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SIMPLE EEG ASSESS WORKING MEMORY PROCESS IN DIFFERENCE GENDER

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Abstract

Terminology working memory often used to describe the whole process of structure in memory, including executive function, which all information retains and uses in temporary period. Simple EEG, like Headband Muse Electroencephalography (EEG) which used 4 sensors EEG is one of the tools in neuroscience research to investigate neuronal process in different condition, as well as working memory process in simple and easiest way. Results in this study hopefully provide baseline data for another neurofeedback research in cognitive process. Material & Methods using the Muse, simple EEG as portable low cost and wireless two-channel EEG headband, we record 23 students at 4th grade elementary school in Jatinangor. The α brain waves bands were recorded while they get memory span task, which had sequences base 1, read 1, interphase1, recall 1, base 2, read 2 interphase2, recall 2. EEG recorded result difference between gender. Oscillation α brain wave will loaded into MATHLAB. In this study, we report sex related changes α trends bands in EEG power as peak frequency for both frontal and temporo-parietal sites, in several condition task in working memory process. In male participants increasing trends for α in working memory process higher than female students. The result also stated asymetri frontal cortex and decreasing power of α wave between TP and AF. We discuss our finding probability sex related chages their attentional and emotional in working memory process. Encoding process and retrieval also probability influence.

Keywords: Working memory, power alpha wave frequency, Simple EEG

1. Introduction

Individual learning process is a very unique process. Several factors involve the process like learning environment, learning habituasi, intelligence level, and also comorbidity.[1] Since previous study has shown there was a difference between gender in cortical thickness and brain regional volume, a lot of novelty studies continue another brain variable research associated difference gender. One of the study was learning behaviour associated with brain activity, hormonal and haemodynamic phase.[2]

EEG is one of medical device which can reflect synaptic activity. Qualitative EEG were used in clinically practice to diagnosed several abnormality in brain. Recently, neuroscience, psychologist also used EEG, to studied pattern of brain waves in several condition including learning process in cognitive study as neurofeedback.[3] Total power or amplitude in specific frequency brain waves were studied. Increasing brain wave oscillation plays important role in long term memory or in working memory processing. (Berger et al., 2015) Memory as part of learning process, is a complex system which consists of various functions and cognitive processes. Memory divided into 2 system, short term memory (STM) and Long term memory (LTM). Working memory, is part of short term storage system, which use and update information from LTM.[3] In this study, use two category modified memory span task: memory words task and memory digits task. The population sample are elementary student at level 4th grade, that assumed they can read the word and number in the memory span task, as their LTM information source. In Working memory, central executive (CE) in frontal lobe is highly demand as monitoring and coordinating all the process of learning or cognitive process. Firing information to CE comes from dorsal and ventral stream. Oscillation of the brain waves in temporal and frontal describe the firing network of neural.[4]

This study use Muse EEG with two channels, frontal (AF7 and AF 8) and temporoparietal (TP9 and TP 10) with active noise suppresion. Muse EEG is widely used by the neuroscience as an immersive meditation device, which can record brain waves activity as a real time feedback. The device use dry electrodes and send signal via wireless.This study use the adventages of the device : fancy, simple use, comfortable to wear,portable and low price, to gain the brain waves easier and faster than conventional EEG.[5]

Inspired from the previous study, this study by using simple EEG, like Headband Muse EEG which only 4 sensors EEG, we highlight some of the challenges in cognitive development research.We use Muse EEG to analyzes trend brain waves activity, especially α wave (8-12Hz) in several task cognitive load, to find out optimal pattern in certain learning activities between gender in elementary students.

2. Methods

This research has been approved by the Research Ethics Committee of Padjadjaran University (Ethical Approval No. 786/UN6. KEP/EC/2021).

Twenty-three participants (ages 10-11, 11 males and 12 females) from 4th grade elementary school in Cikeruh Jatinangor performed modified memory span task while Muse EEG was recorded. All of the participants in healthy condition (normal term on vital sign), has taken breakfast before the task and no learning disabilities. Informed consent was obtained from each subject (parents) prior to the study.

2.1 Study Procedure

Participant sitting on the arm chair with the relax condition in front of the monitor personal computer. They shall be explained about the procedure, the Muse EEG, memory span task, and the aim of the study, to make become familiar for the participants. The scalp participant should aberation to remove dead cell.

