which, however, was in the opposite direction from the changes observed during Heal. As expected, the healer's B1–Photic *t*-tests showed widespread increases in alpha band coherence during Photic.

Healer's Absolute Power Baseline Correlations

To ascertain the stability of the healer's absolute power measures across the baselines, his B1–B2 Pearson correlation coefficients were calculated from 16 referential electrodes and 4 sets of bipolar electrodes from the delta, theta, alpha and beta 1 bands. His mean power correlation coefficients were .98, .98, .95 and .95 ($p < .001$), respectively. All of the healer's individual electrode power correlations were > .88 ($p < .001$).

Healer's Absolute Power Paired *t*-Tests

The healer's significant ($p < .01$) absolute power *t*-tests demonstrated several trends that also can be discerned from the power maps in Figure 1. There were 3 significant increases in posterior alpha power from B1 to B2 that were probably due to the subject becoming more relaxed as the experiment progressed. The Heal–B2 and Heal–Med periods had 36 significant *t*-tests indicative of markedly reduced frontal, central and temporal theta and alpha band power during Heal. These *t*-tests did not meet the criteria for reliability because they did not also occur between Heal and B1.

The B1-Photic power *t*-tests revealed only 1 significant increase in posterior alpha from T6. However, 8 more posterior electrodes had increases in alpha at the $p < .024$ significance level.

Client's Background Activity

The client's Baseline 1 total amplitudes (rms) from the left and right occipital head regions were 13 and 14 microvolts respectively. As can be observed from

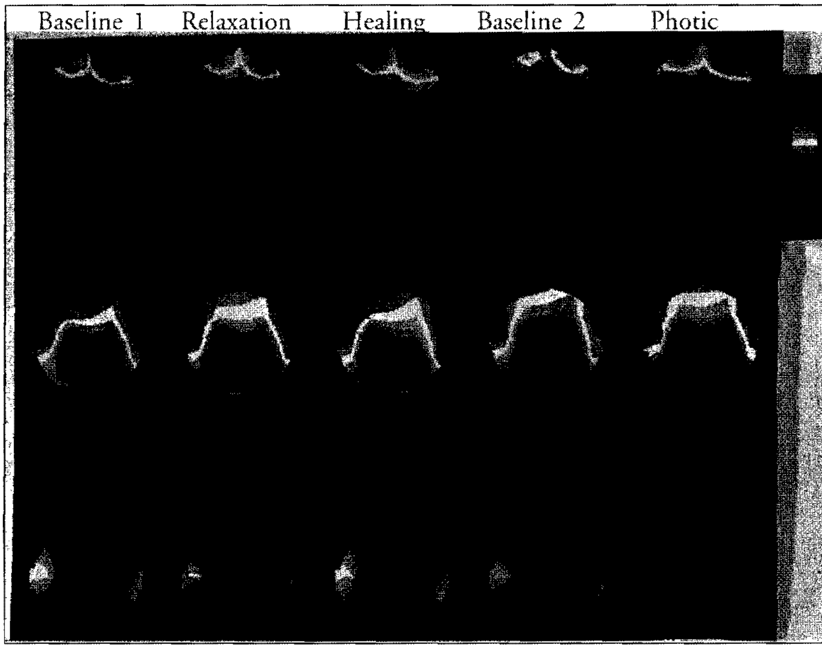

Figure 2. Client's absolute power across periods divided into the delta, theta, alpha, beta and total power frequency bands. Darker shading corresponds to increased power.

Figure 2, her highest power alpha band activity was from the parietal head region. Her Baseline 1 alpha band centroid from the occipital head region was 10.4 Hz. She remained alert throughout all the experimental periods with very few drowsy epochs.

Her Baseline 1 alpha band coherence measures ranged from .48 to .83 except from the interhemispheric mid-temporal pair (T3–T4) which had a value of .12. Her interhemispheric (F3–O1 vs. F4–O2) electrode pairs had the highest alpha coherence at .83.

