

**Analysis of Alpha and Sensory Motor Response Brainwave Changes
Before and After Bioenergetic Exercise and Bioenergetic Analysis**

Author:

**Dr. Pamela J. Bell, EdD, CBT, EEG-BCIA, LPCC
30 Alcalde Rd., Santa Fe, NM, 87508
USA**

Email: DRPBELL@prodigy.net

Telephone and Fax: 505-466-9800

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**Lexicor Medical Technology
5589 Arapahoe Avenue, Suite #206,
Boulder, CO, 80301, USA**

Email: mdoohan@lexicor.net

and

**Dr. Roger deBeus, PhD,
Clinical Director, Neurotherapy Services
Riverside Hospital**

11815 Rock Landing Drive, Newport News, VA, 23606, USA

Email: roger.debeus@rivhs.com

In September 2000, I received in kind support from the Lexicor Medical Technology, Inc. of Boulder, Co. at the recommendation of Mike Doohan. I performed 18 raw EEG recordings on subjects in the study and in January 2001, Lexicor artifacted and performed database analysis on the 18 recordings (brainmaps) for this research study. This generous grant gave me the support to get the EEG data analysis measured against the normed database. I am also indebted to my friend and colleague, Roger, deBeus, PhD., Head of the Neurofeedback Program at Riverside Hospital in Newport News, VA. Roger helped me with statistical analysis for this study.

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Abstract:

Conclusions: The conclusions drawn about the results of this study are that Bioenergetic Exercise and Bioenergetic Analysis positively affect the brainwave functioning (or the state of mind) of this group of subjects. When subjects in this study engage in Bioenergetic Therapies they have significant and positive changes that occur in their brainwave functioning. The result would be a quiet body, alert and focused mind without intrusive thoughts, and a relaxed state of mind without anxiety. Lowen and Reich has postulated the theory that body and mind are functionally identical. While there are other fields of science that have examined this theory, none have actually proved this theory in the field of Bioenergetic Analysis. The results of this brainwave study are evidence of this theory.

Key words: Brainwaves, Electroencephalogram, Bioenergetic Analysis, Bioenergetic Exercise, State of mind, Alpha, Sensory Motor Response, Brain functioning

The Author: Dr. Pamela Bell received her doctorate in counseling and psychology in 1983 from Oklahoma State University. She did her bioenergetic training in the Dallas Society for Bioenergetic Analysis and completed her CBT in 1997. During her training in bioenergetics, she became interested in bioenergetic research because of the profound changes that occur in this work and a lack of scientific data to support its efficacy. Dr. Bell decided in 1997 to begin learning about EEG as a possible measure of efficacy in bioenergetics, which led to her certification as an EEG biofeedback. She lives in Santa Fe, New Mexico, USA, and practices both bioenergetics and neurofeedback.

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Background

The International Institute of Bioenergetic Analysis (BA) has a history of 50 years, volumes of books written by Alexander Lowen, M.D. and other noted authors, and numerous training programs across three continents. We have not had, until recently, however, scientific evidence that supports the efficacy and theories of BA. The Winter 2002 *Clinical Journal of the International Institute of Bioenergetic Analysis* was dedicated to research. Ventling, 2002, developed a model for reasoning and challenging bioenergetic therapists to do research. Now we have a beginning of comparison of methodologies of Bioenergetics and other forms of psychotherapy from the scientific evidence provided by the research of Ulrich Gudat, (2002) and the efficacy of BA results after therapy and its stability over time, (Ventling, 2002).

BA can be measured scientifically, in many ways, to determine the impact on health. EEG is part of that work toward discovery. Candace Pert (1997) coined the word psychoneuroimmunology in her book, *Molecules of Emotion*. Pert's discovery of the opiate receptor molecule while working for the National Institute of Health, helped open the scientific door to understanding how human emotions are linked to bodily chemical processes. Pert mentions BA in her writings and she clearly has had some personal understanding. She described the *vibration* of the receptor molecules as they look for a common shape or key (neuropeptide) to bind to the receptor. Pert asserts that it is the *electrical forces* that allow the receptor molecules and the neuropeptides to bind to each other. She asserts that the receptor molecules are the "sense organs" while the neuropeptides are the "states of mind". This binding stimulates emotion. She used terms that describe an alive and vibrating energy system in the human body (Pert, 2000). These are terms we are familiar with in bioenergetics. We need to measure the efficacy of BA within this relatively new field of psychoneuroimmunology.

