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Comparing the effects of brain exercise to listening to mozart in improving short term memory

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ABSTRACT

Background: Doing a brain exercise or listening to Mozart are believed to improve short term memory. We examined whether these methods may differently improve the cognitive function. **Methods**: We conducted an experiment with pre-test and post-test involving two groups of 24 subjects each. The first group had a brain exercise and the second group listened to Mozart. Both groups had the treatment for four weeks, four times a week. The pre-test and post-test were a digit span test. The test scores were compared within the group and between the two groups. **Result**: The results indicated brain exercise and listening to Mozart improving the short term memory ($p<0.05$). However, the improvement was not significantly different between the two methods ($p>0.05$). **Conclusion**: One method showed no superiority against another in improving short term memory.

Keywords: Brain exercise, Mozart, Short term memory, digit span test.

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INTRODUCTION

Teachers are expected to improve students' performance at school to produce quality human workforce.[1] Students are required to process information in a fast-paced in life and business. Thus, needing a fit brain and physique to think faster and sharper, and to work more efficiently and creatively.[2]

It is believed that there are ways to improve human cognitive function both pharmacologically and non-pharmacologically. Some non-pharmacological approach to improve our cognitive function is through the process of education and training. A training known as brain exercise is a collection of 24 simple physical or spatial movements aim to connect or unify the mind and body.[3] Brain exercise is claimed to be able to stimulate and access both brain hemispheres simultaneously so that the hemispheres are working in an integrated state.[3] A study by Putranto showed brain exercise improves the short term memory of children from low economic status families when given three times a week for eight weeks.[4] Another non-pharmacological method claimed to increase cognitive performance is listening to classical music. A study by Laurence showed that listening to Mozart improved human short-term memory.[5] The study showed a group of 19 to 20-year-old women who listen to Mozart for 490 seconds had an improvement in their digit span test result.[5]

There has not been a published study comparing the effectiveness of brain exercise to listening to Mozart in increasing short term memory. Therefore, we conducted our study to compare the two methods.

METHOD

We conducted an experimental research with pre-test and post-test. The study was conducted from September to October 2016. Our sample were undergraduate students of physiotherapy in Medicine Faculty of Udayana University. The inclusion criteria in this study were student 18-29 years old consenting to do regular brain exercises and to listen to Mozart classical music on a predetermined schedule; not engage in activities that may affect cognitive function such as yoga, meditation, cognitive function tests of short term memory including low and medium level. The participants agreed to be involved in the research and signed an informed consent form. The participants were excluded if they smoke, drink alcohol, had a history of head trauma, heart disorders, neurological disorders, or hearing impairment.

There were 48 eligible participants. All of them were given the digit span test prior to the intervention and at the end of 4 weeks of intervention. A digit span test is one of the

Wechsler Adult Intelligence Scale (WAIS) for measuring the Working Memory Index (WMI). The researchers performed the test to the participants to assess the short-term memory of each subject. The test required the participants to repeat a series of numbers, either in forward or in backward order (digit span forward and backward).

The participants were randomly divided into two equally numbered groups. The first group was requested to do 24 movements of brain exercise for four times in a week for four weeks (brain exercise group). Each movement of the brain exercise was performed for a minute. The other group (Mozart Group) was requested to listening to Mozart in a room with a loudspeaker for 20 minutes for four times in a week for four weeks.

The two groups' digit span test results acquired before and after the intervention were compared using statistical tests. The normally distributed data were tested with paired T test while the not normally distributed data were tested with Wilcoxon rank test. The difference between the two groups' digit span improvement score was also statistically tested.

RESULTS

The subject characteristics are shown in **Table 1**. The entire subject in both groups was 18-19 years old. Based on the digit span test before the treatment number of subjects who had average digit span scores were 9 (37.5%), and low was 15 (62.5%) in brain exercise group. In Mozart group, the number of subjects who scored average on the digit span test was 12 (50%), and the rests 12 people (50%) scored low.