Client's Coherence Baseline Correlations

The client's Baseline 1 to Baseline 2 coherence Pearson correlation coefficients were calculated from 10 electrode pairs from the theta, alpha, beta 1 and beta 2 bands. Client's mean correlation coefficients were .98, .98, .99 and .99 ($p < .001$), respectively. All of the client's individual electrode correlations had values $\geq .96$ ($p \leq .001$).

Client's Coherence Paired *T*-tests

The same six comparisons were performed for the client as the healer except the relaxation control period was substituted for the meditation control period. The same 10 electrode pairs and frequency bands that were used for the healer's coherence *t*-tests were used for the client except that client's beta 1 band coherence could be tested between all six comparisons. The client had 6 significant ($p < .05$) *t*-tests that demonstrated increased theta and alpha band coherence between client's B1–B2 and B1–Relax control periods. These coherence increases were probably indicative of increased relaxation as the experiment progressed.

A strong trend toward increased interhemispheric parietal (P3–P4) alpha band coherence occurred with significant tests between B1–Heal ($p = .047$), Relax–Heal ($p = .012$) and an almost significant test ($p = .062$) between B2–Heal. No significant P3–P4 alpha band B1–B2 or B1–Relax changes were observed, so this result almost met all the criteria for reliability.

As expected, the client had a number (10) of significant *t*-tests indicative of increased coherence during Photic. Interestingly, these positive results were all in the theta and beta 1 bands instead of the alpha band.

Client's Absolute Power Baseline Correlations

The client's B1–B2 absolute power Pearson correlation coefficients were calculated from 20 electrode pairs from the delta, theta, alpha and beta 1 bands. Client's mean correlation coefficients were .98, .97, .96 and .97 ($p < .001$), respectively. All of the client's individual electrode power correlations were >.92 ($p < .001$).

Client's Absolute Power Paired t-Tests

The client's significant ($p < .01$) power t-tests results are presented in Table II.

The client's B1–B2 comparisons yielded only one significant result in the beta 1 band. In sharp contrast B1, B2 and Relax comparisons to Heal had numerous (14) reductions in frontotemporal beta 1 power. Non-parametric Wilcoxan signed ranks tests of client's beta 2 power indicated similar drops of beta 2 power during healing. One left frontotemporal electrode (F7) had significant reductions in beta across all three of the comparisons to Heal. This F7 beta power drop during Heal met the criteria for reliability.
Two of the comparisons (B1-Heal & Relax-Heal) had a significant increase in beta from C4 during Heal. However, inspection of the compressed spectral array from C4 revealed this increase was not due to an increase in beta 1 power but to an increase in alpha power that slightly overlapped into the lower limit of the beta 1 band.

The client's B1–Photic t-tests demonstrated a marked increase in theta, alpha and beta 1 power across the entire scalp during Photic.

Between Subject Coherence Independent *T*-tests

A method was devised to circumvent the large coherence differences between the subjects. The coherence differences between the healer and client's B1–B1, Med–Relax, Heal–Heal, B2-B2 and Photic-Photic periods were calculated. Then independent t-tests of the relative coherence *differences* between the healer and client's B1s to B2s, B1s to Med/Relax, B1s to Heals, Med/Relax to Heals, B2s to Heals and B1s to Photics periods were performed. The significant ($p < .05$) coherence differences t-test results are presented in Table III.

The six significant theta and alpha band t-tests between the B1s–B2s and the B1s–Med/Relax control periods all demonstrated increased coherence differences between the subjects as the experiment progressed (*i.e.*, B2s > B1s and Med/Relax > B1s).

Table II
Client's significant power *t*-tests between periods by frequency band.

