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ORIGINAL RESEARCH

COMPARATIVE SUDY OF THE ELECTROENCEPHALOGRAPHIC ACTIVITY AT PROFESSIONAL HANDBALL AND FENCERS PLAYERS

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Abstract
Purpose. Our purpose was to study the electroencephalographic activity of professional handball and fencers players, to compare the obtained data and to identify a possible neurophysiologic pattern associate to practiced sportive activity.
Material and method. The study was performed on a group of 22 male athletes, 11 handball players and 11 fencers (different stress degrees of the upper members), active for between 5 and 12 years exclusively in either handball or fencing.
Using Nihon-Kohden EEG-9200 device, was recorded EEG line during some activities (relaxation-contraction), which can emphasize possible characteristic cerebral patterns, EEG analyze was made by assessing the classic rhythms and synthetic indexes as edge frequency. To perform spectral analyze was used fast Fourier transformation and for wave values comparison was used Pearson correlation coefficient.
Results. For both groups was remarked a slight increase of the theta wave values and for handball players a high degree of correlation for theta and beta indexes and also a correlation in the dominant hemisphere for alpha1 and 2.
Conclusions. EEG complex testing of professional sportsmen, as well as the outlining of an EEG pattern specific to studied sportive discipline, represent an original aspect of this study.
Key words: electroencephalography, handball, fencing, neurophysiologic pattern.

Introduction

Electroencephalography (EEG) represents the technique of cerebral electrical activity acquisition during a period time, through electrodes put on the scalp. After one of the EEG specific parameters, the frequency, were identified four types of waves (rhythms): alpha 8-13 Hz, beta 14-30 Hz, theta 4-7 Hz and delta 0,5-3,5 Hz. The EEG wave's aspect depends on more factors as: age, cerebral activity, metabolic conditions. EEG brings only partial information about the functional state of the central nervous system, if the central electrogenesis is not controlled modify through different methods: intermittent visual stimulation, auditory stimulation, induced sleep, etc.

Objective

Our purpose was to study the electroencephalographic activity of both professional handball and fencers players, to compare the obtained data and to identify a possible neurophysiologic pattern, associate to the professional sportive activity, which can objectify the athletes' selection and the efficiency of the training specific to the studied sportive disciplines, thus emphasizing the inter-sports differences.

Material and method

The study was performed on a group of 22 male athletes, 11 handball players, which use intensely both the upper limbs (with enhanced stress on one of them) and the lower ones and 11 fencers, where the effort is sustained predominantly by one of the upper limbs, active for between 5 and 12 years exclusively in either handball or fencing, with average ages, heights and weights alongside the standard deviation presented in Table 1.

Table 1. Average ages, heights and weights for the studied groups

	Whole group	Handball	Fencing
	males	males	males
Age years	20.06	22.00	16.33
Standard deviation	3.11	2.45	0.52
Height cm	183.81	188.25	171.13
Standard deviation	10.44	5.65	4.05
Weight Kg	75.65	78.75	62.00
Standard deviation	15.13	12.40	11.89

By analysing the age histogram for the whole male group, the age homogeneity of the group is noted.

Although there are characteristic weight differences between the selected sports, the analysed group is homogenous both from the point of view of weight and height and training regime. Taking into account the fact that the investigations took place in equivalent conditions for all subjects, we can state that the determining factor for the different behaviour of the administered tests were the changes induced by the practiced sports.

The studied sports were chosed, taking into account the more extensive representation of the upper limbs in the motor cortex, thus, a higher number of plastic changes are possible to appear as a result of repeated complex movements performed during specific training.

Our studies aimed to compare the two groups of sportsmen without including a sedentary subjects sample group, as the motor cortex did not display significant differences between professional sportsmen and sedentary groups [6].

The testing was performed under current ethical rules, each participant being informed of the experimental processes.

All the investigated sportsmen have been subjected to electric-neuro-physiological investigations by measuring the EEG waves, using Nihon-Kohden EEG-9200 device. The EEG response was registered with surface electrodes which have a letter to identify the lobe (F frontal, T temporal, P parietal, C central, O occipital) and a number to identify the hemisphere location (even numbers refer to electrode positions on the right hemisphere, odd numbers to those on left hemisphere), placed on the scalp according to the electroencephalography 10-20 system (Figure 1), bipolar acquisition, 16 channels, the reference being the two ears (A1, A2), using a time constant of 0,3 seconds and a filter below 50 Hz. In consideration of the study objective, we recorded the EEG line during some activities which can emphasize the possible characteristic cerebral patterns.

