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Anxiety Disorder Caused by Learning Difficulties in Mathematics

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ABSTRACT

One of the brain disorders causing great damage to those who suffer from it is dyscalculia. Dyscalculia often causes math anxiety. This circumstance is characterized by feelings of tension and fear that interfere with performance in tasks related to Mathematics. Mathematics anxiety is not always caused by a learning difficulty but in cases where this difficulty exists, if it is not diagnosed and treated properly, it is not possible to eliminate the anxiety.

By using the BAEP technique, it is possible to determine the existence of a certain type of learning disorder, which allows attention to be focused on remedying the specific cause that produces the anxiety.

Due to the existence of multiple factors that cause anxiety, the neuronal system that is activated is a network of interconnected networks whose controllability we need to study. In this work, we also study the controllability of multiagent neural networks by simulating possible brain networks.

Keywords
Anxiety, Brain Auditory Evoked Potentials (BAEP), Dyscalculia, Neural networks,

Introduction

Anxiety is a neuropsychological disorder that negatively interferes with the daily activity of those who suffer from it. This disorder can appear as a consequence of different situations that the individual perceives as threatening or stressful [1]. Among the possible causes of this alteration, are learning disorders and among these is dyscalculia.

Dyscalculia is a learning disorder that causes problems in math, but dyscalculia is not the same as math anxiety, although as discussed dyscalculia often causes anxiety.

Many children do their homework with relative ease and do most of the exercises correctly, but feel anxious about doing it. Others may even make mistakes because they feel so anxious that they focus too much on some details or do not pay attention to others, this type of anxiety is known as math anxiety [2]. Math anxiety is the product of a student's lack of confidence in their abilities to learn math and solve math problems; It is not necessarily caused by the existence of learning problems, although their existence causes anxiety.

The objective of this work is to present a method for detecting dyscalculia in order to reduce, and if it is possible to suppress, the anxiety that it produces. At the same time, the detection of this dysfunction will allow us to proceed with the appropriate treatment to overcome dyscalculia and consequently reduce the degree of anxiety.

The different learning disorders have their origin in specific neuronal regions. Although they are different, they interrelate with each other and can cause different degrees of anxiety. An attempt to study the functioning of the neural networks involved in learning can be done by mathematically modeling these networks. The basic processing unit for processing information in a mathematical model of a neural network is inspired by the biological neuron.

Neural networks have the ability to learn and improve their operation, so if there is information about the input to the neural network, the target output, and what the actual output is, a control could modify the dynamics of the said network until the output is achieved. desirable or at least as close as possible [3].

Preliminaries

Mathematical anxiety is defined as the set of negative emotions (fear, anguish, tension) that appear at the prospect of facing a task that involves the use of mathematics [4]. Suffering from math anxiety has many consequences, including high anxiety leading to poor performance on math tests (which happens) and people concluding that they were born to be bad at math. In this sense, Rozgonjuk et al. [2]. Found that math anxiety had a very high negative correlation with math self-efficacy. More specifically and relating math anxiety to dyscalculia, the studies by Kucian et al. [5].

A student with 'mathematics anxiety' can experience everything from nervousness or discomfort to blocks in the brain's working memory, which triggers a cycle of underachievement in the subject. In addition, as indicated by Chang and Beilock [6] in general, anxiety causes affective-physiological problems in those who suffer from it.

The discourse that mathematics is difficult and that only students with superior talents, special abilities, or peculiar interests can learn it turns mathematics learning into a kind of elite club that excludes most of the student population.

Dyscalculia is a learning disability that affects a child's ability to understand, learn, and perform mathematical and number-based operations, as well as to perform tasks that require the use of mathematics [7,8].

The person suffering from dyscalculia, regardless of their IQ, which may even be high, has an academic performance in mathematics below that expected for their age and mental development. Its causes may be due to developmental, educational, neurological and/or cognitive aspects and deficits may appear in different skills: linguistic, perceptive, attentional and mathematical.

Dyscalculia, as noted, is often accompanied by math anxiety. This circumstance is characterized by feelings of tension and fear that interfere negatively in the performance of tasks related to mathematics.