Period	FP1	FP2	F3	F4	F7	F8	C3	C4	T3	T4	T5	T6	P3	P4	01	02	T3-01	T4-02	F3-01	F4-02
									Electrode											
B2–B2																				
Theta																				
Alpha																				
Beta 1												.010↑								
B1–Relax																			.003↑	
Theta																				
Alpha																				
Beta 1																	.003↑			
B1-Heal																				
Theta																				
Alpha																				
Beta 1					.001↓[a]			.005↑		.001↓										
Rel–Heal																				
Theta																				
Alpha																				
Beta 1	.009↓				.001↓[a]			.001↑	.001↓											
B2–Heal																				
Theta																				
Alpha																				
Beta 1					.001↓[a]					.002↓	.001↓	.001↓			.001↓	.001↓		.004↓	.002↓	.005↓
B1–Photic																				
Theta	.004↑	.010↑	.001↑	.001↑	.001↑		.005↑	.001↑	.006↑				.005↑	.002↑	.002↑	.005↑	.001↑		.002↑	.005↑
Alpha	.002↑	.006↑	.001↑	.005↑	.001↑	.008↑	.003↑										.001↑	.008↑		.007↑
Beta 1	.001↑	.001↑	.001↑	.001↑	.001↑		.001↑	.001↑	.001↑			.001↑	.001↑	.001↑	.001↑		.001↑	.003↑	.001↑	.001↑

Note: *Arrows denote the direction of the mean power changes (second period relative to first period).*
Note: $p < .01$ [a]*Meet all criteria for reliability*

Table III

Between subject significant *t*-tests of relative coherence differences between periods by frequency band.

Period	Electrode Pair F3–01 F4–02	T3–01 T4–02	F3–F4	T3–T4	P3–P4	01–02	F3–C3	F4–C4	F3–P3	F4–P4
B1s–B2s										
Theta + Alpha										
Theta										.002↑
Alpha		.033↑	.009↑					.050↑		
Beta 1		.001↑	.028↑					.001↑		
B1s–Med/Rel										
Theta + Alpha										
Theta				.018↑						
Alpha		.047↑								
B1s–Heals										
Theta + Alpha	.001↓[a]									
Theta	.038↓[a]									
Alpha	.008↓[a]	.031↑						.043↑		
Med/Rel–Heals										
Theta + Alpha	.004↓[a]									
Theta	.005↓[a]	.044↓	.002↓							
Alpha	.008↓[a]								.028↑	
B2s–Heals										
Theta + Alpha	.003↓[a]									
Theta	.001↓[a]		.002↓							
Alpha	.020↓[a]		.001↓							
B1s–Photics										
Theta + Alpha										
Theta	.023↓		.008↓						.049↑	
Alpha			.015↓	.004↑						.001↑
Beta 1	.008↑	.001↓			.049↑	.042↑		.008↓		

Note: Arrows denote the direction of the mean coherence changes (second period relative to first period).
Note: $p < .05$
[a]*Meet all criteria for reliability*

In sharp contrast, The B1s–Heals, the B2s–Heals and the Med/Relax–Heals periods had thirteen significant theta, alpha and theta + alpha band tests with decreased differences during Heal. The decrease in differences during the healing periods was most pronounced from the interhemispheric frontal to occipital electrode pair (F3–O1 vs. F4–O2) which had highly significant results from all three comparisons across all the frequency bands. Since there were no F3–O1 vs. F4–O2 B1s–B2s or B1s–Med\Relax changes, these significant results met the criteria for reliability.

ANOVAs of *A Priori* Coherence Measures

One-way analyses of variance were performed on the two *a priori* within subject coherence values across the experimental periods. The Tukey-b multiple comparisons test was used to determine which periods were significantly ($p < .05$) different.

The healer's F3-O1 vs. F4-O2 combined theta + alpha band coherence ANOVA was highly significant (F (4, 375) = 7.61, ($p < .001$). His Tukey-b multiple comparisons test demonstrated significant ($p < .05$) differences between Heal and all other periods.

The ANOVA from the combined theta + alpha band coherence differences between the subjects from F3–O1 vs. F4–O2 was significant (F (4, 238) = 2.62, ($p = .035$). One Tukey-b multiple comparison test between the Healing periods and the B1s was significant ($p < .05$).

While the use of ANOVA with single case studies violates some of the assumptions underlying ANOVA techniques, in this case the ANOVA results correlated quite well with both the healer's and the between subjects' coherence t-tests.

Somatic Physiological Comparisons

Figures 3, 4 and 5 display the graphs of the subjects' heart rates, skin conductances and hand temperatures across the five periods.

