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Effects of the binaural wave as a stimulus for student hyperattention: brain frequency records without interactive media context

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Abstract *— The brain works with electrochemical, generating brain waves that represent brain activity. The basic frequencies of brain functioning are gamma (30-70 Hz), beta (13-30 Hz), alpha (8-13 Hz), theta (4-8 Hz), and delta (1-4 Hz). With these references it is possible to condition the electrical activity, inducing a specific wave pattern. The way for this to happen is through binaural waves to synchronize brain patterns. This technique is addressed in this study, in the context of interactive media and in the student's attention stimuli, so the sounds are received independently in each ear creating different effects in parts of the brain.*

Keywords *— **Binaural wave. Media interactives. Attention.***

I. INTRODUCTION

Every day, our society undergoes a constant transformation in which the use of information and communication technologies (ICTs) has become essential in our lifestyle. The use of ICTs contributes to a globalization process in all aspects of society, including innovation, entertainment and education. Mobile devices within the classroom are no longer a paradigm for teachers and students worldwide. For this reason, several software developers have implemented various educational applications, among which are applications, most of which are free that can be used on smartphones. Thus, its use does not present any restriction for either students or teachers.

Previously, the ability to track brain rhythms was only available using electroencephalography in large volumes, requiring medical EEG recording technique. And yet with all these difficult requirements, the quality of the EEG obtained was not always high. Currently microelectronics has taken another qualitative leap, and in recent years a large number of ready-made devices or nearly ready kits have appeared on the market, allowing the technology to be wearable, EEG data being collected with a device in real time [3]. This made it possible to provide neuroeducation feedback to track the state of the brain and mind directly connected during various types of activities, mainly in the development of attention.

To understand the influence of technology on the human brain, Hayles approaches that human beings are born with the nervous system ready to be reconfigured in response to the environment (p.123). So, the human brain is constantly reconfiguring itself to respond to the challenges posed by technology. Katherine Hayles in 2007 addresses the new technological paradigm and calls it hyperattention. The brain still works with electrical and chemical energy, and when used with electricity the brain can be considered a low-frequency machine generated by the action of the phenomena [13].

Brain waves are electrical activities that are produced by the firing of neurons in the brain. Each of these neurons comes into contact with another ten thousand neurons [20]. These electrical activities can be measured on the scalp using an electroencephalogram (EEG) device. These electrical waves emit electrochemical impulses of different frequencies that are received by an electroencephalogram [15]. The functioning of the human brain has always been a curiosity for scientists [13]. It is incredible to think that simple changes in the electrical potential of the brain can create thoughts, feelings and synchronize thousands of muscle movements and processes. Brain waves are divided

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into six categories that range from the smallest to the most active. Table 1 shows brain waves and their respective frequencies [2]

Table.1: Brain waves and their frequencies

Frequency Types	***Frequency Range***	***Mental State***
Delta	0.1Hz to 3Hz	Deep sleep
Theta	4Hz to 7Hz	Creative
Alpha	8Hz to 12Hz	Imagination / Dreams
Low Beta	12Hz to 15Hz	Relaxation and Focus
Mid-Range	16Hz to 20Hz	Conscious
High Beta	21Hz to 30Hz	Alert / agitation

Source: Prepared by the authors, (2020).

The states of consciousness are the various stages that the mind can go through in a day, from very relaxed to very alert.

● Beta: The beta state is when we have 13 to 40 brain waves per second and we are most alert. It is when we are involved in activities that go through the normal day, such as talking and working.

● Alpha: The alpha state is when the brain waves decrease slightly, from 8 to 13 per second. In the alpha state, we still wake up, but we are very relaxed. This is the state that people are in during meditation.

● Theta: In the Theta state, our brain waves decrease further to 4 to 7 per second. It is in Theta that we are sleeping, or close to it.

● Delta: In the Delta state, our brain waves are 1 to 4 per second. In this state, we sleep deeply every night.

It was once approached that the bridge from brain research to education was too long a bridge (BRUER, 1993). In recent times, important progress has been improving research in the field of neuroeducation. Cognitive neuroscience is already highly relevant to education [18]. Our understanding of learning algorithms includes the importance of prediction, prediction error, consolidation of memories that is directly relevant to the efficient learning project [4]. Our understanding of the role of attention and reward, the negative effects, distraction, are important genetic discoveries that affect a lot when thinking about education [13].

