Synchronization of Brainwaves with the Schumann Resonance

Saskia BOSMAN[1], Pavel KOSTECKY[2], Jelbert HOLTROP[1], Stefaan VAN NUFFEL[1], Jacques GROENEN[1], Marc KROEKS[1]

1 Independent Research Group, sothis@euronet.nl

2 Comenius University, Faculty of Mathematics, Physics and Informatics, Dept.of Astronomy, Physics of the Earth and Meteorology, Mlynska dolina F-1, 842 48 Bratislava, Slovak Republic, kostecky@fmph.uniba.sk

Abstract. Indications have been found for intermittent synchronization of the EEG with the base frequency (8 Hz) of the Schumann Resonance (SR), a naturally occurring electromagnetic field in the atmosphere. This frequency is in the low-alpha band, reached by the subjects in a state of deep, near-sleep relaxation. As this band is related to the self-repair ability of the human body, this may indicate a biological function of synchronization with the SR base frequency.

1 Introduction

Based on earlier studies on entrainment of the human EEG by artificial oscillating magnetic fields in the range of 1 to 60 Hz it has been suggested that the EEG may synchronize (intermittently) with the frequencies of the SR [1]. We have not been able to find a report in the scientific literature about simultaneous measurements of the EEG and natural SR signals. This paper reports such measurements conducted in order to find out whether the EEG, in a state of deep relaxation, synchronizes (part of the time) with the SR base frequency.

2 Materials and methods

The human EEG and the natural SR were measured simultaneously. The SR signal (electric field component) was monitored at Modra observatory (48.37° N, 17.27° E, 531 m.s.l.) through a 5 m high ball antenna, amplifier, filter bank and a 16-bit, 200 Hz sampling ADC. For testing synchronization between SR and EEG signals the phase response of SR amplifiers and filters were determined and used for correction. The digitized SR signal has been used for the computation of frequency spectra, the output analogue signal was fed into one channel of a I-330 C2 mini EEG/HRV interface (J&J Engineering, Poulsbo, WA, USA, sample rate 128 Hz), connected to a PC with software for two-channel data acquisition. The EEG signal from position Pz of the international 10-20 system (reference and ground at the earlobes) on the back of the head was fed into the other channel of the interface, which contained EEG amplifiers, a 1 Hz high-pass and a 30 Hz low-pass filter. Each of the 5 subjects (authors of this article) was in seated position in a chair at a table and received the instruction to close the eyes and relax as deeply as possible, as if (s)he would fall asleep. While all participants were able to relax deeply and to reach the low-alpha band, the seated position prevented falling asleep. Raw SR and EEG signals were recorded for 10-minute periods. For analysis of the signals (Morlet) wavelet and statistics for testing synchronization between both signals as described by Lachaux et al. were used [2]. Both were included in a LabVIEW computer program (National Instruments, Austin, TX, USA). Synchronization between the EEG and SR signals were tested in 2 Hz wide bands centered around 8, 11 and 14 Hz, of which the first and second are two subsequent frequencies of the SR [2].

3 Results

Figure 1 shows periods of synchronization between EEG and the base frequency of the SR (8 Hz), more than with the second SR mode (14 Hz) and a frequency chosen in between (11 Hz). Significant synchronization with the SR base frequency was found in 3 of the 5 subjects and this varied as a function of time. Differences in synchronization among the frequencies (8, 11 and 14 Hz) become visible when the percentage of time that synchronization is significant ($P<0.05$) rises above 10 %.

