EFFECTS OF FOOT STIMULATION ON THE HUMAN ELECTROENCEPHALOGRAM

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ABSTRACT

Objectives: The purpose of this study was to explore the effects on the human electroencephalogram (EEG) by replacing standard cloth socks and placing socks with a patterned somatosensory form sewed into the bottom of the socks.

Methods: The electroencephalogram (EEG) was recorded from 19 scalp locations from 60 subjects ranging in age from 14 years to 83 years (Females = 26, males = 34). An approximate five minute baseline EEG was recorded with subjects wearing standard store purchased socks on their feet. The subject's standard socks were removed and the Voxx pattern socks were placed on the subject's feet and a second EEG recording was obtained. Both eyes-closed and eyes-open conditions were recorded. A FFT auto and cross-spectral power analysis of the surface EEG was conducted from 1 Hz to 50 Hz. The variables were absolute power EEG in 1 Hz increments and coherence and phase differences in 10 frequency bands (delta, theta, alpha1, alpha2, beta1, beta2, beta3 and hi-beta). Paired t-tests between the standard socks and Voxx pattern socks conditions were computed for each subject for all EEG measures as well as group paired t-tests.

Results: The results showed statistically significant t-test differences ($P < .01$) in 59 out of 60 subjects in absolute power and 60 out of 60 subjects showed statistically significant differences in coherence and phase difference. The largest differences were in the alpha1 and beta2 frequency bands and especially in central scalp locations. Paired t-tests of LORETA current source densities between socks on and socks off demonstrated statistically significant differences in 60 out of 60 subjects. The largest effects of Voxx socks on were on the medial bank of the somatosensory cortex as well as in the left frontal lobes in the theta and alpha frequency.

Conclusions: A strong effect size of the Voxx pattern socks on the EEG was present primarily in the theta and alpha frequency bands. Anatomical validation was evident because of the strong effects on the homuncular projection of the feet to the medial somatosensory cortex. The mechanism of action of the Voxx pattern socks on the brain and the EEG is still under investigation.

Introduction

The peripheral nervous system (PNS) connects the central nervous system to environmental stimuli to gather sensory input and create motor output. The PNS coordinates action and responses by sending signals from one part of the body to another (From the various receptors such as mechano-receptors and dermatomes to the brainstem). The PNS includes all other sensory neurons, clusters of neurons called ganglia, and connector neurons that attach to the brainstem and other neurons (Hubbard, 1974). The brainstem connects the forebrain with the spinal cord. It consists of the midbrain, medulla oblongata, and the pons. The primary input into the brainstem are through the Area Postrema (AP) and Nucleus Tractus Solitarius (NTS). Motor and sensory neurons relay signals between the brain and spinal cord. Ascending neural pathways cross allowing the left hemisphere of the cerebrum to control the right side of the body and vice versa. The brainstem coordinates motor control signals sent from the brain to the body. It also controls several important functions of the body including pain management, alertness, arousal, breathing, blood pressure, digestion, heart rate, swallowing, walking, posture, stability and sensory and motor information integration.

Different PNS receptors have an integrative relationship between themselves and correlate to specific nervous stimulation and signals that can be sent through General Somatic Afferent (GSA) Pathways, Special Somatic Afferent (SSA) Pathways, General Visceral Afferent (GVA) Pathways, and Special Visceral Afferent (SVA) Pathways to the brainstem (Robertson and Biaggioni, 1995). These signals can be very specific and can help the brainstem reach homeostasis (equilibrium) and enhance the functions of the brainstem and the reticular nuclei, the monoaminergic and cholinergic nuclei as well as the parabrachial nucleus and periaqueductal gray.

It was recently discovered that when a somatosensory pattern of stimulation is applied to the metatarsal region of the foot then improved balance and movement coordination often occurred (Dahliwal, 2018). As a consequence the somatosensory pattern of stimulation was woven or molded into socks and worn on one's feet to better facilitate the effects of the somatosensory stimulation of the metatarsal region of the bottom of the feet on the peripheral and central nervous system.

The purpose of this study was to explore the effects on the human electroencephalogram (EEG) when subjects place specially designed socks that provide tactile pattern pressure on the metatarsal region of the human foot.

Methods

Subjects

A total population of 60 subjects ranging in age from 14 to 83 years (Females = 36, Males = 24).

EEG Recording

The Wearable Sensing DSI-24 dry amplifier system was used to amplify and digitize the EEG recorded from 19 scalp electrodes according to the International 10/20 electrode locations. Approximately 2 to 5 minutes of EEG was recorded in the eyes closed condition and the eyes open condition with no socks on the subject's feet. A second 2 to 5 minute recording in the eyes closed and eye open condition was recorded after placing the Voxx socks on each subject's feet.

Power Spectral Analyses

Each EEG record was visually examined and manual deselection of segments containing artifact of any type were deleted from the record. Split-half reliability and test re-test reliability measures of the artifact free data were computed using the Neuroguide software program (NeuroGuide, v2.9.9). Split-half reliability tests were conducted on the edited artifact free EEG segments and records with > 90% reliability were entered into the spectral analyses. A Fast Fourier transform (FFT) auto-spectral and cross-spectral analysis was computed on 2 second epochs thus yielding a 0.5 Hz frequency resolution over the frequency range from 0 to 50 Hz for each epoch. A 75% sliding window method was used to compute the FFT in which successive two-second epochs (i.e., 256 points) were overlapped by 500 millisecond steps (64 points) in order to minimize the effects of the FFT windowing procedure.

Surface EEG Coherence

The cross-spectrum was used to compute EEG coherence and phase differences in ten frequency bands: Delta (1 to 4.0 Hz), theta (4 - 8 Hz), alpha (8 - 12 Hz), beta broad (12 - 25 Hz), beta 1 (12 - 15 Hz), beta 2 (15 - 18 Hz), beta 3 (18 - 25 Hz) and hi-beta (25 - 30 Hz). Coherence is a measure of the consistency of the analytical phase differences over some interval of time and is equivalent to a squared correlation coefficient and is dependent on the number of degrees of freedom used to estimate the consistency of the phase differences. When the phase difference in successive epochs is constant then coherence = 1 and when phase differences are random then coherence = 0. Coherence is mathematically defined as:

$\Gamma^2{}_{xy}(f) = \frac{\left(G_{xy}(f)\right)^2}{\left(G_{xx}(f)G_{yy}(f)\right)}$, where $G_{xy}(f)$ is the cross-power spectral density and $G_{xx}(f)$ and $G_{yy}(f)$ are the respective autopower spectral densities. The computational procedure

to obtain coherence involved first computing the power spectra for x and y and then computing the cross-spectra. Since complex analyses are involved this produced the average cospectrum ('r' for real) and quadspectrum ('q' for imaginary). Then coherence was computed as:

$$\Gamma_{xy}^2(f) = \frac{\sum_N \left[r_{xy} + q_{xy}\right]^2}{\sum_N G_{xx} G_{yy}}$$

LORETA Current Density

LORETA is a distributed EEG inverse solution where the currents at 3-dimensional gray matter voxels J are a linear combination of the signal S recorded at a scalp electrode:

$$J = T \bullet S$$

Where T is a minimum norm 3-dimensional matrix of 2,394 gray matter voxels with x, y and z coordinates in a generalized inverse that weights the solution to sources that are synchronous in local volumes or regions using the 3-dimensional Laplacian Operator (Pasqual-Marqui et al., 1994; Pasqual-Marqui, 1999). The T matrix is mathematically defined as:

$$T = \{inv(WB'BW)\}K'\{pinv(WB'BW)K'\}$$

Where B is the discrete Laplacian Operator and W is a weighting matrix (inv indicates inverse) and pinv(X) is the Moore-Penrouse pseudoinverse of X (Menke, 1984).

