Literature Review: *Electroencephalogram* (EEG) the Characteristics of Students' Learning Concentration Due the Audio Stimulus

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Abstract. The thinking concentration is easily affected by the presence of distractions around. One of the aspects that has a disturbing effect or eventually stimulates the mind is the audio stimulus. If the audio gives unwanted and destructive sounds or is noisy, it can affect the concentration of thinking. This study aims to analyse a comparison in the literature based on several stimulations that can be given to students to see a comparison of brain waves to the given stimulus. In particular, the purpose of this study is to determine the types of audio that have the effect of increasing students' learning concentration. The method used is a literature review based on keywords, issues, methodology, and similarities in the research. Brain waves can be used to identify concentration levels by recording EEG signals with different stimuli. Based on the 10 studies described, it is found that brain waves can be used to identify concentration levels by recording EEG signals with different stimuli.

Keywords: Electroencephalogram (EEG) · concentration · audio stimulus · sound

1 Introduction

Concentration is the focus of the mind on one thing by setting aside other unrelated things [1]. Concentration allows individuals to avoid disturbing thoughts when trying to solve the problem that they are facing [2]. However, concentration is easily affected by surrounding distractions. The focus of concentration is actually divided into various streams of thought which actually makes the concentration of thinking even more unfocused.

One aspect that has a disturbing effect or actually stimulates the mind is audio stimulus. Based on the third edition of the Indonesian Dictionary (KBBI), audio is a tool that can be heard [3]. If the audio gives unwanted and destructive sounds or is noisy, it can affect the concentration of thinking.

One of the methods that can be used for clinical diagnosis as well as for research to detect activities in the brain and study the brain's response to certain stimuli is by Electroencephalography signals. Electrical activities occurs in the human body. One of

which is the electrical activity in the brain called Electroencephalography (EEG), where this electrical activity releases electrical charges simultaneously and rhythmically or in a pattern so that they can generate electric waves. The components that make up the EEG are electrical rhythms and transient discharges which are differentiated by location, frequency, amplitude, shape, periodicity, and functional properties. Humans will get into trouble if their brain does not generate one of the signals when it should be there. For patients experiencing stress, one of the treatments that can be used for them is audio treatment by listening to certain types of sounds. The experimentee's comfort level can be indicated by looking at the increase in the theta and alpha wave amplitudes on them [4, 5].

If a person's concentration level decreases, it will cause obstacles in all his/ her activities. If the level of students' learning concentration decreases, it will hamper their achievement. Therefore, stimulation is needed that can increase concentration, especially in the teaching and learning process for students. One of the stimulations that can be given is the provision of audio stimuli.

Based on these conditions, the researcher conducted a study in the form of a comparative analysis in the literature based on several stimulations that can be given to students to see a comparison of brain waves to the given stimulus. The types of audio stimulation that will be given are qur'an recitation (murottal qur'an), classical music, and favorite music, and then the brain waves are recorded and analyzed using an Electroencephalograph (EEG). EEG is an instrument used to record static electrical activity resulting from stimulation received by the brain [6].

Research related to audio stimulus on learning concentration has previously been studied about the effect of classical music on learning concentration. There is also a similar study that examines the influence of music in general to increase student learning concentration. Actually, research like this has been studied by several researchers, but the research was limited to the type of audio in the form of music only and data collection was limited only subjectively using methods such as control group design.

Meanwhile, for research related to EEG related to audio stimulus, Djamal and Arif (2014) and Djamal, Pangestu, and Dewi (2016) have examined it. Their research shows sound stimulation can lead to an increase in the occurrence of alpha waves by 75%, while theta and beta waves decrease by about 48% and 56%. However, this study has not linked it to the level of concentration in the participants. There is also research that analyzes EEG signals to estimate human concentration levels, but this research is more focused on extracting features used in processing EEG signals, while to see the concentration of experimenters it is done by solving puzzles (puzzles).

Until now, research that tries to examine the effect of giving audio stimuli on the concentration level of students by measuring EEG signals has never been done. So this study aims to measure the learning concentration of students who are given an audio stimulus based on the characteristics of their brain signals recorded through an EEG tool. In addition to measurements with EEG signals, in this study we will compare reaction time and memory recall data collection in experimental participants.

2 Method

The method used is a literature review based on keywords, issues, methodology, and similarities in the research.