Purpose of the Study

This research project is attempting to gain a greater understanding of the effects of bioenergetics by measuring the bio-electrical currents in the brain, brainwaves, with

electroencephalograms (EEG). Why should we study bioenergetics and its effect on our brainwaves? By measuring the electrical firing, charge, or discharge, of the EEG we may be able to demonstrate the changes in the brain after bioenergetic analysis (BA) and/or bioenergetic exercise (BE). It is the movement of the energetic field of bio-electricity through the body that can be reflected in the brainwaves and can demonstrate changes in mood and aspects of well-being. Each electrical frequency in the brain reflects states of well-being.

Sensory Motor Response (SMR)

In the mid 1960's, Barry Sterman, a leader in the field of EEG and neurofeedback discovered the frequency he named Sensory Motor Rhythm (SMR). Barry Sterman and his associates were performing experiments on cats to collect EEG recordings while conditioning with reward of milk and chicken broth. They read the brain wave activity across the cat's sensory motor cortex, the strip of the brain across the middle of the skull that governs the cat's motor activity and its sensory processing. Sterman also introduced a tone that coincided with stopping the reward. "The cat remained absolutely still, though extremely alert, waiting for the tone to end...Accompanying this motor stillness was an EEG 'spindle', that is, the scribbled display of the brain's rhythmic electrical signal on the EEG paper that was unlike any seen previously...'It was clear, rhythmic change,' Sterman said...He named the frequency sensorimotor rhythm, a rhythmic signal peaking in the range of 12 to 15 hz. It is a beta frequency, but over a specific part of the brain, the sensorimotor cortex, and so it is called SMR." (Robins, 2000, p. 39) Sterman continued his study of SMR and found that he could train not only cats but also humans to develop more of this frequency. Sterman began to work successfully with this frequency in humans to reduce epileptic seizures. Subsequent studies by Dr. Joel Lubar and associates applied the SMR frequency in training children with ADHD to quiet the motor system along with decreasing the slow wave frequency of theta (4-7hz.) for better attention (Lubar & Shouse, 1976; Lubar & Bahler, 1976). SMR analyzed over the Central Motor Cortex and Pre-Motor Cortex for the purpose of this study can be a reflection of quiet body, active mind, and problem-solving thinking and focused attention. Laibow (1999) defines it both as 12-14 hz. and as 12-16 hz. Others have defined SMR as 11.5-14.5 hz. as measured over the Central Motor Cortex. SMR is defined as 12-16 hz. in this study, using the analysis of Lexicor Medical Technology, Inc., Boulder, Co.

The Alpha Connection

Another leader in the field of EEG and neurofeedback, Dr. Joe Kamiya at the University of Chicago had a research breakthrough that essentially started what has now become known as EEG biofeedback or neurofeedback. Kamiya was studying subjects using a tone to reinforce alpha bursts when it appeared. He learned that subjects could learn to control and increase their alpha wave. His research findings indicated that the 'alpha state' felt peaceful and relaxing (Budzynski, 1999). Later research, Budzynski, & Stoyva, (1972) trained subjects to successfully increase alpha to decrease anxiety and cure a long-term phobia (32 year follow-up) in only 4 sessions. In normal subjects, highest alpha amplitudes are predominantly in the posterior region of the brain. Alpha (8-12 Hz) is "predominantly associated with a relaxed, alert, unfocused state often characterized by creativity and dreamy thoughtfulness (Laibow, 1999). Alpha normally increases in the posterior region of the cortex when eyes are closed and when persons are meditating. Alpha analyzed for the purpose of this study in the posterior region of the brain can be a reflection of the states indicated by Laibow, (1999), and decreased anxiety, (Budzynski & Stoyva, (1972).

The Other Frequency Bands

The other frequency bands are typically defined as follows: Delta (0-4 Hz) is often described as a "slow wave" associated with sleep and restorative processes of repair during deep sleep. Theta (4-8 Hz) is commonly described as the hypnogogic state. "Increased levels of theta are seen in psychotic states, delusion, and other states associated with poor reality testing and with seizure disorders. Excessive theta is also seen in head injury and trauma. However, theta seen in healthy functioning is associated with deep creativity, the "Ah ha!" experience and complex, sustained inspiration" (Laibow, 1999, p.99-100). Beta 2 (16-20 Hz) is described as greater focused concentration and attention to detail. Higher amplitudes of Beta 20 Hz and greater can reflect states of physiological arousal, stress related disorders, panic, anxiety, fear, chronic pain, and a response to threat (Laibow, 1999, p.100).

