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№ 13798

Review of the Comparative Research on the Sensitivity to Anxiety of the Y and Z Generations Based on Brain Neurophysiology Data

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July 3, 2024

REVIEW OF THE COMPARATIVE RESEARCH ON THE SENSITIVITY TO ANXIETY OF THE Y AND Z GENERATIONS BASED ON BRAIN NEUROPHYSIOLOGY DATA

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Abstract. Our research aims to study how the neurophysiological waves generated in the brain change when a person receives from the work environment. Brain computer analysis has identified that neurophysiological wave changes occur in the frontal lobe of the brain during the brain response. Based on brain computer analysis, it was believed that different anxiety symptoms can occur in each employee depending on the type of communication that may occur in the work environment. It stated a hypothesis that the anxiety sensitivity of Z and Y generations can be studied by comparing the brain measurements method. For the test, we selected a well-known organization and subjected the employees to the test. Two types of machine learning algorithms were applied to process the measurement results. Using ICA and PCA, brain neurophysiological data were processed with Matlab's EEGLAB and BCILAB. We measured the brain using the EEG LAX-32 instrument with 11 electrodes. We also illustrate the process and results of the experiment in order to make the measurement results understandable.

Keywords: Electroencephalogram (EEG), Matlab, Independent Component Analysis (ICA), Principal component analysis (PCA), Digital Signal Processing (DSP), Signal Processing (SP) Time-Frequency Analysis (TFA), Machine learning (ML)

1 Introduction

1.1 Introduction

The specialty of our research work is to show a certain part of the communication patterns that arise in the working environment from a psychological point of view. In other words, there are many negative mental types [5]. Among these, anxiety is a factor that we all have, but which directly affects the productivity we expect from employees. It has a direct impact on many factors such as expectations from the employee - achievement, creativity, health, workplace relationships, and job satisfaction [5]. Therefore, we defined the basis of the research to determine how human brain activity can change at the level of anxiety, not at the level of stress, using a combination of

machine learning [6] methods. Based on this, we made the following assumptions. It includes:

> ***Hypothesis****: It is hypothesized that anxiety sensitivity may be different for workers belonging to periods X and Z. We put forward that hypothesis on the example of a Mongolian person.*

To confirm the above hypothesis, we defined the measurement process according to the sequence shown in the figure below. (See Fig. 1.)

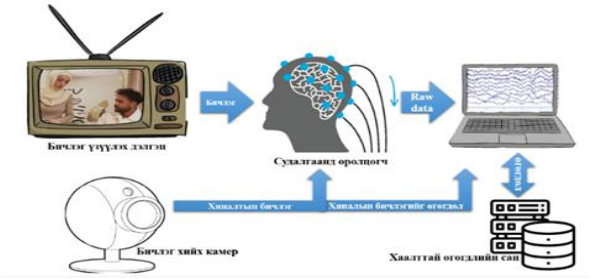


Fig. 1. Sequence of data collection in the framework of the research

We will show a video and study the measurement using machine learning algorithms ICA and PCA to see how the human brain reacts to that video. We will visualize the processing results by spectral analysis method. As mentioned in the works of many researchers, the most obvious method to show the changes in the brain wave over time is the spectral analysis method.

2. Data generation process

Before collecting the data, we conducted the survey according to the steps below. We divided the research into three phases. See Fig. 2 for the three phases below. There was a decrease in the number of respondents between each phases or measurements.

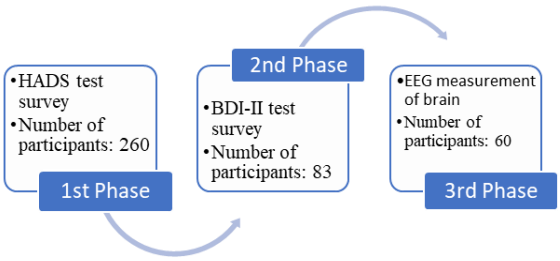


Fig. 2. Sequence and number of participants in the three-phase study

We conducted the first phase of the study using psychiatric diagnostic tests validated in the field of psychology. About 260 participants get involved in this phase. Moreover, for the next level phase, we took a repeated psychology test study within 14 days in

cooperation with an organization operating in the field that provides help and advice in the field of psychology. The total number of participants was 83. Based on the Phase 2 test study, a total of 63 participants involved brain measurements. Of the eligible participants for the Phase 3 study, 60 participants were included in the study.

