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Measuring electro-physiological response to a tibetan bell as stimulating agent

Measuring electro-physiological response to a tibetan bell as stimulating agent

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Abstract. In the context of the experiments on "Extremely Weak Fields" (EWF), measurements have been carried out to detect a quantifiable response of skin parameters when subjects are stimulated by a very low intensity signal, a Tibetan bell. A first interesting feature is that the maximum of information of what happens is given in the frequency interval [0, 0.1] Hz. Such a fine structure of measurements is guaranteed by a device of advanced electronics, APEC 300. The reported results on fifteen subjects, before and after stimulation, are briefly commented.

1. Introduction

This research has been carried out in the program "Extremely Weak Fields" (EWF), that is coordinated by Prof. Massimo Scalia at the "Interuniversity Centre of Research for Sustainable Development"-University "La Sapienza"-Roma.

This line of the research stemmed from the traditional opposition of many Physicists against the possibility that a very low intensity signal can overcome a specific physical "barrier", the intensity of which is some orders of magnitude greater than that of the signal. Then, no effect was associated to that signal. Apart quantum phenomena generating effects on macroscopic scale, like "tunnel" effect does, that only can explain the macroscopic transformation from reagent into product in many biochemical reactions, also in the classical biological domain we can observe very weak signals producing detectable effects in a biological system. It is the case of a concentration of aldosterone in the interval [10^{-10}, 10^{-12}] M that is capable of saving sodium request of renal tubules in our body; or the human eye retina, that is activated by a few photons; or the electroreception in elasmobranchs, that is activated by 1μV, and so on.

Precisely in Bioelectromagnetism, from the answer given to the issue if the very lowelectromagnetic field (EMF) irradiated by a tension line will be masked by thermal noise that agitates a tissue or a cell [1] arose the idea at the base of the program on Extremely Weak Fields.

Always in the framework of EWF, it has also been relieved that special sounds or a soft background of music can modify psycho-physiological status of whom is listening, as it has also been experimented in our research program [2].

In this paper we analyze what happens when the stimulation is given by the sound of a Tibetan bell.

2. The purpose of research

Our preliminary tests have convinced us that it is true, as widely reported in the scientific literature, that an observable effect on humans due to a very low stimulation can be measured as cutaneous potential difference between two parts of the body. In particular, previous tests with measurement values in the range of a tenth of millivolt (1 mV = 10^{-3} Volt) and the ease with which measurements can be made led us to choose the palm of the hand and the corresponding forearmas body districts.

Thus, the research aims to check by quantitative measurements if the trend of the cutaneous potential between the palm of the hand and the forearm is affected by a weak signal, such as the sound emitted by a Tibetan bell.

3. Material and methods

The real possibility to perform measurements of such a sensitivity is allowed by a device of advanced electronics, APEC-300 (Figure 1), which is able to perform on biological and non-biological materials, two fundamental types of measurement:

-exceedingly small potential differences (p.d.);

-impedance at low frequencies.

APEC-300 has been designed, built and calibrated in order to perform the measurements of p. d. and impedance not only on areas of the human body but also on water and aqueous solutions, cell cultures, solid inorganic bodies.

In particular, in the field of electrophysiology, the skin potential is the expression of the electrical activity of the skin organ (epidermis + dermis + subcutaneous) and its measurement can be performed directly with APEC-300, recording through of the electrodes the signals of this activity with the same modalities with which one proceeds with the electrocardiogram (ECG) and the electroencephalogram (EEG). The skin impedance characterizes the electrical properties of the skin organ (resistance and capacity) and the measurement is performed with particular surface electrodes to which an electrical voltage or current is applied.

Figure 1. Image of APEC 300, by the company MCS s.r.l. of Pomezia, Rome, Italy.

The measurement frequency extends in the range from 0 to 30 Hz and the minimum detectable difference among voltage values is 10 nV (1nV = 1 nanovolt = 10^{-9} Volt, i.e., one billionth of a Volt). The duration time of the single recording can be adjusted up to a maximum of 300 seconds and is stored.

APEC-300 is endowed with an its internal software able of producing, for each measurement of the potential level as a function of time, a frequency analysis, that is, the Fourier components to the different orders. This particular performance allows associating to each measure a kind of electromagnetic footprint, typical of an inanimate body, an aqueous solution, of the body district, of the organism, – animal, vegetable – or the cell culture, which are under examination.