The outline of the steps to be taken in this research are as follows:

1. This research was conducted through measurement and observation techniques which were carried out by analyzing the electrical signals generated by the brain when given audio or sound input. This measurement technique is called Electroencephalography (EEG).
2. Signal processing from time domain form to frequency domain form and grouping into brain waves is done directly using software installed on the computer, where the computer is connected to the instrumentation system, including the electrodes.
3. Data processing is then carried out statistically, which includes hypothesis testing using the Analysis of Variance (ANOVA) method. Hypothesis testing is a method for concluding whether the proposed hypothesis is true or false. The Analysis of Variance (ANOVA) method can be used to test hypotheses.

3 Results

3.1 Results

The results of this literature review are then used as a reference in research. The results of a literature review of several related references regarding the Electroencephalogram (EEG) The Characteristics of Students' Learning Concentration Due to the Audio Stimulus, as shown in Table 1.

3.2 Discussions

A research related to audio stimulus on learning concentration has previously been studied, such as in the study of Thoma et al. (2013) or what Guan (2021) did about the influence of classical music on learning concentration [7, 8]. There are also similar studies that examine the effect of music in general to increase student concentration (Shih, Huang, and Chiang 2012; Chang and Zhou 2022; Li et al. 2021). Actually, this kind of research has been studied by several researchers, but the research is limited to the type of audio in the form of music only, and data collection is limited only subjectively using methods such as control group design [9–11]. Meanwhile, for the research related to EEG about audio stimulus, Djamal and Arif (2014) and Djamal, Pangestu, and Dewi (2016) have examined it. Their research shows that sound stimulation can lead to an increase in the occurrence of alpha waves by 75%, while theta and beta waves decrease by about 48% and 56% [12, 13]. However, this study has not linked it to the level of concentration in the participants. There is also a research that analyzes EEG signals to estimate human concentration levels by Velnath, Prabhu, and Krishna kumar (2021). However, this research focuses more on feature extraction used in EEG signal processing, while to see the concentration of the experimentees, it is done by solving puzzles (puzzles)[14].

Table 1. The table of Literature Review

No	Researcher	Title	Method	Results
1.	Ratna Karmila, Esmeralda C. Djamal, Dian Nursantika (2016) (Karmila et. al., 2016)	The Identification of the Concentration Level of EEG Signals with Wavelets and Adaptive Backpropagation	This research was conducted by creating a system identification of concentration levels through EEG signals that had been recorded on ten people aged 20–25 years with wavelet transformation and backpropagation.	The results show that the use of adaptive propagation is able to improve the learning process with an accuracy of 75%, and signal testing with wavelet extraction is 95% for the training data being tested and 45% for the tested data.
2.	Yoza Radyaputra, Inung Wijayanto, Sugondo Hadiyoso (2018) (Radyaputra et al., 2018)	The Analysis of Alpha and Beta EEG Brainwave Signals Against Comparison of Someone's Concentration in Listening to Music and Smoking	The EEG signal was collected using an ectroencephalogram on three respondents recorded in a quiet atmosphere, listening to classical music and smoking.	• In the TP9 channel, the classical music stimulus has an alpha signal accuracy of 77.78% with 7 data and a beta signal of 88.89% with 8 data. • In the AF7 channel, the smoking stimulus has an alpha signal accuracy of 88.89% with 8 data and a beta signal of 77.78%. With 7 data.
3.	Febrina Yumiko, Iwan Iwut Tritoasmoro, Hilman Fauzi (2021) (Febrina Yumiko et al., 2021)	The Classification of EEG Signals Against Individual Concentrations Using the K-Nearest Neighbor Method	EEG signals were collected from 10 respondents using a 1 channel Neurosky Mindware Headset. Respondents were directed to drink antioxidant water to determine concentration standards	The Discrete Consine Transform (DCT) extraction method is able to extract features for alpha and beta signals in EEG signals when given a stimulus after drinking antioxidant water and before drinking antioxidant water with the best accuracy reaching 100% using training data.