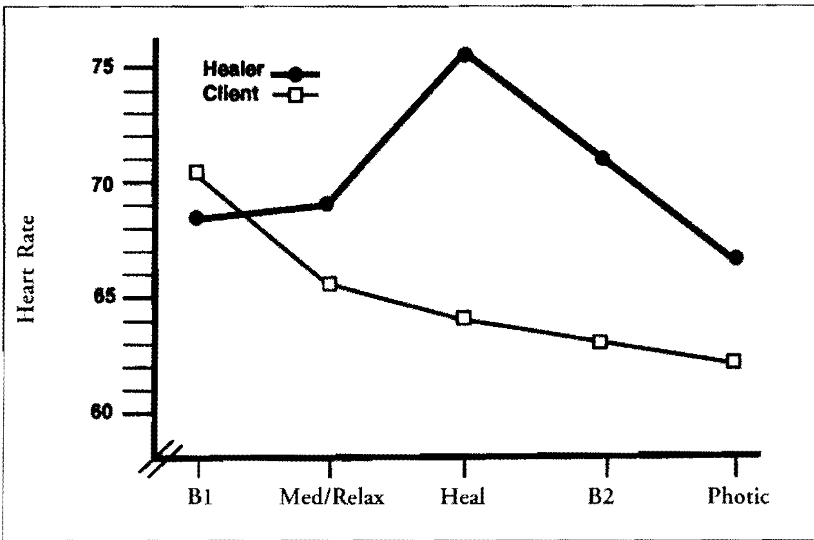

Figure 3. Heart rates in beats per minute.

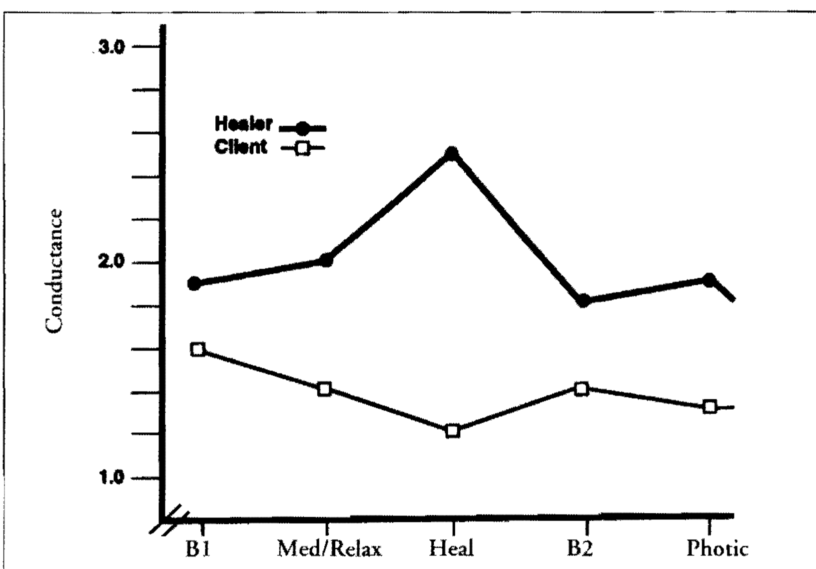

Figure 4. Skin conductances in micromhos.

