Effects of EMF Radiation on EEG Brainwaves

Abstract:

This pilot study was designed to test the effects of electromagnetic frequencies (EMF) emitted by modern cell phones on brain waves during an EEG scan. Participant underwent three evaluations. The first was to establish a baseline of brain functionality for comparison to test conditions. The second evaluation included placing a phone close to the participant's ear mimicking a phone call. In the third, a *Lambs* cap was placed over the EEG cap and the phone returned to the same location as the first. The participants' EEG data showed a significant increase in their Alpha, Beta and High Beta waves when a phone was placed next to their ear. This pattern then subsided and returned to baseline when the *Lambs* EMF blocking hat was placed on the participants head. Data from this pilot study suggest that EMF radiation from cellphones when held close to the head induce a state of neurological dysregulation in the brain. It also suggests that *Lambs* EMF blocking technology is effective in preventing potential states of neurological stress via EMF radiation.

Introduction:

Electromagnetic frequencies (EMFs) are a spectrum of waves that travel through space and carry energy. They are composed of both an electric wave and a magnetic wave. They are classified by their frequency, which is the number of waves that pass a given point in space per second. EMFs exist all around us, and are emitted from our cell phones, the sun and earth, medical devices like x-rays and visual light are all examples of EMFs. Electromagnetic waves are produced by

electrically charged particles that are undergoing acceleration. For example, radio waves are produced by antennas, microwaves are produced by magnetrons, and visible light is produced by atoms in light bulbs and other light sources. The electromagnetic spectrum ranges from radio waves to gamma rays. In between are microwaves, infrared radiation, visible light, ultraviolet radiation, and X-rays. Electromagnetic waves have a wide range of applications in modern technology. Radio waves are used for broadcasting, cellular phones, and Wi-Fi. Microwaves are used for cooking, radar, and satellite communications. Infrared radiation is used for remote controls, night vision goggles, and thermal imaging. Visible light is used for communication, lighting, and photography. Ultraviolet radiation is used for tanning beds, sterilization, and water purification. X-rays are used for medical imaging and security screening. Gamma rays are used for cancer treatment and materials testing. With the dramatic increase of EMF waves due to these technologies, many studies are suggesting that they are putting our health at risk. The World Health Organization (WHO) classifies EMF waves as a class 2 carcinogen meaning it is likely to cause cancer[1].

The aim of this pilot study was to understand the impact EMF radiation has on brainwave function during an electroencephalogram (EEG) scan. Then, to compare those effects utilizing EMF blocking technology provided by *Lambs*. This study was conducted on one participant during one sitting. A normal QEEG test was first conducted according to industry standards to establish the participant's baseline functioning. This was then followed up by a test following the same standards but with a cellphone placed next to the participant's left ear attempting to mimic a cell phone call. Finally, a *Lambs* hat was placed over the EEG cap and the participant's head and the phone returned to its previous position next to the participant's left ear. This third test was conducted the same as the other two.

[1]https://www.who.int/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-phones

Results:

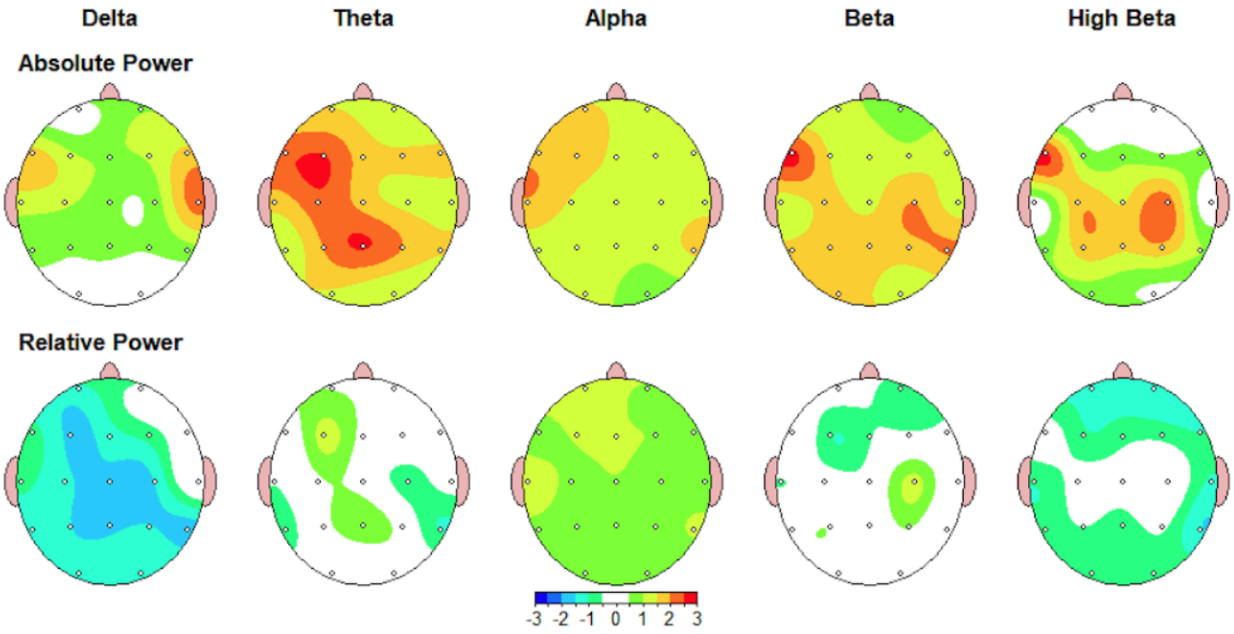

Figure 1: Show the summary results of the participants' baseline EEG brainwave activity. Prior to any experiments being conducted. Divided into their specific wavelengths. Results showed high activity (2-3 Standard Deviations above a normative population) in the right temporal delta, central and left theta and in the right temporal lobe in the participants' alpha, beta and high beta waves.

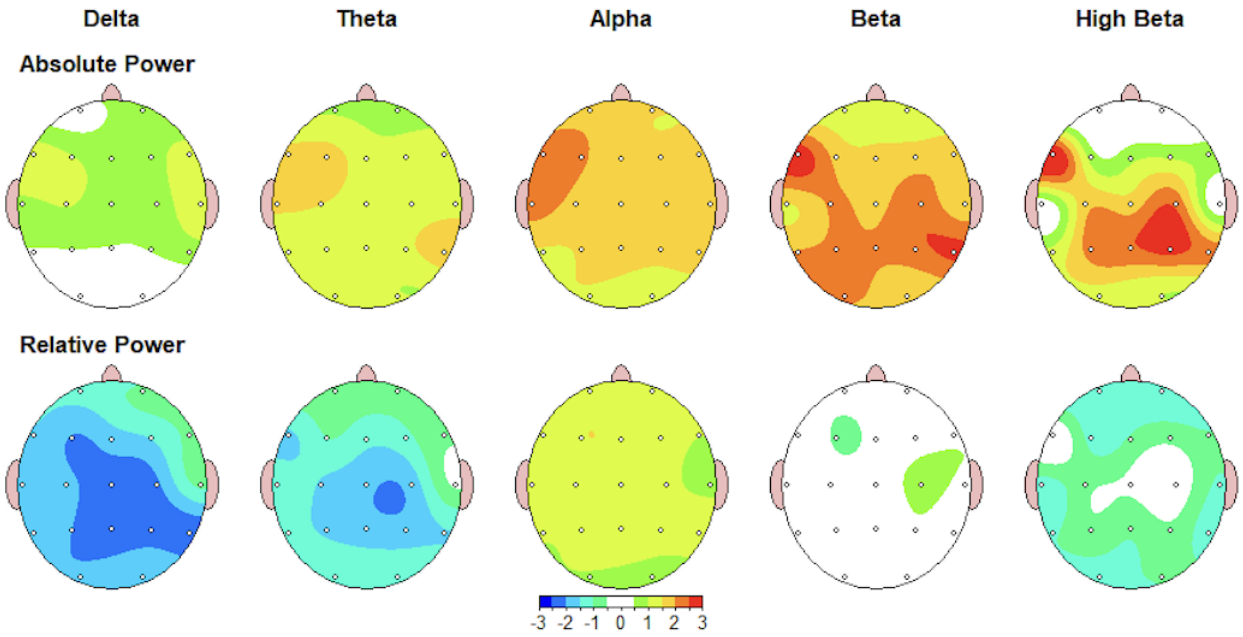

Figure 2: EEG results after eyes closed condition when a cell phone was placed next to the participants left ear mimicking a phone call. Participants' brain wave patterns showed high power of their alpha, beta and high beta frequencies. High beta and beta is indicative of stress and anxiety. Especially located by the left ear where the phone was placed.