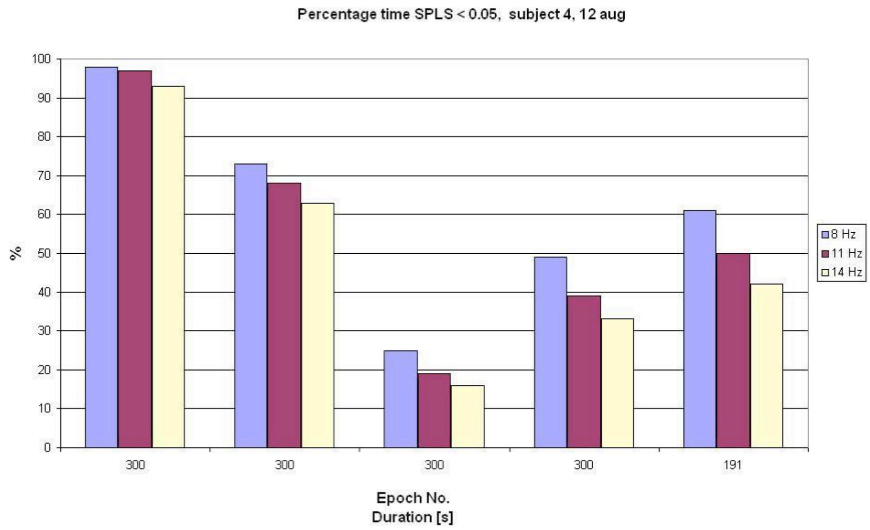

Fig. 1: Percentage of time in each trial of 191-300 s that a significant synchronization occurs (SPLS or $p<0.05$) in subject No. 4. Synchronization has been tested statistically for the lowest two frequencies of the SR; 8 Hz (7-9 Hz), 14 Hz (13-15 Hz) and a frequency in between; 11 Hz (10-12 Hz).

4 Discussion

The sample rate of the data acquisition equipment enabled only a rough phase comparison between the two signals. Research is planned and may be reported in a full paper, with a higher sample rate data acquisition interface, enabling thus a more accurate phase comparison of EEG and SR signals (8 and 14 Hz) and higher variability in synchronization among nearby frequencies (8, 11 and 14 Hz) within each trial. However, Hainsworth [3] has suggested the alpha rhythm avoids the frequencies of the SR in order to prevent interference by these. In a normal relaxed state with the eyes closed, most people show an alpha peak on or near 10,5 Hz. In deep, near-sleep relaxation the EEG shows low-alpha brainwaves (7-9 Hz). Both possibilities could be functional. In normal relaxation the brain may avoid the SR frequencies, staying independent as an oscillator. In deep, near-sleep relaxation the brain may be tuning in to the SR to stay in low-alpha, stimulating self-repair of the body [4].

5 Conclusion

These preliminary results are promising as these indicate that the human brainwaves may synchronize part of the time with the base frequency (8 Hz) of the SR, more than with higher frequencies, when the subject is in seated position, in deep, near-sleep relaxation and with the eyes closed.

References

[1] H. L. König. Behavioural changes in human subjects associated with ELF electric fields. In: M.A. Persinger (ed.), *ELF and VLF electromagnetic fields effects,* Plenum Press, New York, 1974.

[2] J. P. Lachaux, E. Rodrigues, M. le van Quien, A. Lutz, J. Martinerie and F.J. Varela.. Studying single-trials of phase synchronous activity in the brain, *International Journal of Bifurcation and Chaos* **10** (2000) 2429-2439.

[4] L.B. Hainsworth, The effects of geophysical phenomena on human health, *Speculations in Science and Technology* **6** (1983) 439-444.

[3] J. L. Oschman. Silent Pulses, *Journal of Bodywork and Movement Therapies* **1** (1997) 179-194.

Acknowledgments - The authors thank Prof.Dr.Peter Moczo, DrSc., Head of Dept.of Astronomy, Physics of the Earth and Meteorology, Comenius Univ., for making possible measurements at the Astronomical and Geophysical Observatory of Comenius University at Modra, Slovakia. They also thank Doc.Dr.Sebastian Sevcik, CSc., Dr.Ladislav Rosenberg, PhD. from this Department and Dusan Kalmancok from the Observatory staff for valuable help in the organization of measurements and the processing of data obtained.