The Talairach Atlas coordinates of the Montreal Neurological Institute's MRI average of 305 brains (Lancaster et al, 2000; Pascual-Marqui, 1999) and the linkage to standard anatomical 7mm x 7mm x 7 mm voxels each with a distinct Talairach Atlas Coordinate. Groups of voxels are also defined by the clear anatomical landmarks established by von Brodmann in 1909 and referred to as Brodmann areas. The resultant

current source vector at each voxel was computed as the square root of the sum of the squares for the x, y and z source moments for each 0.5Hz frequency band. In order to reduce the number of variables, adjacent frequency 0.5 Hz bins were averaged to produce nine different frequency bands: delta (1-4 Hz); theta (4-7 Hz); alpha1 (8-10 Hz); alpha2 (10-12 Hz); beta1 (12-15 Hz); beta2 (15-18 Hz); beta3 (18-25 Hz) and hi-beta (25-30 Hz) for each of the 2,394 gray matter voxels.

Results

Absolute Power Surface EEG

Table I are the percent difference between socks on vs socks off from the 19 scalp electrode locations for the ten frequency bands in the eyes closed condition. The differences ranged from 0.04 % difference at O1 in the alpha frequency band to 54.68 % in the delta frequency band in F7.

Montage: LinkEars EC_No Voxx.ngg - EC_Voxx.ngg

FFT Absolute Power Percent Difference (%)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP1 - LE	8.99	4.64	1.77	-5.96	-2.32	-2.30	-9.62	-6.46
F3 - LE	21.67	8.88	1.22	-4.31	-13.72	-0.47	-3.91	-7.47
C3 - LE	10.94	5.28	1.24	-0.68	-1.94	-0.76	-0.22	-0.92
P3 - LE	14.38	4.66	-1.45	-3.09	-7.58	-2.87	-0.49	-5.17
O1 - LE	-17.24	2.03	0.04	-2.35	-8.99	-2.00	-0.12	-4.15
F7 - LE	54.68	13.04	3.95	-0.16	-1.82	3.09	-1.25	-1.95
T3 - LE	4.06	5.92	4.79	7.90	6.94	8.12	7.82	7.77
T5 - LE	19.92	7.31	0.45	0.02	-1.85	0.13	2.25	-1.68

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP2 - LE	7.93	3.94	2.66	-6.08	-2.94	-2.35	-8.50	-7.26
F4 - LE	5.22	2.61	1.11	-3.02	-7.07	-0.86	-2.51	-4.90
C4 - LE	-1.94	1.41	-0.16	-2.22	-4.88	0.17	-2.11	-4.21
P4 - LE	33.90	6.12	-1.32	-1.78	-2.93	-1.18	-0.78	-3.11
O2 - LE	-28.70	-1.79	-0.96	-4.19	-9.75	-2.99	-2.49	-6.61
F8 - LE	7.94	0.88	2.18	-3.16	-1.09	-1.43	-4.84	-3.42
T4 - LE	20.35	12.70	8.22	5.40	3.79	7.23	5.04	4.45
T6 - LE	13.56	1.26	-0.75	-2.05	-3.84	-1.80	-0.64	-3.32

Intrahemispheric: CENTER

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
Fz - LE	10.58	3.86	1.73	-2.07	-1.69	-0.03	-2.98	-3.23
Cz - LE	-9.54	-0.09	0.34	-2.55	-6.23	-0.78	-1.97	-4.59
Pz - LE	-7.24	-6.68	-1.66	-3.97	-7.71	-4.67	-1.96	-4.60

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Table I - Percent difference in absolute power in the surface EEG in all frequency bands between socks on versus socks off in the eyes closed condition.

Table II shows the results of the paired t-tests in absolute EEG power between socks off vs socks on in the eyes closed condition. Statistically significant differences were primarily in the delta and theta frequency bands and especially in the left hemisphere in comparison to the right hemisphere.

Montage: LinkEars

FFT Absolute Power Group Paired t-Test (P-Value)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP1 - LE	0.207	0.107	0.573	0.474	0.426	0.618	0.598	0.312
F3 - LE	0.031	0.003	0.757	0.890	0.826	0.714	0.790	0.642
C3 - LE	0.050	0.014	0.837	0.993	0.365	0.920	0.606	0.788
P3 - LE	0.108	0.031	0.581	0.455	0.521	0.461	0.423	0.225
O1 - LE	0.513	0.096	0.770	0.678	0.119	0.642	0.419	0.350
F7 - LE	0.016	0.023	0.407	0.462	0.572	0.205	0.416	0.775
T3 - LE	0.024	0.057	0.549	0.194	0.555	0.223	0.196	0.358
T5 - LE	0.015	0.005	0.552	0.689	0.638	0.241	0.276	0.508

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP2 - LE	0.239	0.222	0.607	0.542	0.631	0.555	0.608	0.440
F4 - LE	0.336	0.400	0.420	0.356	0.358	0.499	0.570	0.208
C4 - LE	0.494	0.290	0.263	0.425	0.565	0.766	0.790	0.213
P4 - LE	0.039	0.016	0.584	0.763	0.873	0.767	0.230	0.845
O2 - LE	0.464	0.678	0.585	0.231	0.168	0.284	0.735	0.097
F8 - LE	0.462	0.594	0.414	0.301	0.439	0.262	0.422	0.263
T4 - LE	0.000	0.000	0.079	0.097	0.040	0.021	0.026	0.274
T6 - LE	0.287	0.529	0.984	0.303	0.348	0.404	0.801	0.313

Intrahemispheric: CENTER

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
Fz - LE	0.187	0.077	0.873	0.764	0.505	0.910	0.889	0.419
Cz - LE	0.435	0.546	0.499	0.428	0.234	0.760	0.997	0.089
Pz - LE	0.458	0.956	0.853	0.770	0.527	0.471	0.550	0.819

Table II - Paired t-tests in absolute power in the surface EEG in all frequency bands between socks on versus socks off between socks on and socks off in the eyes closed condition.

Table III shows the percent difference between socks on vs socks off from the 19 scalp electrode locations for the ten frequency bands in the eyes closed condition. The differences ranged from 0.06 % difference at Cz in the beta frequency band to 62.26 % in the delta frequency band in P4.

Montage: LinkEars EO_No Voxx.ngg - EO_Voxx.ngg

FFT Absolute Power Percent Difference (%)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP1 - LE	6.32	7.33	6.41	3.09	1.15	3.75	3.91	2.42
F3 - LE	19.60	7.26	6.65	2.07	1.13	2.77	1.71	1.84
C3 - LE	5.15	4.40	3.18	0.82	-1.04	0.35	3.10	-0.17
P3 - LE	6.23	6.15	6.14	0.11	-2.19	0.45	0.96	-0.73
O1 - LE	11.07	6.78	6.72	2.52	0.99	2.48	3.64	1.90
F7 - LE	28.52	9.40	8.23	6.95	6.13	5.38	9.42	6.59
T3 - LE	-2.27	2.27	6.66	6.28	-1.17	3.92	7.70	6.97
T5 - LE	11.89	7.47	6.71	2.19	-0.15	0.35	5.48	1.65

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP2 - LE	-0.84	2.64	4.04	-3.74	-7.18	-0.15	-1.58	-6.17
F4 - LE	5.68	-0.71	2.77	-3.23	-0.81	-2.26	-2.12	-4.33
C4 - LE	4.93	-1.77	1.76	-4.38	-6.66	-3.25	-2.04	-6.63
P4 - LE	62.26	15.55	10.30	3.06	0.90	3.20	4.53	1.97
O2 - LE	2.35	2.58	5.87	0.90	0.04	1.60	-0.32	1.05
F8 - LE	-15.05	-6.67	0.23	-4.44	-2.93	-2.50	-2.96	-5.82
T4 - LE	10.87	10.33	7.23	1.86	-1.52	2.60	4.12	0.38
T6 - LE	-18.54	5.03	8.50	6.06	6.08	1.35	2.28	11.34

Intrahemispheric: CENTER

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
Fz - LE	5.87	4.63	4.73	1.07	-2.23	1.88	2.85	-0.55
Cz - LE	1.32	2.09	6.31	0.06	-2.45	0.25	1.51	-0.95
Pz - LE	-6.13	-0.86	11.59	0.26	-3.42	1.76	0.34	-1.23

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Table III – Percent difference in absolute power in the surface EEG in all frequency bands between socks on versus socks off in the eyes open condition.