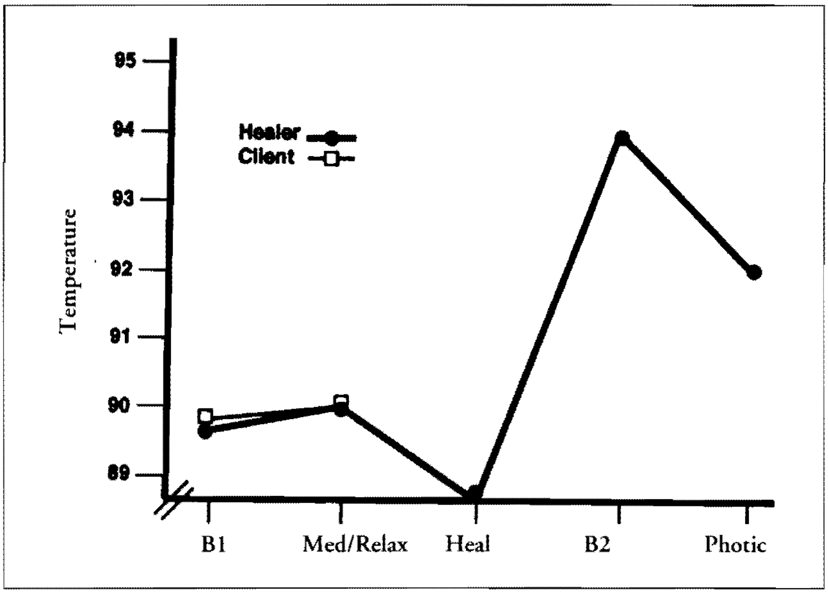

Figure 5. Hand temperatures in degrees Fahrenheit.

The client's hand temperature thermistor malfunctioned halfway into the Heal period and no further data was recorded from it during the remaining periods. As is apparent from the figures, the healer became more aroused during healing with increases in heart rate and skin conductance and a slight drop in hand temperature. The client became more relaxed during healing as evidenced by a drop in skin conductance.

SUBJECTS' ASSESSMENTS

After the experiment the subjects filled out a short questionnaire that rated the level of their relaxation or meditation and the intensity of their healing experience. The healer reported that both his meditation and feeling of energy transfer during healing were more intense than normal. The client categorized her state of relaxation as being somewhat relaxed which was listed between not very relaxed and good relaxation.

The healer and client both reported that during healing the healer was focusing on the heart area where the client had experienced "energy blockages" in the past. During the healing the healer placed his right hand above the client's left arm. They both reported that at one point the client's left hand actually begin to vibrate. Interestingly, the client's temperature thermistor that was on her left hand malfunctioned at about the same time. However, the experimenter was not closely observing the subjects at this point and did not observe any vibrations of the client's hand.

The client reported that initially she experienced tingling up client's left arm and across client's mid-back. She noted that although the healer had worked on client's many times before, client's eyes had always been open. She reported being startled by the intensity of the sensations with client's eyes closed. As the healing progressed she felt "an opening of the energy around client's heart" followed by a sense of relaxation and tiredness.

DISCUSSION

Appropriateness of Statistical Techniques

There has been much debate about the propriety of performing multiple *t*-tests on both group-to-group comparisons and individual-to-group comparisons.[16-18] While the statistical issues are much too complex to fully examine here, there have been some EEG studies that are more directly relevant to the present study.

These test-retest EEG studies have addressed the propriety of multiple paired *t*-test comparisons of EEG data from a single subject at retest times varying from five minutes to 16 weeks.[9,11,15] These studies all found that correlations of power measures are quite consistent across retest intervals using the average values from small numbers of subjects. However, Burgess and Gruzelier cautioned against single subject multiple *t*-test power comparisons for research purposes because some individuals in their groups demonstrated poor (< .80) test-retest correlations from various frequency bands.[11]

Fortunately, both of the subjects in the present study had very high Baseline 1 to Baseline 2 power and coherence correlations (means of approximately .97 and .985 respectively across all the frequency bands).

Additionally, the stringent *t*-test reliability requirements across the experimental conditions greatly reduced the possibility of type I (false positive) errors due to chance. The positive ANOVAs from the same coherence measures that met the *t*-test reliability requirements helped confirm the validity of the reliability criteria.

Finally, the inclusion of a photic stimulation condition provided an estimate of the power of the various statistical tests to detect actual changes that are known to occur and helped avoid type II (false negative) errors. Even though neither of the subjects demonstrated a clear driving response to photic stimulation on their polygraphic tracings, they (especially the client) had a number of significant power and coherence changes between Photic and B1 that were picked up by the paired *t*-tests.

Relevance of Results

The experimental hypotheses were that significant within-and-between subject physiological changes would occur during healing that would differentiate healing from the baseline and control conditions. Additionally, it was hypothesized that if significant between-subject changes did occur during healing they would be in the direction of increased physiological covariance. It was hoped that if physiological indices covaried during healing they might shed some light on possible mechanisms for, or direct by-products of, interpersonal healing.