So, the activities followed during EEG recording were: first relaxation time ((R1), right fist contraction (A), left fist contraction (B), right fist contraction order without performing the move (C), left fist contraction order without performing the move (D) (Figure 2). After every mentioned moment was recorded a relaxation

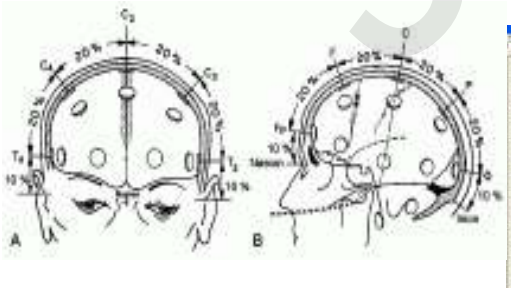

Figure 1. 10-20 electrode placement system

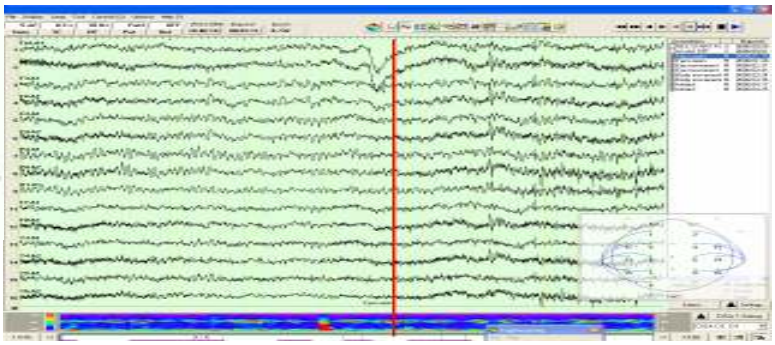

Figure 2. Modification of EEG line by changing an activity to another and the electrodes position

time (R1-R5).

The EEG analyze was made by assessing the classic rhythms: Theta [4-8Hz], Alpha1 [8-10Hz], Alpha2 [10-13Hz], Beta1 [13-20Hz], for which the used device programme offers synthetic indexes as edge frequency (the frequency from which all inferior frequencies represent 90% of whole EEG line length), which characterizes most relevant the EEG modifications specific to each sport discipline.

We, also, used FFT (fast Fourier transformation) on periods of 10 seconds, for spectral analyze, thus, obtaining information about the whole frequency spectrum and synthetic indexes. For wave values comparison was used Pearson correlation coefficient.

Results

For fencing and handball groups, was remarked a slight increase of the theta wave values, as showed in Table 2 and 3.

Table 2. Theta values at fencers group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	0.831	0.387	0.59	0.776	0.68	0.394	0.49	0.545	0.946
T3-A1	1.22	1.138	1.18	1.217	1.51	1.853	1.42	1.116	1.485
F7-A1	0.886	0.382	0.52	0.817	0.53	0.437	0.44	0.434	0.777
O1-A1	1.643	2.677	1.18	1.412	1.51	2.679	1.24	1.108	1.406
P3-A1	0.579	0.907	1.51	0.560	0.64	1.12	0.62	0.542	0.583
C3-A1	1.063	1.011	0.99	1.009	1.14	1.779	1.41	0.804	1.243
F3-A1	0.528	0.560	0.6	0.629	0.67	0.698	0.6	0.521	0.588
Fp1-A1	1.563	2.527	0.99	1.188	1.23	1.937	1.11	0.902	1.125
Fp2-A2	0.35	0.379	0.31	0.314	0.37	0.906	0.33	0.337	0.314
F4-A2	1.374	1.167	1.72	1.299	1.5	1.328	1.33	1.499	1.479
C4-A2	0.547	0.483	0.47	0.428	0.5	0.816	0.49	0.541	0.485
P4-A2	1.744	1.601	1.87	1.511	1.75	1.879	1.67	1.772	1.517
O2-A2	0.275	0.297	0.25	0.277	0.25	0.285	0.3	0.215	0.302
F8-A2	1.214	0.673	1.17	0.939	1.04	0.919	1.04	0.979	1.2
T4-A2	0.22	0.210	0.23	0.229	0.27	0.286	0.22	0.315	0.245
T6-A2	1.46	0.872	1.47	1.153	1.55	1.1	1.43	1.273	1.61