3. Research Modeling

3.1 EEG data processing and mathematical modeling

Waves recorded by the electrodes of the EEG Laz-32 instrument placed in the brain are defined as "raw data". To process this raw data, we used the Independent Component Analysis (ICA) [8] algorithm. When we imported the 11 electrodes placed in the brain into the processing algorithm, we considered each one as an independent component. The number of independent components is 1, and the dependent variable is the potential difference at each time step. This is the value of the voltage released on the cortex of the brain. High-frequency and low-frequency filters were used for detailed decompression and processing of brain waves. The mathematical model of the high-frequency filter can be seen in the model below. The mathematical model of the low-frequency filter is illustrated in Fig.3. (see Fig. 3.)

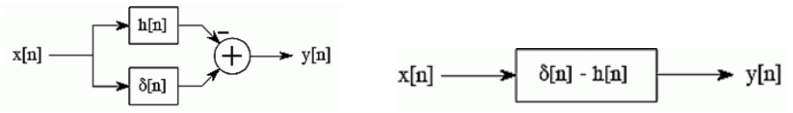


Fig. 3. Mathematical model of high and low frequency filters

In the brainwave processing stage, we selected the low-frequency filter value to be 75Hz. But we calculated the high frequency filter to be 0.5 Hz. There are six types of waves emitted from the human brain. These waves are delta (0.5-4Hz), theta (4-8Hz), alpha (8-13Hz), beta (14-30Hz), beta high (30-60Hz), gamma (80-120Hz) [1-12, 1-45] are available.[9] The most important waves for our research are beta and high beta waves.[10] Therefore, we have chosen the value of high and low frequency filtering to be 0.5 to 75Hz.
See below for a comparison of the reprocessed waves with the raw data. (see Fig. 4.)

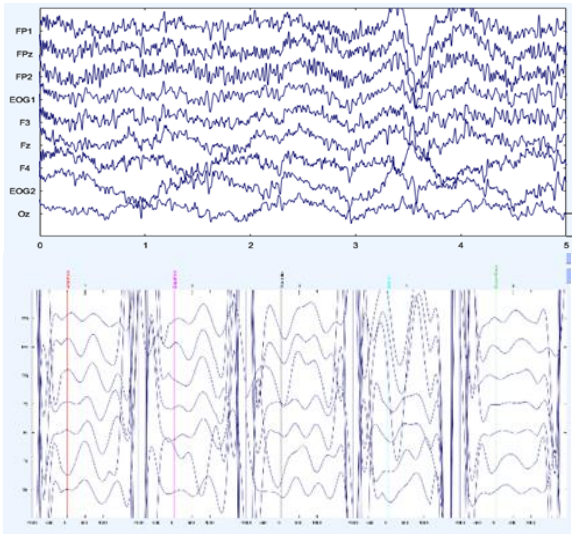


Fig. 4. Raw data and the result of the reprocessing

The main goal of the study is to determine the relationship between ICs, which shows how brain waves change. Therefore, how brain waves change along the time axis is calculated by the following algorithm. This is Independent Component Analysis (ICA) and Principal Component Analysis (PCA) discussed above.
Each IC was defined as a channel and treated as a defining marts row value to calculate Independent Component Analysis. On the time axis, the variable voltage values at each moment are considered as X and the equation below is considered. (see From Eq 1.)

$$S = W * X \quad (1)$$

X- Value recorded at each instant of time.
The X is the value of the potential difference recorded at each instant of time or point. See the table below for examples.