The experimental tests were carried out in the period of June and July 2019. The potential difference was measured between two points on the skin surface, respectively the palm and forearm of the left hand (Figure 2).

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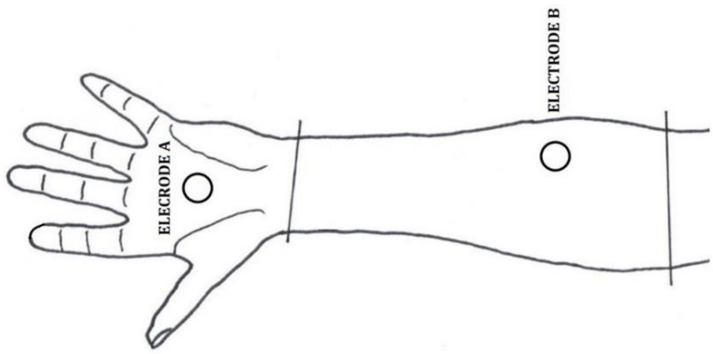

Figure 2. Position of the electrodes on the left hand. The two electrodes (A and B), model for ECG, are connected to the APEC-300 by means of shielded cables (BNC – BNC). With this arrangement, the output voltage is the measure of the potential difference (p.d.) between the two points of the skin under examination.

Figure 3. On the left the Tibetan bell used in the experiment, and on the right the bell and the drum stick to produce the sound. The emitted frequency is about 330 Hz.

Changes in temperature, humidity, pressure, etc. do not have a particular significance with regard to the quantities that translate a bioelectrical activity of our organs; just think of EEGs or ECGs. We report them in the attachment, as a tribute to the protocol we followed.

4. Measurements

First of all, we have to quantify what the meaning of "very low stimulation" in our experiments is. The acoustic intensity of the sound of our Tibetan bell is the physical quantity to be determined, that depends on acoustic pression, velocity of sound and the density of medium through which sound propagates. In our experimental conditions– environmental temperature and humidity taken into account–the calculated value of acoustic intensity was about 90 picowatts (1 picowatt = 10^{-12} W). The latter value enables us to define as "very low stimulation" the one that impacts body surface and to classify that sound intensity as an EWF.

Fifteen subjects, five males and ten females, aged between 24 and 69 years, were examined for a total of 30 measurements. The latter lasted 300 seconds (5 minutes). The first series of measurements (15 measurements) was performed in the absence of observable external stresses, the second series (15 measurements) in the same conditions as the previous one but after listening to the sound produced by the Tibetan bell.

How we proceeded on each of the subjects who participated in the experimentation will now be shown for only one of them – Figures 4 to 7 and Tables I and II – which will conventionally be referred to as measure "number 1". In Figures 4 and 5, the temporal trend of the potential hand forearm of subject number one (MEASURE 1), before and after stimulation, is examined respectively. By analyzing the two figures, it is possible to determine the average value V_m (the average of all the individual readings of the potential in the 300 seconds of measurement) and the difference ΔV between the maximum and minimum value of the gastric potential difference (p.d.) in the absence of stimulation and after stimulation. This last value provides an indication of how much the skin potential fluctuates during the measurement. In particular, V_m = -24.62178 mV and (in absolute value) ΔV = 5.377 mV are obtained before stimulation (Figure 4). The minus sign indicates that the potential on the palm of the hand is negative compared to that measured on the forearm. After stimulation there is a decrease of both V_m = -29.25543 mV and ΔV = 2.151 mV (Figure 5). In this way it was possible to collect for all 15 subjects the measurements shown in Table I.

The trend over time of the skin potential in the absence of stimulation (Figure 4 and 5) was then studied in relation to the frequency (Figures 6 and 7). Figure 6 and 7 are the graphs of the frequency spectrum, from 0 to 0.1Hz, of subject number one: respectively before and immediately after the stimulation. Prior to stimulation (Figure 6), the potential value at zero frequency was approximately -24 mV and the first three frequency components were 1.02 - 0.85 - 0.48 mV. After stimulation with the Tibetan bell (Figure 7) the value of the potential at zero frequency decreased, passing from - 29 mV to about -24 mV. The first three frequency components have significantly decreased, passing to 0.21 - 0.26 - 0.06 mV.