As a person undergoes changes in their level of attention or mental state, small changes occur in the levels of tension and in the frequency of the signals emanating from their neocortex. The method is known as electroencephalogram (EEG) using electrodes connected through the scalp by scientists to accurately measure the signals and their fluctuations in measurement that occur [18]. These signals can be used for a variety of purposes, including diagnosing a person's attention and stress level. Some findings support the hypothesis that rhythmic stimuli trigger changes in the thalamus and the neocortex [1]. The rhythmic frequency of electrical activity within brain areas is captured by wave bands, measured in number of waves per second, or Hertz, which tend to be associated with the student's psychological state.

II. TECHNOLOGIES

2.1 Interactive Media: During the study, videos with binaural content and sound were used with the appropriate frequencies of the study. The videos were selected because they were judged the most appropriate for the proper test and that we could use for free. Following in Figure 1 is shown image resource used during the study with the headset illustration used and binaural frequency.

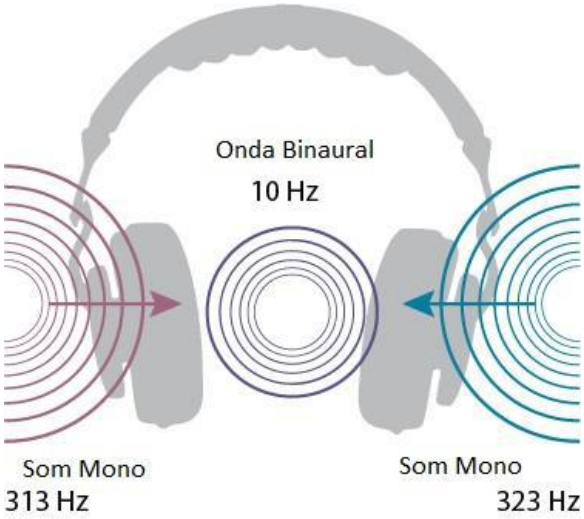

Fig. 1: Illustrative image of the binaural sound

Source: Prepared by the authors, (2020).

2.2 Biosignal sensor technology

Data collection is performed using the Neurosky Mindwave experimentation device. The mindwave has an electrode located in the subject's frontal area, and a reference electrode located near the ear that allowed to determine the students' concentration. A non-invasive alternative for acquiring signals to monitor brain activity, in particular the assessment of cognitive tasks related to the

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use of attentional resources investigated in this study. The signals collected by dry electrodes are filtered and interpreted by the firmware inside the device to provide a continuous signal line. The five brain frequencies are Gamma, from 30 to 100 Hz, Beta, from 12 to 30 Hz, Alpha, from 8 to 12 Hz, Theta, from 4 to 7 Hz and Delta from 1 to 4Hz. Figure 2 shows the image of the Mindwave device.

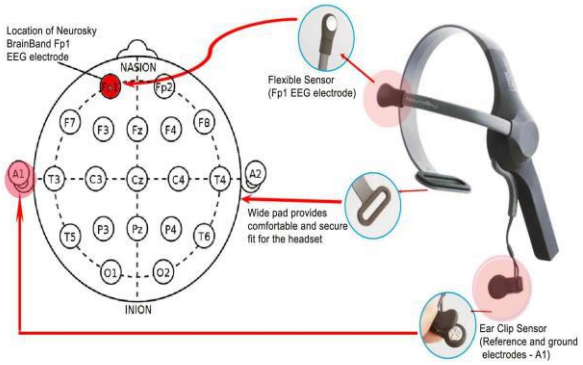

Fig. 2: Mindwave and its sensors

Source: Neurosky, (2020).

This biosensor sends brainwave signals via Bluetooth to a device and provides attention and meditation with Bluetooth paired communication. The sensor eliminates the need to use gel while using its electrode (BOS et al. 2019). Many articles have been published in research using mindwave [12].

2.3 Effective Learner Technology

For this study, the Effective Learner application was used as a brain wave recording tool. With a very simple interface, the application brings graphs of sectors and line, without limit in the measure of time, being able to store and share the data.

III. MATERIAL AND METHODS

To find out the degree of contribution that the brain reading system makes available, together with the biosignal sensor, we are proposing to investigate the types of students' attention during the study. To capture brain waves, we use the Neurosky mindwave that contains an EEG TGAM chip (Think Gear AM) that collects brain waves in the form of electrical pulses. Electric pulses are produced in the head whenever two neurons communicate [19].

This article presents a study on the effect of the binaural beat on the human brain during the process of reading a text. In this study we performed experiments on two subjects and recorded their brain waves. The research subjects are students of the course of a Department of Sciences of a renowned University, aged between 20 and 28 years old, with a similar degree of knowledge. The data were acquired through a brain frequency reading system discussed above. Each sample lasted about 7 minutes with 10 Hz alpha binaural beats. These beats were played while reading the text.