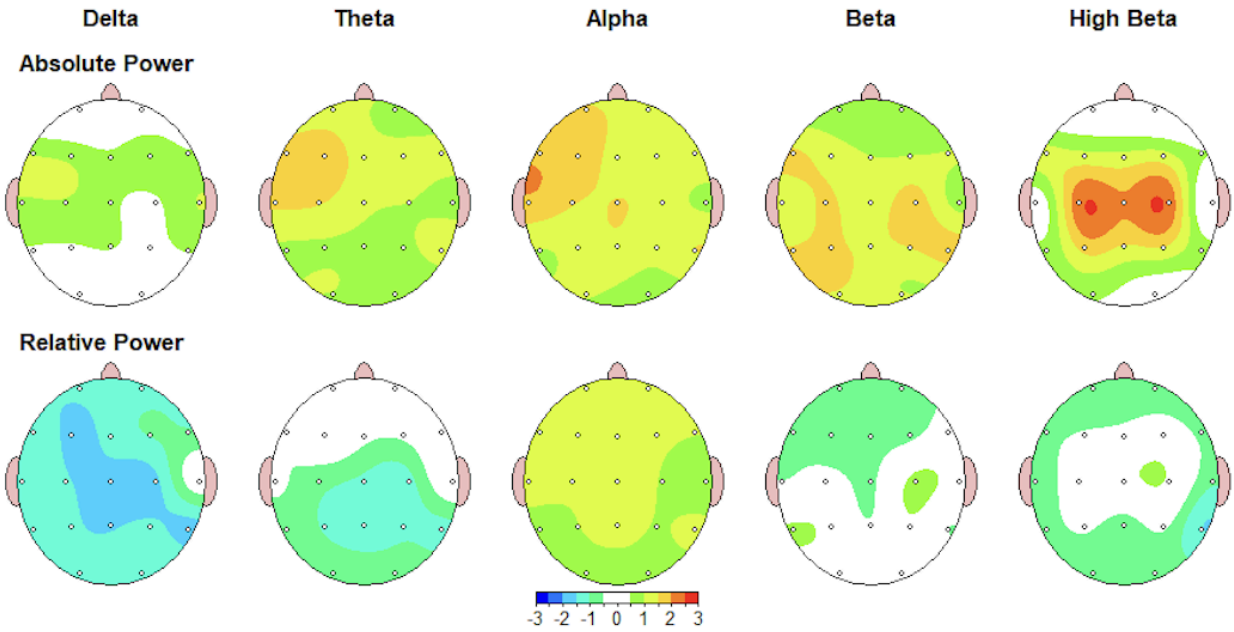

Figure 3: Results of EEG scan while the participant had a phone next to their left ear while wearing a *Lambs* EMF blocking hat. Participants' brains appeared overall balanced with most brain waves within 1-1.5 SD above the normative mean. With the exception of their high beta where C3 and C4 appeared 3 SD above.

This pilot study was conducted in one sitting during the eyes open condition. The participant's baseline was first taken in order to ensure a comparison for the following test conditions. During the test condition, a phone was held to the participant's head and his brain waves were measured during another 10 minute eyes closed period. Finally, a Lambs EMF blocking hat was placed on the participant's head over the eeg cap and a phone placed next to the participant's ear for another 10 minute period.

The participant's initial baseline showed high theta activity located primarily at F3 (left frontal) and Pz just posterior of the center of the head. Baseline scans also showed high beta activity at F7 (just forward of the left ear) which was also present in the participants alpha and high beta waves. Next a cellphone was placed next to

the participant's left ear mimicking a phone call. During this condition the same protocol was applied as the baseline.

Absolute power results showed a decrease in the participant's delta and theta waves. Especially the participant's theta which decrease by 1-1.5 standard deviations. Contrastingly, the participant showed significant increases in alpha, beta and high beta.

Significant increases were seen at the F7 location close to wear the phone was being held. High beta and beta waves also showed increases in similar areas. As well as P4 and T6 locations. While both the baseline and the with phone test condition had similar patterns of activation, the test condition showed an overall higher degree of activation and subsequent dysregulation in all brain waves except delta and theta wavelengths.

