A cortical study of the attention in military simulation tests

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Introduction. Attention is one of the most widely studied superior cerebral functions and base of many other cognitive processes. It is sometimes understood as concentration on a task or target. The level of execution of a task and the ability to process information are dependent on the state of cerebral activation of the subject. This brain activity can be recorded with the electroencephalogram (EEG).

Aim. Attention is studied in states of rest and during the performance of tasks in military personnel, exploring the differences between two groups (cadets and officers/NCOs).

Subject and methods. EEG signals have been recorded from 19 cadets and 17 officers of the General Military Academy and from the General Hospital of the Defense during military simulation tasks and in states of rest. Our team uses its own methodology of the dynamic systems and fractal techniques for the modeling and quantification of the EEG signals, in this case for the computation of the fractal dimension of the record of each derivation. The data obtained are subjected to a statistical study.

Results. Higher cortical global mean values were observed in the officers group. The dimension increases in both groups by raising the difficulty of the task in all areas of the brain except in the frontal zone. They highlight the significant differences between groups in the simulation task of driving combat vehicle in the central, parietal and temporal areas.

Conclusions. The results obtained show that the two groups studied do not behave homogeneously in the same attention task that involves a video game.

Key words. Attention. Brain activity. Electroencephalogram. Fractal dimension. Military simulation. Quantification.

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Introduction

Attention, one of the last complex brain processes in acquiring the category of superior cerebral function and base of many other cognitive processes, is one of the most widely studied functions. The concept of attention has varied over time. It is now viewed as a set of networks of neural areas that carry out specific operations of information processing. Among these two networks appear as significant: the anterior attentional network, anatomically located in the frontal areas of the brain and fundamentally related to the detection/selection of targets, and the posterior attentional network, linked to the visual-spatial orientation of the attention and anatomically formed with areas of the thalamus, the upper colliculi and the posterior parietal cortex.

Thus, attention can be defined as a central mechanism to control information processing, which acts in accordance with the objectives of the organism by activating and inhibiting processes. It can also be oriented towards the senses, structures of knowledge in memory and response systems. In addition, it is widely accepted the possibility that this central control mechanism shows different structural characteristics depending on the area in which it acts [1].

Attention is sometimes understood as concentration on a task or target. Maintaining vigilance or sustained attention is possibly the first requirement for people facing certain tasks, even if these are monotonous. The decrease in vigilance in certain situations could lead to dangerous consequences such as accidents, loss of life, etc. Therefore, the study of attention and loss of attention during the performance of different tasks is a topic of current interest from a neurological point of view [2].

The level of execution of a task and the ability to process information are dependent on the state of cerebral activation of the subject [3]. Such activation can be studied by means of the brain electrical potential oscillation register using the electroencephalogram (EEG).

The mere visual inspection of the graphic representation of the waves does not allow the extraction of all the information that these signals contain. Several authors have used methodological approaches from nonlinear dynamics to describe changes in brain activity during the performance of various tasks [4]. Yang et al [5], for example, use the correlation dimension to quantify changes in brain activity during the performance of 7 types of EEG (rest, arithmetic, graphical, linguistic, orientation, etc.). Our team has developed its own methods for the quantification of the EEG and applied them to the study of attention in children with attention deficit hyperactivity disorder (ADHD) during the performance of different tasks [6-9].

Bodala et al [2] prove, through EEG analysis, an increase in the level of vigilance in a monotonous task due to the integration of noisy visual stimuli. Such distracting external stimuli produce relative delta power suppression, an increase in theta activity in the frontal midline, and an increase in the frontal/alpha parietal ratio, showing an increased level of surveillance. Other authors [10,11] have studied the increase in delta activity such as fatigue increase. The suppression of relative delta power due to the integration of an external stimulus is related to fatigue inhibition and increased levels of vigilance. The increase in the ratio of frontal theta to parietal alpha suggests an increase in cortical excitation and evidence of improvement in surveillance capacity.

