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The Effect of Brain Training Game activities on Improvement of Cognitive Function measured by Montreal Cognitive Assesment Indonesia version (MoCA-Ina)

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ABSTRACT

Background: The function of cognition in young adults (around the age of 20 years) mostly does not develop to its peak, even though at that age a person needs better cognitive abilities to deal with the lectures. Brain training game activities by playing games through the Neuronation™ application can improve cognitive function.
Objective: To determine the effect of Brain training activities on improvement of cognitive function
Method Experimental study with two group pre and post design. 74 Sample were medical students of Faculty of Medicine, University of Muhammadiyah Malang class of 2017-2018, divided into control and treatment groups of 37 samples each. The treatment group was given by game brain game training 30 minutes a day, 20 times in 4 weeks.. Cognitive function was measured by the MoCA-Ina test in the control group and pre and post test. The hypothesis test used the pairet samples test.
Result: Cognitive function of pre and post test of the control group good cognitive function increased 2.69% and cognitive function of pre and post test of treatment group increased 58.8% with the result of pairet sample analysis of significant p = 0,000 which means that in the control group there was a tendency for increased function cognition after treatment (post test) but the improvement was not significant. In the treatment group with brain training activities cognitive function increased sharply and statistically significant,
Conclusion: Brain training activities affect the improvement of cognitive function.

Key words : Cognitive function, brain training, MoCA-Ina test, Neuronation™.

INTRODUCTION

Human neurodevelopment is strongly influenced by repetitive activity/stimulation. Activity/stimulation will provide a significant increase in memory in developing the human brain. Stimulation is responded to through one or a combination of the five senses; stimulation that is not noticed will immediately disappear, but if it is seen through training and games, the information is transferred to the short-term memory system (Bhinnety, 2008). Environmental stimulation affects brain development; children with congenital hearing loss who received bilateral cochlear implants and at the age of 3.5 to 7 years experienced a better growth of CAEP (Cortical Auditory Evoked

Potential) than children who received a cochlear implant later. Sharma, Dorman, Kral, 2005). Someone who always trains his brain to think will be different from people who think less. Stimulation/activity in older people causes an increase in neuronal connections in the right fusiform cerebral cortex and lateral orbitofrontal cortex, which affect cognitive performance (Engvig, Fjell, Westlye, et al, 2010).

In this era of technological advancement, the young adult age group spends more time playing games. In 2014, 80% of children who grew up to be teenagers had become addicted to playing games (Padangekspres, 2014). According to research in America, one-third of teens play games every day that spends at least 30 hours per week (Young KS et al., 2011).

Seeing the phenomenon of game addiction, many companies have made games more useful, namely by creating games that can improve brain abilities, including cognitive function or what is commonly called brain training or brain training. Some experts have already researched the effectiveness of brain training in improving cognitive function, one of which is the NeuronationTM software. (Schmiedek F et al., 2010)

The research conducted by experts on brain training still experiences many differences regarding its effect on cognitive function. Some experts get the results that brain training can improve cognitive function abilities, including short-term memory, attention, seeing ability, reading ability, brain processing speed, as well as intelligence, according to the age group (adults to the elderly) and the length of exposure of the given brain training. (Nouchi R, 2013, Owen AM et al, 2010)

Cognitive function is the ability to receive, process, and store sensory input; cognitive function is also associated with behavior with the function of a person's nervous system. Cognitive function can change according to age and the activities a person does. At around the age of 20 years or young adults, cognitive function mainly does not develop to its peak (Nouchi R et al., 2013). At the age of a young adult, a person must adapt because he has passed the high school education level (SMA). He enters the world of lectures as a student and, of course, requires better cognitive abilities to adapt to new activities and knowledge input. Therefore, giving brain training treatment to students who have just entered the world of lectures is very appropriate for developing their cognitive function.

Based on the facts and phenomena above, the researcher wants to prove the effectiveness of brain training activities with increasing cognitive function.

RESEARCH METHOD

This research is an experimental study with a two-group pre and post-design. The place and time of the research were carried out at the Laboratory of Physiology, Faculty of Medicine,

University of Muhammadiyah Malang, starting from April 2019 until the minimum number of samples was met. A target population group is a group of young adults aged 18-22 years who are registered as students of the Faculty of Medicine, University of Muhammadiyah Malang. The research sample was a group of young adults who, during the study period, were registered as students of the Faculty of Medicine, University of Muhammadiyah Malang who met the inclusion criteria. Inclusion criteria are 1st and 2nd semester students of FK UMM aged 18-22 years, in good health, and willing to undergo the Indonesian version of the Montreal Cognitive Assessment (MoCA-Ina) test. Exclusion criteria were having a history of brain disorder or injury, vascular disease, and metabolic disease, having a psychiatric disorder, being on a certain diet, and having used NeuronationTM Software before.