Table 1. X values at each instants of time

Electrode	Time
Electrode /FPz	0.134 0.424 0.653 0.739 0.932 0.183 0.834 ….
Electrode /FP1	0.314 0.154 0.732 0.932 0.183 0.834 0.134 ….
Electrode /FP2	0.824 0.534 0.314 0.654 0.739 0.932 0.183 ….

The above data is directly related to the measurement duration. Our measurement time was between 4 and 6 minutes, so the recorded X value was around 84000. But we will consider the concept of Dipole. According to the 10/20 standard, the area of each

electrode location is represented. It is the area of the dipole to record the waves coming from the source of the brain. Since each electrode has a linear projection, it is necessary to calculate it. Therefore, we will use reverse marts. (see Eq 2.)

$$S=W^{-1}*X \tag{2}$$

Each data value is represented by the equation below. (see Eq 3.)

$$x(t) = a_1 s_1(t) + a_2 s_2(t) + \cdots + a_n s_n(t) \tag{3}$$

From here, the following equation follows. (see Eq 4.)

$$X(t) = A * s(t) \tag{4}$$

When processing brainwaves, we rely on the Unimix matrix principle, so the equation is: See Eqs 5 and 6:

$$W \triangleq A^{-1} \tag{5}$$

$$p_x(x_t) = |\det W| p_s(W * x_t) = |\det W| \prod_i^n p_{s_i}(w_i^T * x_t) \tag{6}$$

When analyzing and processing the measurement results by ICA, we considered the equation described above as the basis for algorithmic analysis. We will also use ICA to obtain spectral prevalence maps of brainwaves and investigate the relationship between groups. PCA, on the other hand, separates the above-mentioned components into clusters and determines the correlation between ICs. PCA was calculated based on the following equation. Considering the covariance matrix calculation, the following matrix equation is defined. See from Eq 7.

$$[\Sigma]_{ij} \triangleq E\{(x_i - \mu_{x_i})(x_j - \mu_{x_j})\} \tag{7}$$

From this:

$$\Sigma = E\{(x - \mu_x)(x - \mu_x)^T\} \tag{8}$$

In other words, in order to consider the results of our experiment in detail, we considered it important to conduct a correlation analysis between groups. In correlation analysis, we can first consider the relationship between ICs and then see how the prevalence of brain waves evolves from a fixed image.

Participant-by-participant representation of brainwave data processing results is difficult. Therefore, we explored the possibility of using group analysis. We considered SIFT as a possible algorithm for group analysis. Algorithms such as wave amplitude-frequency correlation, phase-amplitude correlation, and frequency-time analysis are important during neurophysiological wave processing.[11] Neurophysiological data is a collection of brain waves generated by the human brain at all levels. We worked to develop based on the amplitude and time relationship equation. [13,14] See Eq 9, 10.

$$x_t = \sum_{k=1}^{p} A_k x_{t-k} + U_t \tag{9}$$

From here, considering the inflexion field in z

$$A(f) = \sum_{k=1}^{p} A_k e^{-i2\pi fk} \quad (10)$$

Based on this auto-regression, brain wave IC or individual component values were processed. [15,16] See Experimental section.

