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The Effect of Using Isochronic Tones in Improving Learning Concentration: Experimental Study on Students of State Senior High School in Jakarta

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Abstract: Isochronic tones are sound waves used as brainwave entrainment to manipulate the dominant brainwave frequencies, thus influencing modulation of human responses and neurophysiology, common types of isochronic tones include theta, alpha, beta, delta, and gamma, each with varying effect on dominant brainwave frequencies. Isochronic tones are recognized to enhance sustained attention or concentration for cognitive task such as learning. Individuals naturally have varying levels of concentration. The initial assumption or hypothesis of this research is that alpha, beta, and gamma isochronic tones have a significant impact on an individual's sustained attention or concentration. To test this hypothesis, we conducted a study involving 60 highschool students from SMA Negeri 6 Jakarta, who were divided into four groups, including three experimental groups and one control group. Respondents underwent the Sustained Attention to Response Task (SART) to measure their level of sustained attention. Respondents completed the SART at two different times : pretest and posttest. After the pretest, the experimental groups were subjected to a 10-minute intervention involving listening to isochronic tones, while the control group was provided with placebo effect (mute audio). After conducting repeated measure analysis of variance, it can be concluded that isochronic tones effectively and significantly enhance concentration, with gamma isochronic tones (30-100 Hz) having the most significant effect, with an average SART score increase of 10.06.

Keywords: Isochronic tones, SART, sustained attention, concentration

I. INTRODUCTION

We are in a time of globalization and digitalization transformation. The world is experiencing significant changes in various aspects of life, including in education. The COVID-19 pandemic that occurred in 2020 has accelerated the digitalization of education throughout the world. Social restrictions and school closures have forced many educational institutions to switch to digital platforms. Therefore, digitalization is an important aspect in the education process. This is in line with Indonesia's efforts to welcome the industrial revolution 4.0.

A survey conducted by Yogyakarta State University Pahriji on distance learning during the pandemic showed that the level of effectiveness of distance learning tends to be low due to the many distractions in the online learning environment [1]. One of these distractions is the misuse of digital technology for purposes other than the learning environment. This has resulted in a decrease in the concentration of students who currently have to adapt to learning at school. This is our concern because the learning process that was originally effective has undergone quite significant changes so that students need to adapt.

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Based on the 6th International Conference of Early Childhood Education, the use of digital technology can be a distraction that results in loss of focus, decreased concentration, and learning achievement [2]. Concentration in learning is very important for students to be able to understand the subject matter presented by the teacher. Concentration is greatly influenced by a person's attention. If utilized properly, digital technology can be used as an instrument that has the potential to increase students' attention, for example by listening to music. According to research conducted by Supradewi found that listening to music can be an audio stimulus that can increase a person's attention [3]. Audio stimuli that are played repetitively and synchronized can cause changes in brain wave patterns, resulting in modulation of neurophysiological and behavioral responses [4]. Based on research conducted by Zhuang on the use of brainwave entrainment using an electroencephalogram (EEG), there was a difference in brain wave frequency activity in the central temporal SCALP after using brainwave entrainment technology [5]. This area of the brain plays an important role in intellectual function, memory, emotion, focus, and attention.

Dominant brain activity can be synchronized using isochronic tones. Isochronic tones present a certain tone that appears and breaks at regular intervals. Isochronic tones are the latest technology in brainwave entrainment. Isochronic tones and binaural beats can increase brain modulation [6]. Isochronic tones have a 15% higher effect in modulating brain wave frequency activity compared to binaural beats on the prefrontal cortex [7]. This can have a positive effect on mental state focus and attention. However, there have been no studies discussing the application of isochronic tones to improve student learning concentration, especially in Indonesia.

