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Quantitative Shifts in the Second Harmonic (12-14 Hz) of the Schumann Resonance Are Commensurate with Estimations of the Sleeping Population: Implications of a Causal Relationship

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Abstract: Recent spectral power densities of quantitative electroencephalographic measurements of normal brains indicate they reveal peaks that correspond with the fundamental and harmonics of the Schumann Resonance. Coherence between the human brain and Schumann power occurs for about 300 ms every 30 s. We examined the conspicuous diurnal complex variation in Schumann values and the estimated numbers of people asleep at the time globally. The overlap was visibly obvious for the 12-14 Hz (second harmonic), which is the Stage 2 sleep spindle range, with peak-to-peak changes of ~0.1 Hz and 0.1 pT. Residuals from multiple regression analyses after potential artifacts were removed showed that as the estimated numbers of people sleeping increased the frequency increment within the 12-14 Hz range increased while the intensity decreased by about 1 pT. The Lorentz Lemma for population brain-Schumann activity and comparable current densities for the ionosphere-earth gradient and human brain current densities are similar magnitudes and suggest potential interactions. Experimental manipulation by HAARP of the Schumann Resonance employed a power density (10 mW per m^2 range) that is comparable to that from the photon power densities emitted from the brain activities of billions of people. Although causality is not demonstrated, the presence of a strong coherence could suggest interactions at global levels.

Keywords: Schumann Resonance; population sleeping; pT intensities; 10-14 Hz; sleep spindles; biophoton emissions

1.Introduction

The increasing sensitivities of technology by which the quantifications of human electroencephalographic activity and the Schumann Resonance within the earth-ionosphere boundary are measured have revealed remarkable similarities. Both show: 1) resonance frequencies of 7-8 Hz, 13-14 Hz, 19-20 Hz, etc [1-4], 2) magnetic field strengths within the picroTesla range [3,4], 3) electric field intensities within the 0.3 to 1.0 mV per m range [3,5-7], 4) phase modulations and "refresh" rates of about 20 ms [4, 8-9] , 5) generation from a relatively "thin shell of origin" [10], and 6) and origins from discrete electrical impulses equivalent to 10^5 A per m^2 [11]. The magnetic energy within the volume of the human brain from Schumann fundamental magnetic field strengths is ~10^{-20} J [12]. This is a unit quantity of energy associated with action potentials and the sequestering of many ligands to receptors [13].

Because the cerebral and ionospheric EM fields are similar in frequency, exist outside their source, and are within a linear isotropic medium, there is the potential for the Lorentz Lemma [14]: del· (E_c x H_s)=del·(E_s x H_c), where E refers to the electric field in V per m, H refers to the magnetic field vector in A per m and the subscripts refer to the cerebral cortices (c) and Schumann (s) sources, to occur which relates the two EM fields. For example assuming typical values within both cerebral cortical and ionospheric-earth sources to be 0.5 x

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10^{-6} A per m and ~10^{-6} V per m, the radiant flux density would be about 0.5 x 10^{-12} W per m^2. This is within the range of the photon emissions from the human brain during cognition [15-16] as well as hippocampal slices during intrinsic stimulation [17-18]. Here we present evidence of a potential mass effect from the total numbers of people sleeping at any given time and small but conspicuous shifts in the peak frequencies of the 12-14 Hz harmonic of the Schumann Resonance.

Sleep processes within the human brain are associated with relatively stereotyped ~90-minute progressions and are displayed by all normal members of the human species, from the perspective of electrophysiology. The four classic and repeating stages of sleep can be discerned visually by measuring the waveforms of the brain's electric field recorded with the electroencephalograph. One conspicuous indicator of the onset of stage-2 sleep is the appearance of regular spindle oscillations within the 12-14 Hz range. The source of these oscillations appears to be the reticular formation of the thalamus that "deactivates" about 8 min before the cortices at the onset of sleep [19]. Correlational studies have demonstrated that sleep spindle densities are associated with elevations in the performance of cued-recall and thus may be the cortical manifestation of the consolidation of long-term memory that occurs within the hippocampus [20]. The 12-14 Hz spindle activity that occurs within the human brain matches the approximate frequency of the second harmonic of the Schumann resonance

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A potentially temporally-linked relationship between the electromagnetic activities from human brain and earth-ionosphere shell within the ultra-low frequency range has been recently been shown [1]. Earlier measurements with less sensitive equipment by Pobachenko et al [21] had produced estimates of coherence between the two phenomena, which approached magnitudes of 0.1 to 0.6. They were also correlated with daily estimates of the static geomagnetic field in the form of Ap indices. Saroka and Persinger [1] further demonstrated that there are transient periods of about 300 milliseconds where the coherence between QEEG and both local and distal Schumann values within the first three modes (8, 14, 20 Hz) were particularly enhanced. These transient coherences occurred 1-2 times per 60 seconds over the caudal temporal-parietal region, an area that has been a frequent inference of activation of hippocampal structures such as the parahippocampal gyrus [22].