The article discusses how the alpha wave dominates over the other three frequencies (beta, theta and delta). The best way to observe is through the wave that creates an illusory auditory system with lower frequency bands in the brain (below 50Hz). The brain has different experiences for different frequency bands [17]. In the alpha range, an individual tends to be more relaxed and calmer, in a state of light meditation. The graphs are also plotted for the level of care [5]. The attention measures in each of the students were made by Mindwave in units of millivolts.

IV. RESULTS AND DISCUSSIONS

The results of this research measured whether this type of frequency induction can stimulate students' attention. The charts for attention were plotted and the values were presented in them. The average values of attention were considered for the use of reading the text and when viewing the interactive video. Figure 3 shows the study of student A with the viewing of a video and the reading of a text. Figure 3 on the left shows the use of interactive media technology, in which the student was 27.2% with the most effective brain activity, and 12.5% very effective. Still in figure 3 of student A, on the right, which shows brain activity during the use of reading a text, however with the use of a soundtrack with sound at the binaural frequency at 10Hz, it is clear that the student was with 86 , 1% very effective in his brain activity with the stimulus caused by the interference when simultaneously hearing the binaural frequency. Figure 3 shows the results of the samples from Study A.

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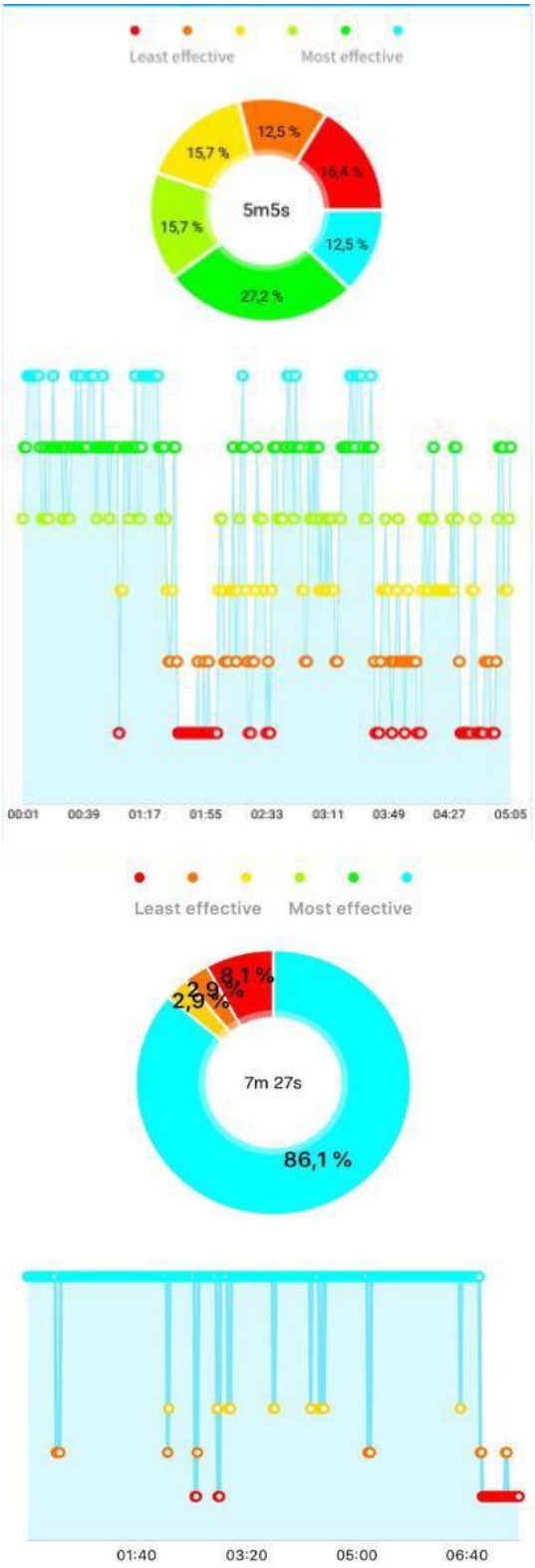
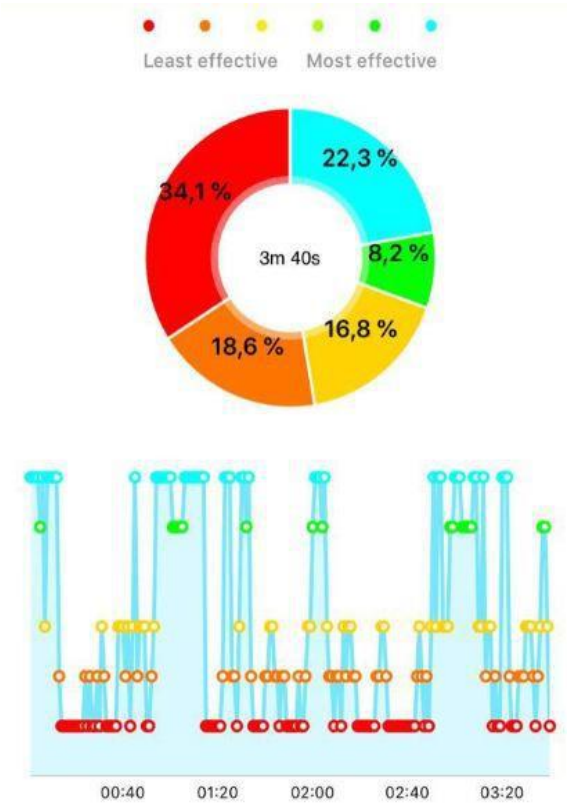