It is important to immediately note that in Figures 6 and 7 the frequency spectrum ranges from 0 to 0.1 Hz. It is far from obvious that the maximum information is obtained in such a limited range and, above all, in such a low frequency range (Ultra Low Frequencies); the part of the spectrum for frequencies higher than 0.1 Hz does not provide interesting data for any of the thirteen subjects examined.

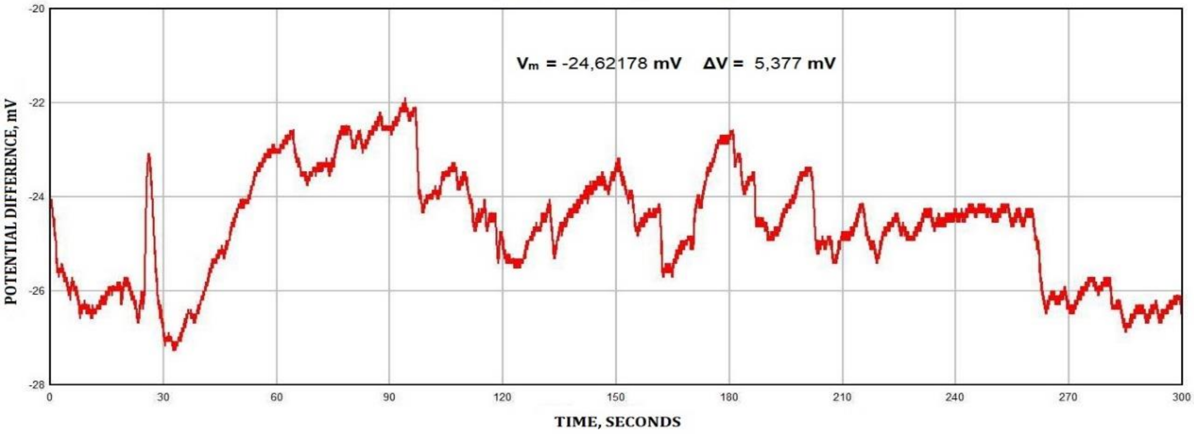

Figure 4. Trend over time of the skin potential, relative to subject 1. Full Scale 50 mV; Duration measurement betweenpalm and forearm before stimulation, 300 s.

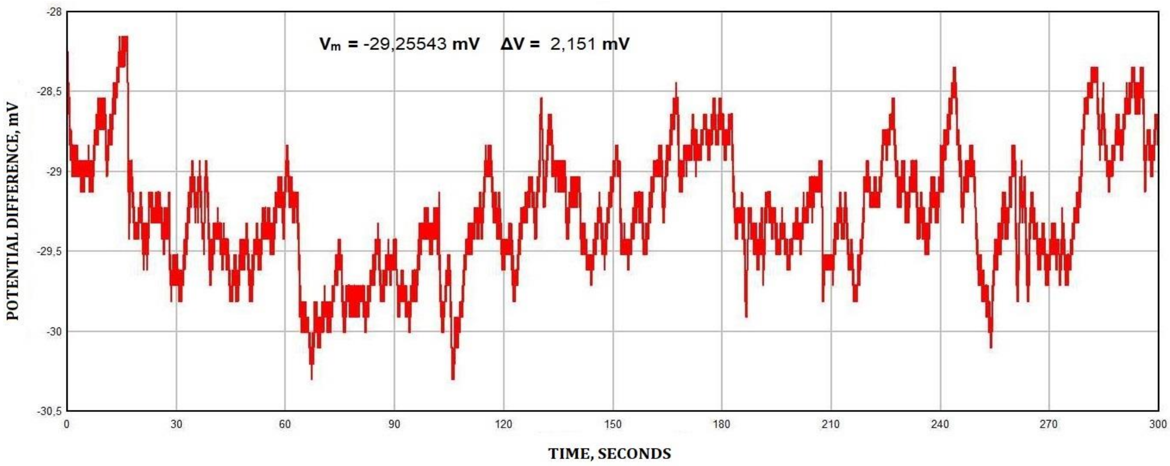

Figure 5. Trend over time of the skin potential, relative to subject 1. Full Scale 50 mV; Duration measurement between palm and forearm after stimulation, 300 s.

