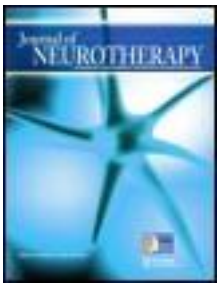


Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Neurofeedback Equipment Study One — Focused Technology F-1000 Main Board Investigation

Robert J. Hamilton MS [a] & Timothy Barnes MA [a a] University of North Texas, Department of Rehabilitation, Social Work and Addictions (DRSWA) Neurotherapy Laboratory , USA Published online: 17 Oct 2008.

To cite this article: Robert J. Hamilton MS & Timothy Barnes MA (2000) Neurofeedback Equipment Study One — Focused Technology F-1000 Main Board Investigation, Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience, 4:1, 63-70, DOI: 10.1300/J184v04n01_07

To link to this article: http://dx.doi.org/10.1300/J184v04n01_07

Neurofeedback Equipment Study One– Focused Technology F-1000 Main Board Investigation

Robert J. Hamilton, MS
Timothy Barnes, MA

ABSTRACT. Eight neurofeedback participants were alternately connected to two different Focused Technology F-1000 main computer boards during their neurofeedback sessions. Finger temperature, and theta and beta EEG measurements at two different sites were recorded for three minutes using each computer. Between individuals ANOVA was done on the F-1000 calculated variables to determine the contribution from computer, client and measurement site. The results of this analysis indicate that the two different F-1000 computers were consistent in their analysis of temperature and EEG inputs, and that the vast majority of any observed variance was due to individual. As this is the first of a series of ongoing and planned studies to investigate neurofeedback equipment characteristics, study limitations are discussed as well as implications for future investigations. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.HaworthPress.com>]*

KEYWORDS. EEG biofeedback, biofeedback equipment, reliability

INTRODUCTION

Although there are several manufacturers of neurofeedback (EEG biofeedback) equipment, there is little information available on the

Robert J. Hamilton, MS, and Timothy Barnes, MA, are associated with the University of North Texas Department of Rehabilitation, Social Work and Addictions (DRSWA) Neurotherapy Laboratory. Mr. Hamilton is an electrical engineer and Mr. Barnes is a clinical neurotherapist. Both men are interested in the interactions between clients and equipment.

Address correspondence to: Robert Hamilton (E-mail: rhamilto@scs.cmm.unt.edu).

characteristics of this equipment. What is available differs greatly from manufacturer to manufacturer and consists primarily of sales information from the respective manufacturers. A growing amount of experience with different neurofeedback equipment and communication with therapists seems to indicate that there may be significant differences between the calculated parameters within and between neurofeedback equipment currently being used.

This is the first report of a series of planned and ongoing studies to investigate whether there is a variance in actual vs. calculated values within and between neurofeedback equipment. Also of interest is whether this is caused by hardware or software differences or by therapist techniques or situations. This initial study is a very basic look at the processing and calculations of the main circuit board of the F-1000. As such, it is a very limited look at potential equipment variation, as it does not include the analogue/digital converter in variation consideration. Although this study utilizes the Focused Technology F-1000 machine, it was chosen for convenience and not because of any suspected shortcomings.

METHODS

Participants. Eight student participants of a neurofeedback training workshop were used as participants. As the only research interest was the consistency of EEG calculations, each participant was randomly assigned a number and no personal data was taken. This greatly simplified the research design, as no matching or screening procedures were necessary.

General Procedure. The eight participants were randomly paired into four groups. Each participant was given a series of handouts explaining the experimental procedure and the process was also verbally explained. For each measurement session the ''therapist'' located C3 (or C4) on the participant's head (Figure 1). The site was abraded, cleaned, and an electrode was placed. Then a single site monopolar hookup was made (using an earlobe as a reference), and all leads were secured using a headband and clips (Figures 2 and 3). The Focus ''artifact'' and ''spectrum'' screens were examined and photographed (Figure 4) to ensure a ''good'' connection and the session began.

The general session order for each client was the same. First a three-minute eyes closed recording was made at C3, using one of the

FIGURE 1

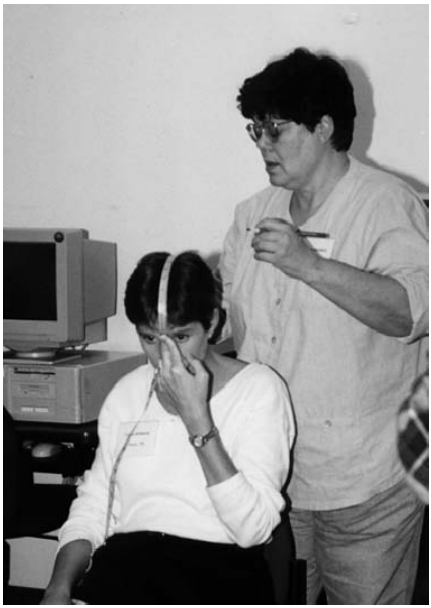


FIGURE 2. Typical C4 Hookup–Lateral View

focus machines for each of two clients (Solid Arrows in Figure 5). Upon completion of this recording the outputs from the ''preamps'' were moved so that the computer (and Focus Main Board) were switched (Broken Arrows in Figure 5). Another three-minute eyes closed recording was taken. Following recording C3 using both of the