The study of attention during the realization of diverse mental tasks becomes more important when it is analyzed during the performance of tasks in military personnel, in the health sector or in the industry or in those cases in which avoiding the decrease in the vigilance in the performance and improvement of a task.

Astolfi et al [12] point to an increase in the overall spectral power density of the EEG during the take-off and landing phases of the aircraft compared to airborne stages (all performed in a simulator). Dussault et al [13] evaluate cortical changes due to variations in mental effort during different simulated flight sequences, detecting anxiety and vigilance states.

In a recent article, Di Stasi et al [14] analyze brain activity during complex flight procedures performed by military helicopter pilots, using the power spectra of the EEG. In their article they observe how greater difficulty tasks, such as take-off or landing, correspond to the highest values of power in the EEG high frequency bands, whereas less demanding flight procedures are associated with lower power levels EEG in the same frequency bands. Their results indicate that the power spectrum of the EEG is sensitive to variations in the complexity of the procedures used during the actual flight.

Dussault et al [15] use EEG indicators to record brain activity during real fly piloting with several exercises of different levels of difficulty. They show a 22.5% increase in theta band activity during the flight compared to rest periods, and an alpha decrease of 30%.

Borghini et al [16] perform a bibliographic review on the neurophysiological tests registered to pilots and drivers in their vehicle management tasks, in which the brain activity is related to mental overload or fatigue in these tasks. They observe an increase in EEG power in theta band and a decrease in the alpha band in those tests that require a high mental workload, as well as an increase in the power in the theta, delta and alpha bands in the transition between the effort and mental fatigue. Other works have recently revealed the existence of cortical and subcortical brain networks involved in varying EEG power spectra during complex tasks such as flying or driving [12,17].

Our group has explored brain activity during the simulation of handling combat vehicle using EEG quantification parameters (fractal dimension, Hjorth parameters, etc.) computed using the methods developed by our team. These parameters have shown to be good indicators of brain activity, varying in the areas involved in the performance of the simulation task [18-20].

The work presented here focuses on the study of differences in brain activity between cadets and officers and NCOs of the Military Academy of Zaragoza and the Defense Hospital of Zaragoza during the simulation of various military tasks as well as in situations of rest with open and closed eyes. The measurements made are based on the calculation of the geometric complexity of brain waves. The quantification analyzed by our team shows that the two groups studied do not behave homogeneously in the same attention task which involves a video game.

Subjects and methods

Approval of the Ethics Committee

The study is in accordance with the Biomedical Research Law (Law 14/2007, of July 3, on biomedical research) and is governed by the principles agreed in the Declaration of Helsinki. The research protocol and informed consent were approved by the Ethical Committee of Clinical Research of the General Inspection of Defense Health. Each participant signed a corresponding patient information sheet and informed consent before the test.

Subjects and experimental design

The sample used for the study belongs to two groups of volunteers, including 19 cadets (males and females) and 17 officers and NCOs. The mean age of the cadets group was 20.33 ± 2.22 years-old and that of the officers group was 42.55 ± 9.18 years-old.

The EEG signals analyzed in this work were collected in the Defense Hospital of Zaragoza. For each subject, 6 types of 3-minute EEG signals were recorded in the following order:

- Rest with closed eyes (ce).
- Rest with open eyes (oe).
- Simulation of handling a combat vehicle with a video game (j1).
- Performing the task (j1) while the subject receives external distracting stimuli (a series of questions unrelated with the test had to be answered at the same time) (j2).
- Repeated simulation exercise (j1) without external stimuli (j3).
- Rest with open eyes (oe2).