Table 1. Indicates the measure of the average value of the skin potential.

MEASURE	BEFORE THE STIMULATION		AFTER THE STIMULATION				
	V_mmV	ΔV mV	V_mmV	ΔV mV	V	%	OSC
1	-24.62178	5.377	-29.25543	2.151	-	15.8	D
2	-2.577134	2.834	-3.130678	7.430	-	17.7	A
3	1.67195	17.690	6.948527	6.843	+	75.9	D
4	-9.529952	16.520	-7.182279	11.339	+	24.6	D
5	-18.01057	10.851	-9.228041	20.528	+	48.8	A
6	12.376420	44.184	8.616056	41.055	-	30.4	D
7	-5.245794	57.478	28.70461	20.039	+	84.6	D
8	-19.93058	14.076	-19.07697	8.700	-	4.3	D
9	-7.832204	16.716	1.490933	10.361	+	84.0	D
10	-24.32206	5.474	-22.97847	7.820	+	5.5	A
11	-0.246837	13.881	-20.70593	7.234	-	70.6	D
12	-9.973124	23.949	-3.373838	16.032	+	66.2	D
13	-5.923217	4.595	-6.859702	2.444	-	13.7	D
14	-21.35695	13.979	-21.13512	13.783			
15	-12.86206	10.752	-10.11588	9.755	+	21.4	D

Notes:
ΔV, is the extent of the oscillation of the skin potential in absolute value. In the sixth column, the + sign indicates a decrease in the average negative value of the potential of the palm of the hand (expressed as a percentage); the – signmeans an increase in the negative potential of the palm of the hand. In the seventh column OSC indicates the skin potential excursions (D means that they decrease; A, that they increase).

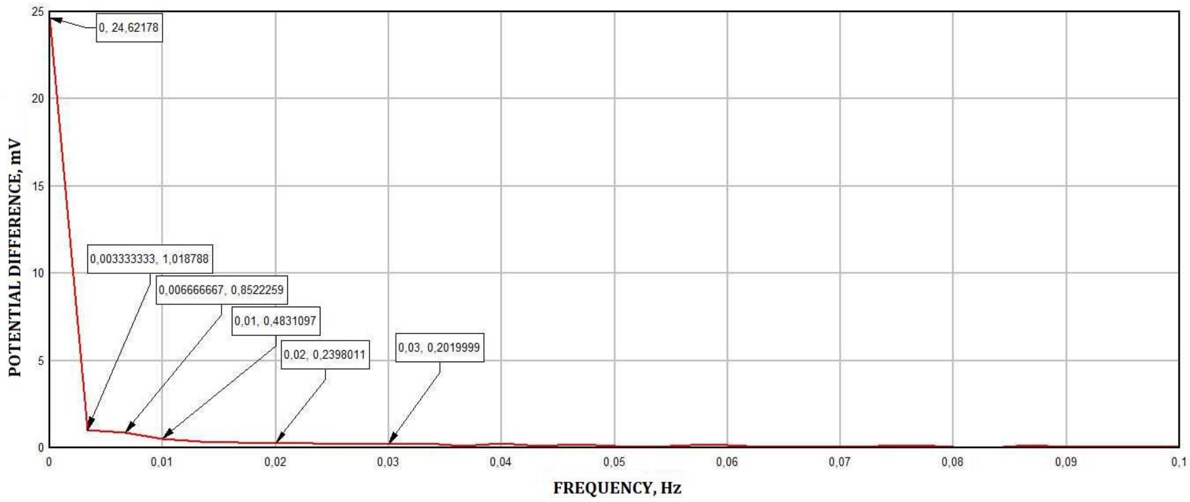

Figure 6. Frequency spectrum, before stimulation, related to subject 1. Full Scale 50 mV; Duration measurement between palm and forearm, 300 s.