Normality test of the pre-test, post-test, and the difference in each group can be seen in **Table 2**.

Table 3 showed the comparison between the pre-test and the post-test in brain exercise group has a p-value <0.05. The pre-test and post-test in the Mozart group also have a p value <0.05.

Table 4 showed the pre- and post-test difference in Brain group when compared to the Mozart group has a p-value of 0.097.

Table 1. The sample characteristics

Characteristics	Brain Exercise n = 24 f (%)	Mozart n = 24 f (%)
Age		
16-17 years	0 (0%)	0 (0%)
18-19 years	24 (100%)	24 (100%)
20-21 years	0 (0%)	0 (0%)
Digit Span Score		
Average (11.38≤ x ≤13.56)	9 (37.5%)	12 (50%)
Low (x <11.38)	15 (62.5%)	12 (50%)

Table 2. Shapiro-Wilk Test Results

Variables	p	Mean (SD) or median (min-max)
Brain Exercise Group		
Pre-test	0.109	10.75 (1.726)
Post-test	0.318	13.29 (2.196)
Difference	0.073	2.54 (1.956)
Mozart Group		
Pre-test	0.024	11.50 (7.00-14.00)
Post-test	0.007	14.00 (10.00-16.00)
Difference	0.095	1.75 (1.189)

Table 3. Statistical analysis comparing pre-test to post-test in each group

Comparing Pre-test to Post-test	Test	p-value
Brain exercise group	Paired T	0.000
Mozart group	Wilcoxon	0.000

Table 4. Comparing the pre- and post-test difference between groups

Variables	Mean	95% CI	p-value
Brain exercise group	2.54	(1.68 - 3.32)	0.097
Mozart group	1.75	(1.25 - 2.25)	

DISCUSSION

Characteristics of Research Subjects

The subject characteristics showed the age was 18-19 years. In the brain exercise group, there were nine people (37.5%) with an average score and 15 people (62.5%) with a low score. Meanwhile, in the Mozart group, the medium was 12 (50%), and the low was in the same number.

Disturbances in memory are often not showing easy signs to be detected.[6] A study which screened 300 children of 8 to 12 years old with normal IQ revealed 5.8 to 5.9% had an impaired episodic and semantic memory. [6] A study on functional MRI (fMRI) of the brain showed in adults, a sensitive period of sensorimotor function occurs as a result of synapse reorganization. Therefore, every stimulus from the environment is significant to improve an adult cognitive function.[7]

Dopamine also influences the brain development in adolescence. Dopamine is a neurotransmitter which has a capacity in the process of concentration, memory, and learning. Some studies suggested that in teenagers, dopamine production increased when exposed to a positive environmental stimulus, so that the brain may process new information faster.[8]

Mozart's Role in Improving Short Term Memory

Our study showed a significant increase in the digit span score after the subjects listen to Mozart. We may assume that listening to a classical music may improve the short-term memory.

An electro encephalography (EEG) examination conducted in a group who subjects who played classical music of Mozart before and after a cognitive training showed a less complex EEG pattern. The study showed the influence of classical music to the brain activity in a learning process. A less complex EEG pattern is associated with individuals with higher intelligence and creativity. The Mozart group in the study showed more cognitive synchronization wave pattern lower-1 Alpha in parietooccipital cortex area and frontal area.[9]

Another study showed after listening to Mozart; there was an increase in the brain wave pattern associated with memory function, cognitive and problem-solving. The result of the study displayed an activation of the cerebral cortex neural circuits associated with concentration and cognitive function after listening to classical music.[10] Several studies also exhibited Mozart effects in the learning process and in improving cognitive function through neurophysiological brain activity changes.[10,11] Mozart is believed to raise the basic patterns existed in the cerebral cortex which has an impact on higher brain functions.[11] A study by Jausovec and Habe showed Mozart stimulated several areas in the brain associated with concentration.[12]