Research Questions

1) Will there be a significant change in the EEG frequency bands of each subject between conditions that helps explain the effect of the bioenergetic therapies on the brain?

2) Will there be a significant change in the SMR (12-16 Hz.) frequency over the Central Motor Area of the brain between Baseline and Treatment 1 conditions that helps explain the effect of BE on the brain?

3) Will there be significant change SMR (12 to 16 Hz.) frequency over the Central Motor Area of the brain between Baseline and Treatment 2 conditions that helps explain the effect of BA on the brain?

4) Will there be a significant change in the SMR (12-16 Hz) frequency over the Central Motor Area of the brain between Treatment 1 and Treatment 2 conditions that helps explain any difference between conditions?

5) Will there be a significant change in the Alpha (8-12 Hz) frequency over the Posterior Region of the brain between Baseline and Treatment 1 conditions that helps explain the effect of BE on the brain?

4) Will there be a significant change in the Alpha (8-12 Hz) frequency over the Posterior Region of the brain between Baseline and Treatment 2 conditions that helps explain the effect of BA on the brain?

6) Will there be a significant change in the Alpha (8-12 Hz) frequency over the Posterior Region of the brain between Treatment 1 and Treatment 2 conditions that helps explain any difference between conditions?

Background of Subjects

Data collection began November 2000 with six female subjects. No random selection occurred, the subjects came from the clients that agreed to participate. The subjects ranged in age from 40 to 55 years. All subjects had been participating in a regular one-hour weekly bioenergetic exercise class and a monthly bioenergetic therapy group before collecting data. The monthly therapy group was 2 hours long allowing two of the six participants to work bioenergetically each month. The subjects had participated in four bioenergetic sessions in the group over the course of the year and all had some additional individual bioenergetic therapy with the researcher/therapist. All subjects were new to bioenergetic therapy when the group began 12 months before collecting baseline data.

Subject #1, Post Traumatic Stress Disorder, Anxiety, dissociative qualities, raped at age 11 or 12 by a gang of teenage boys, a regular cigarette smoker, marijuana substance use history but abstinent for many years, sexual dysfunction, oral character structure with masochistic torso and pelvis.

Subject #2, Post Traumatic Stress Disorder, dissociative qualities, abusive family history, regular marijuana smoker for many years and decided to stop smoking after baseline and post-exercise treatment data was collected, promiscuity, oral and rigid character structure.

Subject #3, Depression, regular cigarette smoker for many years and decided to stop smoking after baseline and post-exercise treatment data was collected, probable mild head trauma history, masochistic character structure.

Subject #4, Depression, anti-depressant medication, during the data collection it was determined she has an absence seizure disorder, schizoid character with oral features.

Subject #5, Depression, dissociative qualities, anti-depressant medication, sleep problems, history of sexual abuse, oral character structure with schizoid features.

Subject #6, Depression, anxiety, anti-depressant medication, past cocaine addiction history, masochistic character structure with oral schizoid features.

Data Collection

1) Baseline – An electroencephalogram was collected on all subjects before 1 hour of bioenergetic group led exercise (BE). Each baseline EEG was collected on six consecutive Friday mornings prior to BE.

2) Post electroencephalogram was collected after 1 hour of bioenergetic group led exercise (BE). Each subject's data was collected on six consecutive Fridays so EEG's could be collected immediately after BE.

3) Post EEG's were collected immediately after bioenergetic therapy session in the treatment group. Frank Hladky, M.D., International Bioenergetic Trainer did BA therapy sessions.

4) The researcher performed all EEG's on the subjects with Lexicor NRS-24 equipment. The data was acquired by using a stretchable electrode cap (Electrocap International, Inc.) with recording electrodes placed according to the 19 standard regions defined by the International 10/20 System of electrode placement, referenced to linked ears. All electrode impedance levels were below 3 Kohms with no electrode differences of more than 500 ohms. Artifacts of data and quantitative analysis of the EEG's was

done by Lexicor Medical Technology, Inc, in Boulder, Colorado, USA. (See acknowledgement)

Treatment

Treatment 1 - Bioenergetic Exercise (BE): One hour of bioenergetic exercise was performed on all six subjects. A standard bioenergetic exercise routine was designed by the researcher to use each week to perform BE and in the same order for each subject to maintain the same treatment protocol. That protocol is provided in the Attachment 1.