Seeing the urgency that there is a decrease in student concentration due to distraction and that there has been no research related to the use of isochronic tones to improve student learning concentration in Indonesia, researchers are interested in conducting further research on this topic. This study aims to determine the effect of the use of isochronic tones in improving student learning concentration, as well as determining the most effective frequency in supporting the learning process. With a focus on students of SMA Negeri 6 Jakarta, this study tests the hypothesis regarding the relationship between isochronic tones and increased learning concentration. The results of this study are expected to be a source of scientific development, provide references for further research, and increase public understanding of the benefits of isochronic tones in the world of education.

II. LITERATURE REVIEW

A. Brain Waves

Brain waves consist of rhythmic patterns of neural activity or synchronized electrochemical pulses from groups of neurons in the central nervous system [8]. All brain waves are produced by synchronized electrical pulses from masses of neurons communicating with each other. There are five widely recognized types of brain waves that are distinguished by their frequency and function (table 1).

TABLE I
CLASSIFICATION OF BRAIN WAVES BY FREQUENCY

Waves	Frequency	Description
Gama **(γ)**	30-100 Hz	High state of consciousness, concentration, and cognitive function
Beta **(β)**	13–30 Hz	Conscious state, full alertness, and external attention
Alfa **(α)**	7-12 Hz	Rest and relax
Theta **(θ)**	3–7 Hz	Relax until you fall asleep
Delta **(δ)**	0.5–3 Hz	Falling asleep or deep meditation

According to Shakshi and Jaswar, the five waves above have their respective roles and functions [9]. Alpha waves are generally associated with a state of rest and relaxation. Beta waves dominate the brain when a person is in a state of consciousness, full alertness, and external attention. These waves are usually produced in the

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frontal and central parts of the brain. Delta waves are the slowest brain waves and usually dominate the brain when a person is in a deep sleep or meditation stage. Gamma waves have the highest frequency and are associated with a state of consciousness, full concentration, and high cognitive function. Theta waves are generally associated with a person's state when they are relaxed or sleeping. In a conscious state, excess theta waves can cause a daydreaming condition.

B. Isochronic Tones

Isochronic tones are brainwave entrainment technology that can manipulate certain dominant brain frequencies so that they can affect the modulation of human responses and neurophysiology [10]. Isochronic tones are the latest technology from brainwave entrainment that has an influence on the dominant brain wave frequency. It can be concluded that isochronic tones have an average result of 15% higher in modulating brain wave frequency activation compared to binaural beats when measured in the prefrontal cortex which plays a role in the focus and attention of the brain's mental condition [7]. Isochronic tones present a single tone that appears and breaks at a constant time (figure 1). The tone is arranged in such a way as to form a synchronous pattern so as to accelerate the brain's stimulation process. Isochronic tones work by guiding dominant brain activity to a certain frequency so as to affect the mental and emotional state that is desired or more optimal.

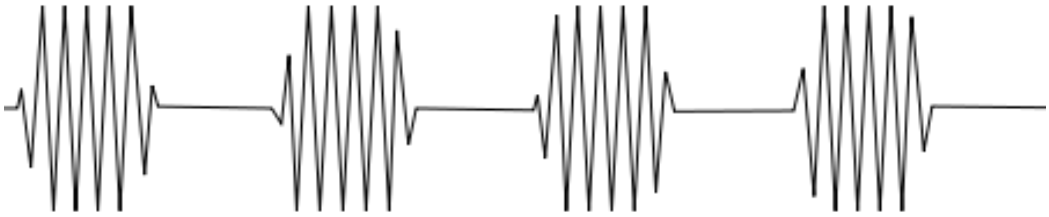

Fig. 1 Amplitude form of isochronic tones

The way isochronic tones work is that the brain that receives the stimulus will then resemble the frequency according to the audio frequency that we hear. This phenomenon is known as frequency following response (figure 2). The number of waves per second is the frequency, for example 7 Hz means there are 7 waves per second.