Table 3. Theta values at handball group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	0.275	0.582	0.511	0.597	0.263	0.189	0.330	0.252	0.504
T3-A1	0.787	0.681	0.786	1.334	1.259	1.119	0.665	0.739	0.602
F7-A1	0.328	0.237	0.261	0.359	0.285	0.232	0.329	0.254	0.281
O1-A1	0.789	0.700	0.869	1.014	1.263	0.974	0.731	0.670	0.627
P3-A1	0.446	0.445	2.652	0.478	0.531	0.420	0.505	0.444	0.475
C3-A1	0.549	0.546	0.581	1.271	0.736	0.663	0.527	0.641	0.533
F3-A1	0.477	0.373	0.540	0.414	0.654	0.394	0.500	0.489	0.475
Fp1-A1	0.585	0.629	0.912	1.104	0.981	0.748	0.533	0.583	0.619
Fp2-A2	0.428	0.365	0.790	0.576	0.700	0.426	0.445	0.425	0.396
F4-A2	0.512	0.391	0.514	0.423	0.630	0.403	0.520	0.440	0.485
C4-A2	0.391	0.449	0.486	0.523	0.447	0.387	0.399	0.400	0.449
P4-A2	0.362	0.355	0.380	0.349	0.318	0.266	0.345	0.320	0.311
O2-A2	0.273	0.207	0.332	0.261	0.300	0.235	0.262	0.266	0.204
F8-A2	0.452	0.359	0.406	0.376	0.498	0.415	0.488	0.407	0.359
T4-A2	0.216	0.157	0.258	0.187	0.278	0.202	0.229	0.181	0.194
T6-A2	0.551	1.165	0.741	1.142	0.506	0.555	0.607	0.520	0.675

Alpha1 band for fencers was lower in the dominant hemisphere, as showed in Table 4, handball athletes alpha1 activity was proved to be more homogenous and with classic reactivity, being lower during any active moment and higher during repose moments, as in Table 5.

Table 4. Alpha1 values at fencers group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	1.785	1.475	1.76	1.977	1.74	1.763	2.76	2.182	2.108
T3-A1	1.142	0.750	1.2	0.943	1.2	1.219	1.26	0.785	1.353

F7-A1	1.316	1.200	1.04	1.491	1.03	1.012	0.97	0.926	1.16
O1-A1	1.031	1.121	0.83	1.055	1.03	1.516	0.91	0.711	1.292
P3-A1	1.292	1.130	1.51	1.408	1.51	1.076	2.22	1.406	1.542
C3-A1	0.508	0.532	0.51	0.621	0.64	0.858	0.76	0.652	0.862
F3-A1	1.345	1.214	1.6	2.060	1.17	0.888	1.81	1.047	1.233
Fp1-A1	0.782	0.768	0.52	0.750	0.81	1.176	0.59	0.534	0.827
Fp2-A2	0.314	0.235	0.27	0.305	0.26	0.329	0.28	0.24	0.345
F4-A2	13.86	9.760	12	11.343	9.89	8.905	12.7	12.46	15.39
C4-A2	0.46	0.331	0.42	0.409	0.37	0.4	0.47	0.314	0.388
P4-A2	20.97	10.091	20.3	15.241	13.1	13.32	20.3	17.91	21.85
O2-A2	0.514	0.365	0.48	0.598	0.53	0.491	0.86	0.54	0.552
F8-A2	9.79	5.603	10	8.326	7.54	6.442	9.53	9.358	11.66
T4-A2	0.674	0.460	0.66	0.664	0.66	0.554	1.11	0.736	0.604
T6-A2	18.03	6.411	15.8	12.037	11.9	7.562	15.2	13.98	18.59

