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Extraction of Body Posture Characteristics as a Correlation Variable with the Level of Attention

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Abstract. Nowadays, several factors have been associated that intervene in the behavior of the level of attention of people. These factors can be internal or external to the context in which the user develops. This paper addresses one of the factors inherent to human behavior: Body posture. Starting from this variable, the extraction of 8 statistical characteristics (mean, variance, obliquity, kurtosis, standard deviation, maximum, minimum, and rank) is obtained, which are processed mathematically to eliminate out-of-range measurements and measurements produced by errors or noise present in the experiment. For the visualization process, the characteristics extracted are correlated with the mean of the percentage of attention that is obtained from brain waves to finally show their shape in 2D graphics. This analysis is performed using statistical tools that graphically demonstrate some differences in the level of attention among a child with ADHD and a child without ADHD . With the results obtained in this work and as future work, behavior patterns and mathematical models will be sought which describe the level of attention based on the user's body posture.

Keywords. Attention level, brain signals, body posture, diagnostic ADHD, statistic analysis.

1 Introduction

ADHD is characterized by lack of attention, impulsivity and hyperactivity. Recently it has been estimated that it affects 3.5% of school-age children worldwide and is said to be one of the most common psychiatric disorders among young people. Children with these problems are often unpopular and lack reciprocal friendships, but are not always aware of their own unpopularity. Although these symptoms tend to decrease with age, at least 50% of children with ADHD still have symptoms that decrease in adulthood. Despite the vast literature that supports the efficacy of stimulant medication in the treatment of attention deficit / hyperactivity disorder (ADHD), several limitations of pharmacological treatments highlight the clear need for effective alternative psychosocial treatments. There is also evidence of interventions that involve both the school and the training of parents that have resulted in classifying them as "empirically validated treatments" [1]. Attention deficit hyperactivity disorder (ADHD) is a common neurobiological condition that affects school-age children. One of the main symptoms is the lack of attention, which is a key factor of low academic performance, especially in tasks that require a lot of concentration time [2]. Children with Attention Deficit Hyperactivity Disorder (ADHD) experience a deficit in cognitive processes responsible for behaviors aimed at specific objectives, known as executive functioning (FE) [3]. The biggest challenge for adults with attention deficit hyperactivity disorder (ADHD) is the management of information and tasks [4].

2 Systems for Measuring the Level of Attentıon

The study of physiological signals such as brain waves, heart rate, body temperature, among others, has revealed great advances in recent times obtaining significant results in applications from different fields of study such as medicine, robotics, psychology, among others. Currently there are low-cost commercial devices to obtain the reading of brain signals with which it is possible to know the level of attention of the user in an unreliable way. The performance of these devices is limited to the software and hardware established by the manufacturer for a specific task, added to the lack of accuracy in reading the signals, because the devices do not have a robust system for data acquisition and processing. The performance of these devices is limited, since their manufacture is oriented to simple tasks or didactic games. Another cause of the low performance of these devices is that they are invasive or intrusive; Tiaras, helmets, blood samples are used to obtain the signals of the user's physiological variables, any error in the calibration could generate an error in the final diagnosis [5].

To know the degree of affectation that ADHD produces in people, it is necessary to have tools that can provide a feedback of the percentage of attention when executing a specific task. Currently there is a variety of commercial devices that quantitatively provide the level of concentration, meditation, relaxation and user care, but in some cases are achieved in an invasive way, affecting the response of the user and consequently the final diagnosis. These devices usually use a physiological variable to infer the levels of attention in people, they are of the single-user type and of an accessible cost. The performance of these devices is limited since they have restrictions on the part of the manufacturer regarding the software and hardware implemented.

Data acquisition and processing speeds of MINDWAVE, EMOTIV EPOC, MUSE devices, among others; they have delays and can not obtain a reading of the acquired variables in a time approximated to the real time. Another disadvantage presented by this type of device is its low usability and versatility in practice, since the user requires a long time for the devices to recognize the physiological signals that are desired to be acquired. Some devices have a graphic interface designed by the manufacturer, whose feedback is based solely on the indication of the level of attention graphically.