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Table 1. (*continued*)

No	Researcher	Title	Method	Results
4.	Jatmika Nurhadi, Rosita Rahma (2017) (Nurhadi& Rahma, 2017)	The Comparison of EEG Spectrum on Reading Aloud Activity between Indonesian Speakers and Foreign Speakers	This research was conducted using a qualitative descriptive method with two data sources.	The results show that subject A (native Indonesian speakers) processed information by imaginative and emotive processes while subject B (foreign Indonesian speakers) processed information by visual processes such as understanding letter shapes.
5.	Nendra Cahya Permana, Esmeralda C. Djamal, Agus Komarudin (2017) (Permana et al., 2017)	The Real-Time Detection of Concentration Response to Sound Stimulation Using Wavelets and Support Vector Machine	This research was conducted using Absolute Power analysis Spectrum, Wavelet, and Adaptive Backpropagation for offline concentration identification.	This research has resulted that training without Wavelet extraction results in a faster training time. This is because training using Wavelet takes longer to process the original signal data extraction into Theta, Alpha, Beta and Gamma frequencies.
6.	K. G. Li, Mohd Ibrahim Shapiai, Asrul Adam, Zuwairie Ibrahim (2017) (Li et al., 2017)	*Feature Scaling for EEG Human Concentration using Particle Swarm Optimization*	This study used wavelet transform and PSO feature scaling methods. EEG signals were used as a performance evaluation of the proposed method.	The results show that the classification using Particle Swarm Operation resulted in better accuracy between concentrations and non-concentrations.

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No	Researcher	Title	Method	Results
7.	Tae Jin Choi, Jong Ok Kim, Sang Min Jin, Gilwon Yoon (2014) (Choi et al., 2014)	*Determination of the Concentrated State Using Multiple EEG Channels*	The brain waves of the two respondents were measured using an 8 channel EEG and then analyzed to see comparisons when a person was resting and concentrating	The result of this study is that from 8 channels, frontal lobe locations (Fp1 and Fp2) show that there is an increase in concentration measurements during all subjects. Six other channels show different results depending on the type of subject given.
8.	Ilham A. E. Zaeni, Utomo Pujianto, AgustaR. Taufani, Mahfud Jiono, Pradareza (2019) (Zaeni et al., 2019)	*Concentration Level Detection Using EEG Signal on Reading Practice Application*	This research was conducted using brain wave measurements from 14 subjects (12 men and 2 women) who were asked to read 3 paragraphs and then answer 4 multiple choice questions from each paragraph and then look at the comparison of the EEG results and the scores of the questions given.	The results show that the error rate of the model estimation using Artificial Neural Network (ANN) is 26.19% while the accuracy of the model is 73.81%.
9.	Seon Ok Kim, Ji Eun Jeong, Yun Ah Oh, Ha Ram Kim, Shin Ae Park (2021) (Kim et al., 2021)	*Comparing Concentration Levels and Emotional States of Children Using Electroencephalography during Horticultural and Nonhorticultural Activities*	The method of this research is a cross-over experiment in which the participants carry out horticultural and non-horticultural activities and then the brain waves are recorded using EEG for each activity for 3 min.	The results show that the theta waves (RT) are lower when harvesting and reading books. Mid beta (RMB) is higher when harvesting and playing ball. The ratio of the RMB to RT wave spectrum reflects concentration. This ratio increases during harvesting. This indicates that the subject's concentration increased during harvesting.

Table 1. (*continued*)

No	Researcher	Title	Method	Results
10	Seokbeen Lim, Mina Yeo, Gilwon Yoon (2019) (Lim et al., 2019)	*Comparison between Concentration and Immersion Based on EEG Analysis*	The study was conducted on 33 people aged in their 20s and recorded brain waves during two stimuli, concentration and playing games.	The results show that alpha waves decreased during concentration and playing conditions. Theta waves decreased during concentration but increased during playing. Beta waves increased during concentration and play on the frontal and occipital lobes. In the temporal lobe, beta waves decreased during concentration and increase during play.

Up to now, the research that tries to examine the effect of giving audio stimuli on the concentration level of students by measuring EEG signals has never been conducted. Thus, specifically this study aims to find out a research related to students' learning concentration given an audio stimulus based on the characteristics of brain signals recorded through an EEG tool whether it has been done or not in order to find out how the participants' concentration is when given the sound input. The tool used to record brain waves is Muse [15, 16].

4   Conclusion

Based on the 10 studies described, it is found that brain waves can be used to identify concentration levels by recording EEG signals with different stimuli. It is hoped that this research can provide updated knowledge regarding the provision of audio stimuli in the form of murotal sounds or recitations of the Koran, instrumental music, and favorite songs to find the type of audio that has the maximum effect on increasing student learning concentration. Recommendations for further research can use a different stimulus such as light intensity or temperature in the place.