Table 5. Alpha1 values at handball group for every studied moments

channel	**R1**	**A**	**R2**	**B**	**R3**	**C**	**R4**	**D**	**R5**
T5-A1	0.934	0.711	0.97	1.031	1	0.345	0.91	0.520	1.01
T3-A1	0.792	0.519	0.94	0.887	1.39	0.806	0.8	0.595	0.813
F7-A1	0.661	0.407	0.74	0.675	0.72	0.409	0.91	0.338	0.695
O1-A1	1.085	0.934	1.26	0.865	1.58	0.912	1.44	0.677	1.366
P3-A1	1.717	1.057	2.65	1.293	2.54	1.087	2.5	1.340	1.915
C3-A1	0.313	0.314	0.33	0.609	0.48	0.408	0.35	0.320	0.347
F3-A1	2.093	2.209	4.68	2.174	3.09	1.858	3.45	2.260	1.931
Fp1-A1	0.334	0.323	0.4	0.586	0.45	0.429	0.31	0.312	0.366
Fp2-A2	0.685	0.309	1.11	0.489	1.09	0.447	1.06	0.451	1.054
F4-A2	2.681	2.348	2.46	2.082	2.12	1.706	2.6	1.568	1.793
C4-A2	0.57	0.275	0.71	0.404	0.93	0.414	0.76	0.601	0.664
P4-A2	1.505	1.213	1.61	1.385	1.38	0.854	1.5	0.976	1.159
O2-A2	1.803	2.685	3	1.478	2.24	1.805	2.34	1.836	1.467
F8-A2	1.304	0.979	1.03	0.932	0.94	1.024	1.07	0.906	0.699
T4-A2	1.067	0.757	1.88	0.783	1.66	0.69	1.58	0.893	1.251
T6-A2	2.282	4.076	0.74	1.876	1.68	1.711	1.61	1.581	1.034

Regarding alpha2 values, there are lower for handball players in comparison with the fencers' ones that are also characterised by a small activity of the left hemisphere, reflecting a ″quiet″ conduct, aspect revealed in Table 6 and 7.

Table 6. Alpha2 values at fencers group for every studied moments

channel	**R1**	**A**	**R2**	**B**	**R3**	**C**	**R4**	**D**	**R5**
T5-A1	0.94	0.826	1.04	0.905	0.87	1.026	0.76	0.774	1.138
T3-A1	0.51	0.431	0.51	0.485	0.72	0.774	0.78	0.445	0.693
F7-A1	0.609	0.524	0.7	0.549	0.72	0.64	0.69	0.51	0.697
O1-A1	0.492	0.598	0.57	0.592	0.61	0.985	1.02	0.553	0.801
P3-A1	0.697	0.998	1.22	0.892	1.04	0.975	1.19	0.703	1.059
C3-A1	0.28	0.291	0.28	0.344	0.32	0.448	0.42	0.279	0.311
F3-A1	0.533	1.066	1.19	0.960	0.98	0.877	1.51	0.883	1.195
Fp1-A1	0.339	0.457	0.32	0.361	0.34	0.644	0.33	0.277	0.299
Fp2-A2	0.186	0.190	0.24	0.209	0.21	0.282	0.27	0.183	0.247
F4-A2	8.577	8.463	10.6	6.968	12.9	11.93	9.31	9.077	11.57
C4-A2	0.218	0.214	0.29	0.224	0.35	0.307	0.41	0.213	0.28
P4-A2	9.166	10.056	13.7	8.810	16.5	16.54	9.9	10.18	9.406
O2-A2	0.29	0.348	0.47	0.410	0.36	0.358	0.41	0.275	0.445

F8-A2	6.037	6.296	8.64	5.721	10	9.004	6.75	6.855	8.172
T4-A2	0.411	0.365	0.45	0.338	0.5	0.466	0.46	0.374	0.448
T6-A2	6.123	7.343	11.4	7.135	13.9	14.56	7.21	7.644	6.535

Table 7. Alpha2 values at handball group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	0.522	0.401	0.7	0.618	0.61	0.469	0.52	0.393	0.577
T3-A1	0.732	0.413	0.75	0.747	1.24	0.616	0.69	0.494	1.202
F7-A1	0.608	0.458	0.73	0.692	0.78	0.613	0.68	0.548	0.736
O1-A1	0.62	0.328	0.9	0.511	1.37	0.719	0.82	0.532	1.412
P3-A1	1.767	0.913	2.52	1.829	2.43	1.881	2.42	1.457	1.973
C3-A1	0.255	0.218	0.35	0.454	0.42	0.425	0.37	0.341	0.429
F3-A1	2.114	1.460	3.64	2.967	2.77	1.783	2.63	2.037	3.363
Fp1-A1	0.232	0.229	0.37	0.381	0.41	0.354	0.25	0.224	0.37
Fp2-A2	0.625	0.243	0.95	0.846	1.33	0.594	0.81	0.490	1.216
F4-A2	2.402	1.679	3.08	2.799	3.02	2.798	2.7	1.860	2.597
C4-A2	0.667	0.394	0.87	0.961	1.13	0.691	0.78	0.498	1.152
P4-A2	1.086	0.752	1.52	1.637	1.3	1.101	1.19	0.883	1.382
O2-A2	0.749	0.527	1.38	0.868	0.85	0.52	1.04	0.827	1.263
F8-A2	2.233	1.531	2.55	2.128	2.62	3.046	2.9	1.629	2.046
T4-A2	0.404	0.216	0.78	0.510	0.59	0.339	0.71	0.419	0.807
T6-A2	1.778	1.814	2.6	2.171	2.4	2.26	2.18	1.354	1.459