4. Experiments

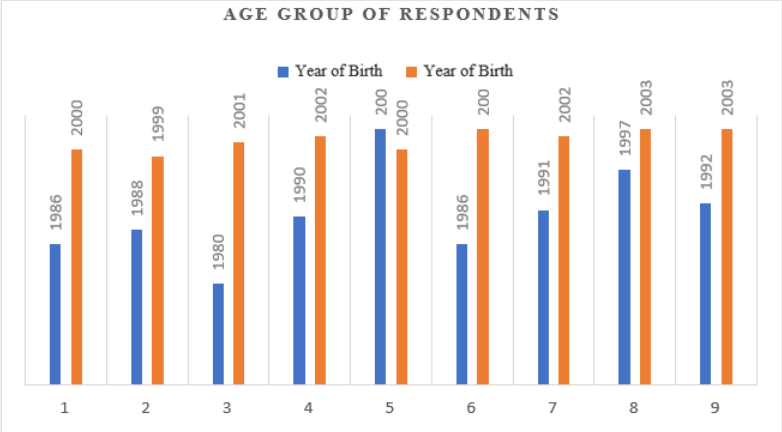
4.1 Test results and wave reprocessing

As described above, we selected the frontal lobe of the brain for brain recording and selected the location for measuring neurophysiological data using the International 10/20 Electrode Placement System standard for EEG. We selected the locations of EEG electrodes FP1, FP2, FPz, F1, F2, Fz, and Oz from the defined standard locations. In addition, GND and Ref are placed at the back of the ear. Data were collected in the order described in the figure.

TeleScan was used as the software for brain data acquisition. Brain neurophysiology data were processed by transferring them from TeleScan to MATLAB. [7] As for the electrodes placed in the brain, they were classified according to the right and left hemispheres. The electrodes of the left brain are FP1 and F3, the electrodes of the junctional area are FPz and Fz, and the electrodes of the right are FP2 and F4.

Specifically, it was mentioned in the previous section that there is a voltage difference that occurs in the interaction of neurons during the brain response. The resistance potential released during the brain's response is microvolts in size, activated by positive and negative voltages. Depending on the value of the voltage generated around the dipole of the brain, the value of the wave propagation is determined in red for plus and blue for minus. We can show this classification by the results of ICA processing. However, PCA can show component dependency. **See the figure below for the results obtained using those calculation methods.** Based on the results of the research, we looked at the video and studied how anxiety occurs in the human brain. Anxiety is defined as the response of the human brain through neurons [18]. When a person is in a state of anxiety, beta and high beta waves are observed around the dipole of the brain. If the brain is experiencing high wave intensity, it is represented by a deep red color. As the wave intensity decreases, the color becomes red, green, yellow, and blue. Also, according to the hypothesis proposed by the research, the brain waves of Y and Z generations participants were compared. Therefore, our experimental group included a total of 18 participants in two parts. A total of 60 participants have been included in the research. There are 2 groups of 18 participants who have presented the results of brain wave processing. The age range for group 1 participants was between 1980 and 1995, and for group 2 between 1996 and 2003. See the chart below for age categories.

Table 2. Age group of the research participant



We have described above the processing of brain data. First, we'll look at the recording and events that are displayed in the test. The average test duration is 4 minutes. The content of the recording was presented in relation to workplace communication. However, to determine which part of the recording is causing anxiety in the brain, the events are uploaded to the project that is being created in the EEG Lax-32 measurement device. Each event represents each content to be recorded. The start and end time of the image is marked with an event, and it is easy to distinguish the event. In this experiment, we deployed a total of 16 events. A participant looking at a picture can identify which event in the recording is causing anxiety. But when the participant watches the recording, he feels anxiety related to the content, which is depicted in the diagram below.

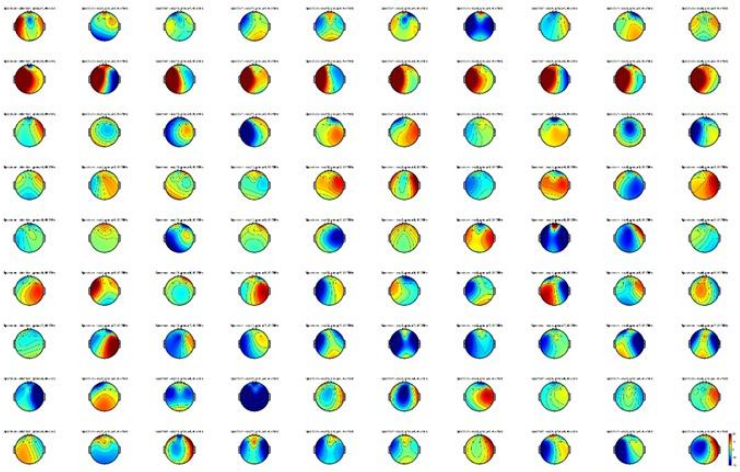


Fig. 6. Brain waves of participant group 1 are illustrated by ICA dipole method

Based on the results of spectrum analysis in the image, the event with relatively high anxiety was selected. It is worth noting that each participant's reaction to the recording varied. However, according to the "Imprint hypothesis" theory of human periodization, classification was made according to the definition that it is appropriate to classify people by periodization, not by age, gender, origin, or knowledge. The results of Group 1 experiments are shown in the figure below.