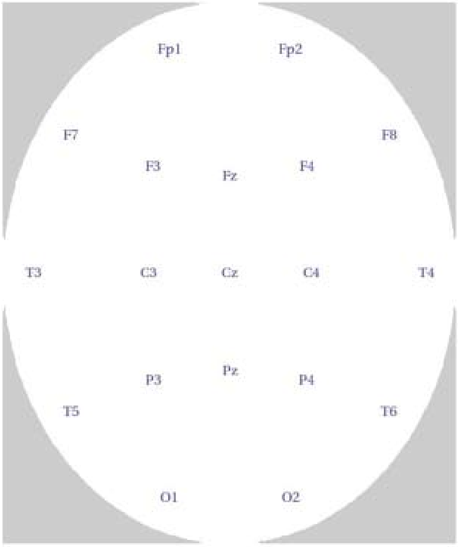
The tests were carried out in a quiet dimly lit electrically shielded room with constant temperature and always between 10 and 14 o'clock. The EEG signal from each subject has been recorded with digital ambulance equipment using the Compumedics Limited Profusion EEG 4 software. The monopolar assembly (with Ag/AgCl electrodes) and 16 channels of the Jasper International 10-20 System referenced to Cz, 12 of which were analyzed: C3, C4, F7, F8, O1, O2, P3, P4, T3, T4, T5 and T6 (Fig. 1). Filters with cutoff frequencies 0.5 Hz and 70 Hz have been applied. Once the signal had been recorded, it was digitized with a converter of the program sampling at 256 points per second. The third minute of each of the signals was later analyzed.

Before performing the electroencephalographic tests, the subjects completed the army's health questionnaire (Annex to Instruction 22/2008 of January 31) and several questionnaires with personal information. Once the EEG records was finished, the subjects performed the limited time selective attention test d2, which measured the processing speed, the ability to follow instructions and the quality of the execution of a visual stimuli discrimination task.

EEG analysis

In this paper it is proposed the use of the quantifier called the variance fractal dimension, which is not excessively restrictive in terms of signal stationarity hypothesis and does not require too long registers, so that its computation is simplified.

Figure 1. Location of the electrodes in the Jasper System 10-20.

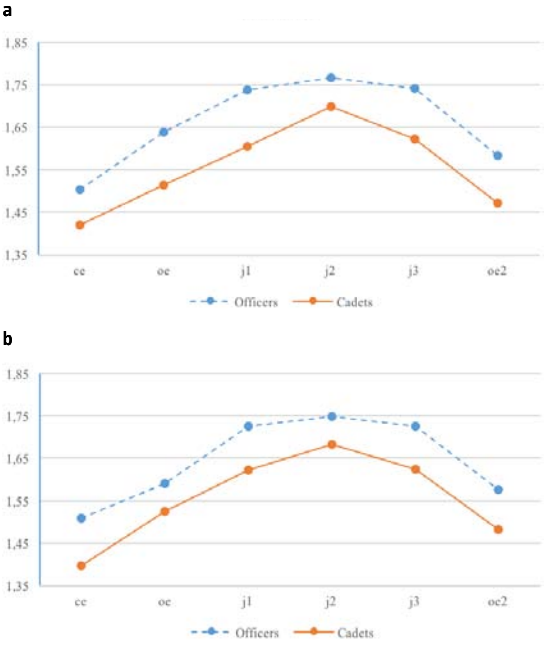


The fractal dimension of a curve is a dimensionless parameter that takes a fractional value between 1 and 2. This parameter indicates the density with which a set (in this case a curve) occupies the metric space in which it is located, i.e., its dimension as a geometric object. This dimension is a measure that enables comparisons between different sets and signals.

In this work we have implemented a procedure to calculate the variance fractal dimensión (D) of the mapping of each channel of the EEG as a curve of the real plane, using the existing relation with another parameter of quantification, the Hurst exponent (H): $D = 2 - H$.

The Hurst exponent is an indicator of self-similarity and persistence of the signal. Depending on the value of H, $0 \leq H \leq 1$, you can distinguish the 'color' of the signal movement. The value $H = 0$ is associated with a white noise (corresponding to $D = 2$), $H = 1$ indicates a smooth signal ($D = 1$), and $H = 0.5$ is related to a Brownian motion or red noise. Roughly speaking, the higher the value of H (or equivalently the lower the value of the fractal dimension), the more predictable or less complex the signal will be.