Each subject had significant physiological changes during healing that allowed differentiation of healing from their control and baseline conditions. As is evident from both their EEG and somatic physiological measures, the healer became more aroused during healing and the client became more relaxed. Unfortunately, since no active experimental control condition (such as mental arithmetic) was utilized in this study it is impossible to ascertain whether the healer's EEG and other physiological changes during healing were state-specific for healing or were simply symptomatic of his general state of arousal.

It is worthwhile to note that one study reported increased sympathetic arousal and occipital alpha blocking during healers' successful attempts to resuscitate anesthetized mice.[19] Similarly, another study found an increase in occipital beta activity during healing versus resting and mental arithmetic in a study of five therapeutic touch healers.[20] Fahrion *et al.* also reported that their healer demonstrated increased fast activity from the right frontal head region during healing.[2] These three reports and the present study suggest that for many healers the process of attempting a healing involves an active, aroused psychophysiological state that is quite different from the more relaxed, passive states observed during meditation and relaxation. The present study clearly demonstrates the desirability of including somatic physiological measures in conjunction with EEG activity for the assessment of states of consciousness.

The client also experienced physiological changes during healing that did not occur during client's baseline or relaxation conditions. These EEG and skin conductance changes are consistent with a less focused, more relaxed state and correlate quite well with client's subjective assessments of increased relaxation and tiredness as the healing condition progressed. The client also had one coherence change during healing that was significant between B1-Heal & Relax-Heal and another that was almost between B2–Heal (p = .062). The significant change was an increase in interhemispheric (P3–P4) parietal alpha-band coherence. A minute-by-minute examination of client's P3–P4 alpha band coherence showed a steady increase in coherence with values of .48, .55, .59 and .65 from the first to fourth minutes of the healing period. The four minutes of the twelve-minute healing condition that preceded the four- minute healing period had an average P3–P4 alpha band coherence value of .46. The ninth, tenth, eleventh and twelfth minutes of the healing condition (recorded after the active portion of the healing was over) had P3–P4 alpha band coherences of .65, .61, .60 and .59 respectively. This intriguing result could possibly be a direct effect of the healing and may be reflective of an increased interhemispheric integration of the client's sensory cortex. The healer did not demonstrate either an overall, or minute-by-minute significant increase in P3-P4 alpha band coherence during healing.

At first glance, this study's finding of significantly decreased between-subject interhemispheric coherence differences during healing confirms the hypothesis that an increased similarity of coherence patterns might occur during healing. Closer examination reveals that this increased similarity of coherence values was due exclusively to the reduction in the healer's very high coherence values as he became more aroused during the healing. This reduction resulted in his coherence values more closely resembling the lower coherence values of the client. With the exception of the strong trend toward increased interhemispheric parietal alpha coherence, the client's coherence values did not rise significantly during the healing condition.

Thus, no clear evidence was found of a meaningful increase in the similarity of EEG or somatic physiological measures during healing. Consequently this case study did not help pinpoint a possible mechanism for interpersonal healing. It is possible that if an energy transfer does occur during healing, the EEG may not directly reflect it.

The most interesting sites for future EEG research appear to be the intrahemispheric frontal to parietal and interhemispheric parietal sites. The parietal lobes control the cortex's sensory processes and would be expected to play a large role in at least perceiving an energetic process, as may possibly have been the case with the client. The functional coupling between the more process-orientated frontal lobes and the parietal lobes (as assessed by coherence) might shed light on the interplay between these brain regions during healing.

This study presented a statistical model for the assessment of large numbers of EEG power and coherence variables across several experimental conditions. This model was effective for the exploratory analysis of a single subject's data as well as comparisons between two subjects. It is hoped that this study's statistical model can be effectively utilized in the future for the often difficult problem of assessing single subject and between subject EEG data across a number of experimental periods.

• • •

CORRESPONDENCE: Thomas S. Bearden • 1338 Chambers Street • Vicksburg, MS 39180.