Table IV shows the results of the paired t-tests in absolute EEG power between socks off vs socks on in the eyes open condition. Statistically significant differences ($P < .05$) were present bilaterally with increased power in the lower frequency bands. Statistically significant reduction in absolute power were present in the higher frequency bands in the right hemisphere.

Montage: LinkEars

FFT Absolute Power Group Paired t-Test (P-Value)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP1 - LE	0.960	0.286	0.881	0.323	0.147	0.954	0.396	0.170
F3 - LE	0.016	0.007	0.296	0.597	0.655	0.209	0.574	0.967
C3 - LE	0.104	0.098	0.853	0.723	0.915	0.730	0.171	0.702
P3 - LE	0.034	0.038	0.291	0.975	0.689	0.999	0.433	0.622
O1 - LE	0.027	0.009	0.142	0.602	0.749	0.477	0.372	0.995
F7 - LE	0.316	0.063	0.434	0.982	0.415	0.331	0.983	0.652
T3 - LE	0.808	0.533	0.885	0.918	0.435	0.671	0.481	0.930
T5 - LE	0.101	0.064	0.404	0.938	0.404	0.855	0.352	0.675

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP2 - LE	0.721	0.541	0.863	0.026	0.011	0.275	0.091	0.013
F4 - LE	0.151	0.793	0.712	0.103	0.074	0.333	0.356	0.058
C4 - LE	0.266	0.830	0.927	0.132	0.068	0.355	0.816	0.045
P4 - LE	0.025	0.016	0.060	0.186	0.792	0.201	0.068	0.480
O2 - LE	0.177	0.451	0.427	0.654	0.651	0.546	0.561	0.961
F8 - LE	0.877	0.337	0.197	0.029	0.029	0.070	0.038	0.027
T4 - LE	0.012	0.017	0.229	0.972	0.497	0.801	0.324	0.435
T6 - LE	0.662	0.247	0.380	0.837	0.420	0.884	0.669	0.880

Intrahemispheric: CENTER

	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
Fz - LE	0.233	0.022	0.456	0.820	0.344	0.270	0.513	0.575
Cz - LE	0.003	0.043	0.534	0.770	0.443	0.549	0.175	0.630
Pz - LE	0.880	0.731	0.507	0.830	0.367	0.784	0.461	0.711

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Table IV- Paired t-tests in absolute power in the surface EEG in all frequency bands between socks on versus socks off in the eyes open condition.

Surface EEG Coherence

Figure 1 shows then results of paired t-tests in the surface EEG coherence measures between socks off vs socks on in the eyes closed condition. Significant differences ($P < .05$) were present in widespread electrode pairs and in all frequency bands in both the left and right hemispheres. The socks on condition generally resulted in reduced coherence with the exception of the interhemispheric temporal lobes (T3-T4) in the delta frequency band.

Montage: LinkEars

FFT Coherence Group Paired t-Test (P-Value)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA
FP1 F3	0.002	0.134	0.356	0.825
FP1 C3	0.018	0.141	0.851	0.520
FP1 P3	0.246	0.615	0.040	0.317
FP1 O1	0.350	0.399	0.186	0.154
FP1 F7	0.022	0.347	0.617	0.477
FP1 T3	0.001	0.039	0.658	0.766
FP1 T5	0.265	0.788	0.100	0.244
F3 C3	0.012	0.001	0.585	0.423
F3 P3	0.425	0.142	0.044	0.399
F3 O1	0.786	0.448	0.102	0.392
F3 F7	0.956	0.038	0.130	0.138
F3 T3	0.036	0.030	0.686	0.245
F3 T5	0.205	0.229	0.076	0.494
C3 P3	0.731	0.261	0.889	0.414
C3 O1	0.958	0.844	0.110	0.994
C3 F7	0.392	0.051	0.302	0.366
C3 T3	0.082	0.042	0.551	0.699
C3 T5	0.075	0.189	0.418	0.662
P3 O1	0.014	0.047	0.510	0.080
P3 F7	0.118	0.391	0.034	0.216
P3 T3	0.254	0.443	0.438	0.932
P3 T5	0.506	0.050	0.289	0.250
O1 F7	0.379	0.601	0.280	0.272
O1 T3	0.871	0.847	0.886	0.779
O1 T5	0.069	0.073	0.333	0.158
F7 T3	0.666	0.098	0.239	0.144
F7 T5	0.976	0.841	0.126	0.347
T3 T5	0.010	0.160	0.599	0.449

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA
FP2 F4	0.002	0.027	0.898	0.698
FP2 C4	0.002	0.453	0.691	0.254
FP2 P4	0.337	0.109	0.039	0.011
FP2 O2	0.827	0.524	0.742	0.547
FP2 F8	0.253	0.221	0.390	0.738
FP2 T4	0.010	0.041	0.085	0.159
FP2 T6	0.708	0.944	0.928	0.330
F4 C4	0.045	0.569	0.447	0.119
F4 P4	0.095	0.077	0.021	0.028
F4 O2	0.958	0.482	0.394	0.480
F4 F8	0.112	0.150	0.500	0.900
F4 T4	0.004	0.019	0.082	0.132
F4 T6	0.427	0.675	0.326	0.318
C4 P4	0.256	0.027	0.127	0.884
C4 O2	0.561	0.037	0.026	0.318
C4 F8	0.003	0.371	0.882	0.270
C4 T4	0.003	0.003	0.481	0.251
C4 T6	0.013	0.041	0.435	0.729
P4 O2	0.066	0.160	0.815	0.192
P4 F8	0.639	0.437	0.031	0.080
P4 T4	0.033	0.012	0.024	0.009
P4 T6	0.038	0.038	0.173	0.085
O2 F8	0.500	0.631	0.809	0.338
O2 T4	0.342	0.264	0.860	0.470
O2 T6	0.109	0.098	0.730	0.867
F8 T4	0.050	0.004	0.068	0.106
F8 T6	0.103	0.585	0.921	0.143
T4 T6	0.020	0.015	0.037	0.001

Interhemispheric: HOMOLOGOUS PAIRS

	DELTA	THETA	ALPHA	BETA
FP1 FP2	0.393	0.426	0.086	0.209
C3 C4	0.044	0.235	0.415	0.424
O1 O2	0.355	0.048	0.245	0.943
T3 T4	0.018	0.501	0.571	0.693

	DELTA	THETA	ALPHA	BETA
F3 F4	0.015	0.222	0.621	0.516
P3 P4	0.025	0.010	0.481	0.022
F7 F8	0.366	0.783	0.668	0.292
T5 T6	0.426	0.229	0.353	0.502