Finally, a Lambs EMF blocking cap was placed on top of the participant's head over the EEG brain cap, the phone returned to its same placement next to the left ear and another 10 min eyes closed test was conducted. There was a slight decrease in activity in the Theta and Delta wavelengths but there was a closer regression back to what is considered "normal functioning." When compared to the with phone condition. Most significantly, there was a major decrease in activity in the participant's beta and high beta waves. In the participant's beta waves there was no activity above 1-1.5 standard deviation above the mean. High beta still maintained some high activity but the extent of it was significantly reduced across the brain. With the exception of the participant's alpha and high beta frequencies, the participant's brain showed improved brain balance, even as compared to their baseline brain map.

These findings were from the participant's absolute power, which is the measure of the total electrical activity in a particular frequency band at a specific electrode or brain region. It represents the overall strength or intensity of the electrical signals generated by the brain cells in that area. While relative power, the total electrical activity of a particular frequency compared to a normative population offers additional insight. The main focus for this study was the participant's absolute power.

Discussion:

The participants baseline scan showed a degree of dysregulation across all brain wave frequencies. With the least dysregulation in the participants alpha frequency. When compared to the *With Phone* test the QEEG results showed a decrease in high theta and delta activity. Since delta and theta are slow brain wave frequencies (1-4Hz and 2-8Hz respectively) and are associated with deep sleep and daydreaming, the decrease in the activity of these brain waves could be due to the participant becoming more alert as the test progressed. Conversely, given that placing the phone close to the participant's head caused an increase in beta, and high beta frequencies, this potentially associated stress could have placed the brain in a fight or flight state. Also leading to a decrease in theta and delta frequencies. The participant showed similar brainwave patterns across the brain. Which was also seen in both test conditions. In the baseline condition the participant's alpha frequency had a point of higher activity (+2.5 SD) just forward of the left ear and an area of slightly lower activation (+1.5-2 SD) stretching from the ear out to Fp7. The participant showed the same pattern in the *With Phone* condition with higher degree of activity which propagated much further affecting the majority of the brain except the occipital lobe. Beta frequencies showed the exact same pattern in the baseline and the *With Phone* condition; however, the area of high activity jumped from +1.5-2 SD to 2.5-3 SD. High beta again showed the same pattern of increased activity from baseline most exacerbated in regions that were already dysregulated. Faster brain wave frequencies (beta and high beta) are commonly associated with problem solving however too much power in these frequencies is associated with stress and anxiety. Given the high power seen in the participants' brain maps it can be concluded that having the phone next to their head without *Lambs* protective gear induced a state of stress. Though it is inconclusive whether that was due to the effects of EMF waves, placebo effect or other confounding variable.

When comparing the baseline and *With Phone* condition to when the participant wore *Lambs.* There was an increased regression to the normative mean in the participants delta and theta waves compared to the *With Phone* condition,

suggesting that the high theta and delta seen in the baseline were due to the participant's decreased state of wakefulness as opposed to just their normal baseline state. Wearing *Lambs* caused an improvement in the participant's alpha back to his baseline state, with a dramatic regulation of activity when compared to the *with phone* condition. Similarly, beta showed another regulational decrease in high activity when wearing *Lambs* becoming more balanced than the participant's original baseline. Again showing a significant decrease in dysregulation and high activity when compared to the *with phone* condition. The participant's high beta showed the same regression to greater balance when wearing *Lambs* as the beta and alpha frequencies. Whole brainwave patterns were still present as were two points of +3 SD activity at C3 and C4 which were not present in the participants' baseline but were elevated. With the exception of the participant's alpha frequency the +3 SD activity at F7 totally disappeared.

Wearing the *Lambs* hat improved overall brain balance in this participant. As well as reduced a state of neurological stress potentially induced by EMF radiation. However, given the participant's baseline and degree of dysregulation, it is possible that they were at an increased risk of being affected by EMF radiation from a cell phone. It is also important to note that there was a significant amount of professional camera equipment present in the room. Which could also have contributed to the drastic changes seen. The participant was also informed of the potential effects of EMF radiation prior to the test which could have led to a placebo effect resulting in increased high frequency brainwave activity shown in the *With phone* condition.