REFERENCES AND NOTES

1. Daniel P. Benor, Survey of Spiritual Healing Research, *Complementary Medical Research* 4 (1991), pp. 9-32.
2. Steven L. Fahrion, Mietek Wirkus & Patricia Pooley, EEG Amplitude, Brain Mapping and Synchrony in and Between a Bioenergy Practitioner and Client During Healing, *Subtle Energies* 3,2 (1992), pp. 19-52.
3. H. Sugano, S. Uchida, & I. Kuramoto, A New Approach to the Studies of Subtle Energies, *Subtle Energies* 5,2 (1994), pp. 143-166.
4. Jacobo Grinberg-Zylberbaum, & J. Ramos, Patterns of Interhemispheric Correlates During Human Communication, *International Journal of Neuroscience* 36 (1987), pp. 41-53.
5. D. Orme-Johnson, M.C. Dillbeck, R. K. Wallace, & G.S. Landrith, Intersubject EEG Coherence: Is Consciousness a Field?, *International Journal of Neuroscience* **16** (1982), pp. 203-209.
6. William Braud & Marilyn Schiltz, Possible Role of Intuitive Data Sorting in Electrodermal Biological Psychokinesis (Bio-PK), *Journal of the American Society for Psychical Research* **83** (1989), pp. 289-302.
7. Elmer E. Green, Peter A. Parks, Paul M. Guyer, Steven L. Fahrion & Lolafaye Coyne, Anomalous Electrostatic Phenomena in Exceptional Subjects, *Subtle Energies* 2,3 (1992), pp. 69-94.
8. R.obert O. Becker, *Cross Currents* (St. Martin's Press, New York, NY, 1990).
9. B. S. Oken & K. H. Chiappa, Short Term Variability in EEG Frequency Analysis, *Electroencephalography & Clinical Neurophysiology* **68** (1988), pp. 191-198.
10. T. Gasser, P. Bacher & H. Steinberg, Test-Retest Reliability of Spectral Parameters of the EEG, *Electroencephalography & Clinical Neurophysiology* **60** (1985), pp. 312-319.
11. A. Burgess & J. Gruzelier, Individual Reliability of Amplitude Distribution in Topographical Mapping of EEG, *Electroencephalography & Clinical Neurophysiology* **86** (1993), pp. 219-223.
12. D. Tucker, D. Roth & T. Bair, Functional Connections Among Cortical Regions: Topography of EEG Coherence, *Electroencephalography & Clinical Neurophysiology* 63 (1986), pp. 242-250.
13. G. Fein, D. Galin, J. Johnstone, C. Yingling, M. Marcus & M. Kiersch, EEG Power Spectra in Normal and Dyslexic Children. I. Reliability During Passive Conditions, *Electroencephalography & Clinical Neurophysiology* 55 (1983), pp. 399-405.
14. E. R. John, L. Prichep, H. Ahn, P. Easton, J. Fridman & H. Kaye, Neurometric Evaluation of Cognitive Dysfunction and Neurological Disorders in Children, *Progress in Neurobiology* 21 (1983), pp. 239-290.
15. M. C. Salinsky, B. S. Oken & L. Morehead, Test-Retest Reliability in EEG Frequency Analysis, *Electroencephalography & Clinical Neurophysiology* 79 (1991), pp. 382-392.
16. K. Abt, Significance Testing of Many Variables, *Neuropsychobiology* 9 (1983), pp. 47-51.
17. B. S. Oken & K. H. Chiappa, Statistical Issues Concerning Computerized Analysis of Brainwave Topography, *Annals of Neurology* **19** (1986), pp. 493-494.
18. F. Duffy, P. Bartels & R. Neff, A Response to Oken and Chiappa, *Annals of Neurology* **19** (1986), pp. 494-495.
19. G. K. Watkins, A. M. Watkins & R.A. Wells, Further Studies on the Resuscitation of Anesthetized Mice, *Research in Parapsychology* (1972/1973), pp. 157-159.
20. C. Brown, R. Fischer, A. Wagman, N. Horrom & P. Marks, The EEG in Meditation and Therapeutic Touch Healing, *Journal of Altered States of Consciousness* 3 (1977/1978), pp. 169-180.

21. I am grateful to Susan Brown for her editorial and statistical assistance.

∞ ∞ ∞