Figure 2. Values of the fractal dimension in parietal channels P3 (a) and P4 (b) comparing the dimension in the group of officers and cadets for the different types of EEG.



Statistical analysis

Once the values of the fractal dimension for each of the channels and type of EEG had been calculated, a complete statistical study of the results was carried out, with two different phases:

- First, an exploratory analysis of the data was carried out with bar charts, box-plots and error graphs.
- In a second phase, we studied the existence of possible significant differences between the two groups under study (cadets and officers) in each of the types of EEG analyzed in the 12 channels, applying a hypothesis test. The Kolmogorov-Smirnov test was applied to check the normality of the data and the Levene test was used to explore the homoscedasticity hypothesis (equality of variances). We did not reject any of the hypotheses in all channels with a confidence level of 95%, so we applied a parametric test T for independent samples that allowed us to contrast the assumption that the difference of means between the two groups is zero on any of the 12 electrodes and type of EEG, with a confidence level of 95% ($\alpha = 0.05$) and 99% ($\alpha = 0.01$).

Results

The exploratory analysis of the data, shows that the cortical global mean values obtained for the fractal dimension in the officers group in the six types of EEG analyzed and in the 12 channels are greater than the means in the cadets group, as can be seen in the last row of table I. Only one case of almost equal means appeared during the execution of the task (j2) at the T3 electrode. However, by means of the statistical analysis with the hypothesis test we verified later that these differences are only significant in certain types of EEG and electrodes.

Figure 2 shows how, for example, in the parietal area channels (P3, P4) the average values of the dimension are higher for the officers in all types of EEG.

It has also been observed that the range of variation of the dimension is 1.384-1.848. In the cadets group the minimum is 1.384 in the closed eyes basal test, channels O1 and O2 and the maximum value is 1.845 in the electrode T3 of task (j2). In the officers group the minimum is given in the basal eyes closed test taking the value of 1.456 in O2 and the maximum is 1.848 in the channel T4 in the task (j2), which is the one that requires the maximum attention. Thus, the areas where the minimums and maximums of the parameter are given coincide in both groups.

The box-plots in figure 3 show how the values of the dimension for the officers are greater than the values of the parameter for cadets in all types of EEG in the parietal zone channels (P3 and P4). It is also observed that in tasks (j1), (j2) and (j3) the values of the dimension obtained by the officers are much more homogeneous (the box-plot is very small) than those of the cadets group in both P3 and P4. In (ce) and (oe2) the parameter values for the officers are more heterogeneous than the values in the cadets group. The scores rise as the task difficulty increases to the maximum in (j2), descending from this step to the final open-eyed EEG (Figs. 2, 3 and 4).

By exploring the differences in means between the two groups under study (officers-cadets) in each case (electrode and type of EEG), as can be seen in table II, the greatest difference is given in the electrode P3 during the execution of the task (j1) and takes a value of 0.133 in favour of the officers. The smallest difference is 0.004 in the T3 location during the execution of the simulation task with external stimuli (j2) in favour of the cadets.

Observing the evolution of the fractal dimension when changing the type of EEG (Tables I and III) in each of the groups we can conclude the following:

Table I. Average values of the fractal dimension for the two groups (officers/cadets).