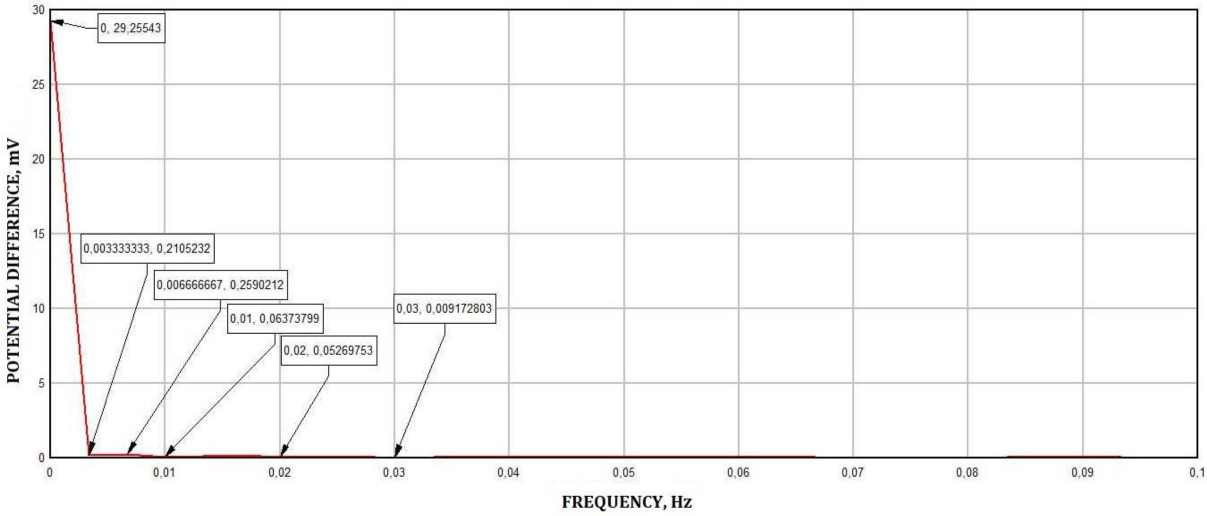

Figure 7. Frequency spectrum, after stimulation, relative to subject 1. Full Scale 50 mV; Duration measurement between palm and forearm, 300 s.

Table 2. Hz frequency spectrum data for subject number one.

FREQUENCY Hz	POTENTIAL PEAK mV before the stimulation	POTENTIAL PEAK mV after the stimulation	POTENTIAL MEAN VALUE mV before the stimulation	POTENTIAL MEAN VALUE mV after the stimulation
0	-24.621780	-29.255430		
0.00333	1.0187880	0.2105232		
0.00666	0.8522259	0.2590212		
0.01	0.4831097	0.0637380		
0.02	0.2398011	0.0526975		
0.03	0.2019999	0.0091728		
GRAPHIC ANALYSIS IN[0, 0.1] Hz				
0.00 – 0.01			8.830931	9.908325
0.01 – 0.02			0.338805	0.098454
0.02 – 0.03			0.086009	0.052669
0.03 – 0.10			0.106089	0.053732

Notes:
The lower part shows the *average values*in the potential spectrum for the subsets in which [0, 0.1] Hz has been analyzed; then, each *average value* is the area enclosed between the spectrum curve and the corresponding frequency subset divided by the subset length.

Table 3. Frequency spectrum data for 0 - 0.0033 - 0.0066 - 0.01 - 0.02 Hz.