Sampling was done using purposive sampling, namely selecting subjects according to the research inclusion criteria to be research subjects. The research sample size was calculated using the hypothesis test formula for the mean difference before and after treatment in a single population.

$$n = \frac{Z\alpha^2 PQ}{d^2}$$

N = Number of samples

Zα2 = Confidence level 1.96

P = Estimated proportion of events in 50% sample= 0.5

Q = 1-P = 0.5

d = relative determination 20%= 0.2

The estimated proportion of events in the sample is 50% (P=0.5) because the data regarding this proportion are not yet known. The value of Q = 1-P = 1-0.5 = 0.5. The value of Zα = 1.96 for = 0.05. The relative accuracy value (d) is 0.2 then the sample size is:

$$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.2^2} = 24.01 \approx 25$$

Based on the calculation of the sample size, the number of subjects required is a minimum of 25 samples.

Samples who met the inclusion criteria signed informed consent as evidence that the sample agreed to participate in this study. Then the measurement of cognitive function was carried out on both the dick group and the treatment using the Indonesian version of the Montreal Cognitive Assessment (MoCA-Ina). The research sample installs the brain training application (NeuronationTM) on their smartphones. It ensures that each sample has an account and password that the examiner only knows with the aim that the sample does not exercise outside the specified time so that there is no positive bias in research results. The sample did brain training using the NeuronationTM application for 30 minutes every five days for one week. The examiner re-measured the cognitive function of each subject after being given treatment using the Indonesian version of the Montreal Cognitive Assessment (MoCA-Ina). Researchers analyzed the data on cognitive function results in the control group and the treatment before and after the brain training treatment. Data analysis includes descriptive analysis and hypothesis testing. The descriptive analysis of cognitive function data on a nominal scale is expressed as a frequency and percentage distribution. The normality of the distribution of data was analyzed using the Shapiro-Wilk test. This test was chosen because the sample size in this study included a small sample (<50). Hypothesis testing of differences in cognitive function in the control group and the treatment group before and after the brain training treatment was tested using the paired samples test.

RESULT

This research was conducted at FK UMM with a sample of 74 students who met the inclusion criteria. The sample was divided into two groups, 37 students as control and 37 as treatment. The control and treatment groups were examined for cognitive function using the MoCA-Ina test before and after treatment (brain training) so that pre-test and post-test data were obtained. The data obtained were analyzed according to the research objective to determine the effect of brain training activity on improving cognitive function in the control and treatment groups. In this study, researchers only received data from officers who had been determined so that researchers did not know and knew the sample, and officers and samples did not know the purpose of the study.

Based on table 5.1, cognition function (MoCA-Ina test), 37 control samples, and 37 treatment samples showed the exact composition of cognitive function, 59.5% poor and 40.5% good, before treatment (pre-test), after treatment (brain training), there was a very significant difference in the treatment group from 59.5% poor cognitive function decreased drastically to 2.7%, namely 56.8% and in the control group from 59.5% poor cognitive function decreased to 56.81 %, which is a decrease of only 2.69%. The excellent condition treatment group increased drastically from 40.5% to 97.3%, which was an increase of 58.8%, while in the control group, it increased from 40.5% to 43.25%, which only increased by 2.69%.

Tabel 5.1 Fungsi kogninif *pre-test* dan *post test* kelompok kontrol dan perlakuan (perlakuan *brain training*)

	Cognitive function (MoCA-Ina test) Pre test		
	Poor	Good	N
Control	22 (59,5%)	15 (40,5%)	37 (100%)
Treatment	22 (59,5%)	15 (40,5%)	37 (100%)

	Cognitive function (MoCA-Ina test) post test		
	Poor	Good	N
Control	21 (56,81%)	16 (43,2%)	37 (100%)
Treatment	1 (2,7%)	36 (97,3%)	37 (100%)

Source: Primary Data, 2019.

Based on table 5.1.2, the paired sample test analysis results show that in the control group with a 95% confidence level, there is an increase in the mean cognitive function of 0.3. Still, the analysis results are not significant, p = 0.571. In the treatment group with a 95% confidence level, there was an increase in cognition function, a mean of 5.7 with a significant analysis result, p = 0.000, which means that in the control group, there was a tendency for an increase in cognition after treatment (post-test), but the increase was not significant. In the treatment group with brain training activity, cognitive function increased sharply and statistically significantly; this shows that brain training activity affects increasing cognitive function.

Table 5.2 Analysis of paired samples test of cognition function pre-test and post-test control and treatment groups (brain training treatment)

	Mean	95% Confidence interval of the difference		sig
		Lower	upper	
Control	-,03	-,12	-,07	0,571
Treatment	-,57	-,74	-,40	0,000

Source: Primary Data, 2019.

DISCUSSION

The study was conducted on 74 students of FK UMM who were divided into two groups: the control group and the treatment group, and each group had 37 samples. Samples that meet the inclusion criteria are students in the first year aged 18-22 years. The average age of the sample obtained is 19.18, with the youngest age obtained is 18 and the oldest age is 21 years; BMI is

normal, and willing to undergo the MoCA-Ina test. The treatment group underwent brain training in the form of an online game NeuronationTM software for four weeks. This study aims to determine the effect of brain training activity treatment on improving cognitive function, which was tested using MoCA-Ina.