The image shows the brain waves of 9 participants. As mentioned above, the voltage changes around the dipole of the human brain are shown in color. The wave is high in the red area and weak in the blue area. Eye waves and muscle movement waves were removed as much as possible during the processing of the image. However, it was not possible to remove the waves in some areas. Participants of group 1 show the spectrum method of waves during the period of anxiety and is shown in Fig. 7 below. As can be seen from the figure below, every event in the video we prepared was seen, but the anxiety sensitivity was not seen in Y generation people. In other words, anxiety exposure is relatively low. Because it is one of the characteristics of the people of this generation. However, I am a little worried about being fired from the workplace and losing my job. It was mentioned in the research work that is being carried out according to the descriptive chronology that the characteristic of people of generation Y is to accept the situation as calmly as possible.

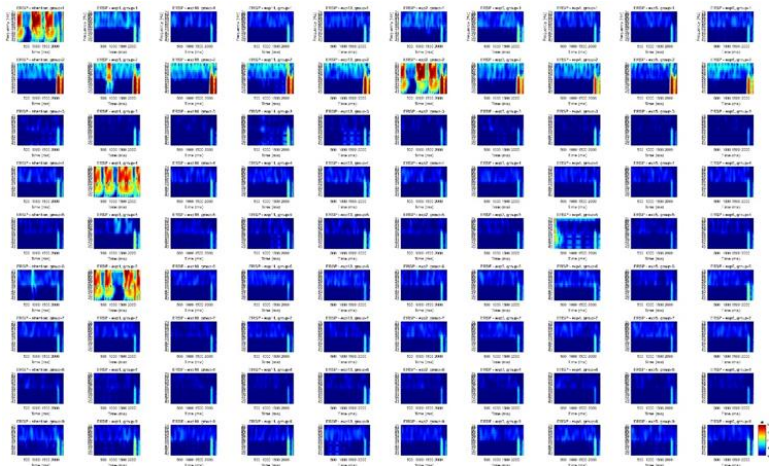


Fig. 7. Brain mapping during anxiety

Instead, we examined the conditions of fearless calm activity to test whether this was true. When changing the value of the brainwave filter from 9Hz to 14 Hz, the following results were obtained. (see Fig. 8.)

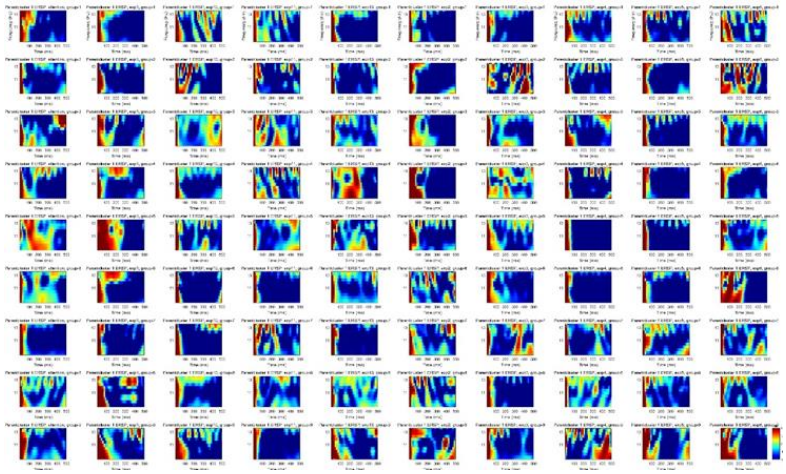


Fig. 8. When changing the value of the brainwave filter from 8Hz to 14 Hz

This means that the brain is relatively calm and accepting of the situation.
See Fig. 9 below for the brain wave pattern of Participant Group 2.