The participants had to perform memory span task`into 2 phase. The first phase is reading the name of the object (five words)-memorizing-recalling task. The second phase is reading the number (Five digits)-memorizing-recalling. The material object presented visually on the computer screen central-horizontally, with black background, font : Arial and font size : 80. Two phase running simultaneously. The Muse EEG place on scalp from base 1 until recall 2. Every sequences memory span task were performed in 1 min. Placing the Muse electrode on the frontal left and right (AF7 and AF 8), Temporoparietal left and right (TP9 and TP 10) . The device must be set up before using in 5 minutes. Raw EEG output can be seen on Table1.

Phase 1 :

Base1 →	Read1 →	Interphase1 →	Recall 1
α waves record in 1 min Participant on relax condition and open eyes	α waves record in 1 min Participant reading 5 different words on screen computer	α waves record in 1 min Screen computer closed Participant recall 5 different words by their ownself	α waves record in 1 min Participant asked to verbalization the 5 different words

Phase 2 :

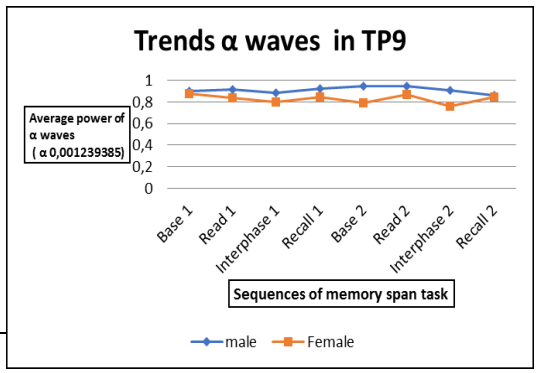
Base2 →	Read2 →	Interphase2 →	Recall 2
α waves record in 1 min Participant on relax condition and open eyes	α waves record in 1 min Participant reading 5 different numbers on screen computer	α waves record in 1 min Screen computer closed Participant recall 5 different numbers by their ownself	α waves record in 1 min Participant asked to verbalization the 5 different numbers

The EEG data were loaded into MATLAB using custom built functions and applied correction factor 1,25. Power spectral density of EEG for each 1s epoch was calculated using Welch ‘s modified periodogram method with a Hamming window tapering of the1s length.[5] Analysis with theone paired t-test and correlation with Anova

3. Results

3.1 Trends α waves in Temporo Parietal (TP)

Trends alpha waves male and female on temporo parietal (TP9 and TP 10) in all memory span task process shows differentially significant ($\alpha < 0{,}05$) with the t test. Power of male alpha waves higher than female.



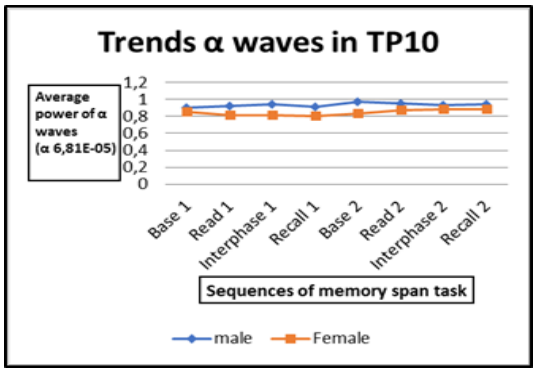
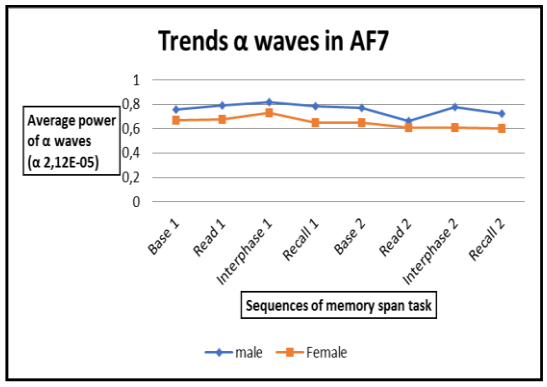


Fig. 1 Trends α waves in temporoparietal (TP)

3.2 Trends α waves on Antero Frontal (AF)

Trends alpha waves male and female on Antero Frontal (AF7 and AF 8) in all memory span task process shows differentially significant ($\alpha < 0,05$) with the t test. Power of male alpha waves higher than female.