Authors' Contributions. This research can be used as information and evaluation regarding the effect of brain waves when giving several types of audio stimuli, especially on student concentration.

References

1. Csikszentmihalyi, Mihaly. 2013. *Flow: The Psychology of Happiness*. Random House.
2. Rosenfield, Sarah, and Dawne Mouzon. 2013. "Gender and Mental Health." In *Handbook of the Sociology of Mental Health*, 277–96. Springer.
3. KBBI. 2016. "Kamus Besar Bahasa Indonesia (KBBI)." *Kementerian Pendidikan Dan Budaya.*
4. Gao, Xiang, Hongbao Cao, Dong Ming, Hongzhi Qi, Xuemin Wang, Xiaolu Wang, Runge Chen, and Peng Zhou. 2014. "Analysis of EEG Activity in Response to Binaural Beats with Different Frequencies." *International Journal of Psychophysiology* 94 (3): 399–406.
5. Cochrane, Karen Anne, Lian Loke, Caitilin de Bérigny, and Andrew Campbell. 2018. "Sounds in the Moment: Designing an Interactive EEG Nature Soundscape for Novice Mindfulness Meditators." In *Proceedings of the 30th Australian Conference on Computer-Human Interaction*, 298–302
6. Ekayama, R., Djamal, E. C., Komarudin, A., & Jenderal Achmad Yani Jl Terusan Sudirman, U. (2016). Identifikasi Kondisi Rileks Dari Sinyal Eeg Menggunakan Wavelet Dan Learning Vector Quantization. *PROC. ITB Sains & Tek*, *37*, 69–92.
7. Thoma, Myriam V, Roberto La Marca, Rebecca Brönnimann, Linda Finkel, Ulrike Ehlert, and Urs M Nater. 2013. "The Effect of Music on the Human Stress Response." *PloS One* 8 (8): e70156.
8. Guan, Mingshu. 2021. "The Role of Classical Music in the Creative Thinking of University Students." *Thinking Skills and Creativity* 41: 100925.
9. Shih, Yi-Nuo, Rong-Hwa Huang, and Hsin-Yu Chiang. 2012. "Background Music: Effects on Attention Performance." *Work* 42 (4): 573–78.
10. Chang, Zhenhua, and Min Zhou. 2022. "The Influence of Different Music Styles on Chinese Students' Lateral Thinking Skills." *Thinking Skills and Creativity* 43: 100990.
11. Li, Fanjie, Zuo Wang, Jeremy Tzi Dong Ng, and Xiao Hu. 2021. "Studying with Learners' Own Music: Preliminary Findings on Concentration and Task Load." In *LAK21: 11th International Learning Analytics and Knowledge Conference*, 613–19.
12. Djamal, Esmeralda C, and Ahmad Arif. 2014. "Identification of Alertness State Based on EEG Signal Using Wavelet Extraction and Neural Networks." In *2014 International Conference on Computer, Control, Informatics and Its Applications (IC3INA)*, 176–80. IEEE.
13. Djamal, Esmeralda C, Dewi P Pangestu, and Dea A Dewi. 2016. "EEG-Based Recognition of Attention State Using Wavelet and Support Vector Machine." In *2016 International Seminar on Intelligent Technology and Its Applications (ISITIA)*, 139–44. IEEE.
14. Velnath, R, V Prabhu, and S Krishnakumar. 2021. "Analysis of EEG Signal for the Estimation of Concentration Level of Humans." In *IOP Conference Series: Materials Science and Engineering*, 1084:12003. IOP Publishing.

15. Abujelala, Maher, Cheryl Abellanoza, Aayush Sharma, and Fillia Makedon. 2016. "Brain-Ee: Brain Enjoyment Evaluation Using Commercial Eeg Headband." In *Proceedings of the 9th Acm International Conference on Pervasive Technologies Related to Assistive Environments*, 1–5.
16. Krigolson, Olave E, Chad C Williams, Angela Norton, Cameron D Hassall, and Francisco L Colino. 2017. "Choosing MUSE: Validation of a Low-Cost, Portable EEG System for ERP Research." *Frontiers in Neuroscience* 11: 109.