FIGURE 3. Typical C4 Hookup–Posterior View

computers, the therapist moved the sensor to C4 and the process was repeated. First, a three-minute eyes closed recording was done with the ''other'' computer (Dotted Arrows in Figure 5). Then the leads were switched back to ''my computer'' (Solid Lines in Figure 5). Upon recording of all four sessions the therapists/clients/observers were rotated in accordance with Table 1, and the process was repeated. During this entire process, the designated ''observers'' carefully watched the therapist and client to ensure that the experimental procedures were being followed, noting any deviations. Supervisory personnel were also observing the entire process.

Instructions to Study Participants. Detailed descriptions and checklists were given to participants prior to the study. Each procedure was verbally reviewed several times prior and during the study to ensure participant understanding and consistency.

RESULTS

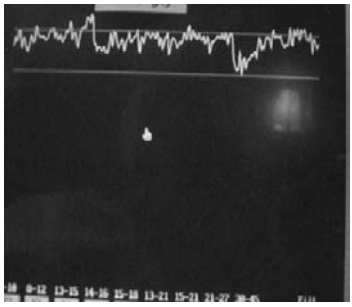
All thirty-two participant trials produced usable EEG and temperature data–that is none were rejected due to excessive artifact, measurement or experimental error. F-1000 calculated T1 (temperature), Filter A and Filter B (4-8 Hz and 13-15/15-18 Hz EEG) means were input into the UNT SPSS Statistical Program for Analysis of Variance.

Table 1 shows the results of this univariate analysis. This indicated that the client participant contributed the greatest majority of the vari-

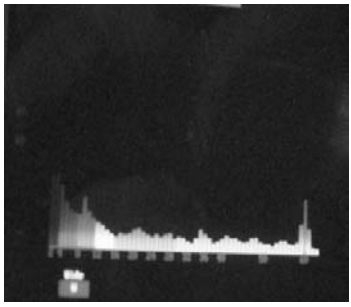
FIGURE 4. Typical Artifact and Spectrum Screens

Client 1

Left Computer

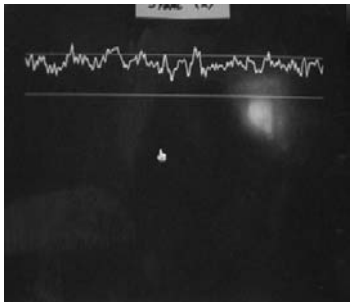


Artifact Screen

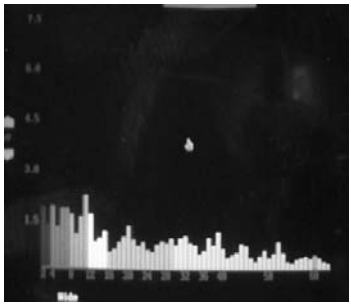


Spectrum Screen

Right Computer



Artifact Screen



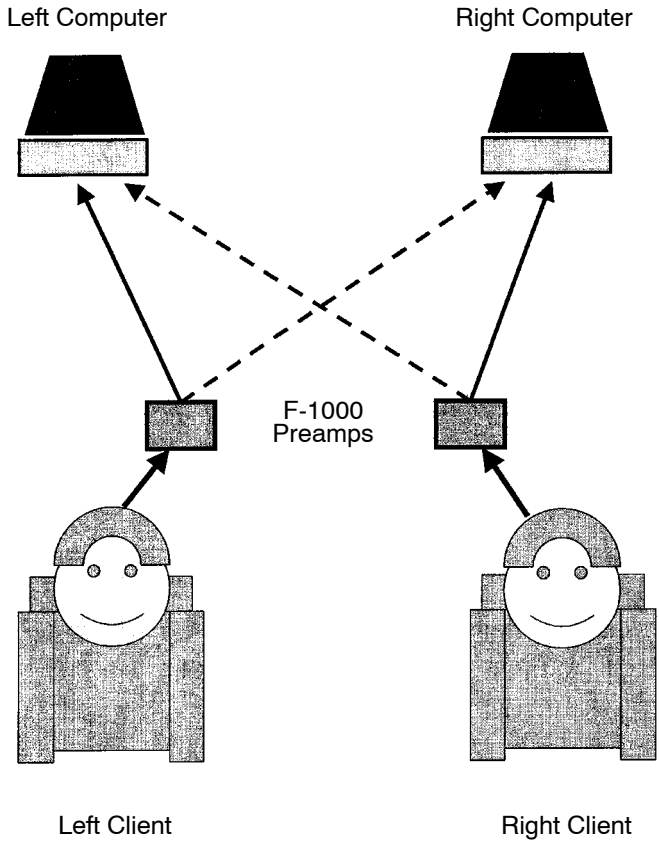
Spectrum Screen

ance of temperature and EEG signal, and a very small contribution was from the computer or the site used.