Regarding beta band power spectrum was observed a perfect synchronization of both beta frequencies, connected to the analyzed moments, both for dominant and non-dominant hemisphere, for the two studied sports, as showed in Tables 8, 9.

Table 8. Beta1 values at handball group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	0.12	0.178	0.17	0.196	0.13	0.104	0.14	0.134	0.159
T3-A1	0.263	0.209	0.28	0.402	0.31	0.255	0.2	0.213	0.244
F7-A1	0.121	0.120	0.12	0.136	0.11	0.085	0.12	0.090	0.11
O1-A1	0.232	0.187	0.24	0.211	0.3	0.206	0.19	0.201	0.236
P3-A1	0.289	0.280	0.42	0.279	0.11	0.34	0.33	0.268	0.307
C3-A1	0.149	0.132	0.15	0.221	0.17	0.145	0.12	0.132	0.141
F3-A1	0.272	0.223	0.31	0.239	0.38	0.286	0.31	0.274	0.237
Fp1-A1	0.143	0.145	0.18	0.180	0.17	0.132	0.1	0.108	0.143
Fp2-A2	0.137	0.096	0.21	0.125	0.16	0.105	0.11	0.107	0.15
F4-A2	0.291	0.256	0.3	0.297	0.35	0.286	0.27	0.298	0.256
C4-A2	0.145	0.109	0.17	0.135	0.16	0.112	0.12	0.123	0.149
P4-A2	0.147	0.227	0.16	0.168	0.16	0.117	0.12	0.134	0.13
O2-A2	0.127	0.133	0.16	0.120	0.15	0.112	0.14	0.146	0.12
F8-A2	0.413	0.328	0.43	0.415	0.58	0.513	0.5	0.527	0.308
T4-A2	0.106	0.093	0.11	0.088	0.12	0.093	0.1	0.088	0.099
T6-A2	0.309	0.534	0.5	0.553	0.41	0.364	0.36	0.288	0.312

Table 9. Beta1 values at fencers group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	0.17	0.142	0.2	0.187	0.19	0.171	0.16	0.194	0.189
T3-A1	0.242	0.207	0.23	0.253	0.28	0.298	0.29	0.228	0.253
F7-A1	0.154	0.134	0.16	0.151	0.15	0.128	0.13	0.136	0.162
O1-A1	0.25	0.275	0.22	0.253	0.26	0.36	0.24	0.213	0.297
P3-A1	0.14	0.148	0.14	0.139	0.07	0.171	0.17	0.123	0.142

C3-A1	0.175	0.138	0.15	0.181	0.17	0.224	0.23	0.167	0.183
F3-A1	0.141	0.137	0.16	0.147	0.18	0.156	0.18	0.133	0.223
Fp1-A1	0.185	0.212	0.15	0.182	0.14	0.289	0.17	0.139	0.164
Fp2-A2	0.052	0.058	0.06	0.054	0.06	0.124	0.06	0.051	0.061
F4-A2	0.54	0.502	0.57	0.524	0.56	0.53	0.57	0.547	0.636
C4-A2	0.073	0.078	0.08	0.070	0.08	0.12	0.09	0.079	0.08
P4-A2	0.683	0.547	0.67	0.633	0.63	0.596	0.61	0.614	0.645
O2-A2	0.096	0.093	0.09	0.088	0.08	0.076	0.11	0.077	0.098
F8-A2	0.407	0.404	0.44	0.438	0.43	0.438	0.48	0.459	0.499
T4-A2	0.13	0.111	0.14	0.110	0.14	0.139	0.12	0.126	0.115
T6-A2	0.55	0.453	0.57	0.489	0.56	0.534	0.59	0.564	0.641

As was previous mentioned, edge frequency, which characterizes most relevant the EEG modifications specific to each sport discipline, had a high variation interval for fencing (Table 10), as for handball was observed the biggest condensation of the values, as showed in Table 11.