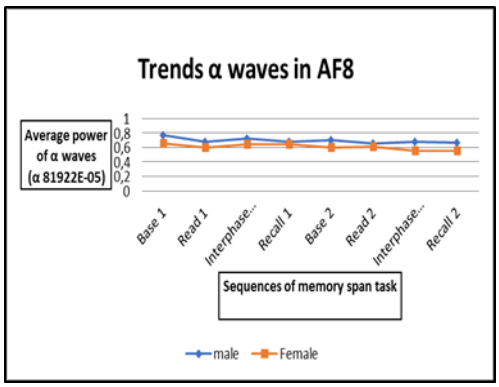


Fig. 2 Trends α waves in Anterio-Frontal (AF)

3.3 Gender associated ability memory span task : words task and digits task

In ability to memorizing and recalling memory memory span task : words task and digits task, there is difference trends in average power of α waves between gender, but no significancy by statistic Anova p=0,822 (p>0,05)

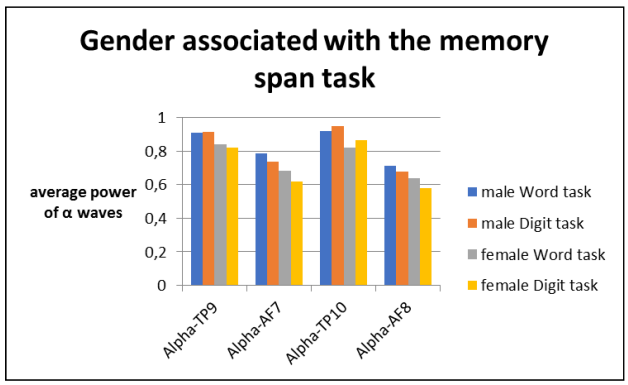


Fig. 3 Gender associated with the memory span task

4. Discussions

Learning process associated with the individual memory storage. In this study, sensory memory information from visual (visuospatial), reach occipital cortex on area 17,18 and 19 (V1, V2 and V3). After all by using association fibers, neuron impuls moves ventral and dorsal cortex through dorsal and ventral streams pathway, which run pararel continously. Dorsal stream (DP) pathway reach parietal cortex to destinate in pre motor cortex and pre frontal cortex as executive function cortex, which responsible for spatial working memory. Meanwhile ventral stream (VP) pathway reach medial temporal cortex, striatum cortex, amygdaloid area, orbitofrontal area, and pre frontal area, which contribute in long term memory, object reward association and object working memory. Circuit occipito-parietal link information to pre frontal, pre motor and medial temporal pathway with the highly reciprocal interaction .DP and VP are associated in a mutual effort for perceiving an object, an important information on attentional process, as part of

cognitive behavior.[1,2,6]

In this study Muse EEG records α waves in male with higher oscillation than female (Fig.1 & Fig.2). Previous study, alpha band waves also stated higher significant than female. It's associated with higher level estrogen and progesteron hormone, sexual dimorphism influence neuronal activity. Another study find the corelation between low hemoglobin in female has positif effect in neuron activity in pre frontal cortex rather than male. It stated there are probability associated skull conductivity with the saturation oxygen.[6]

Asymetri α waves also record in memory span task between gender (Fig.3). Frontal asymetri is typical indicator of asymetrical brain activity in frontal cortex, which refers different activity between left and right hemisphere.[7,8] Previous study stated, this is corelated with emotional coordinated mapping in brain in different pattern. Oscillation α waves in AF8 lower than AF7, it is predicted that in the same time there are positive and negative feeling inside participants during the task. In the future studies, we can elaborate approach motivational positive emotion as cognitive neurofeedback in term of frontal asymetri.

In this study, oscillation α wave, either in the left hemisphere or in the right hempisphere, show decreasing trend α power from TP to AF. In the pathway dorsal and ventral stream, the impuls from occipital cortex firing to reach cortex parietal and temporal to destinate in frontal cortex, as coordinated working memory. Previous study stated that decreases α power in parietal cortex due to semantic encoding related to retrieval information from storage memory in working memory process.[9, 4, 8, 10] Old previuos research, stated that decreasing trend α power waves also associated with attention. In group of learning dissabled, there was decrease alpha wave band.[11, 12]

5. Conclusions

The finding of our study confirm the presence of portable Muse EEG in recording α waves simple and faster to gain the data. There is difference between gender in terms of trend α waves. Trend α waves in male relative higher than female. But there is no significancy correlation gender with the ability memorizing, word task and digit task. The result also finding frontal asymetrical oscillation, which assumed related with the emotion during the process memorizing. Decreasing oscilltion α wave from TP to AF also assumed related with the attention and encoding process.Using simple EEG, like Muse EEG can describe cognitive function with low cost and quick to setup. For further work, we can use Muse EEG for large samples number with more different cognitive performance.

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