	Officers						Cadets					
	ce	oe	j1	j2	j3	oe2	ce	oe	j1	j2	j3	oe2
C3	1.638	1.709	1.741	1.793	1.746	1.659	1.572	1.603	1.638	1.723	1.649	1.566
C4	1.625	1.667	1.752	1.773	1.742	1.612	1.549	1.591	1.623	1.707	1.633	1.555
F7	1.718	1.778	1.715	1.780	1.702	1.754	1.677	1.723	1.640	1.752	1.655	1.712
F8	1.717	1.770	1.709	1.797	1.715	1.752	1.678	1.708	1.667	1.753	1.667	1.709
O1	1.461	1.617	1.755	1.793	1.741	1.603	1.384	1.533	1.696	1.749	1.692	1.528
O2	1.456	1.575	1.762	1.789	1.770	1.574	1.384	1.549	1.684	1.742	1.666	1.528
P3	1.504	1.639	1.738	1.767	1.742	1.583	1.421	1.514	1.605	1.699	1.623	1.472
P4	1.509	1.591	1.726	1.749	1.725	1.576	1.396	1.526	1.623	1.682	1.624	1.482
T3	1.682	1.783	1.761	1.842	1.761	1.730	1.615	1.682	1.715	1.845	1.729	1.704
T4	1.641	1.714	1.792	1.848	1.801	1.699	1.624	1.668	1.742	1.821	1.716	1.681
T5	1.508	1.657	1.819	1.846	1.827	1.643	1.456	1.575	1.709	1.779	1.723	1.574
T6	1.463	1.619	1.829	1.828	1.819	1.616	1.416	1.562	1.710	1.790	1.705	1.525
Mean	1.577	1.677	1.758	1.800	1.758	1.650	1.514	1.603	1.671	1.754	1.674	1.586

ce: rest with closed eyes; j1: simulation of handling a combat vehicle with a video game; j2: performing the task (j1) while the subject receives external distracting stimuli; j3: repeated simulation exercise (j1) without external stimuli; oe: rest with open eyes; oe2: rest with open eyes.

Table II. Differences between the average values of the fractal dimension of both groups for each electrode and type of EEG.

	ce	oe	j1	j2	j3	oe2
C3	0.066	0.106	0.103	0.070	0.097	0.093
C4	0.076	0.076	0.129	0.067	0.109	0.057
F7	0.041	0.055	0.075	0.028	0.047	0.042
F8	0.039	0.062	0.042	0.044	0.047	0.043
O1	0.077	0.084	0.059	0.044	0.049	0.075
O2	0.073	0.027	0.078	0.047	0.104	0.045
P3	0.083	0.125	0.133	0.068	0.119	0.111
P4	0.112	0.065	0.103	0.066	0.101	0.094
T3	0.067	0.101	0.046	–0.004	0.032	0.026
T4	0.018	0.047	0.050	0.027	0.086	0.018
T5	0.052	0.082	0.111	0.068	0.105	0.069
T6	0.047	0.056	0.118	0.037	0.114	0.091

ce: rest with closed eyes; j1: simulation of handling a combat vehicle with a video game; j2: performing the task (j1) while the subject receives external distracting stimuli; j3: repeated simulation exercise (j1) without external stimuli; oe: rest with open eyes; oe2: rest with open eyes.

- In both groups the dimension increases when switching from the resting state with closed eyes (ce) to the resting state with open eyes (oe) at all the electrodes. This difference is more important in the occipital, temporal and parietal areas.
- In the change from the basal EEG with open eyes to perform the simulation task (j1) there is a generalized increase of the dimension in both groups in all the brain areas except for the frontal zone (F7, F8), where there is a decrease thereof. In the officers group there is also a very weak decrease in the electrode T3.
- The execution of the simulation task with external stimuli (j2) implies an increase of the dimension with respect to the task (j1) in practically all the channels and in both groups.
- After performing the task (j2), the return to the simulation task without external stimuli (j3) implies a decrease of the dimension in all the brain areas in both groups.
- After completing the task (j3), and once the simulator is removed, when the subject is in the basal state (oe2), a reduction of the dimension occurs in all channels, except in the frontal zone (F7, F8), where there is an increase thereof.
- Comparing the values of the dimension in the basal state with open eyes before and after the performance of the simulation tests (oe, oe2), it can be observed that in the officers group there is a decrease of the dimension in all the channels in the last case with respect to the first one. In the cadets group, the dimension is also reduced compared to the first test, except for channels F8, T3 and T4. These changes may reflect less activation in the final test.
- The activation (increase of the dimension) due to the task (j1) is higher in the officers group on average (last row, second column table III). However, activation by external stimuli is greater in the group of cadets (last row, third column table III).