Table 10. Edge frequency values at fencers group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	15.772	17.188	13.215	16.553	17.38	17.43	16.75	18.067	15.35
T3-A1	18.408	19.287	19.531	18.945	18.99	19.14	18.31	21.436	17.47
F7-A1	17.236	18.897	16.602	17.383	18.26	18.16	17.14	18.311	16.63
O1-A1	16.944	17.969	18.066	17.627	17.72	17.38	17.68	19.629	16.74
P3-A1	17.188	17.236	16.357	16.699	16.46	16.5	16.75	17.578	16.18
C3-A1	17.774	17.920	17.725	18.164	17.48	17.53	17.43	20.02	16.85
F3-A1	17.823	17.041	17.09	16.602	16.8	18.26	16.5	17.969	16.52
Fp1-A1	15.235	16.260	17.139	16.846	16.85	16.75	17.24	18.799	15.74
Fp2-A2	17.188	18.067	18.604	17.725	17.77	17.14	18.41	18.408	17.24
F4-A2	15.332	15.283	15.039	15.674	15.63	14.99	14.75	16.065	14.73
C4-A2	17.773	18.848	18.604	18.457	19.04	18.07	19.04	18.848	18.97
P4-A2	14.258	13.281	13.965	13.574	14.31	12.89	13.82	14.795	13.39
O2-A2	20.166	19.873	19.141	18.994	19.78	18.99	19.19	20.361	19.53
F8-A2	16.211	15.625	15.772	15.430	16.06	14.8	15.38	15.918	14.9
T4-A2	20.703	20.898	20.459	19.873	20.07	20.51	19.63	20.215	19.2
T6-A2	16.455	15.674	12.681	15.039	15.53	15.43	15.58	15.967	14.68

Table 11. Edge frequency values at handball group for every studied moments

channel	R1	A	R2	B	R3	C	R4	D	R5
T5-A1	19.063	21.016	18.056	19.805	19.3	19.73	19.38	19.336	19.49
T3-A1	20.139	21.658	19.965	21.485	19.4	20.1	19.18	19.575	20.1
F7-A1	18.395	20.064	18.715	18.359	18.18	19.14	17.93	18.821	18.22
O1-A1	18.679	18.608	18.928	18.430	18.25	19.46	18.04	20.099	18.79
P3-A1	16.939	18.359	15.696	16.726	16.55	16.65	16.09	16.513	16.76
C3-A1	20.977	20.977	20.781	19.922	20.04	19.77	19.77	20.000	20.04
F3-A1	15.696	15.980	15.59	16.229	16.05	16.34	15.59	16.229	17.19
Fp1-A1	19.744	20.064	19.318	18.999	19.35	19.92	19	19.602	19
Fp2-A2	17.33	18.537	16.868	17.010	16.87	17.68	17.19	17.507	17.79
F4-A2	15.874	17.117	15.909	16.229	16.37	16.19	15.87	16.193	16.23
C4-A2	18.203	19.336	18.477	18.047	18.16	18.63	18.24	19.102	19.1
P4-A2	17.472	18.928	17.614	17.969	17.9	17.79	16.97	18.288	17.08
O2-A2	18.75	19.567	19.425	18.075	18.54	18.36	18.25	19.496	19.64
F8-A2	17.071	18.711	17.969	17.930	17.54	18.09	17.66	18.750	18.95
T4-A2	19.792	21.962	19.141	20.530	20.1	20.62	19.23	20.269	20.23
T6-A2	17.969	18.848	18.08	18.408	17.58	17.92	17.97	17.676	19.09

The statistic analyzes (Pearson correlation coefficient) emphasize the presence of some correlations between wave values (Table 12).