2. Methods and Materials

Since August 2015, the Laurentian University Radio Observatory has been continuously monitoring the Schumann Resonance within the ultra-low frequency range of 0-50 Hz using an induction coil magnetometer. The instrument was constructed from about 96,000 turns of copper wire wound around a steel core. Calibration has confirmed that it is sensitive to measure down to 0.1 picoTesla strength magnetic field perturbations within the 0-50 Hz frequency band. More specific information regarding this equipment can be found in Saroka and Persinger [1]. All data is made publicly available at www.vlf.it/laurentian/livedata_laurentian.html as part of a network of researchers situated in Italy who monitor ULF, VLF and other natural radio emissions. Daily raw time-series measurements are recorded via soundcard using Spectrum Lab, an open-source software that is used to simultaneously analyze and record (sample rate=204 Hz) in real-time the measurements collected from the magnetometer.

From qualitative inspections of the spectrograms generated at the station, conspicuous 'bending' of the frequency of the second 12-14 Hz mode has been consistently observed, particularly at two peak periods around 0200-0900 and 1500-2200 hours UTC. An example spectrogram is shown in Figure 1. These periods overlap with what we have inferred to be the peak sleeping times of the majority of people in the eastern and western hemispheres respectively.

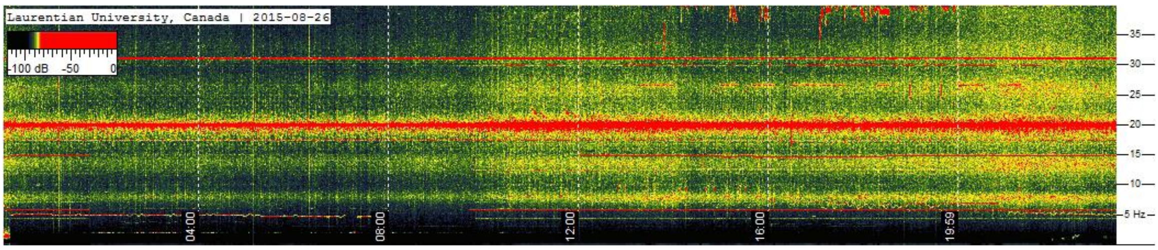

Figure 1-Sample spectrogram for one complete day. Vertical axis on right is frequency. Horizontal axis is time. Bending of the second harmonic Schumann resonance is visible between roughly 3 and 8 UTC as indicated by dilution of the thin red line for the 12-14 Hz band.

This observation led to the question: are the 12-14 Hz sleep spindles associated with light sleep somehow related to the shifting of the 12-14 Hz peak frequency of the Schumann resonance generated globally? The following analysis was conducted in order to explore this possible relationship by computing estimates of the individuals who might be engaged in sleep. Estimates of the sleeping population as well as land area and lightning strikes for co-variation were obtained. The population and land area per unit degree longitude were extracted from the NASA Socioeconomic Data and Applications Center [23]; global lightning per unit longitude was extracted from Christian et al [24] using the 'grabit' open-source tool in MATLAB that extracted data points from Figure 8B of their publication. These data were then organized such that 0-degrees longitude coincided with 0000 UTC because it was estimated that the numbers of people sleeping at this time and place would be congruent. All of these 'static' variables were represented as time series with the assumption that 1) all variables showed diurnal variations and that 2) these diurnal variations were relative measures per unit longitude and hence time, relative to the axial rotation around sun.

Estimations of peak frequencies and peak amplitudes for the first and second Schumann modes were conducted for 5 days (September 20, 21 and October 17,1 8,23) in year 2015. For each day data was parsed into 360 segments (corresponding to the spatial analog of longitude). Spectral analyses were then computed and estimates of peak frequency and peak magnitude within the 7.3-8.2 and 13.5-14.3 Hz bands (resolution=.05 Hz) were calculated. The peak frequencies and amplitudes for each day were smoothed with a moving average (period=30), averaged across all 5 days and then imported into the dataset. The first 5 and last 5 degrees of 360 were then removed because of smoothing artifacts.

3. Results

Zero-order correlation analyses indicated a logarithmic relationship (Rho=.72 $p<.05$, R=.70, $p<.05$) between numbers of sleepers and peak frequency. These raw data are presented in Figure 2 which displays the log of the population estimated to be sleeping, the shift in the second harmonic of the Schumann (the 12-14 Hz band) and alteration in the amplitude in picoTeslas (pT) as a function of longitude (degrees). The similarities of the variations are conspicuous.