MEA-SURE	BeforeStimulation						After Stimulation					
	Peak Value V [mV]											
	Frequency [Hz]											
	0	0.0033	0.0066	0.01	0.0133 0.0166	0.02 0.023 0.026	0	0.033	0.0066	0.01	0.0133 0.0166	0.02
1	24.62	1.019	0.852	0.483		0.240	29.26	0.211	0.259	0.064		0.053
2	2.58	0.250	0.076	0.070	0.101	0.097	3.13	0.930	0.147	0.137	0.113 0.042	0.104
3	1.67	2.146	4.116	2.479	0.405 0.918	0.335	6.95	1.241	0.853	0.398		0.208
4	9.53	5.128	2.387	1.029	0.373 0.266	0.469	7.18	1.675	1.300	0.976	0.745 0.568	0.462
5	18.01	2,.90	0.610	0.335	0.149 0.422	0.158	9.23	5.422	2.685	2.177	1.198 0.951	0.956
6	12.38	11.059	5.330	5.060	3.670 2.621	2.196	8.62	15.765	8.789	2.167	4.039 3.680	1.048
7	5.25	1.580	2.578	2.445	1.627 1.195	1.195	28.71	6.396	3.013	1.057	2.093 0.479	0.900
8	19.93	4.174	2.643	1.325	0.997 0.996	0.674	19.08	2.433	1.144	0.766	0.518 0.303	0.281
9	7.83	5.030	1.985	1.106	0.614 0.985	0.619 1.697	1.49	1.659	1.012	0.677	0.702 0.655	0.510
10	24.32	1.009	0.821	0.239		0.129	22.98	1.084	0.632	0.311		0.430
11	0.25	2.679	0.970	0.763	0.431 0.143	0.861 - 0.617	20.71	0.265	1.081	1.162		0.671
12	9.97	5.089	4.247	0.750	1.745 1.393	0.785 1.096 0.429	3.37	4.659	1.563	1.645	0.515 0.914	0.436
13	5.92	0.792	0.405	0.320	0.205 0.031	0.072	6.86	0.374	0.059	0.051		0.049
14	21.36	6.044	0.859	0.896		0.812	21.14	3.601	3.079	0.924		0.338
15	12.86	1.027	0.366	0.575		0.237	10.12	1.950	1.247	0.995	0.413	0.530

Notes: Frequency spectrum data for 0 - 0.0033 - 0.0066 - 0.01 - 0.02 Hz, for all the tests performed. Almost all measurements had additional rate components (0.0133 and 0.01666), reported in columns six (before stimulation) and twelve (after stimulation), respectively. Measure 7 is particular and is detailed in Table 4.

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Table 4. Hz frequency spectrum data for subject number 7.

FREQUENCY Hz	POTENTIAL PEAK VALUE (mV) before stimulation	POTENTIAL PEAK VALUE (mV) after stimulation	POTENTIAL MEAN VALUE (mV) before stimulation	POTENTIAL MEAN VALUE (mV) after stimulation
0	5.245794	28.70461		
0.00333	1.580239	6.395788		
0.00666	2.577520	3.012885		
0.01	2.446742	1.056487		
0.01333	1.626875	2.092715		
0.01666	1.194524	0.478801		
0.02	1.702887	0.899620		
0.03333	2.703583	0.089249		
0.04	2.300974	0.124618		
0.06333	2.135149	0.284470		
0.07	0.429293	0.029388		
0.1	1.307109	0.223881		
Graphic Analysis in [0,1] Hz				
0.00 – 0.01			2.962574	9.792441
0.01 – 0.02			1.742757	1.131905
0.02 – 0.03			1.924906	0.572842
0.03 – 0.10			1.551557	0.260638

Notes: In this case there were significant components even at 0.02Hz; moreover, some components had a greater amplitude than the previous ones (grayed out in the table). The lower part shows the average values of the potential in the corresponding subsets in which [0, 0.1] Hz has been analyzed.

5. Results

Stimulation with the Tibetan bell in three out of fifteen trials determined a variation in the mean value of the potential difference modulus (V_m) of the subject, not exceeding ± 6%. In all other cases the variation was equal to or greater than ± 14%.

Stimulation with the Tibetan bell in 11 out of 15 tests resulted in a decrease in the amplitude of the excursions over time of the skin potential - (the oscillations; in Table I the OSC column). In three cases there is an increase in the oscillations, while in one case the oscillations remain constant.

In general, the 11 subjects in which the excursion of the skin potential decreases, regardless of whether the palm potential after stimulation becomes more or less negative, show, with the exception of subject 15 and subject 7 (whose trend is particular) the trend towards a decrease in the amplitude of the first three components (or two of these) of the spectrum (0.00333, 0.00666 and 0.01 Hz). The opposite always occurs for the three cases in which the range of variation of the skin potential increases (indeed, in subject 10 the second component does not increase after stimulation).

In some measures (five) some components of the spectrum have a smaller amplitude than the next (in gray in Table III). The significance of this “particular” trend is not known at the moment.

6. References

[1] Scalia M, Sperini M and Guidi F 2012 The Johnson noise in biological matter *Mathematical Problems in Engineering*

[2] Pulcini F, Fantauzzi A and Uhl L 2021 A New Experimental Method to Verify Psycho-physiological Phenomena”, not yet published.