Table 12. Pearson correlation coefficient values between EEG wave values

Handball					
channel	**theta-beta**	**beta-alfa1**	**beta-alfa2**	**alfa2-theta**	**alfa1-alfa2**
T5-A1	0.9608635	0.5324221	0.3479288	0.3171618	0.7405733
T3-A1	0.8335601	0.5532527	0.3614415	0.2296869	0.7797635
F7-A1	0.6875358	0.5663743	0.1793132	0.404506	0.7418648
O1-A1	0.6556294	0.6064433	0.7437811	0.2794794	0.8079079
P3-A1	0.5524751	-0.0304525	0.0580903	0.4703894	0.8616823
C3-A1	0.9286536	0.9059936	0.5051707	0.5304877	0.6924991
F3-A1	0.8608326	0.5950598	0.258417	0.5069357	0.568636
Fp1-A1	0.84843	0.7234934	0.6937507	0.7877677	0.7590493
Fp2-A2	0.8207278	0.7522409	0.6797538	0.5723488	0.8336191
F4-A2	0.6399374	-0.0516744	0.480521	0.5516581	0.1425279
C4-A2	0.4269137	0.6751589	0.7072291	0.4439933	0.6107754
P4-A2	0.5363437	0.2451065	-0.2197973	0.1842602	0.4791343
O2-A2	0.7632224	0.7399968	0.4612652	0.4053844	0.1613303
F8-A2	0.7604668	0.2167896	0.5148729	0.6197465	0.2905145
T4-A2	0.9037122	0.8333468	0.4688858	0.5678533	0.7911052
T6-A2	0.8369329	0.3405259	0.5510039	0.0511357	-0.2161857
Fence					
	theta-beta	**beta-alfa1**	**beta-alfa2**	**alfa2-theta**	**alfa1-alfa2**
T5-A1	0.4730132	0.1284909	0.3945121	0.4797368	-0.3222739
T3-A1	0.8477567	0.68087	0.9172739	0.8796495	0.7880232
F7-A1	0.7060967	0.4062358	0.3843685	0.0583829	-0.3320939
O1-A1	0.756008	0.9783528	0.5876652	0.2254332	0.4952828
P3-A1	0.3045421	0.0426223	0.174974	0.5203273	0.4971473
C3-A1	0.8028932	0.7382421	0.8991988	0.8897653	0.6895454
F3-A1	0.3156422	0.0379904	0.5628083	0.1924566	0.3875424
Fp1-A1	0.7147817	0.8211464	0.9615474	0.7234728	0.8185879
Fp2-A2	0.9814338	0.435557	0.6431771	0.5135448	0.5093932
F4-A2	0.5973689	0.7006626	0.5142446	0.4607924	-0.1579214
C4-A2	0.9187085	0.0432578	0.3722293	0.1115453	0.4536102
P4-A2	0.1794901	0.7572801	-0.0538654	0.704543	-0.3991172
O2-A2	0.6404923	0.5335725	0.3285517	0.3864127	0.2479342
F8-A2	0.406956	0.6591126	0.1936354	0.2339253	-0.0482936
T4-A2	0.5077929	-0.0325147	0.6716757	0.1897727	0.2153263
T6-A2	0.8749393	0.7740647	-0.0141448	0.0079677	-0.4461651

For handball players, was remarked a high degree of correlation for theta and beta indexes and also a correlation in the dominant hemisphere for alpha1 and alpha2 indexes. At fencers the correlations were not structured equally.

Discussions

Because our study aimed the identification of neurophysiologic patterns specific to a long sportive activity, the attention was directed towards athletes of whom the initial cerebral plasticity process stopped and the morphologic differences are born especially in M1 (primary motor) area.

Following during our study, the electroencephalographic activity of each studied sportive discipline, we observed different response patterns, but constant for the same group of athletes (specific changes being reported by Pearce in 2000, by using magnetic stimulation [5]). At the beginning of the recordings, for theta power spectrum, only the fencers presented a spread activity, left frontal, occipital, temporal and only right frontal-parietal, thus, not following 1998 Klimesch premises [4], but similar to the results found by Dopplemayr in 2008 [3]. The handball group did not present for the recording initial moment any theta band activity, so, outlining the premises of the first different electroencephalographic feature of fencers group.

The same moment of recording showed for handball group an alpha frontal-occipital activity, followed by beta rhythm, with a larger spreading but a smaller power. The dominant hemisphere presented a beta temporal-occipital activity at fencers and only an occipital one at handball group, aspect reported by Klimesch in 1998 [4] and Babiloni in 2009 [2]. The right fist contraction moment produces spectacular EEG modifications in comparison with initial moment ones.