Various applications in areas such as: psychology, education, business, health, among others require a system that accurately identifies the level of attention in people, and that in turn provides an instant response of what happens , as well as a reliable final

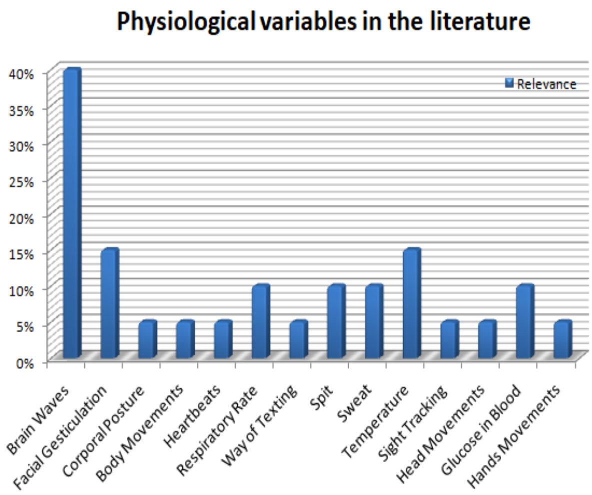

Fig. 1. Relevance of the physiological variables related to the level of attention in the literature.

Fig. 2. Correct positioning of the Neurosky MindWave headband.

diagnosis for decision making. It is also desirable to obtain a feedback that encourages the user to raise the level of attention at the same time as executing a specific task [6].

Biofeedback training systems foster a specific mental or physical state in a user through a closed cycle of bio-feedback. These systems gather the physiological state of a person through the detection of hardware, integrate this state into a computer-based interactive system and present the comments so that the user can work to adjust their status [7].

In this research work, we propose to implement a system to measure the level of attention in children with ADHD, generating an analysis on the samples obtained, with the purpose of characterizing the behavior of their brain waves and obtaining statistical patterns that allow us to identify the presence of ADHD in students through the use of this device. The system is non-invasive and has an interface centered on the user, with the aim of obtaining a final diagnosis that reliably describes the level of attention.

2.1 Physiological Variables Related to the Level of Attention

The variety of techniques applied in the field of research to quantify the level of attention of people leads toward a descriptive analysis that is presented in this work [8].

Starting from the review in the literature of the variables used to relate the level of attention in people, has been found that the brain waves are the physiological variables with greater relevancy due to the cognitive relationship that exists between think-ing and brain activity. Therefore its implication is direct [9, 10, 11].

The graph of the Fig. 1 shows the relevance that each one of the physiological variables has on the level of attention of the people. This analysis is ob-tained from the state of the art of the related works.

Depending on the physiological variable used, the device is chosen to perform the data acquisition. Within the most devices used in the literature are: the electroencephalogram, WEB cam, motion sensors, gyroscopes, electrodes, mouse, electrocardiogram, electrochemical sensors, keyboard, transducers, cam-eras and optical sensors [12].

2.2 MindWave Headband

To realize the implementation of the electronic system in this work we use the MindWave device developed by the manufacturer Neurosky (www.neurosky.com), which allows obtaining EEG signals through a headband type interface that is placed on the head and It is powered by a 1.5 V type AAA battery.

It uses a wireless interface to communicate with the computer and acquires the signals through passive bio-sensors connected to an electrode that makes contact with the forehead. In addition, it has a reference terminal is connected to the earlobe. This feature is used to determine the origin of a signal. In the brain-computer interfaces, the location of the electrodes allows obtaining different representations of the EEG. The MindWave device has only one terminal placed on the front of the subject, in what is formally known as a pre-frontal zone. Fig. 2 shows the correct way in which the device is used [13].

2.3 Body Band to Measure Body Posture

The results of the experiments based on the user's brain waves are considered as a dependent variable and we proceed to relate the level of attention of a person using body posture as a second physiological variable.

The sensor was initially placed in a vest to be able to perform the measurement (Fig. 3A), this involved a longer time in the sampling so it was replaced by a band as shown in Fig. 3B.

The orientation of the MPU-6050 sensor with respect to the three-dimensional system (X, Y, Z), can be seen in Fig. 4. The measured angles are only those that form the movements around the “X” axis and the movements around the Axis y".

This is because they are the only angles where static tonic support reactions are considered which occur to maintain a normal and upright posture against the force of

Fig. 3. A) Posture sensor placed in the vest. B) Posture sensor placed on the body band.