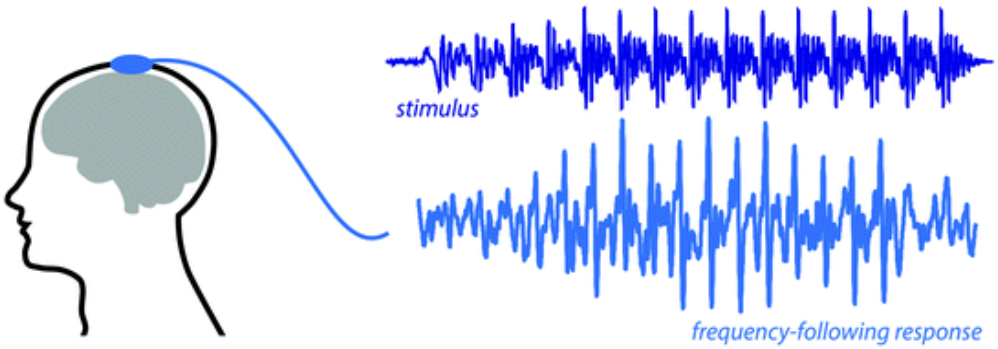

Fig. 2 frequency following response

This technology of isochronic was then further developed by Sievers [10]. Isochronic tones have proven effective in modulating mood, improving attention, and memory processes . Promising results were also obtained from subjects suffering from various central nervous system (CNS) diseases, including attention deficit hyperactivity disorder (ADHD), personality disorder (PD), epilepsy, chronic diseases, and anxiety disorders. However, the study also showed that isochronic tones did not cause significant changes at frequencies below 4 Hz. Attention is a process of direct awareness of information (stimuli) received to decide on an action (Martens, 1998). The attention process helps the efficiency of limited mental resources which will then help the speed of response to certain stimuli. Attention is an indicator of brain efficiency that affects effective knowledge acquisition [11]. The type of attention that has the most important influence on the learning process is sustained

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attention. Sustained attention, or commonly known as concentration, is the ability to maintain attention when performing repetitive activities over a long period of time [12].

The gamma-domain brain wave stimulation using isochronic tones, it can be concluded that isochronic tones can stimulate brain waves 15% higher than binaural beats when tested using an electroencephalogram (EEG) at the location of the brain's prefrontal cortex [7]. This has a positive effect on intellectual functions such as focus and attention to the mental state of the brain. Queensland Health state that attention is the ability to focus on the problem at hand, while concentration is the ability to maintain attention for a certain period of time, commonly known as sustained attention [13]. Concentration can also be defined as focusing attention on something else that is unrelated. A sustained attention helps a person to concentrate on a stimulus for a longer period of time [14]. Based on these data, it can be concluded that the higher a person's level of attention, the more it can affect concentration in carrying out an activity such as studying.

The way to measure the level of sustained attention is to conduct a sustained attention to response task (SART) test. Sustained Attention to Response Task is a computer-based test designed to measure a person's ability to respond to unpredictable stimuli in a fast and rhythmic period [15]. As the name implies, this test interprets sustained attention (concentration) as the ability to maintain full awareness of certain repetitive stimuli and eliminate other stimuli that can result in habituation and distraction from other stimuli. This test requires participants to withhold a response to an infrequent target (usually the number 3) presented amidst a background of frequent non-targets (0-2, 4-9).

III. RESEARCH METHODOLOGY

The research design that will be used in this study is True Experimental Design. True Experimental Design is a study where researchers can control all external variables that can affect the course of the study, so that the internal validity of this study is high. The purpose of True Experimental Group Design is to investigate the possibility of causality by providing treatment and comparing the results with a control group that is not given treatment.