In the second phase of the statistical study, applying the contrast of hypothesis with the parametric test *T* for independent samples between the two groups

Figure 3. Box-plot dimensions in both groups on the electrodes P3 (a) and P4 (b) for each of the six EEG types.

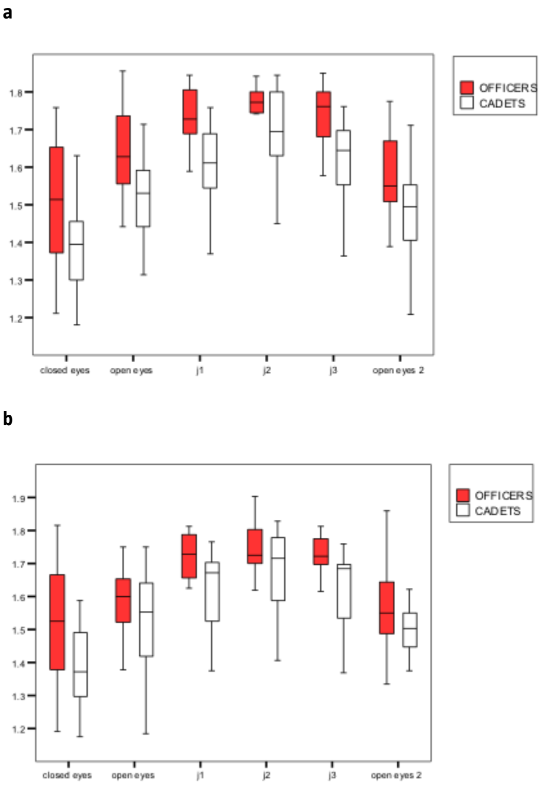
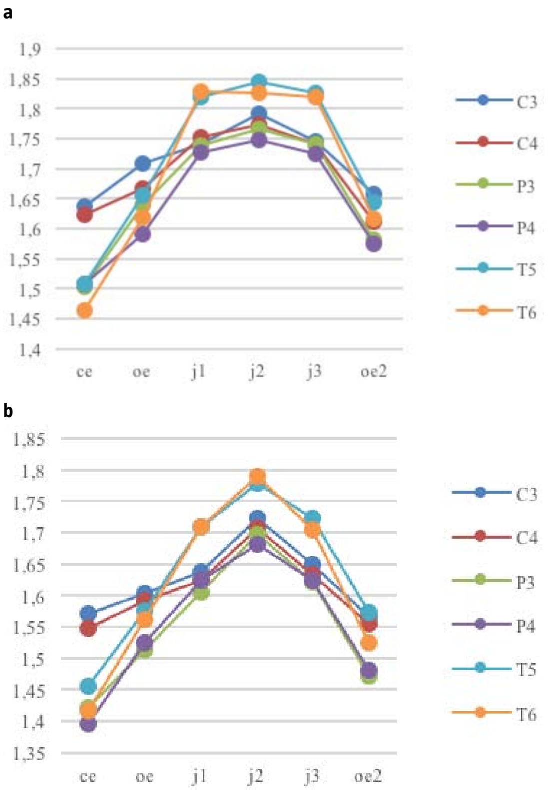


Figure 4. Evolution of the dimension in each group with the change of EEG type in six electrodes: a) Officers; b) Cadets.



(officers and cadets) with the same type of EEG, we obtain the significant differences described in table IV. It can be seen that the greatest variations between groups are recorded during tasks (j1), (j3), corresponding to the simulation exercise without external stimuli, in parietal, temporal and central areas. The values obtained are greater in the officers group.

Discussion

From the quantitative point of view, the higher values in the fractal dimension averages obtained in the whole group of officers with respect to the group of cadets, point to a slightly superior cerebral activation in the officers when performing the tasks (j1), (j3).

It is also evident how the parameter under study detects the changes in brain activity with the switch of EEG type in each of the groups, which increases as the task execution becomes more complex and requires more attention (activation of brain areas) and decreasing when activity ceases.