Treatment 2 - Bioenergetic Analysis (BA): Each subject in the research study gathered for a group bioenergetic therapy experience with Frank Hladky, MD. After each person worked individually with Dr. Hladky (BA) they left the treatment room and entered the EEG office next door to be brainmapped (collection of post EEG data) by the researcher. After completing their brainmap each subject reentered the group treatment room with Dr. Hladky and other subjects. A post QEEG was done after all six subjects worked with Dr. Hladky.

Analysis of Results

Since there was a small sample ($N=6$), non-parametric procedures were used for analyses. The Friedman's ANOVA was utilized for the analysis of group means on each frequency (SMR and Alpha) and on each site being tested (Central Motor Area and the Posterior Region respectively) across conditions. Post-hoc testing was performed with Wilcoxon's Matched Pairs Test to help explain the ANOVA results and identify differences between two conditions (i.e., Baseline to BE, BE to BA, and Baseline to BA). Individual analysis was done using the same statistical procedures. This analysis was done on all frequency bands: Delta 1, Delta 2, Theta, Alpha, SMR, Beta 1, Beta 2, and Beta 3 to look at the different effects on individuals over the whole brain. Significant differences were found with both group and individual analyses.

Group Analysis

SMR: Friedman ANOVA group analyses revealed a significant difference ($p < .04$) at CZ (Central Zero) across conditions. In particular, the ANOVA from Baseline to BE revealed a significant change of ($p < .02$) at CZ. Wilcoxon test for matched pairs validated that again, that SMR increased significantly from Baseline to the BE condition ($p < .02$). No other sites were significant. See the SMR graph for more visual

explanation and Figure 1 for location on the head.

Alpha: Friedman ANOVA group analyses revealed a significant difference ($p < .04$) at PZ (Parietal Zero) across conditions. More specifically, the ANOVAs revealed significance from Baseline to BE at PZ ($p < .01$), and ($p < .01$) at O2. Further analyses using the Wilcoxon matched pairs post hoc test revealed specific differences at particular sites between the conditions. Those differences were between Baseline and the BE condition, indicating Alpha significantly increased at PZ ($p < .03$), O1 ($p < .05$) and O2 ($p < .03$). Alpha also increased significantly between Baseline and the BA condition at P3 ($p < .05$). The Wilcoxon matched pairs post hoc test assumes a rank ordering of the variables therefore the strength of this test between the two variables (BE and BA) does not show significance on most sites with BA even though the means were higher than BE on all but one site (O2). See Figure 1 for location of sites on the head and the Alpha graph for visual understanding.

Individual Subject Analysis

Individual analyses were performed to determine to what extent each individual responded to the two treatments compared to baseline. Eight frequencies were compared across all sites on the head for all conditions (Friedman's ANOVA), and between conditions (Wilcoxon's Matched Pairs Test). See the tables in Figure 2 for results of significance for each subject on all eight frequency bands.

There were 48 total analyses done for all subjects combined. A total of 44 of the 48 frequency bands had significant change at the .01 level or less as revealed on the Friedman ANOVA. The Wilcoxon post hoc analysis revealed by treatment condition:

Baseline vs. Treatment 1	30 frequency bands $p < .001$ 6 frequency bands $p < .01$ 6 frequency bands $p < .05$
Treatment 1 vs. Treatment 2	23 frequency bands $p < .001$ 7 frequency bands $p < .01$ 7 frequency bands $p < .05$
Baseline vs. Treatment 2	27 frequency bands $p < .001$ 8 frequency bands $p < .01$ 3 frequency bands $p < .05$

Discussion

The results of the analysis of group SMR brain wave activity was significant at one

site only, CZ (Central Zero), lying approximately in the middle of the top of the head. There were three sites to sample on the Central Motor Strip, one to the left of CZ at C3, and one to the right of CZ at C4. While only one site (CZ) was found significant for the group means across conditions it seems to be an important site as it reflects the motor area in the center of the brain. While the others were not significant, it is most likely due to the small and non-random sample. The frontal sites are not as focal to the importance of description as the Central Motor Strip, just anterior to the central region of the brain where the fissures of the skull connect from the frontal to parietal areas of the brain. The significance of this site lends support that BE and BA does indeed affect the motor control of this group of subjects. Further, we could assume that from other research on this region of the brain and the SMR frequency that it would reflect a quiet body with a relaxed and focused mind.