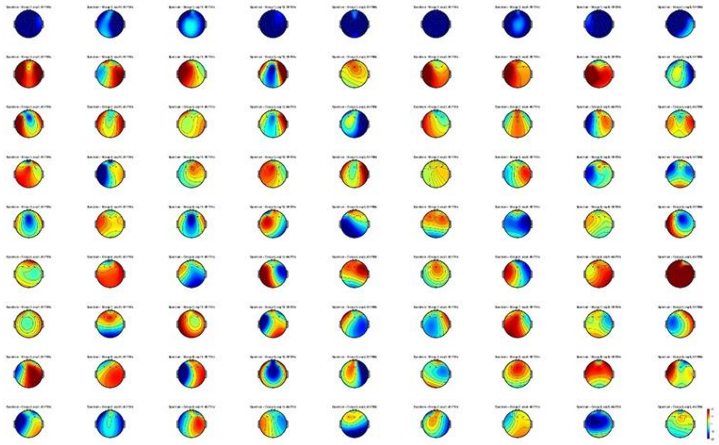


Fig. 9. Group 2 brain map, the data calculated using dipole and ICA

The brain stimulation recordings were identical to those presented in the previous group. Compared to the previous group, each participant's perception of anxiety appears to be similar. (see Fig.10.) The results of PCA calculations are shown in the figure below by spectral method.

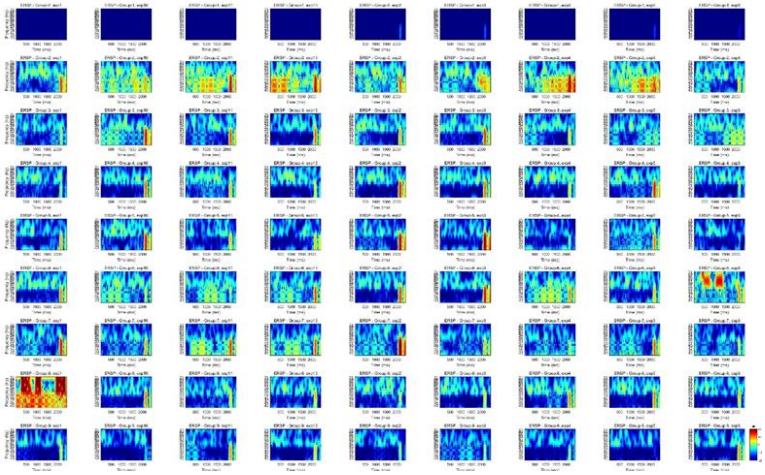


Fig. 10. Brain mapping of group 2 participants during anxiety

According to the figure, it can be observed that the participants of group 2 or group Z have a higher level of anxiety than the participants of group Y. Also, compared to participant Y, they experience anxiety at work and thus have different durations of stable employment. We showed event2, or exp2 as shown in the picture, where the content of section exp2 shows the manager walking in while the employee is doing a job, getting angry at him/her for not fulfilling his/her duties, and not listening to the employee's explanation. (see Fig. 11)

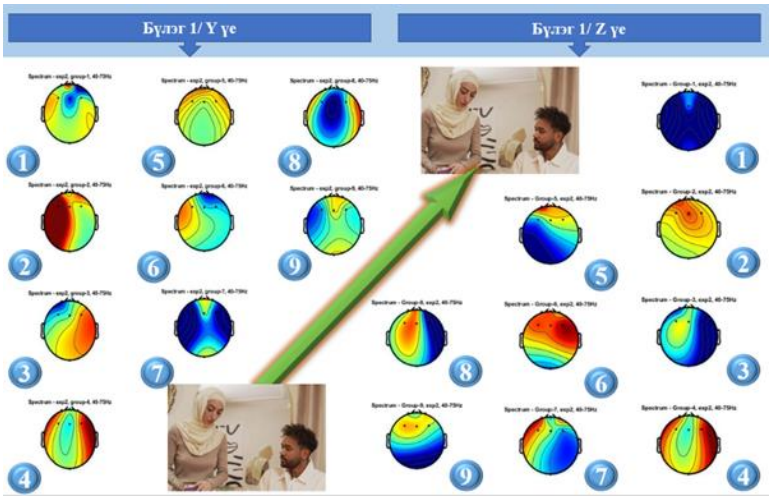


Fig. 11. Comparison of waves generated in brain electrodes of generations Y and Z