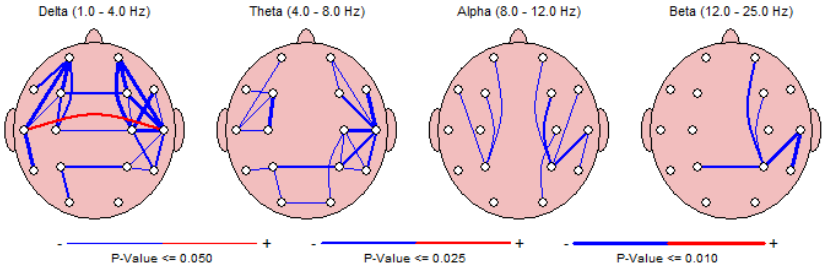

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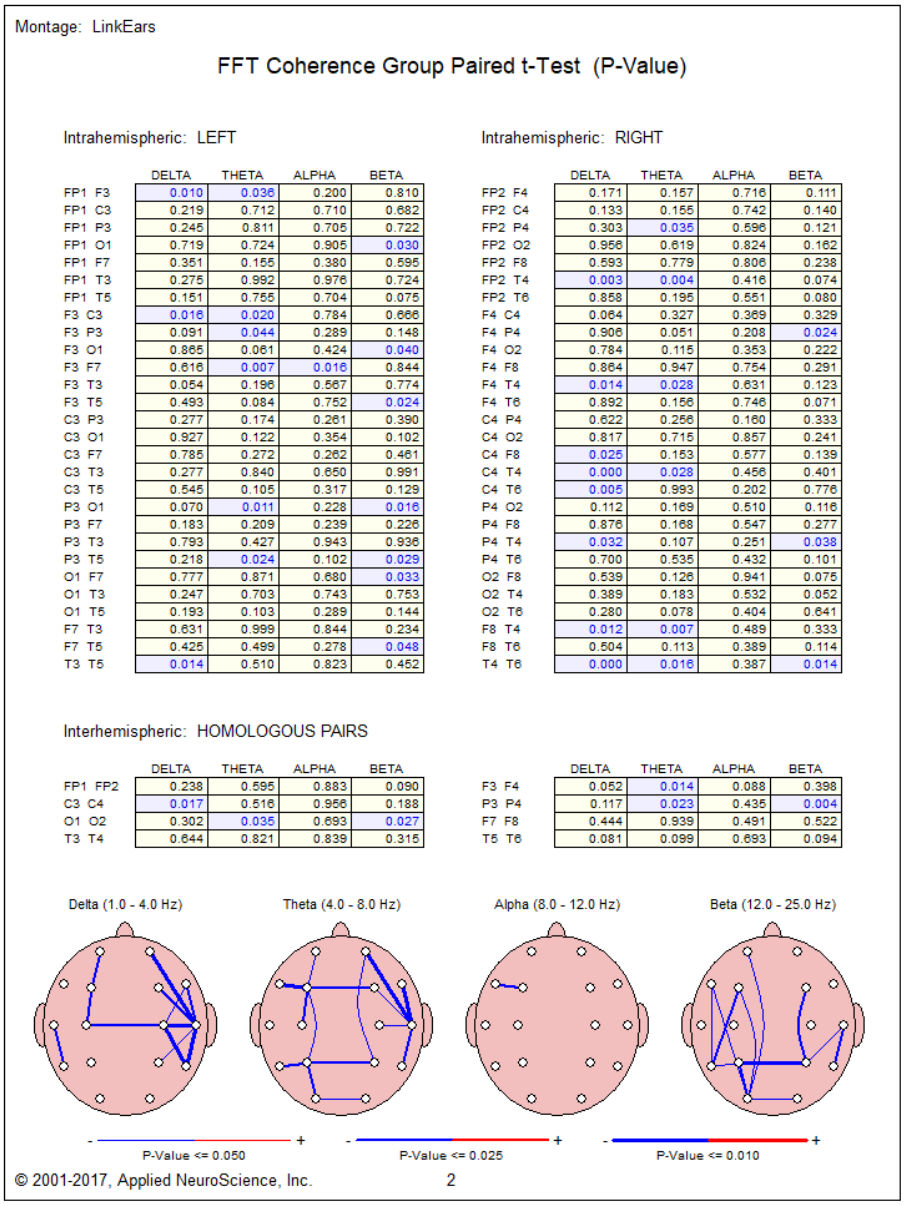
Fig. 1- Paired t-tests in surface EEG coherence between socks off vs socks on in the eyes closed condition.

Figure 2 shows then results of paired t-tests in the surface EEG coherence measures between socks off vs socks on in the eyes closed condition. Significant differences ($P < .05$) were present in widespread electrode pairs and in all frequency bands in both the left and right hemispheres. The socks on condition consistently resulted in reduced coherence.



Montage: LinkEars

FFT Coherence Group Paired t-Test (P-Value)

Intrahemispheric: LEFT

	DELTA	THETA	ALPHA	BETA
FP1 F3	0.010	0.036	0.200	0.810
FP1 C3	0.219	0.712	0.710	0.682
FP1 P3	0.245	0.811	0.705	0.722
FP1 O1	0.719	0.724	0.905	0.030
FP1 F7	0.351	0.155	0.380	0.595
FP1 T3	0.275	0.992	0.976	0.724
FP1 T5	0.151	0.755	0.704	0.075
F3 C3	0.016	0.020	0.784	0.666
F3 P3	0.091	0.044	0.289	0.148
F3 O1	0.865	0.061	0.424	0.040
F3 F7	0.616	0.007	0.016	0.844
F3 T3	0.054	0.196	0.567	0.774
F3 T5	0.493	0.084	0.752	0.024
C3 P3	0.277	0.174	0.261	0.390
C3 O1	0.927	0.122	0.354	0.102
C3 F7	0.785	0.272	0.262	0.461
C3 T3	0.277	0.840	0.650	0.991
C3 T5	0.545	0.105	0.317	0.129
P3 O1	0.070	0.011	0.228	0.016
P3 F7	0.183	0.209	0.239	0.226
P3 T3	0.793	0.427	0.943	0.936
P3 T5	0.218	0.024	0.102	0.029
O1 F7	0.777	0.871	0.680	0.033
O1 T3	0.247	0.703	0.743	0.753
O1 T5	0.193	0.103	0.289	0.144
F7 T3	0.631	0.999	0.844	0.234
F7 T5	0.425	0.499	0.278	0.048
T3 T5	0.014	0.510	0.823	0.452

Intrahemispheric: RIGHT

	DELTA	THETA	ALPHA	BETA
FP2 F4	0.171	0.157	0.716	0.111
FP2 C4	0.133	0.155	0.742	0.140
FP2 P4	0.303	0.035	0.596	0.121
FP2 O2	0.956	0.619	0.824	0.162
FP2 F8	0.593	0.779	0.806	0.238
FP2 T4	0.003	0.004	0.416	0.074
FP2 T6	0.858	0.195	0.551	0.080
F4 C4	0.064	0.327	0.369	0.329
F4 P4	0.906	0.051	0.208	0.024
F4 O2	0.784	0.115	0.353	0.222
F4 F8	0.864	0.947	0.754	0.291
F4 T4	0.014	0.028	0.631	0.123
F4 T6	0.892	0.156	0.746	0.071
C4 P4	0.622	0.256	0.160	0.333
C4 O2	0.817	0.715	0.857	0.241
C4 F8	0.025	0.153	0.577	0.139
C4 T4	0.000	0.028	0.456	0.401
C4 T6	0.005	0.993	0.202	0.776
P4 O2	0.112	0.169	0.510	0.116
P4 F8	0.876	0.168	0.547	0.277
P4 T4	0.032	0.107	0.251	0.038
P4 T6	0.700	0.535	0.432	0.101
O2 F8	0.539	0.126	0.941	0.075
O2 T4	0.389	0.183	0.532	0.052
O2 T6	0.280	0.078	0.404	0.641
F8 T4	0.012	0.007	0.489	0.333
F8 T6	0.504	0.113	0.389	0.114
T4 T6	0.000	0.016	0.387	0.014

Interhemispheric: HOMOLOGOUS PAIRS

	DELTA	THETA	ALPHA	BETA
FP1 FP2	0.238	0.595	0.883	0.090
C3 C4	0.017	0.516	0.956	0.188
O1 O2	0.302	0.035	0.693	0.027
T3 T4	0.644	0.821	0.839	0.315

	DELTA	THETA	ALPHA	BETA
F3 F4	0.052	0.014	0.088	0.398
P3 P4	0.117	0.023	0.435	0.004
F7 F8	0.444	0.939	0.491	0.522
T5 T6	0.081	0.099	0.693	0.094

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Fig. 2- Paired t-tests in surface EEG coherence between socks off vs socks on in the eyes open condition.