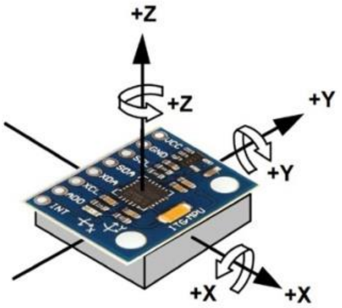

Fig. 4. Reference of position of the MPU-6050 sensor in the band.

gravity causing the user to require a neuromotor balance in relation to their neuroaxis which produces a direct impact on their level of attention and concentration [14].

3 Affectation of ADHD in the Brain

The dispersed attention deficit (whose abbreviation is ADD and ADHD if it is with hyperactivity that is the most frequent) is a disorder of unclear cause, probably with the intervention of genetic and environmental factors, in which there is an alteration at the system level central nervous system, manifesting itself through an increase in activity, impulsivity and lack of attention, and frequently associating other alterations.

The genetic factor is demonstrated, since ADHD is 5 to 7 times more frequent in siblings and 11 to 18 times more frequent in twin siblings. Several genes possibly involved have been described.

ADHD is one of the most frequent causes of school failure and social problems in children.

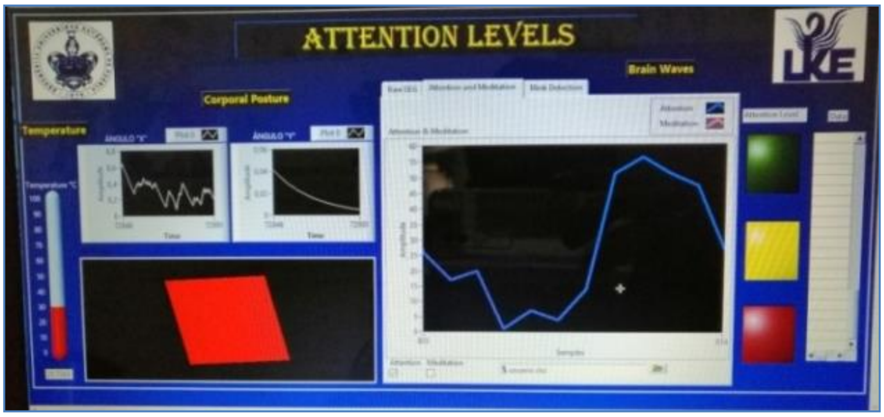

Fig. 5. Graphical interface implemented in LABVIEW.

Fig. 6. Development of the test in students with ADHD.

4 Development of the Attention Test

The experimental tests were conducted using the MindWave commercial device of the Neurosky company, to detect the level of attention in Mexican primary level students.

A sample of 22 students with diagnosed ADHD and 11 students without ADHD was evaluated whose ages are between 6 and 12 years.

The test consisted of a test to identify colors, which was obtained from the demos of the company Brain HQ (https://www.brainhq.com/why-brainhq/about-the-brainhq-exercises/attention).

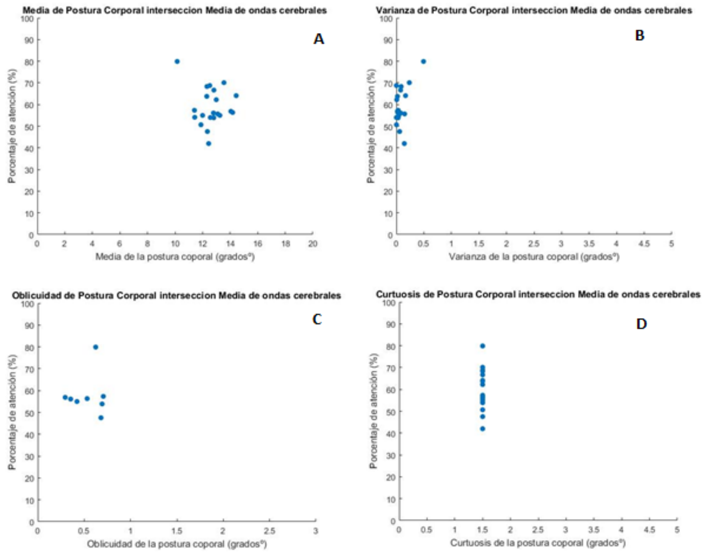

Fig. 7. Scatter plots 2D A) (mean PC, mean OC). B) (variance PC, average OC). C) (PC oblique, mean OC). D) (PC curtuosis, medium OC).