Listening to music is believed to facilitate neurogenesis; regeneration and nerve cells repair through the secretion of steroid hormones that facilitate neural plasticity. Listening to music is thought to affect the genes of cortisol, testosterone, and estrogen receptors.[13] THE Nervous system is a target cell for steroid hormones produced by the peripheral glands and neuroactive steroid produced by the cells nerve. These steroid hormones are neuroactive, showing steroid hormones affecting the plasticity of the human brain.[14] Estrogen and testosterone play a role in the regulation of gene expression for regeneration, repair, and protection of nerve cells. In the genomic system, estrogen has an impact in brain-derived neurotrophic factor (BDNF) and nerve growth factor (NGF) production. While in non-genomic system, estrogen plays a role in the transmission of nerve cell signals and suppression of beta amyloid.[15]

Brain Exercise's Role in Improving Short Term Memory

Similar to Mozart, our study showed a significant increase in the digit span score after the subjects do brain exercise. We can assume that doing brain exercise may improve the short term memory.

The physical movements in brain exercise may activate the entire neocortex area of the brain, especially the frontal lobe, and the primary motor areas in both hemispheres. Literature claimed that by doing a brain exercise, the brain electrical energy and wave would go through the brain stem and the limbic system to the neocortex, helping the person to process information easier.[16]

Some movements performed by crossing the body midline was claimed to be the key to integrate and to activate the right and left-brain hemispheres. The more often the cross motions carried, the more connection and myelination occur in the corpus callosum so that the process occurred between the two hemispheres are getting faster and eventually improving the cognitive function.[16] The increasing number of connections and neurogenesis are mediated by neurotrophic factors such as BDNF and fibroblast growth factor-2 (FGF-2). The latter stimulates the proliferation and differentiation of hippocampal cells and increase the number of hippocampal astrocytes.[17] Physical movements in the brain exercise may affect the brain function by increasing the growth of capillaries of the brain blood flow to the brain, brain oxygenation, production neurotrophin, the

growth of nerve cells in the brain in the hippocampus—the center of learning and memory, the amount of neurotransmitters in the brain, the relationship between nerve and tissue of brain volume.[18,19]

Research by Vaynman suggested that physical activity may significantly increase BDNF, a molecule that plays a major role in neuronal plasticity in the process of learning and memory.[20] The role of BDNF in the nerve synapse plasticity is to regulate the growth, branching and remodeling dendrites and axons.[21] BDNF also influences the effectiveness of nerve transmission and maturation function of excitation and inhibition nerve.[22] A physical exercise induces markers of synaptic plasticity in the hippocampus, mRNA of calcium, protein-cAMP response element-binding (CREB) and synapsin I.[23] CREB is one of the stimulus-induced transcriptional regulators that plays a role in a variety of adaptation response of the nerve.[24]

Following an exercise, neuronal cells will last for several months, so that the cells newly produced neurons to form functional monosynaptic neural connections in area CA3 in the hippocampus and polysynaptic relationship with other areas of the brain. The relationship between neural circuitry is used by the brain in the learning process and memory.[25]

Comparing Brain Exercise to Listening to Mozart in Improving Short Term Memory

Our research showed there is no statistically significant difference in the digit span score between doing brain exercise to listening to Mozart.

STUDY LIMITATIONS

Our sample consisted of 18-19-year-old undergraduates with relatively similar environmental conditions in the campus environment. All of the subjects were undergraduate students in the Medicine Faculty of Udayana University. Therefore, our study result may not be generalized to a bigger population.

Moreover, the digit span test was done manually (not using an electronic technology). Errors in the calculation of the score digit span test may have occurred. Indeed, we could not control every daily activity of the individuals enrolled in our study. The participants may have unintentionally done other activities influencing the result of the pre- and post-test.

CONCLUSION

Brain exercise and listening to Mozart support short term memory improvement. However, any method did not show a superiority against the other.

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