LORETA Current Density

Table V shows the results of paired t-tests in LORETA current density in the eyes closed condition between socks off and socks on. The effects appeared to be widespread with statistically significant differences (P < .05) in 48 out of 86 Brodmann areas. There were more statistically significant differences in the left hemisphere Brodmann areas (36 out of 43) than the number of Brodmann areas with statistical significance in the right hemisphere (12 out of 43). The theta frequency band had more statistically significant differences than other frequency bands.

Group Paired T-TEST RESULTs: EC_Loreta Absolute Power_noVoxx vs Voxx_n=60 Subjects																		
LEFT	DELTA	THETA	ALPHA1	ALPHA2	BETA1	BETA2	BETA3	HI-BETA		RIGHT	DELTA	THETA	ALPHA1	ALPHA2	BETA1	BETA2	BETA3	HI-BETA
BA_1L	0.0091	0.0068	0.2520	0.9683	0.8969	0.5452	0.4724	0.6195		BA_1R	0.6676	0.4232	0.5150	0.6277	0.7651	0.5073	0.4322	0.5111
BA_2L	0.0072	0.0345	0.4136	0.6813	0.5585	0.3207	0.2846	0.4908		BA_2R	0.8443	0.6485	0.6381	0.4071	0.5712	0.4329	0.2906	0.3416
BA_3L	0.0048	0.0246	0.3873	0.7364	0.5895	0.3414	0.3028	0.5003		BA_3R	0.8712	0.6608	0.6632	0.3999	0.5564	0.4159	0.2841	0.3402
BA_4L	0.0549	0.0063	0.7224	0.4776	0.7284	0.3715	0.3555	0.4147		BA_4R	0.3642	0.2016	0.2973	0.9828	0.9371	0.7788	0.7497	0.8860
BA_5L	0.9235	0.5765	0.8976	0.1642	0.5638	0.4701	0.3810	0.6696		BA_5R	0.9862	0.5825	0.9581	0.1631	0.5011	0.3988	0.3217	0.5716
BA_6L	0.2556	0.4902	0.8433	0.2022	0.3498	0.2402	0.2016	0.4114		BA_6R	0.7898	0.9780	0.6941	0.1638	0.2859	0.2996	0.2001	0.3279
BA_7L	0.9216	0.6031	0.9725	0.1960	0.6279	0.5950	0.5319	0.9330		BA_7R	0.8932	0.6066	0.9795	0.2013	0.6259	0.5916	0.5359	0.9334
BA_8L	0.0026	0.0007	0.4090	0.6143	0.5821	0.2953	0.3263	0.4245		BA_8R	0.3995	0.6573	0.9038	0.4959	0.4760	0.4405	0.3699	0.3865
BA_9L	0.0025	0.0006	0.4403	0.5852	0.5766	0.2933	0.3256	0.4201		BA_9R	0.3875	0.6649	0.9168	0.4965	0.4667	0.4401	0.3704	0.3864
BA_10L	0.0894	0.0729	0.3915	0.2252	0.3932	0.2867	0.2010	0.2663		BA_10R	0.1691	0.2811	0.4385	0.1370	0.2257	0.2617	0.2708	0.3775
BA_11L	0.0551	0.0568	0.3042	0.1133	0.2070	0.2186	0.1893	0.3266		BA_11R	0.0470	0.0603	0.3049	0.1021	0.1909	0.2167	0.1984	0.3414
BA_13L	0.1019	0.0359	0.5031	0.7753	0.6183	0.7994	0.6840	0.6131		BA_13R	0.1665	0.1794	0.2271	0.9009	0.9409	0.8879	0.8143	0.8685
BA_17L	0.0842	0.0355	0.0589	0.3766	0.3429	0.8939	0.7262	0.9601		BA_17R	0.0918	0.0372	0.0626	0.3586	0.3662	0.9395	0.7072	0.9763
BA_18L	0.0517	0.0308	0.0411	0.5083	0.1878	0.6255	0.9638	0.6298		BA_18R	0.1404	0.0475	0.0720	0.3465	0.4452	0.9438	0.7231	0.8457
BA_19L	0.0412	0.0451	0.0302	0.4584	0.1407	0.4858	0.7388	0.4436		BA_19R	0.2014	0.1028	0.0402	0.5082	0.3508	0.7749	0.9828	0.5011
BA_20L	0.0864	0.0324	0.2758	0.6705	0.2322	0.7919	0.9921	0.9942		BA_20R	0.2190	0.1339	0.0858	0.6900	0.4267	0.7947	0.9339	0.9931
BA_21L	0.0944	0.0409	0.3714	0.7343	0.2700	0.8335	0.9445	0.9541		BA_21R	0.2536	0.1761	0.1360	0.6741	0.4859	0.7981	0.9248	0.9385
BA_22L	0.1018	0.0421	0.1299	0.6930	0.1890	0.4411	0.3532	0.2800		BA_22R	0.2822	0.0359	0.0684	0.2274	0.0781	0.3108	0.3884	0.4105
BA_23L	0.0966	0.0509	0.0452	0.3621	0.3664	0.8440	0.7171	0.9937		BA_23R	0.1063	0.0606	0.0500	0.3411	0.4060	0.9118	0.7019	0.9865
BA_24L	0.0500	0.0273	0.4855	0.0830	0.3046	0.3099	0.2651	0.4329		BA_24R	0.0500	0.0282	0.4919	0.0805	0.3017	0.3112	0.2688	0.4365
BA_25L	0.0460	0.0255	0.4386	0.1053	0.2981	0.2835	0.2481	0.4016		BA_25R	0.0445	0.0384	0.5531	0.0944	0.3133	0.3216	0.3031	0.4449
BA_27L	0.0402	0.0035	0.0694	0.4698	0.2040	0.7197	0.5886	0.6544		BA_27R	0.0514	0.0122	0.0143	0.2475	0.3827	0.8101	0.5870	0.6083
BA_28L	0.0799	0.0260	0.1481	0.6575	0.2526	0.8554	0.8378	0.8010		BA_28R	0.1342	0.1486	0.0950	0.9488	0.6299	0.9910	0.8584	0.8049
BA_29L	0.0533	0.0165	0.0802	0.8241	0.3276	0.6217	0.5786	0.5814		BA_29R	0.2078	0.1270	0.1917	0.8757	0.4826	0.9963	0.9805	0.8022
BA_30L	0.0289	0.0111	0.0322	0.4541	0.2708	0.6443	0.6002	0.7712		BA_30R	0.0933	0.0189	0.0182	0.2888	0.4456	0.9223	0.6081	0.7436
BA_31L	0.1113	0.0946	0.0391	0.3506	0.4042	0.7449	0.7068	0.9740		BA_31R	0.1324	0.1581	0.0502	0.3089	0.5315	0.9486	0.6801	0.9149
BA_32L	0.0995	0.1307	0.3118	0.1307	0.2449	0.2671	0.2027	0.3708		BA_32R	0.0996	0.1436	0.3210	0.1166	0.2104	0.2483	0.1959	0.3878
BA_33L	0.1352	0.1737	0.4701	0.7354	0.6525	0.3309	0.3729	0.4716		BA_33R	0.3068	0.3829	0.4521	0.4100	0.5028	0.2870	0.3044	0.4302
BA_34L	0.0827	0.0275	0.2416	0.7491	0.3639	0.9956	0.7145	0.6856		BA_34R	0.1525	0.1795	0.1969	0.9966	0.8154	0.9121	0.7855	0.7709
BA_35L	0.0639	0.0127	0.0849	0.7367	0.2227	0.8389	0.8033	0.8021		BA_35R	0.0639	0.0345	0.0165	0.4236	0.3646	0.8280	0.7681	0.7007
BA_36L	0.0813	0.0281	0.1886	0.6251	0.2632	0.8711	0.8372	0.8072		BA_36R	0.1659	0.1862	0.1382	0.9951	0.6684	0.9945	0.8813	0.8305
BA_37L	0.0092	0.0450	0.0732	0.4213	0.1486	0.4780	0.5573	0.4776		BA_37R	0.2462	0.1150	0.0254	0.6817	0.2327	0.3259	0.6465	0.5161
BA_38L	0.0859	0.0337	0.3647	0.7523	0.3514	0.9852	0.7471	0.7587		BA_38R	0.2579	0.2598	0.2688	0.9828	0.7638	0.9824	0.8822	0.8616
BA_39L	0.0477	0.0663	0.0568	0.4134	0.2112	0.6522	0.9963	0.6001		BA_39R	0.1701	0.1518	0.0415	0.6296	0.3001	0.6926	0.9144	0.4524
BA_40L	0.0447	0.0104	0.1503	0.8100	0.5635	0.9650	0.9936	0.9779		BA_40R	0.3747	0.1426	0.2750	0.8902	0.6654	0.8544	0.8644	0.9590
BA_41L	0.0801	0.0274	0.0975	0.7372	0.2420	0.5053	0.4252	0.3850		BA_41R	0.3551	0.1087	0.2410	0.8273	0.6201	0.9369	0.9188	0.8567
BA_42L	0.0933	0.0330	0.1374	0.7107	0.2656	0.5554	0.4664	0.4054		BA_42R	0.3085	0.0464	0.1117	0.3611	0.1602	0.5363	0.5404	0.5281
BA_43L	0.0760	0.0221	0.1629	0.7557	0.4107	0.7729	0.7271	0.6862		BA_43R	0.3695	0.0801	0.1838	0.6059	0.3682	0.8448	0.8076	0.7587
BA_44L	0.0720	0.0215	0.7279	0.7492	0.8061	0.5972	0.4104	0.4600		BA_44R	0.2516	0.3003	0.6236	0.6829	0.7969	0.6662	0.5714	0.5935
BA_45L	0.0731	0.0220	0.6682	0.8028	0.7471	0.6316	0.4321	0.4744		BA_45R	0.2400	0.2877	0.5472	0.7677	0.8576	0.7120	0.6052	0.6303
BA_46L	0.0068	0.0011	0.4093	0.7755	0.7842	0.3892	0.3761	0.4342		BA_46R	0.3109	0.4519	0.8119	0.6379	0.6498	0.5553	0.4850	0.4880
BA_47L	0.0831	0.0315	0.5945	0.9085	0.5917	0.7766	0.5401	0.5789		BA_47R	0.2344	0.2643	0.4375	0.8357	0.9651	0.8050	0.6972	0.7128
AmygL	0.0822	0.0279	0.1816	0.6749	0.2744	0.8834	0.8133	0.7815		AmygR	0.1486	0.1661	0.1183	0.9600	0.6716	0.9924	0.8501	0.8078
HippL	0.0797	0.0247	0.1364	0.7400	0.2642	0.8711	0.8067	0.7747		HippR	0.1163	0.1264	0.0750	0.8242	0.6357	0.9906	0.8081	0.7645