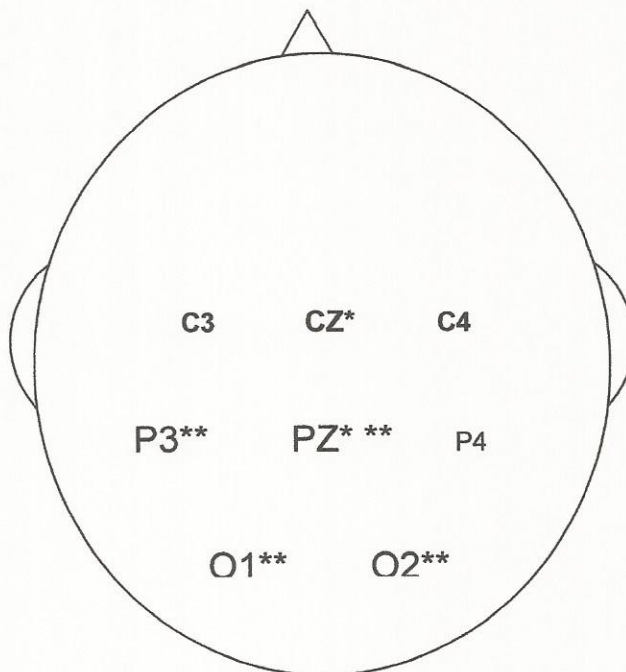
The results of the analysis of group Alpha brain wave activity was significant at one site only, PZ (Parietal Zero) where Alpha is usually dominant during eyes-closed resting conditions. Trends were also noted with other posterior sites, in particular, O1, O2, and P3. Research has indicated that increased Alpha activity indicates a person's ability to quiet the mind without intrusive thoughts. Analyses further indicated an increase of Alpha activity from Baseline to the BE and BA conditions. This may indicate that as a group, that BE and BA treatment was effective in helping these people quiet their minds more effectively.

The results of analyses of all 48 possible frequency bands indicated such a large number of bands significant (44) that the first conclusion is simply that BE and BA effects the brainwaves of these subjects. Even though this is a small and non-random sample, we could predict similar results with other subjects seeking bioenergetic therapies. There was some variability across participants, which is to be expected considering the different presenting symptomology of each person. One important difference shows up in the Theta band for three subjects (1, 2 & 5) that all have trauma history and oral character structure, all had an increase in Theta, which can be understood as trauma memory being recalled. The subject that had cocaine history (#6) had high Beta frequencies on her Baseline, which is common in anxiety states. After BE and BA she had a significant decrease in Beta amplitude, which is positive for decreasing anxiety, and her Delta went up which is positive for deep restorative sleep. Subject #4, found to have absence seizure disorder shows important changes in her Alpha, SMR, and Beta. In this subject, Baseline EEG shows the power of all her frequencies located in the left

temporal lobe, after BE and BA the power spreads out over the brain in more normalized pattern. Subject #3 had similar changes in the pattern of frequency power shifting from left posterior region of the brain toward the central and posterior regions of the brain in a more normalized pattern. Even though her Alpha and SMR did not show significant change averaged over the entire brain there was significant change in the region over the Central Motor Strip SMR and the posterior Alpha for this subject where we would see the most important emotional change.

Data analysis should be done in additional study to examine the normed database reports for further understanding of how a subject changed across conditions. Specifically, data collection included video taped sessions of each subject with Frank Hladky, M.D. A rating scale should be developed to measure the subjects' ability to ground, build a charge, contain a charge, and the level of discharge within the session. This rating measured against the normed database reports on each subject and condition can give the field of Bioenergetic Analysis important information on a major theoretical tenant. Does a person feel healthier emotionally after experiencing charge to the point of discharge? Finally, using QEEG to analyze and correlate with behavioral indices for particular symptomology is important for learning how BE and BA affects these specific conditions. A random sample, a control group, and a larger number of subjects could also strengthen validity of additional studies. EEG is a powerful tool to explore the neurological understanding of the dynamic effects of bioenergetic interventions.