The main consequence is the appearance of avoidance behaviors and low self-esteem. Specifically, on the subject of dyscalculia, figure 1 shows a real case of a student with dyscalculia, who has been asked to write in figures a number that has been provided written in words.

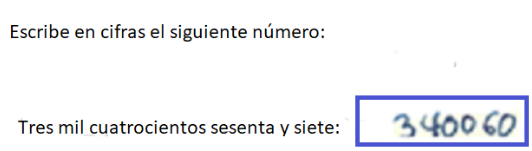

Figure 1: Exercise performed by a student with dyscalculia.

Said figure shows the linguistic deficit presented by said student. This type of deficit disables the subject to perform simple tasks that require numerical knowledge. This lack of capacity causes stressful fear of error.

It is known that math anxiety is not a learning disorder, but it can be a consequence of it. As seen in the aforementioned example (Figure 1), learning disorders manifest themselves in various ways in activities of daily living, hindering to a greater or lesser degree for each person their ability to understand, reason, speak, read, write, calculate..., actions all of them necessary for the development of a normal life. As Villagra [9] indicates, if not properly treated during childhood, learning difficulties not only persist, but worsen, also generating behavioral and mental health difficulties.

Normally, teachers, although they can detect alterations in the mathematical tasks carried out by their students, are not sufficiently trained to be able to make a correct diagnosis of the type of alteration, which is why it is emphasized, like other authors such as [10] the importance of early detection of the type of existing problem to start a rehabilitation that improves the deficits and therefore the anxiety they generate.

This anxiety is often the reason most people go to the doctor. Hence the importance of knowing how to differentiate the cause that has originated it in order to remedy it in the most correct very possible.

The intervention plan must be totally personalized and individualized for each case, and in the specific case of dyscalculia, cognitive stimulation exercises focused on numerical activities whose theme includes the child's interests must be used. Likewise, it is essential to promote self-esteem and provide motivational strategies to face fears and abandon avoidance behaviors.

Dyscalculia Screening

To observe how the brain works in learning processes, it is possible to use the recording of brain bioelectric activity under normal conditions and through the application of an auditory stimulus. This brain activity is translated into responses that represent the variations in voltage of the neurons, which allows objective evaluation of their activity and helps to detect alterations in neuronal function in the areas involved in the numerical process.

The technique used, in this case, to measure changes in electrical potential is called Brainstem Auditory Evoked Potentials (BAEP). BAEP's are a quantitative and qualitative method of recording the activity of the peripheral and central auditory pathways generated in certain areas of the brain that are involved in the cognitive process, through the application of an auditory stimulus.

The application of the auditory stimulus upon reaching the organ of Corti is transformed into an electrical stimulus that reaches the auditory nerve (cranial nerve VIII) and spreads through the auditory pathway until it reaches the temporal cortex. Along the way, the arrival at the different brain nuclei manifests itself in the form of waves with a positive vertex, which are what we call waves I, II, III, IV, V, VI and VII, which are collected in the first 12 ms (As an example see Figure 2).

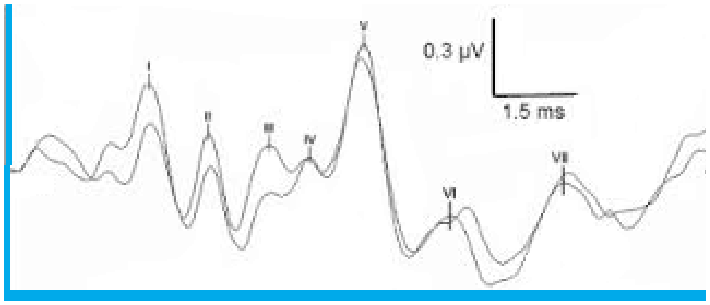

Figure 2: Auditory Evoked Potentials.