Table V – paired t-tests in LORETA current density between socks off vs socks on in the eyes closed condition.

Table VI shows the results of paired t-tests in LORETA current density in the eyes open condition between socks off and socks on. The effects appeared to be widespread with statistically significant differences (P < .05) in 35 out of 86 Brodmann areas. There were more statistically significant differences in the left hemisphere

Brodmann areas (22 out of 43) than the number of Brodmann areas with statistical significance in the right hemisphere (13 out of 43). The theta frequency band had more statistically significant differences than other frequency bands.

Group Paired T-TEST RESULTs: EO_Loreta Absolute Power_noVoxx vs Voxx_n=60 Subjects

LEFT	DELTA	THETA	ALPHA1	ALPHA2	BETA1	BETA2	BETA3	HI-BETA	RIGHT	DELTA	THETA	ALPHA1	ALPHA2	BETA1	BETA2	BETA3	HI-BETA
BA_1L	0.4663	0.1039	0.2409	0.2771	0.3075	0.3273	0.3735	0.5930	BA_1R	0.0704	0.5317	0.4592	0.5135	0.8274	0.6577	0.8733	0.7781
BA_2L	0.6434	0.1692	0.3803	0.4135	0.3711	0.5906	0.6211	0.7509	BA_2R	0.1829	0.6356	0.4527	0.6814	0.7995	0.6593	0.9138	0.8302
BA_3L	0.6238	0.1632	0.3642	0.4074	0.3706	0.5469	0.5864	0.7285	BA_3R	0.1703	0.6577	0.4854	0.7179	0.7562	0.6873	0.8853	0.8367
BA_4L	0.2707	0.0676	0.2688	0.1620	0.2325	0.3280	0.4774	0.4523	BA_4R	0.1385	0.3185	0.3631	0.2569	0.7217	0.4682	0.8942	0.9541
BA_5L	0.7268	0.6729	0.1962	0.2753	0.2767	0.2945	0.0753	0.0715	BA_5R	0.6751	0.6200	0.1790	0.2709	0.2593	0.3339	0.0745	0.0829
BA_6L	0.8136	0.3446	0.5341	0.4506	0.5687	0.7066	0.7440	0.7839	BA_6R	0.1317	0.6405	0.4425	0.6307	0.8578	0.6841	0.9652	0.9864
BA_7L	0.7325	0.6322	0.1851	0.2741	0.2342	0.2812	0.0398	0.0272	BA_7R	0.7217	0.6296	0.1850	0.2748	0.2326	0.2880	0.0393	0.0270
BA_8L	0.2270	0.0268	0.1253	0.1003	0.1968	0.4314	0.7542	0.7415	BA_8R	0.1120	0.3504	0.5028	0.7796	0.7258	0.9210	0.7955	0.9328
BA_9L	0.2204	0.0263	0.1298	0.0994	0.1968	0.4277	0.7489	0.7181	BA_9R	0.1117	0.3545	0.5206	0.7994	0.7205	0.9344	0.7869	0.9395
BA_10L	0.1535	0.0667	0.4818	0.2924	0.4865	0.5220	0.6399	0.6297	BA_10R	0.2555	0.1841	0.7732	0.5351	0.8054	0.6774	0.5773	0.8664
BA_11L	0.1515	0.0634	0.5424	0.3866	0.6047	0.6218	0.9183	0.8781	BA_11R	0.1486	0.0600	0.5701	0.4188	0.6542	0.6547	0.9922	0.9143
BA_13L	0.2011	0.0559	0.1677	0.0720	0.1396	0.2250	0.3025	0.4347	BA_13R	0.5262	0.3187	0.4953	0.2325	0.6630	0.6913	0.7786	0.9149
BA_17L	0.0546	0.0075	0.0868	0.1536	0.1137	0.2961	0.0975	0.0757	BA_17R	0.0598	0.0087	0.0962	0.1670	0.1177	0.3130	0.0973	0.0742
BA_18L	0.0810	0.0060	0.0373	0.0614	0.0840	0.1969	0.0815	0.0810	BA_18R	0.0901	0.0150	0.0766	0.1431	0.0944	0.3175	0.1100	0.0747
BA_19L	0.1195	0.0092	0.0378	0.0443	0.0662	0.1587	0.0507	0.0732	BA_19R	0.1706	0.0403	0.0554	0.0950	0.0687	0.2342	0.0992	0.0838
BA_20L	0.2216	0.0836	0.1377	0.0645	0.1339	0.2006	0.2724	0.5036	BA_20R	0.6476	0.4074	0.3603	0.1762	0.6293	0.6005	0.8701	0.8146
BA_21L	0.2224	0.0895	0.1546	0.0703	0.1461	0.2064	0.2800	0.4899	BA_21R	0.7160	0.4353	0.4111	0.2042	0.6506	0.5714	0.8380	0.8067
BA_22L	0.2269	0.0520	0.1243	0.0972	0.1764	0.1001	0.1334	0.3804	BA_22R	0.2296	0.0638	0.0672	0.0192	0.1482	0.1545	0.7291	0.6268
BA_23L	0.0666	0.0089	0.1016	0.1797	0.1111	0.2939	0.0861	0.0791	BA_23R	0.0816	0.0128	0.1143	0.1971	0.1187	0.3167	0.0854	0.0766
BA_24L	0.1621	0.0540	0.3240	0.2428	0.5165	0.5696	0.9116	0.9100	BA_24R	0.1638	0.0549	0.3264	0.2470	0.5278	0.5771	0.9274	0.9155
BA_25L	0.1439	0.0503	0.3602	0.2634	0.5277	0.5753	0.9014	0.9091	BA_25R	0.1546	0.0571	0.3749	0.3005	0.6452	0.6495	0.9491	0.9509