To allow direct comparison as a function of daily time (hours) for the shifts in peak frequency of the local Schumann frequencies (which are strongly correlated with another station in Italy) and the estimated numbers of people asleep on the earth's surface the data were z-scored (standardized). This relationship is shown in Figure 3A. The overlap over the 24-hour periods is clearly apparent even from gross visual inspection.

All data was log-transformed for further analysis. To control for the confounding variables of lightning strikes (i.e. energy source of the Schumann resonance), land surface area (highly correlated with population), and sequence (5-355) or intrinsic temporal relationships, peak 13-14 Hz Schumann frequency, respective amplitudes and numbers of sleepers were entered into separate linear regressions with the potential confounds entered as predictors. The correlation between the residuals of the regression analyses indicated a significant positive relationship (Spearman Rho=.34, $p<.05$; R=.32, $p<.05$) between estimates of individuals sleeping and degree of shifting of the second mode (12-14 Hz) of the Schumann Resonance (Figure 3B). The residual range is equivalent to about 0.1 to 0.2 Hz within the 12-14 Hz mode.

When the same analyses procedures were applied to peak magnitudes (in pT) a negative relationship (Rho=-.25, $p<.05$; R=-.22) emerged for estimated numbers of people sleeping (Figure 3C). The amplitude of the residuals was equivalent to about 1 pT. For comparison purposes, the same analysis was applied to the 7.8 Hz fundamental harmonic. The results indicated that the relationship was marginally significant (Rho=-.11, $p=.04$). These results suggest that the residuals hidden within the primary relationship (Figure 3A) relate the numbers of people sleeping at any time and a slight increase of ~0.2 Hz in Δf within the Stage-2 sleep spindle range (12-14 Hz) and decrease in the associated amplitude in the 1 pT range. The only other harmonic that exhibited a comparable magnitude correlation was within the 32-33 Hz band whose correlation strength was comparable to the second harmonic when all confounding indicators were removed.

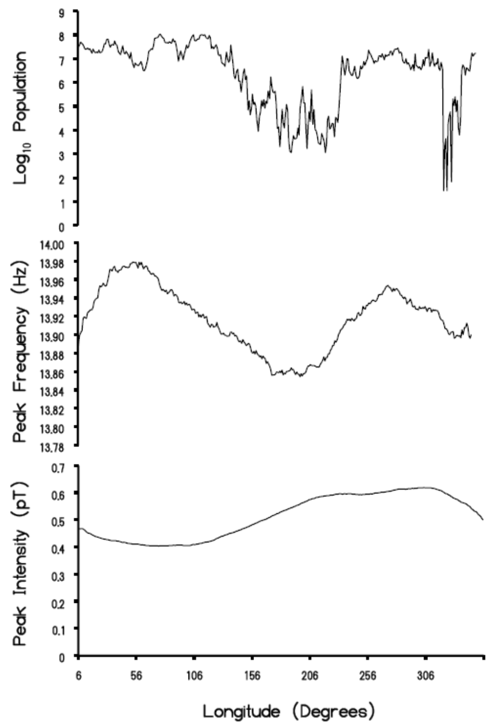

Figure 2. Log_{10} of the sleeping population, shift in peak frequency of the 12-14 Hz Schumann Resonance, and alterations in amplitude as a function of the longitude (in degrees).