The data source of this study was 648 students of SMA Negeri 6 Jakarta in grades X and XI. There are 60 samples will be delegated into four groups consisting of control, alpha, beta, and gamma groups with 15 samples per group. Respondents will fill out an informed consent form to state their availability in this study. Then, respondents will carry out an assessment in the form of a Sustained Attention to Response Task which has been used in various studies and has proven its validity and reliability. This assessment is carried out to measure the level of sustained attention or concentration possessed by the subject. All participants will be selected using the principle of random assignment. The term in random assignment research is placing participants into groups with equal individual variability between groups or conditions in an experiment. In random assignment, each participant has an equal opportunity to be placed in the treatment group or control group.

There are two types of groups in this study, namely the control group and the experimental group, consisting of alpha, beta, and gamma groups. The control group is the group that is not given treatment or is only given a placebo effect, while the experimental group is the group that is given treatment. The results of the group test will be included in the Pretest–Posttest Control Group Design design (table 2). This is done to determine the differences in the initial test (pretest) and final test (posttest) between the control group and the experimental group after being given treatment.

TABLE II
PRETEST – POSTTEST CONTROL GROUP DESIGN

Class	Group	*Pre-test*	*Treatment*	*Post-test*
Eksperiment	A1	O1	X1	O2
	A2	O3	X2	O4
	A3	O5	X3	O6
Control	B	O7	X4	O8

Description
A1 : Group 1 experimental class
A2 : Group 2 experimental class

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A3 : Group 3 experimental class
B : Control class group
O1, O3, O5, O7 : Concentration level at pretest time
O2, O4, O6, O8 : Level of concentration at posttest time
X1, X2, X3 : The experimental class was given an intervention in the form of isochronic sound waves
X4 : Control group that was only given a placebo effect (silent)

Data processing is the process of systematically searching and compiling data obtained from interviews, field notes, and documentation by organizing data into categories, describing them into units, synthesizing, compiling them into patterns, choosing what is important so that it is easy to understand by yourself or others. The data from this study will be processed using Microsoft Excel data processing software and the Statistical Package for the Social Sciences (SPSS).

Data analysis is an effort carried out by working with data, collecting data, separating data, searching for and finding patterns, finding something important and needed, and determining what can be told to others. Because the number of respondents is less than 100, the results of the research data will be tested for normality using the Shapiro-Wilk Test to see whether the distribution of data results in the research variables is normal or not. If the data is normally distributed, then a multivariate analysis will be conducted to determine the relationship between isochronic tones alpha, beta, and gamma to sustained attention using the repeated measures analysis of variance (ANOVA) method. However, if the data is not normally distributed, then the data will be analyzed using the Friedman test. The test is conducted to see the difference between the experimental group that was given treatment and the control group that was not given treatment and to see the difference in the pre-test and post-test in the control group and the experimental group.All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

IV. FINDNGS & DISCUSSION

In order to test the hypothesis, the researcher chose to apply the analysis of variance method with repeated measurements or what is known as repeated measures ANOVA. Repeated measures ANOVA is a type of statistical analysis used to compare the average values of several measurements taken at different times, namely before the experiment (pretest) and after the experiment (posttest). This allows the researcher to assess whether there is a significant difference in the average measurement between two or more measurement times in the context of the study.

TABLE III
DESCRIPTIVE STATISTICAL TABLE

Time	Group	Mean	Std. Deviation	Lower Bound	Upper Bound
Pretest	Control	218.7333	3.34806	215.081	222.385
	alfa(**α**)	215.0000	4.89898	211.348	218.652
	beta(**β**)	211.6667	6.62966	208.015	215.319
	gama(**γ**)	205.4000	10.96618	201.748	209.052
Posttest	Control	218.6000	4.99714	215.908	221.292
	alfa(**α**)	219.4667	3.46135	216.775	222.159
	beta(**β**)	217.5333	4.03320	214.841	220.225
	gama(**γ**)	215.4667	7.42454	212.775	218.159

From the table above, we can see the analysis of the distribution of SART scores from each pretest and posttest group. In the first test (pretest), the control group had an average of 218.73 and a standard deviation of 3.35; the alpha group had an average of 215.00 and a standard deviation of 4.90; the beta group had an average of 211.66 and a standard deviation of 6.30; the gamma group had an average of 205.40 and a standard deviation