In the next section, the PCA estimation results are compared. (See Fig.12)

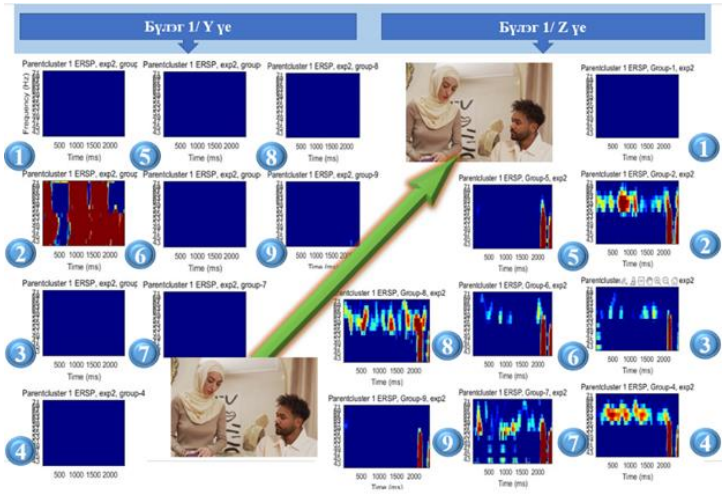


Fig. 12. Brain wave prevalence of participants of generation Y and Z is represented by the Spectral method

According to the results of the processing of the brain data collected during the recording, the two groups perceive the situation differently. It was also worked out that the two groups perceive the subsequent conditions relatively differently. In the context of the above recording, detailing the brain mapping of the Dipole section, shows how the brain waves of both sides change with comparative diagrams.

From the above results, it can be seen that there is a difference between the two generations. It was the same in some parts of the test. Both poverty caused the same reaction in social classes. However, for the participants of Generation Z, it was mentioned in many works that they tend to demand their own space in the workplace, and prefer to encourage and support rather than lead. This situation is shown by the results of the experiment. The results show that Generation Z participants are immediately anxious about content such as bullying, direct invasion of their own space, not listening to their explanations, physical contact, and direct physical contact. Generation Y participants are less likely to react to the content of videos shown to Generation Z participants. Instead, they are calmly accepting and trying to assess the situation, as evidenced by alpha and theta wave activity.

Conclusion

According to the results of the research, it was observed that the neurophysiological data of the brain are generated differently in different conditions in each period. As mentioned in many research texts about human periodization, it can be seen from the research results that the characteristics of human thinking, acceptance of situations, technological evolution, expectations from the work environment, and social communications are different. We used video recording to collect measurement data. It was mentioned in the introduction that this type of research has been done internationally. However, since there was no specific standard for the content of the

recordings, the processed recordings were presented and consulted by professional psychologists and used in the study. Although we did not mention the test results in this research text. But the research participants were divided into two periods. The division was classified based on the theory of "imprint hypothesis". But we used some machine learning algorithms to process the research results. Brain data were processed using ICA and PCA. There were deficiencies in the processing of research results by ICA alone. There was a problem with the results of some waveform processing. It was also revealed during the experiment that aggregated data of the group could not be processed using ICA. Foreign researchers used learning algorithms such as SVM and CNN. Instead, we chose ICA and PCA using our hardware base. In the future, we plan to carry out statistical analysis. Although we have processed statistics for each component for the participants of each group, we have not determined the results of the complete statistical processing of the group.

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