The increase of dimension in the cerebral areas after the change from rest with eyes closed to the rest with open eyes is explained by the blockade of the alpha rhythm produced in normal conditions when the eyes are opened, which suggests an appropriate cortical reactivity.

The increase of dimension in the two groups when moving from rest with open eyes (oe) to the task of simulation (j1) indicates the activation of the posterior attentional network directly related to visual-spatial attention. The decrease in dimension in the frontal zone in both groups can be explained by the appearance of slow activity in that zone because the task requires the activation of the rest of the brain areas responsible for sensory processing (auditory and visual).

The increase in the dimension of the two groups when moving from the simulation task (j1) to the simulation with external stimuli (j2) and the subsequent

Table III. Differences between the average values of the fractal dimension of an EEG type and the previous one.

	Officers					Cadets				
	oa-oc	j1-oa	j2-j1	j3-j2	oa2-j3	oa-oc	j1-oa	j2-j1	j3-j2	oa2-j3
C3	0.071	0.033	0.051	−0.047	−0.087	0.031	0.035	0.085	−0.074	−0.083
C4	0.043	0.085	0.021	−0.032	−0.130	0.042	0.032	0.084	−0.074	−0.078
F7	0.060	−0.063	0.065	−0.078	0.052	0.046	−0.083	0.112	−0.097	0.057
F8	0.053	−0.061	0.088	−0.082	0.037	0.030	−0.041	0.086	−0.085	0.042
O1	0.157	0.137	0.038	−0.052	−0.138	0.149	0.163	0.053	−0.057	−0.164
O2	0.119	0.187	0.027	−0.020	−0.196	0.165	0.136	0.058	−0.077	−0.137
P3	0.135	0.099	0.029	−0.025	−0.159	0.093	0.091	0.094	−0.076	−0.151
P4	0.082	0.136	0.023	−0.024	−0.149	0.129	0.098	0.059	−0.059	−0.142
T3	0.101	−0.022	0.080	−0.081	−0.031	0.068	0.033	0.131	−0.116	−0.025
T4	0.073	0.077	0.056	−0.046	−0.103	0.044	0.074	0.079	−0.105	−0.035
T5	0.149	0.163	0.027	−0.019	−0.184	0.120	0.134	0.070	−0.056	−0.148
T6	0.156	0.210	−0.002	−0.008	−0.203	0.146	0.148	0.080	−0.085	−0.180
Mean	0.099	0.082	0.042	−0.043	−0.108	0.089	0.068	0.083	−0.080	−0.087

ce: rest with closed eyes; j1: simulation of handling a combat vehicle with a video game; j2: performing the task (j1) while the subject receives external distracting stimuli; j3: repeated simulation exercise (j1) without external stimuli; oe: rest with open eyes; oe2: rest with open eyes.

Table IV. *p*-values of the *T*-test that compares the averages of officers and cadets in each type of EEG.

	ce	oe	j1	j2	j3	oe2
C3	0.320	0.076	0.011 [a]	0.062	0.007 [b]	0.065
C4	0.195	0.144	0.002 [b]	0.096	0.004 [b]	0.252
F7	0.393	0.202	0.074	0.345	0.213	0.386
F8	0.410	0.166	0.288	0.167	0.217	0.372
O1	0.154	0.051	0.174	0.247	0.252	0.103
O2	0.170	0.556	0.106	0.201	0.020 [a]	0.348
P3	0.165	0.006 [b]	0.001 [b]	0.073	0.001 [b]	0.037 [a]
P4	0.042 [a]	0.145	0.003 [b]	0.078	0.003 [b]	0.040 [a]
T3	0.240	0.070	0.274	0.903	0.466	0.573
T4	0.765	0.368	0.293	0.378	0.054	0.742
T5	0.314	0.091	0.013 [a]	0.145	0.018 [a]	0.127
T6	0.356	0.236	0.004 [b]	0.339	0.004 [b]	0.077

ce: rest with closed eyes; j1: simulation of handling a combat vehicle with a video game; j2: performing the task (j1) while the subject receives external distracting stimuli; j3: repeated simulation exercise (j1) without external stimuli; oe: rest with open eyes; oe2: rest with open eyes. [a] Differences at the 0.05 significance level; [b] Differences at the 0.01 significance level.

decrease in the simulation (j3) is explained by the higher degree of cortical activation required by distracting stimuli. It is known that in high alert states there is an inhibition of fatigue and an increase in monitoring levels, which results in a significant suppression or decrease of delta power and in an increase in frontal theta activity due to the integration of external stimuli in the EEG [21]. This is consistent with the data obtained for the largest dimension.