Most of the auditory information reaches the left primary auditory cortex where it is decoded and completed with the intervention of other neuronal groups (Reticular System, diencephalon) located in both hemispheres. To date, BAEP's have been used mainly for the assessment of hearing disorders by studying the first 5 waves. It has not been used as a diagnostic method for the detection of learning disabilities because the information provided by these first five waves does not vary significantly between normal people and those with some type of learning dysfunction. It only provides information about the patency of the auditory pathway. Recently, it has been observed [11,12] that wave VI plays a relevant role in the observation of the activity of certain neuronal groups that participate in the cognitive learning process.

The analysis of the results obtained when studying wave VI shows differences between normal people and those with some type of learning disorder. In the following figure (Figure 3), it can be seen that the result obtained in wave VI, in a person with learning difficulties, is lower than the normal values (the peak is reached at a value lower than 7.5).

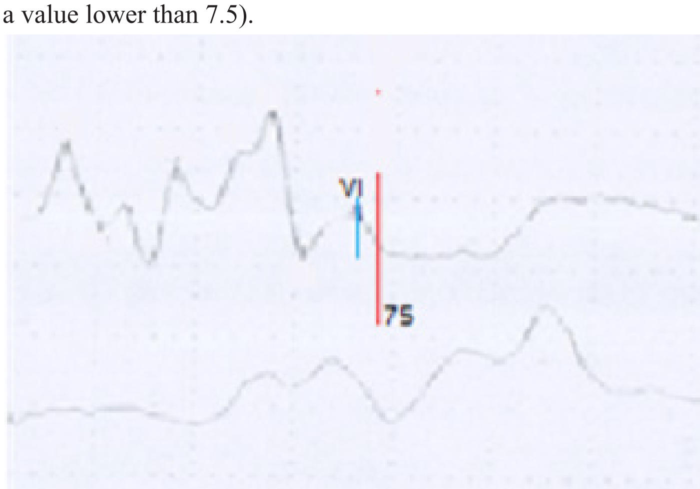

Figure 3: BAEP of a patient with learning difficulties.

The observations made on the results of the tests carried out and which have been approved by the ethics committee of the Clinical and Provincial Hospital of Barcelona, show clear differences between those obtained in students with difficulties and among students who do not present them, as shown. the following graphs (figure 4); in which it is observed that the data of wave V (blue bars), move in both graphs in the same in-

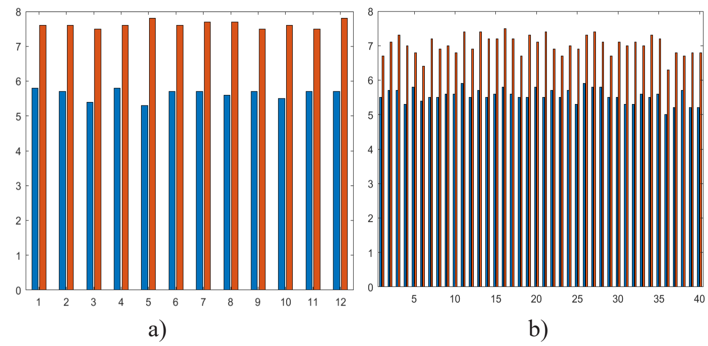

Figure 4: Resultados PEATC ondas V y VI. a) Casos normales, b) Casos TA.

Terval, however, for people with some learning difficulty, the data of wave VI (red bars) are below the data obtained for normal people.

Therefore, considering the technique of auditory evoked potentials is a way to know the functionality of a part of the neuronal groups of the brain that intervene in the learning process by studying the behavior of waves I to VI in an objective way. , non-invasive, easily reproducible and inexpensive.

Neural networks

In an attempt to explain the latency pattern of BAEPs, the use of mathematical models is proposed to describe brain dynamics.

The brain is an organ that is made up of interconnected nodes, each of which participates in a certain function that influences cognitive processing. This allows us to consider the brain as a large complex network formed by a structured system of interrelated neurons, and that can be treated from a mathematical point of view using the theory of neural networks.

A neural network is a mathematical model that tries to reproduce the way in which the human brain processes the information received. More specifically, a neural network is a mathematical model inspired by the human brain that consists of an interconnected network of simple processing units that can learn from experience by modifying their connections.