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of 10.96. In the first test, it can be seen that the beta group had the highest average SART score. In the posttest, the control group had an average of 218.60 and a standard deviation of 4.50; the alpha group had an average of 219.46 and a standard deviation of 3.46; the beta group had an average of 217.53 and a standard deviation of 4.03; the gamma group has an average of 215.46 and a standard deviation of 7.42. These results indicate that the alpha group has the highest average SART score. The results of the hypothesis test above show that all experimental groups experienced an increase in the average SART score after being given an intervention in the form of isochronic tones. From the analysis above, it can be seen that the control group experienced a negative change (decrease) of -0.13; the alpha group experienced a positive change (increase) of 4.67; the beta group experienced an average increase of 5.86; and the gamma group experienced the greatest change, namely 10.06.

This study was conducted to determine the relationship between isochronic tones to improve learning concentration by measuring the level of sustained attention possessed by a person. After comparison and repeated variance analysis tests, it was found that isochronic tones resulted in significant positive changes in sustained attention or concentration possessed by the experimental group.

There are 3 frequencies of isochronic tones that have been tested in this study, namely isochronic tones alpha (7-12 Hz), isochronic tones beta (13-30 Hz), and isochronic tones gamma (30-100 Hz) which were given to the experimental group for 10 minutes after the respondents completed the first test (pretest), then the respondents took the last test (posttest). The average SART score results for each group were compared to see the significance of isochronic tones in improving cognitive abilities such as attention and concentration.

The results of this study found a significant influence between the use of isochronic tones to improve concentration. Each type of isochronic tones that we have tested has a significant effect on concentration, as evidenced by the increase in SART scores of all experimental groups after being given an intervention in the form of isochronic tones except for the control group which was only given a placebo effect (silence). The highest increase in scores was experienced by the gamma group, second was the beta group, third was the alpha group, and the last was the control group which experienced a decrease in the average SART score.

This strengthens the research conducted by Deraman shows that the use of isochronic tones at gamma frequencies has a positive impact on the mental condition, attention level, and concentration of individuals [6]. The results of this study provide concrete evidence indicating that isochronic tones have the potential to be an effective tool in improving individual cognitive performance, especially in the context of focus and concentration in learning.

Changes in the average SART score of the experimental group show that the use of isochronic tones has been proven to significantly increase sustained attention or concentration possessed by a person. This positive finding can provide a basis for the development of other research that can be used to improve cognitive abilities such as individual concentration in various contexts, such as education, work, and self-development in students of SMA Negeri 6 Jakarta. However, further research is needed to ensure the consistency and validity of the results and to understand the neurophysiological mechanisms behind the effects of isochronic tones on concentration.

In research, there may be confounding variables such as motivational factors, individual variability, environmental conditions, and proficiency in using technology. A variable is said to be a confounding variable if the variable has two unique relationships, namely a positive relationship with the exposure variable and a positive relationship with the outcome variable. To reduce confounding factors that can reduce the accuracy of the output data of this study, we used the same audio and visual devices for each respondent so that the data obtained was more accurate.

V. CONCLUSIONS

After conducting an experimental study using several isochronic tones waves, namely alpha, beta, and gamma to students of Senior Highschool Jakarta to improve concentration in learning, it can be concluded that the respondents who were the samples in this study were students in grades X and XI of aged sixteen to eighteen years. The number of male respondents was thirty (30) the same as the number of female respondents. It was found that there was a positive effect of using isochronic tones in improving sustained attention or concentration in learning as evidenced by a significant increase in the SART score in the experimental group. The type of isochronic tones wave that was proven to be the most effective and significant in improving sustained attention or concentration was gamma waves (30-100 Hz). The level of sustained attention that a person has can affect the concentration that students have to do things that require cognitive abilities, for example studying.

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