The reduction of the dimension when comparing the first state with open eyes (oe) and the second one (oe2) may be due to the state of fatigue or tiredness after performing the tasks.

The results obtained in the contrast of hypotheses show that in the basal state there are hardly any significant differences between the group of officers and cadets. Our results thus corroborate the medical assumption that in these groups there are no basic brain differences by age [22], or rather that those differences may be weak. However bioelectric activity it is known to become more complex with age, increasing from childhood to maturity. Until recently, brain maturity was thought to occur before the age of 20. A current study by the Institute of Cognitive Neuroscience in London suggests that the brain continues its development after puberty and reaches maturity after the age of 30 or in some cases after the age of 40 [23].

Significant differences between the two groups occur mainly during the performance of the combat vehicle simulation tasks (j1) in the central, parietal and temporal zones. The posterior parietal cortex, of right predominance, would constitute the main settlement of a posterior attentional system in charge of selective and focused attention [24]. This posterior parietal zone shows intimate associations with the frontal eye fields and is activated in the visual search tests.

The lack of significant differences between groups during the vehicle-handling simulation task with external stimuli (j2) could suggest that in states of maximum alert the same degree of activation of the cerebral areas in the two groups is required. Note that (j2) is the most complex task and it requires maximum attention and has therefore obtained the highest average values in the dimension.

The previous results show that the fractal dimension is a good indicator of brain activity, a fact that our group had already verified in the study of children with ADHD [6] as well as in other works of military tasks simulation [18,19]. The attentional process developed to carry out a cognitive operation (called attention of preparation) mobilizes the most appropriate schemes or responses to the task to be performed, which implies the activation of the cerebral areas where the neurocognitive process is performed. The increase in the fractal dimension numerically records such activation.

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Estudio cortical de la atención en tests de simulación militar

Introducción. La atención es una de las funciones cerebrales superiores más estudiadas en nuestros días y la base de otros procesos cognitivos. En ocasiones se entiende como la concentración en una tarea. El nivel de ejecución de una tarea y la habilidad para procesar información son dependientes del estado de activación cerebral, que puede registrarse mediante el electroencefalograma (EEG).

Objetivo. Estudiar la atención en estados de reposo y durante el desarrollo de tareas propias del personal militar, explorando las diferencias entre dos grupos (cadetes/mandos).

Sujetos y métodos. Se han recogido señales de EEG de 19 cadetes y 17 oficiales de la Academia General Militar y del Hospital General de la Defensa durante tareas de simulación militar y en estados de reposo. Nuestro equipo utiliza metodología propia de sistemas dinámicos y técnicas fractales para modelizar y cuantificar las señales del EEG, en este caso para el cálculo de la dimensión fractal del registro de cada derivación. Los datos obtenidos en diversos estados cerebrales se someten a un estudio estadístico.

Resultados. Se observan mayores valores de las medias globales corticales en el grupo de mandos. La dimensión aumenta en ambos grupos al elevar la dificultad de la tarea en todas las áreas cerebrales, salvo en la zona frontal. Destacan las diferencias significativas entre grupos en la tarea de simulación de manejo de vehículos de combate en las zonas central, parietal y temporal.

Conclusiones. Los resultados obtenidos muestran que los dos grupos no se comportan de manera homogénea en la misma tarea de atención que implica un videojuego.

Palabras clave. Actividad cerebral. Atención. Cuantificación. Dimensión fractal. Electroencefalograma. Simulación militar.