Fig. 3: study samples A

Source: Prepared by the authors, (2020).

In study B of Figure 4, the result presented shows the graph with the use of interactive media without the use of binaural frequency. The measured results indicate that in the time of 3 minutes and 40 seconds, the student was in a state of little effectiveness in 34.1%. Followed by much effectiveness in 22.3%, fluctuating downwards in 18.6%, after decreasing in 16.8% and lastly in 8.2%. In the graph on the right, where the effectiveness of the student's brain activities is presented, the result is with the interference of the 10Hz binaural wave. In the activity with reading and listening to the binaural sound, the student presented 30.8% of brain activity oscillating positively. Followed by 25.6% fluctuating in average difference. After the recorded measurements were 12.8%, very effective for more and at the same time, 12.8% ineffective with few oscillations, these frequencies were identical in their metrics. After the student still brings fluctuations down by 10.5%, followed by 7.5% little effective.



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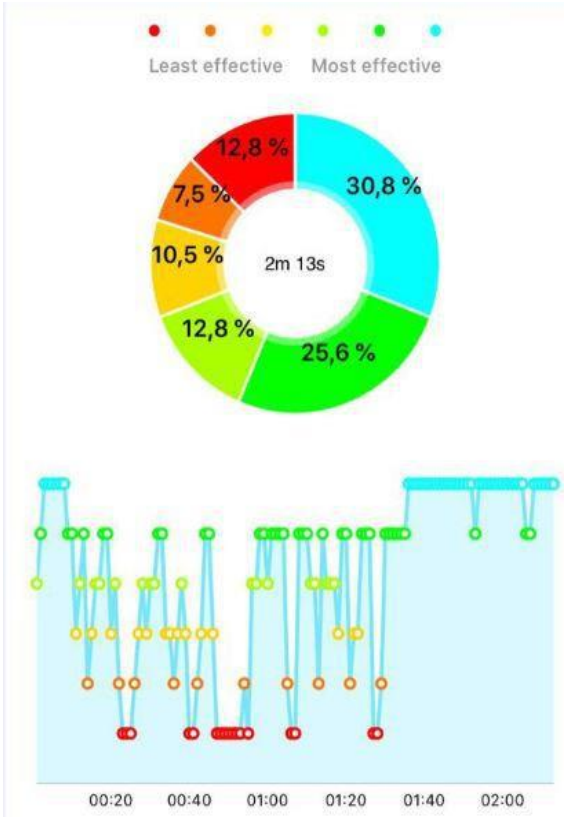

Fig. 4 Study samples B

Source: Prepared by the authors, (2020).

The experiments are based on the intensity of attention and existing neuronal stimuli. The student's attention status is investigated during data collection.

V. CONCLUSION

The use of ICTs in teaching and learning occurs in a process in which a new tool is included to solve problems. Teachers as well as students are willing to use them, for example, educational applications, intelligent systems and accept that these applications have great potential to improve the educational process.

The results of the study data indicate that in different regions of the brain and with various types of stimulation, significant brain activities occur in the specific frequency range. This allows the use of binaural waves for application in the student's learning and focus. So, the binaural pulse is a resource that allows you to change a student's mood. By subjecting the brain to these waves, it is possible to evidence stimulation and synchronization in mental processes.

When comparing the results of the levels of attention achieved by students during the technique used, there were significant differences [7]. This is due to the fact that both studies are structured and both share the characteristics of using only two routes of attention, visual and auditory. Therefore, the link between the results is observed in the data obtained.

Finally, it must be said that the use of stimuli with binaural waves should be used in a moderate way in education to avoid saturation in its function as a distractor. The proper use of these stimuli should be prescribed as a result of further studies.

As an extension of this study, more experiments can be done by looking at other frequency ranges. Several samples of music by different artists can also be used to study the effects of music on the human mind.

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