BA_27L	0.1113	0.0060	0.0567	0.0457	0.0694	0.2470	0.2939	0.4578	BA_27R	0.2564	0.0225	0.1638	0.2252	0.0867	0.3875	0.4744	0.5687
BA_28L	0.1920	0.0649	0.1236	0.0520	0.1280	0.2348	0.3472	0.5641	BA_28R	0.6889	0.4157	0.4501	0.2851	0.7827	0.7569	0.8400	0.8595
BA_29L	0.1485	0.0261	0.1167	0.1470	0.2326	0.1170	0.1376	0.3979	BA_29R	0.0202	0.0415	0.1050	0.1058	0.3086	0.3541	0.5775	0.5191
BA_30L	0.0513	0.0027	0.0727	0.1250	0.0747	0.2595	0.1320	0.1695	BA_30R	0.1032	0.0165	0.1486	0.2411	0.1123	0.3757	0.1160	0.1295
BA_31L	0.0815	0.0097	0.1066	0.1962	0.0967	0.2682	0.0728	0.0840	BA_31R	0.1303	0.0317	0.1376	0.2357	0.1196	0.3377	0.0752	0.0795
BA_32L	0.1853	0.0711	0.5292	0.3653	0.4791	0.5261	0.7175	0.6982	BA_32R	0.1800	0.0623	0.5256	0.3693	0.4770	0.5248	0.8107	0.7320
BA_33L	0.0042	0.0005	0.0251	0.0181	0.1451	0.4167	0.7581	0.7814	BA_33R	0.0064	0.0062	0.0366	0.0366	0.1610	0.4148	0.7162	0.7829
BA_34L	0.1864	0.0623	0.1321	0.0553	0.1398	0.2427	0.3767	0.5574	BA_34R	0.6533	0.4009	0.4794	0.3172	0.8570	0.7657	0.8134	0.8675
BA_35L	0.1947	0.0417	0.0766	0.0410	0.0920	0.2238	0.3072	0.5317	BA_35R	0.4456	0.1055	0.1758	0.1735	0.2233	0.5052	0.9071	0.8046
BA_36L	0.1912	0.0682	0.1318	0.0564	0.1358	0.2349	0.3447	0.5655	BA_36R	0.7196	0.4860	0.5231	0.3348	0.8822	0.7810	0.8204	0.8578
BA_37L	0.3093	0.0395	0.0758	0.0703	0.0698	0.1239	0.0521	0.1682	BA_37R	0.2600	0.0674	0.0499	0.0661	0.0551	0.1676	0.1143	0.1891
BA_38L	0.1950	0.0752	0.1541	0.0696	0.1574	0.2407	0.3416	0.5548	BA_38R	0.7613	0.5707	0.6358	0.4196	0.9823	0.7745	0.7964	0.8468
BA_39L	0.2302	0.0264	0.0498	0.0406	0.0599	0.1584	0.0556	0.0755	BA_39R	0.2434	0.0769	0.0642	0.1095	0.0819	0.2295	0.0880	0.0731
BA_40L	0.2547	0.0423	0.1487	0.1679	0.2482	0.1673	0.2035	0.4601	BA_40R	0.0375	0.1986	0.2389	0.1511	0.6981	0.4386	0.9525	0.6748
BA_41L	0.1759	0.0310	0.1198	0.1225	0.2080	0.1048	0.1311	0.3849	BA_41R	0.0868	0.2946	0.3282	0.1702	0.6309	0.4322	0.9718	0.8404
BA_42L	0.2163	0.0390	0.1370	0.1223	0.2056	0.1129	0.1443	0.3927	BA_42R	0.1485	0.0767	0.1044	0.0332	0.2577	0.2079	0.7941	0.6390
BA_43L	0.2479	0.0399	0.1544	0.1508	0.2338	0.1405	0.1720	0.4198	BA_43R	0.0982	0.1566	0.1871	0.0786	0.4820	0.3011	0.9122	0.6778
BA_44L	0.1669	0.0482	0.1638	0.0762	0.1846	0.2794	0.4202	0.5550	BA_44R	0.4107	0.2990	0.4690	0.3521	0.9018	0.7127	0.7735	0.8339
BA_45L	0.1701	0.0505	0.1579	0.0729	0.1758	0.2709	0.4050	0.5459	BA_45R	0.4557	0.3171	0.4597	0.3390	0.8639	0.7051	0.7824	0.8318
BA_46L	0.0769	0.0050	0.0600	0.0497	0.1720	0.3712	0.7035	0.7640	BA_46R	0.1894	0.2525	0.4616	0.4949	0.8859	0.8501	0.7846	0.8737
BA_47L	0.1837	0.0657	0.1683	0.0778	0.1802	0.2698	0.3937	0.5731	BA_47R	0.6152	0.4297	0.5742	0.4045	0.9466	0.7613	0.7796	0.8579
AmygL	0.1930	0.0668	0.1296	0.0547	0.1324	0.2358	0.3464	0.5546	AmygR	0.7139	0.4407	0.4840	0.3078	0.8234	0.7680	0.8290	0.8605
HippL	0.1930	0.0616	0.1188	0.0498	0.1239	0.2367	0.3473	0.5536	HippR	0.6652	0.3534	0.3944	0.2608	0.7039	0.7400	0.8569	0.8620

Table VI – paired t-tests in LORETA current density between socks off vs socks on in the eyes open condition.

Figure three shows paired t-test ($P < .0.001$) results in the comparison of cortical current densities between standard socks versus Voxx socks in the eyes closed condition. Bilateral significant differences were present with left hemisphere differences more prominent than right hemisphere. The bilateral frontal lobes, including the sensory motor strip on the dorsal surface as well as the medial wall of the somatosensory projection regions of the foot (Homunculus) from 2 Hz to 7 Hz.