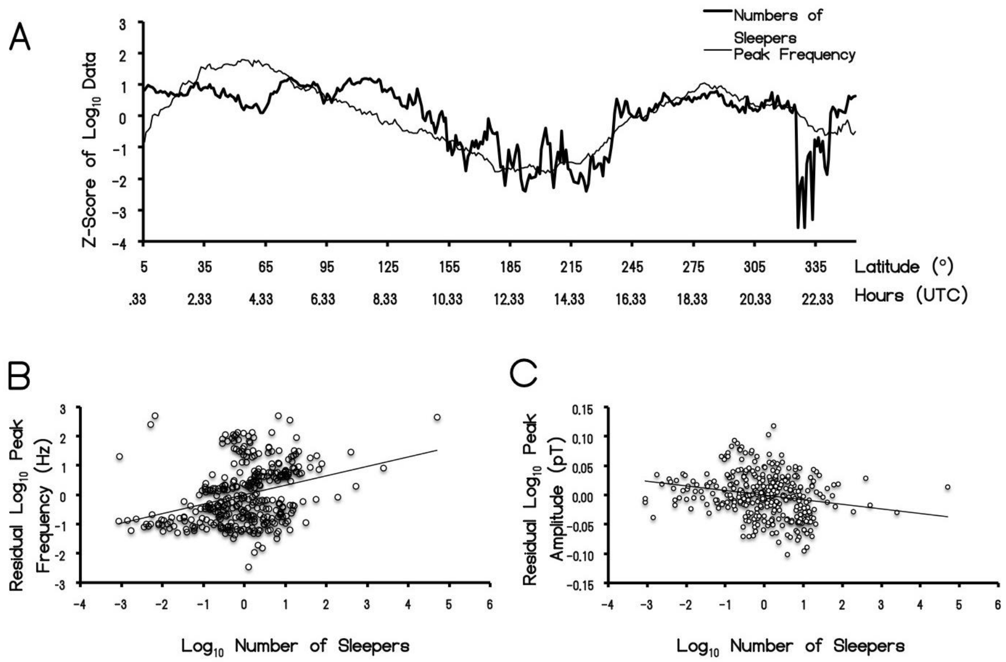

Figure 3 (A) Time-series of estimated numbers of dreamers and peak frequency organized temporally (B) Positive relationship between peak frequency of 2nd Schumann mode and number of sleepers (C) Negative relationship between peak frequency magnitude and the numbers of sleepers.

4. Discussion

It may not be spurious that the human cerebral and earth-ionospheric phenomena occasionally synchronize given that both show relatively comparable frequency and amplitude characteristics. The average spectral density over caudal regions of the human brain measured by electroencephalography is about 0.3 $\mu V^2/Hz$ when the root mean square of the respective sensors is computed. When multiplied by 7.8 Hz (first mode of the Schumann resonance) and divided by the average cortical thickness of 3 mm the resultant electric field strength is about 0.56 mV/m; this is the precise range that the harmonics of the Schumann resonance have been measured when using ball-antennas.

Although our data are clearly correlational and there is always the possible of a third unidentified variable causing the diurnal changes in both the Schumann and human brain electromagnetic values, the possibility that intermodulation might occur cannot be totally excluded. First the Lorenz Lemma indicates that the conditions may be met intermittently for the Schumann and species-related brain activity to intercalate. Second, the vertical currents between the ionosphere-earth are in the order of 10^{-12} A per m^2 [25]. If one assumes the current within each human brain is ~10^{-7} A (10^{-6} V divided by 2 Ω m, quantity multiplied by the average length of the cerebrum of 10^{-1} m) then with 1 billion brains the summed current would be 10^2 A and distributed over the surface of the earth (10^{14} m^2) would be ~10^{-12} A per m^2 [26]. There will be some discrete point in the near future where the numbers of people on the planet would be sufficient to exceed the actual average value of the earth-ionosphere current densities. Whether or not this will influence causal directions is an empirical question.

That the Schumann frequencies can be experimentally shifted has been shown by Streltsov et al [27]. They found that the total power of ~3.6 MW from 2.75 MHz to 4.57 MHz electromagnetic fields modulated between 7 Hz and 8 Hz and emitted as a vertical beam width of ~20 km produced enhancements of Schumann amplitudes at 7.4 Hz, 7.6 Hz, 7.8 Hz and 8.0 Hz. Assuming a circular cross sectional area for the vertical beam the power would be equivalent to ~1.2 x 10^{-2} W per m^2. The human brain emits on average about ~2 x 10^{-12} W per m^2 of photon flux density when engaging in imagination [16]. Assuming 7 billion brains on the planet, this would be 1.4 x 10^{-2} W per m^2. Even if only about one-seventh of these brains were sleeping and dreaming the upper range of the photon flux densities of 10^{-11} W per m^2 from the right hemisphere that was strongly correlated with the total electroencephalographic power over the left prefrontal measured directly by Dotta et al [16] would be within the range produced by the specialized equipment employed by the High Frequency Active Auroral Research Program reported by Streltsov et al [27].

Because the variables were not manipulated experimentally in the present study causality cannot be attributed. It is unlikely that the diurnal variations in the Schumann parameters are causing the proportion of people sleeping. The resonances of 8 Hz, 14 Hz, 20 Hz, 26 Hz, and 33 Hz are caused by the global lightning discharges of about 44±2 strikes per s (42-46 Hz) [24] that originate primarily within the ‘chimney’ equatorial regions around South America, Africa and Southeast Asia [28]. Annual and diurnal variations of both the frequency and amplitude of this phenomenon have been reported. In general, the intensity peaks during June/July and is minimal during December/January, with diurnal peak intensities commensurate with elevated lightning occurrence within the ‘chimney’ regions. Bimodal peaks within the first and second harmonics appear independently at different times of the day [29]. However if there is a mass effect from human organisms engaging in remarkably static and stereotyped behaviors such as sleep and dreaming upon Schumann parameters then the interaction between our species and the dynamic electromagnetic earth may be more quantitative than usually assumed.

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