DISCUSSION

This study is a very basic first look at neurofeedback equipment consistency and has definite limitations. Although the results seem to indicate that the EEG equipment was relatively consistent in measurement, it could be argued that the equipment drifted one way while the participant's EEG changed in the other direction. There is no argument to dispute this possibility, as it is not certain that identical signals were

FIGURE 5. Illustration of Testing Procedure



fed into each computer. It would have been preferable to feed known identical signals into two different neurofeedback machines at the same time. Also if our goal were to check the reliability of the entire system, it would have been preferable to include the preamp when we switched computers. This was difficult given the space and time limitations of this study. We also could not analyze the interaction effect between site and computer due to the small sample in relation to the number of cells included in the design (1 person/cell). Also, ideally every measurement of the Focus F-1000 should have been entered into the statistical analysis program to investigate if the statistical analysis were correct.

TABLE 1. Univariate Analysis of Variance of Temperature and EEG Signals for Participants

Tests of Between-Subject Effects–Temperature

Source	Type III–Sum of Squares	df	Mean Square	F	% Contribution to Mean
Corrected Model	830.549	9	92.283	49.720	
Computer	9.031E-04	1	9.031E-04	.000	.0001
EEG Site	7.315E-02	1	7.315E-02	.039	.084
Student	830.475	7	118.639	63.920	95.3
Error	40.833	22	1.856		
Total	261450.212	32			
Corrected Total	871.383	31			

Tests of Between-Subjects Effects–Frequency Band A

Source	Type III–Sum of Squares	df	Mean Square	F	% Contribution to Mean
Corrected Model	22.835	9	2.537	70.289	
Computer	.240	1	.240	6.643	.062
EEG Site	.478	1	.478	13.235	1.230
Student	22.118	7	3.160	87.532	93.605
Error	.794	22	3.610E-02		
Total	389.007	32			
Corrected Total	23.629	31			

Tests of Between-Subjects Effects–Frequency Band B

Source	Type III–Sum of Squares	df	Mean Square	F	% Contribution to Mean
Corrected Model	5.746	9	.638	25.157	
Computer	.101	1	.101	3.990	.012
EEG Site	.600	1	.600	23.625	.069
Student	5.045	7	.721	28.400	80.029
Error	.558	22	1.856	28.440	
Total	86.25212	32			
Corrected Total	6.304	31			

Future Analysis. Appendix 1 is a listing of the authors' idea of the neurofeedback equipment investigations that remain to be accomplished, including some ongoing and unpublished work at the University of North Texas Department of Rehabilitation, Social Work and Addictions (DRSWA) Neurotherapy Lab. It is hoped that this study, for all its limitations, will encourage others to independently evaluate neurotherapy equipment available to the therapist, for it is believed that this is necessary to be accepted by others in the allopathic medical community.

APPENDIX 1. Envisioned Equipment Investigations

1. *Frequency Sweep*-A frequency generator of known frequency and amplitude would be used to scan across the advertised usable frequency range of all current neurofeedback equipment. The "measured" frequency and amplitude of equipment output would be compared with this known input to check for accurate measurement parameters.
2. *Replicability*-Identical EEG signals would be fed into identical models of neurofeedback equipment to check for reliable (replicable) measurement of signal. This would also be repeated with the same equipment under different environmental (room temperature, humidity, etc.) and experimental (leads, reference connections, etc.) conditions to investigate these effects. Finally, different manufacturers would be investigated to see how comparable equipment was. Initially this would involve simple signals (i.e., single site, referential sine waves) and it would be expanded to include complex actual EEG waveforms.
3. *Data Base Comparisons*-Actual EEG waveforms corresponding to different pathologies would be submitted to different neurofeed normative databases (same manufacturer/different computer, and different manufacturers) to investigate the consistency and comparability of data bases.
4. *Construct Verification*-Review of all constructs (i.e., success rates, feedback percentages, etc.) to determine accuracy, limitations and reliability.

The above are the initial ideas of the authors. It is hoped that this might initiate a lively discussion on the investigations necessary to develop a comprehensive understanding of the capabilities of equipment currently available, their strengths and limitations. It is believed that this would aid the manufacturer in developing their equipment, aid the therapist-consumer in evaluating and choosing equipment for use, and would ultimately, in conjunction with client studies, help in the acceptance of neurotherapy as a valid therapeutic aid by showing the reliability and consistency of neurofeedback equipment.