Fencers presented an increase of the theta band activity, so the theta band was very well represented in left frontal, parietal and occipital-temporal, well outline areas, while the theta band for the right hemisphere was not systematized, as was in the dominant hemisphere. The handball group did not show the same theta activity during right fist contraction. Group of fencers presented minor left frontal-parietal modifications for alpha1 and alpha2 bands. Is sustained the affirmation that for fencers, the changes during right fist contraction were mostly in theta band, having a long duration motor memory for the performed move. For handball alpha1 and 2 decreases were obvious during this action, showing a high attention, so another EEG feature was outlined, that emphasize the difference between the two sports.

The relaxation moment R2 reduced the theta activity in the mentioned cortical areas at fencers group, in this moment, rhythms alpha and beta were preserved in the mentioned areas, this observation being present in many scientific papers, for handball, the frequencies bands had an increased activity in the areas where these frequencies already existed, characteristic for these is an alpha2 increase, more difficult to explain. The left fist contraction determined the same changes for alpha and beta frequencies bands as the right one, additionally appearing little left frontal-temporal-occipital areas that presented minimum increase of theta spectrum. The changes find until now at the two sportive disciplines can not be totally explain by the literature, there are maybe the final result of an intermediary processes pointed out by other authors.

From this moment, the EEG characteristic patterns of the two sports, remain constant, being a small theta increase for handball in the left hemisphere and a alpha, beta majority for both hemispheres at the same sport. A theta increase can be observed also at fencers at D moment, for the other moments this frequency spectrum activity is not different from the point of view of the activated areas, but there are variations depending on the recording moment. Alpha 1 and 2 activity is not higher in the right hemisphere at fencers. The last recording moments are not so different from the initial moments. The significant statistic differences found for C and D moments for beta1 band frequency in left occipital zone at both sports, are due to a possible different ″perception″ of fist contraction, the athletes perform a learned move, phenomena is somehow alike to the one described by Aglioti in 2008 [1]. Because of the particularities of each sportive discipline, is outlining the idea of some sportsmen presenting a performed movement imagination bigger than the one of other tested sport, which is produced by structural changes, signaled by Pearce in 2000 [5]. The whole EEG testing aimed to emphasize the classic rhythms power spectrums modifications, produced by different orders (fists successively contractions, movement thinking without perform it), in comparison with the relaxation moments between actions. The literature describes many observations regarding the motor memory, our objective study was to emphasize the differences inter-sports, an original aspect enough conspicuous outlined by the previous affirmations.

Conclusions

The identification of some neurophysiologic patterns specific to long period sportive activities through electrophysiological tests is imposed as a viable method and easy to use for cerebral electrogenesis appreciation, in presence of functional plastic changes determined by the training.

By processing the results recorded at handball group, was remarked the presence of classic rhythms specific to wakeful state at adult, both during relaxation moments and activity, with a diminution reaction characteristic to each rhythm, depending on relaxation-activity.

Fencers, unlike handball players, presented both during relaxation and movement thinking, theta band activity, aspect mentioned in literature as accompanying the motor memory process.

Complex testing through EEG and automatic analyze of professional sportsmen from handball and fence, as well as the outlining of an EEG pattern specific to each studied sportive discipline, represent an original aspect of this study.

References

1. Aglioti S.M., Cesari P., Romani M., Urgesi C., (2008), Action anticipation and motor resonance in elite basketball players, *Nature Neuroscience,* Volume 11, pp. 1109-1116

2. Babiloni C., Del Percio C., Paolo M., Rossinib D.F., Marzanog N., Iacobonig M., Infarinatoc F., Lizioc R., Piazzah M.,

Pirritano M., Berlutti G., Cibelli G., Eusebi F., (2009), Judgment of actions in experts: A high-resolution EEG study in elite athletes, *NeuroImage*,Volume 45, Issue 2, pp. 512-521

3. Doppelmayr M.P., Doppelmayr H., (2008), Modifications in the human EEG during extralong physical activity, *Neurophysiology*, Number 1/January

4. Klimesch W.M., Doppelmayr H., Russegger T., Schwaiger J., (1998), Induced alpha band power changes in the human EEG and attention, *Neuroscience Letters*, Volume 244, Issue 2, pp. 73-76

5. Pearce A.J., et al., (2000), Functional reorganisation of the corticomotor projection to the hand in skilled racquet players, *Exp Brain Res* 130, pp. 238-243

6. Thomas N.G., Mitchell D., (1996), Somatosensory-evoked potentials in athletes, *Med Sci Sports Exerc,* 4(28): 473-481.