Figure 1



SIGNIFICANT FRIEDMAN ANOVA'S AND WILCOXON MATCH PAIRS

SMR ANOVA ($p < .05$) at **CZ***

Wilcoxon post hoc test of significance for **BE** ($p < .03$) at **CZ****

Alpha ANOVA ($p < .04$) at **PZ***

Wilcoxon post hoc test of significance for **BE** ($p < .03$) at **PZ****

Wilcoxon post hoc test of significance for **BE** ($p < .05$) at **O1****

Wilcoxon post hoc test of significance for **BE** ($p < .03$) at **O2****

Figure 2

Subject 1					Subject 2			
Frequency	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt2	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt 2
Delta 1	***		**	***	***	***	***	***
Delta 2	***	***	***	***	***	***	***	***
Theta	***	***	***	***	***	***	***	***
Alpha	***	***	***		***	**	***	***
SMR	***	**	***	**	***	***	**	**
Beta 1	***	***	*	*	***	***	**	**
Beta 2					***	***	***	***
Beta 3		*	*		***	***		***

Subject 3					Subject 4			
Frequency	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt 2	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt 2
Delta 1	***	***	***	***	***	***	*	**
Delta 2	***	***	***	***	***	***	*	**
Theta	***	***	***	***	**	***	*	*
Alpha	***	***	***		**	***		**
SMR	***	***	***		***	*	**	***
Beta 1	***	***	***	***	***	**	***	***
Beta 2	***	***	***	***	***	**	***	***
Beta 3	***	***		***	***	*	***	***

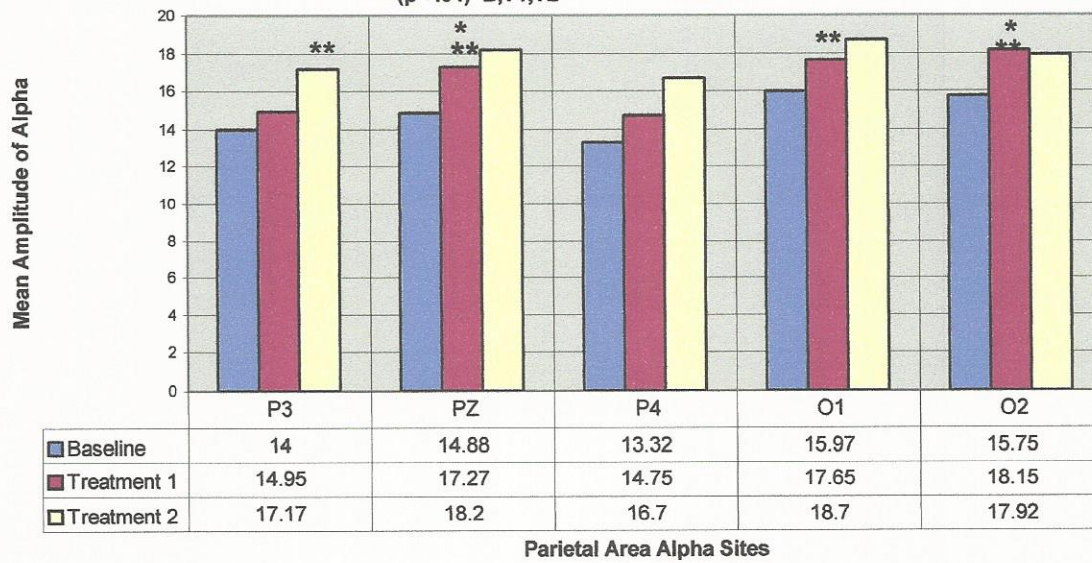
Subject 5					Subject 6			
Frequency	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt 2	ANOVA	Baseline vs Tmt 1	Tmt 1 vs Tmt 2	Baseline vs Tmt 2
Delta 1	***		**	**		*		
Delta 2	***	**		***	***	***	***	
Theta	***	***		***	***	***		**
Alpha	**		***	*	***	***	*	***
SMR	***	*	**		**		**	***
Beta 1	***	***	***		***	**	***	***
Beta 2	***	***		***	***		**	***
Beta 3	***	***		***		*		

Note: * = $p < .05$; ** = $p < .01$; *** = $p < .00$

ANOVA Table of Means for Alpha by Site and Condition (N=6, df=2)