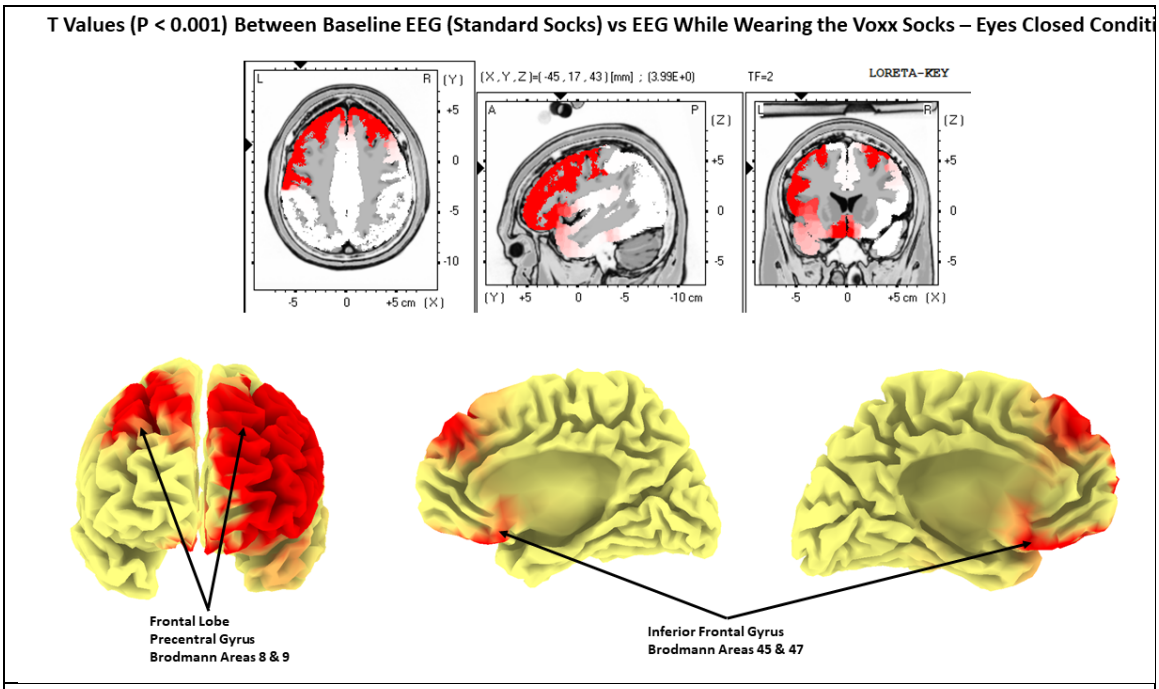

Fig. 3 – Paired t-test (P < 0.001) differences in current density between standard socks versus Voxx socks in the eyes closed condition.

Figure four shows paired t-test (P < .0.001) results in the comparison of cortical current densities between standard socks versus Voxx socks in the eyes open condition. Bilateral significant differences were present with left hemisphere differences more prominent than right hemisphere. The bilateral frontal lobes, including the sensory motor strip on the dorsal surface as well as the medial wall of the somatosensory projection regions of the foot (Homunculus). Significant differences were also present in the left parahippocampal gyrus and the left inferior frontal lobes from 2 Hz to 7 Hz.

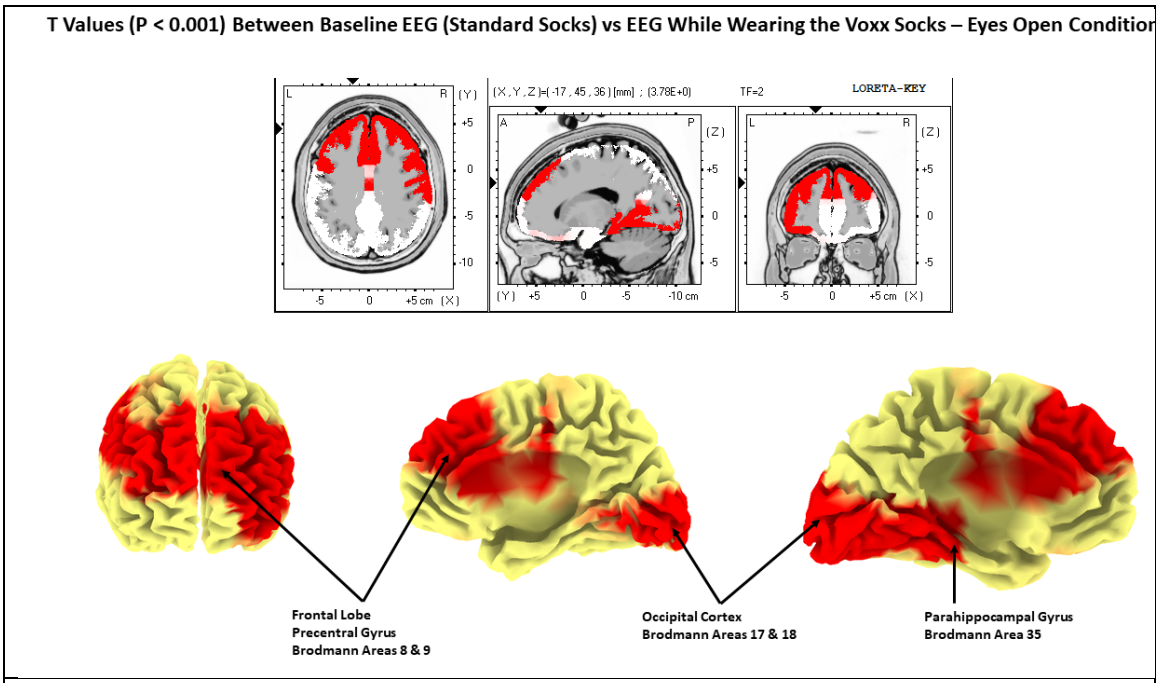

Fig. 4– Paired t-test (P < 0.001) differences in current density between standard socks versus Voxx socks in the eyes closed condition.

Discussion

The results of this study showed that the EEG auto and cross-spectrum is effected when the Voxx socks are placed on a person's feet as compared to a random sample of regularly worn socks. Fifty nine out of 60 subjects exhibited statistically significant changes in surface auto and cross-spectrum. Sixty out of sixty of the subjects exhibited statistically significant changes in the EEG source current density.

There was generally an increase in EEG absolute power in the delta and theta frequency bands, especially in the left hemisphere and a decrease in power in the higher frequency bands, especially in the right hemisphere with Voxx socks on vs Voxx socks off.

EEG coherence primarily decreased with Voxx socks on vs regular socks in all frequency bands and in both hemispheres. Decreased coherence indicates increased differentiation and increased complexity in brain networks.

Validation of the effects of the somatosensory foot stimulation on the central nervous system was further provided by the finding that LORETA current density consistently increased in the foot projection areas on the medial surface of the somatosensory cortex. Bilateral frontal lobe Brodmann areas exhibited the largest t-test differences (99.9%) in the lower frequency bands (e.g., delta and theta) and especially in left hemisphere Brodmann areas. The effects of Voxx socks on the electrical energies of the brain were evident especially in left frontal and left temporal, left anterior cingulate and left parahippocampal gyrus.

The exact mechanisms of action of the Voxx sock foot pattern on the somatosensory system are currently unknown. At least three hypotheses are: 1- The

process of changing socks effects the EEG spectrum, 2- Dishabituation occurs because of the novelty of a sequence of edges that stimulate the foot and, 3- Both hypotheses 1 and 2 contributed to the EEG changes. Future studies are planned to control for the order of sock changes to partition the variance attributable to these two hypotheses.

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