Mathematical models of neural networks, as Kriegeskorte says in [13] are the starting point of a new vision of neuroscience, which allows facing real-world tasks that require extensive knowledge and complex calculations. This type of system has the ability to alter its dynamics to meet the demands of the subject in the processes of receiving, selecting, transforming, storing, processing and retrieving information. This ability is called control of neural systems [14].

Cognitive control of the brain is one of several classes of cognitive processes that are essential for proper human functioning. This concept, understood as that capacity that regulates behavior and that allows selecting the information necessary for the objective and inhibiting irrelevant information, is analogous to the mathematical concept of control of dynamic systems used, for example, in engineering, where the state of a complex system can be modulated by energy input.

An open problem is the detection of the neural networks that are activated in the individual when faced with a learning situation. Knowledge of these networks and their mathematical modeling will allow them to be controlled and thus modulate the individual's response to a possible learning disorder. In this study, interest is shown in the control of anxiety caused by possible learning disorders by studying the controllability of linear multi-systems that can simulate possible brain networks. In this case, it is a time-varying multi-agent control system since the neural network changes its structure over time and modifies the dynamics of the system.

In general terms, controllability consists of analyzing whether it is possible to achieve the desired solution, through some control applied at some point in the network where the equation evolves. It is of interest to recognize the minimum set of controller nodes needed to achieve full control of networks that have arbitrary link structures and weight distributions. This minimum number depends on the level of interconnection of the network nodes and the interrelation topology. Thus, for example, if we consider a network in which the topology that interrelates the agents is such that each agent simply follows all those in front of it, at a higher level. Geometrically, the neural network has the shape of figure 5, the minimum number of controls is 3n where n corresponds to the number of variables that describe each node.

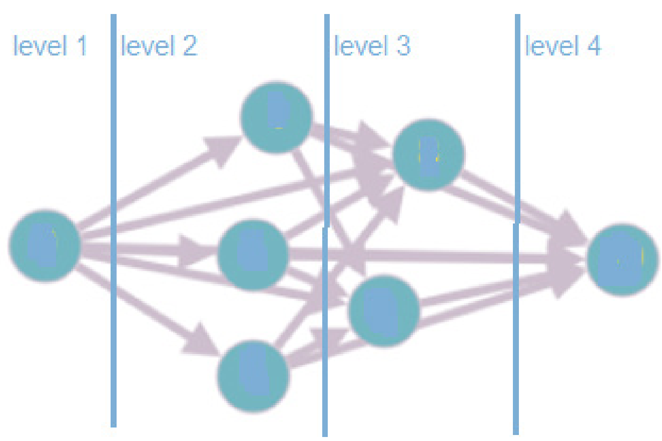

Figure 5: Neural network model.

Discussion

In this work, a mathematical analysis of the results obtained through the use of brainstem auditory evoked potentials of various patients has been carried out. On the other hand, applying the Network Theory, simplified models of cognitive neuronal functionality have been presented, with the purpose of helping to detect learning difficulties that cause anxiety. Authors like Horas el al. [15] have used P300 Cognitive Evoked Potentials to improve medical diagnosis and learning evolution, through artificial neural networks. Valdizan et al. [16], also use these potentials to treat autism.

On the other hand, the im2 research team of the Polytechnic University of Valencia led by Luis Acedo is carrying out an analysis of the neuronal response using another type of neurophysiological technique such as the encephalogram, instead of the BAEPs used in the case presented. The attempt to mathematically model neural networks in order to deal with neuronal disorders such as learning disorders or neurodegenerative diseases, among others, [17] is gaining popularity because they will allow personalized treatments and improve diagnoses of patients with mental and neurological diseases.

Conclusion

A first contribution of this study is to provide a method based on evoked potentials, to determine the possible existence of some type of learning disorder, which allows attention to be focused on remedying the specific cause that produces anxiety. The main contribution of this study is to provide, through the use of neural networks, methods for controlling the anxiety generated by learning disorders, especially dyscalculia, through the use of the control of neural network systems, since knows that these can be modified in relation to changes through the application of training data.

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