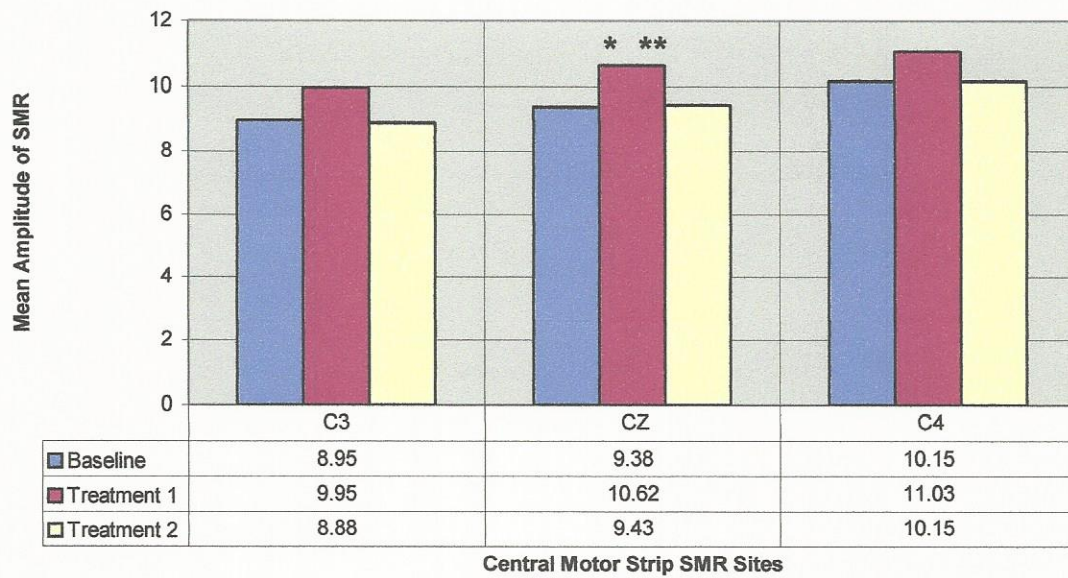
p* ANOVA p** Wilcoxon Matched Pairs

*(p< .04) B,T1,T2



ANOVA Table of Means for SMR By Site and Condition (N=6, df=2)

* (p< .04) Friedman ANOVA ** (p< .02) Wilcoxon Matched Pairs



Attachment 1

BE Protocol:

1. aligned position with feet under the pelvis
2. one foot at a time; open toes by stretching joints on the carpet, first forward then backward
3. one foot at a time; open feet by doing a "crush out the cigarette" move with the ball of the foot
4. one leg at a time support the body weight; shifting the stance from one leg to the other until it is tired or warmed a few seconds, then widening the stance a foot or so each time until the stance is in a wide v formation to stretch the (inner thigh) muscle. Dropping the pelvis in the center with spine erect, to stretch the inner muscles of the pelvis.
5. in this position above bend over with head and neck relaxed, hands lightly on the floor (not supporting the body)
6. then go to the floor on knees into a yoga stretch with forehead resting on the carpet and hand extended in front over the head and on the floor; stay in this position for a minute or so
7. when group is ready go to another yoga stretch sitting back on knees with fists in arches of feet, extend the front of the torso upward resulting in a bending and stretching of the frontal cage
8. move to lie on your back with legs extended toward the ceiling rotate your ankles in one direction until you feel a burning then rotate the opposite direction until ready to stop
9. with legs extended and slightly bent push heels toward the ceiling stretching the backs of the ankles and calves and allow vibration to move through to the pelvis while allowing sound and breath to discharge
10. turn over on all 4's and do the cat and cow stretching spine back and forth while expressing sound
11. move to pushing against a partner shoulder to shoulder while on all fours
12. then sit back to back with partner and feel your back and the support to your back
13. come into the grounding position with head hanging over for several minutes increasing sound and vibration through the legs, pelvis and torso
14. come up slowly uncurling the spine while bending the knees a bit more, bring head up last and keep legs soft to continue vibration

15. bring back of hands together in front of heart area, give some pressure to the hands next to each other as you are slowly bringing your hands above the head, turn hands in a prayerful position above the head and continue to bring hands and arms in back of head, stretch arms outward while trying to touch your elbows in back of your torso, bring arms slowing down to your side while keeping your knees soft, emit sound and respiration

16. end with neck rotations to the right a couple of times then to the left twice

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