Sampling was carried out on first-year students aged 18-22 years with the consideration that at the beginning of the lecture, an adaptation process was needed from high school and different student periods in accepting new knowledge input, while we know that at the age of 18-22 years most of the cognitive functions needed to accept new learning does not develop to its peak (Nouchi R et al., 2013). Based on this background, training to improve cognitive function in the first year of college is necessary. The sample in this study had an average Body Mass Index (BMI) without a history of disease and was not on a particular diet. This is following the theory that the assessment of a person's BMI must be supported by other factors such as a history of illness, psychological conditions, and balanced nutritional intake to be said that a person is in good health. (Ahima, 2013)

Adequate and balanced nutrition will affect cognitive function. Nutrients such as protein, fat, minerals, carbohydrates, and vitamins are appropriately met so that brain cells will develop better. (Wahid, 2018). In this study, the sample was not allowed to go on a particular diet before and during the study to maintain adequate nutritional intake. (Wahid, 2018).

The selection of the MoCA-Ina test instrument in assessing cognitive function is because this test fulfills the domain of cognitive function as a whole and has components that are more specific than other cognitive function test instruments. The MoCA-Ina test was compared with the MMSE in assessing cognitive function, indicating that the MoCA-Ina test was more sensitive and specific than the MMSE (Wibowo, 2014). The MoCA-Ina test includes executive function, higher-level language, and complex visuospatial processing, making it possible to detect changes in the cognitive function domain. It will affect the results of cognitive function measurements if given treatment before and after cognitive function tests (Husein et al., 2011). 2010).

Cognitive function (MoCA-Ina test) 37 control samples and 37 treatment samples showed the same composition of cognitive function, 59.5% poor and 40.5% good before treatment (pre test), indicating this study had a homogeneous sample so that we can clearly distinguish cognitive function after treatment (post test) is meaningful or not. Physical activity is not only in the form of sports or doing daily work but also includes brain training or brain training which of course can improve several domains of cognitive function such as memory, attention, concentration, and language skills. (Lilienthal L et al, 2013, Rueda MR et al, 2005, Loosli SV et al, 2012, Karbach J et al, 2014). Cognitive function after treatment Brain training activity by playing a game 30 minutes every day, 5 days a week for 4 weeks) showed an increase in cognitive function in both the control and treatment groups, but there was a very significant difference in the treatment group from 59.5%

poor cognitive function decreased drastically to 2.7%, namely 56.8% decrease and in the control group from 59.5% poor cognitive function decreased to 56.81% which decreased only 2.69%. In the treatment group, the good condition function increased drastically 40.5% to 97.3%, namely an increase of 58.8%, while in the control group it increased from 40.5% to 43.25%, which only increased by 2.69% (table 5.1) and After analyzing the pairet samples test, it showed that the control group with a 95% confidence level experienced an increase in cognitive function but not significantly p = 0.571, while the treatment group with a 95% confidence level experienced a significant increase in cognitive function p = 0.000 which means that in the control group there is there is a tendency to increase cognition after the post test but the increase is not significant. In the treatment group with brain training activity cognitive function increased sharply and statistically significant, this indicates that brain training activity improved cognitive function. These results support the theory that brain plasticity can be stimulated even better if the activity is repeated (frequently) and with the right duration (Aini, 2016). Brain plasticity is the ability of the central nervous system (brain) to adapt or change after environmental influences or stimulation. Plasticity is a trait that indicates the capacity of the brain to change and adapt to functional needs. The plasticity of the nervous system is based on a process called synaptic reorganization (Heryati E, 2013).

Based on previous research on the effect of brain training also shows that brain training in games explicitly made to train cognitive abilities, such as NeuroNation software, can routinely improve a person's cognitive function. (Strobach, 2017). Increased memory, one of the domains of cognitive function, after being given brain training treatment, will trigger a stimulation that makes new connections to increase the thickness of the brain cortex and cause an increase in cell volume. Storing and retrieving memories will be easier and faster when there is a thickening of the brain cortex and increased cell volume, which causes the ability to communicate between neurons and neurotransmitters to increase (Yusdiyanti, 2017). Other studies also reveal that brain training can affect intelligence, such as problem-solving ability, reasoning ability, and visuospatial intelligence, which is also the domain of a cognitive function. Brain training involves this because of the stimulation of the brain to think and solve problems that are given continuously to form new synapses. (Hayes, 2017).

CONCLUSIONS AND SUGGESTIONS

Based on the results of the research and discussion above, the following conclusions can be drawn:

a. Treatment Brain training activities improve cognitive function
b. The score of cognitive function in the pre and post test control group without brain training treatment, good cognitive function increased from 40.5% to 43.25%, an increase of 2.69%.
c. The score of cognitive function in the pre and post test of the treatment group that was treated with brain training good cognitive function increased from 40.5% to 97.3%, which is an increase of 58.8%

Suggestions

a. The results of this study can be used as a reference for research on the effect of brain training activities on better cognitive function with more stringent inclusion and exclusion factors.
b. Re-study was carried out with more samples and carried out at an older age (elderly) to ensure that brain training activities improve cognitive function.

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