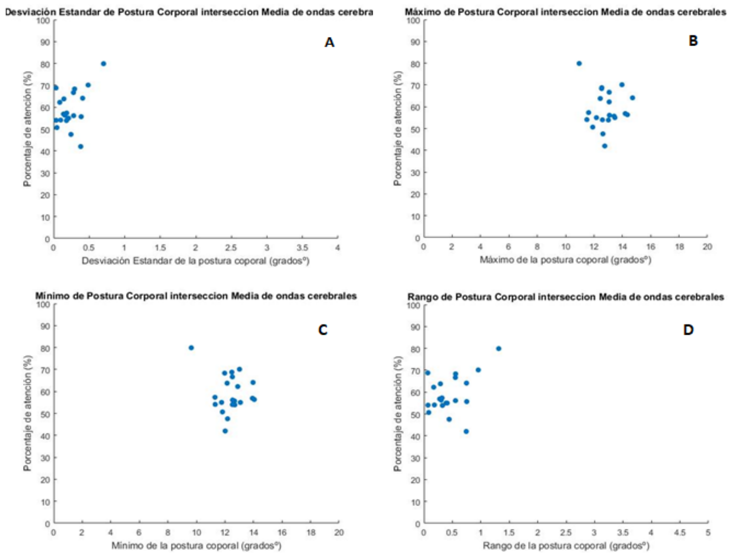

Fig. 8. Scatter plots 2D A) (PC deviation, OC average). B) (maximum PC, average OC). C) (minimum PC, average OC). D) (PC range, average OC).

To obtain the data of brain signals, a graphical interface was implemented, using the LABVIEW software. Fig. 5 illustrates the graphic interface where you can observe the behavior of brain signals, body posture, temperature, a traffic light as feedback , a vector where the sampled data and the variation of the user's attention level are stored.

The test was done in the tablet modality for both cases (students with diagnosed ADHD and students without ADHD). The practical development is shown in the Fig. 6.

The experiment was developed in a classroom where the environment was controlled and adequate to avoid distracting agents and obtain a natural response and a better user performance.

5 Analysis and Results

In the visualization of the data, 2D dispersion diagrams are plotted, which are a fundamental tool for finding patterns and correlation trends between the percentage of attention and the result of body posture.

The vectors are plotted in Fig. 7A (mean PC vector, OC average vector), in Fig. 7B the vectors are plotted (PC variance vector, OC average vector), in Fig. 7C the vector is plotted (PC obliqueness, OC average vector), in Fig. 7D the vectors are plotted (PC tannery vector, OC average vector), in Fig. 8A the vectors are plotted (PC standard deviation vector, OC average vector), in Fig. 8B the vectors are plotted (maximum vector PC, average vector OC), in Fig. 8C the vectors are plotted (minimum vector PC, average vector OC) and in Fig. 8D the vectors are plotted (vector range PC, OC vector).

Using the information analyzed, the correlation factor (ρ_{xy}) is obtained between each independent characteristic extracted from the body posture (X) and the dependent characteristic extracted from the percentage of attention (Y), both for children with ADHD and for children without ADHD (shown in table 1).

Table 1. Correlation coefficients by characteristic extracted in children with ADHD.

Extracted Feature	Correlation coefficient (ρ_{xy}) in children with ADHD	Correlation coefficient (ρ_{xy}) in children without ADHD
Mean	0.1737	0.2225
Variance	0.1098	0.1413
Obliquity	0.1059	0.1746
Curtuosis	0.2999	0.1622
Standard deviation	0.1628	0.1609
Maximum	0.2183	0.2466
Minimum	0.2040	0.2678
Rank	0.1611	0.1379

6 Conclusion

The results obtained on the data analysis show that the most influential statistical characteristics on the correlation between body posture and the level of attention are the minimum, maximum and curtuosis.

In the 2D dispersion diagrams, you can see patterns typical of each of the features extracted where from these you can make a classification where 2 membership groups are obtained which would be: children with ADHD and children without ADHD.

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