# Swimming as an Ultimate Exercise for Enhancing Speed of Psychomotor as A Part of Children Intelligence

Kelli Julianti, Go Goldyanta, and Mumtaz Hidayat

***Abstract*—**During mid and late childhood period, children's motoric development become more refined and coordinated than in the beginning of children's growth. The psychomotor speed is one of the component of intelligence that important for enhancing learning process in children. Psychomotor speed can be improved by physical activity or exercise. Swimming, as the aerobic physical activities can increase psychomotor speed through mechanism of neurogenesis improvement, synapse plasticity, brain blod flow, angiogenesis, vascular growth, neurotransmitter and epigenetic. This research aimed to determine the effect of swimming exercise as one of aerobic physcial exercise to speed psychomotor in children.The method used in this study was an experimental research with pre test – post test group design. The subjects were 13 children listed as a member in the Bina Taruna Pool Club in Purwokerto. The intervention is 5-weeks swimming with the frequency of 2-3 times per week, each swimming session is 30 minutes, divided into 5 series. Each series consisted of 6 minutes swimming and 5 m inutes of rest. Swimming will be carried out in moderate exercise zone (64-76% of maximum heart rate). The speed of psychomotor was measured by block design test, before and after intervention. Analysis of data using paired t test. The result from pre test score mean was 11.77 ± 2.77, and post test score mean was 13.31 ± 2.36. The analysis result showed that there was significant difference in block design score before and after swimming exercise, which is $p=0.020$ ($p<0.05$). There is an effect of swimming exercise to psychomotor speed in children.

***Keywords*—**Swimming, Psychomotor Speed, Children, Block Design Test.

## I. Introduction

LEARNING is one of the tasks of the child's development that involves three important aspects. There are cognitive, affective, and psychomotor which cant be separated. During the mid and late children, child motor development become more refined and coordinated than the early days of children (Santrock, 2002). Psychomotor speed is the amount of time to process a motor stimulus, preparing a response to be given and implement some response. Psychomotor process requires coordination between nerves and muscles (Whitbourne & Stacey, 2011).

Factors that can affect psychomotor speed are physical activity, age, level of education, and food intake. Physical activity has a positive effect on psychomotor abilities in young adults, proven by Gligoroska et al., (2010). Utami (2012) were also shown a link between physical activity in young adults psychomotor speed. Results of the study stated that the aerobic physical activity can improve psychomotor speed.

Aerobic physical activity can affect the function of a person's brain through a variety of mechanisms that increase neurogenesis, the plasticity of synapses, and an increase in cerebral blood flow, the process of angiogenesis, increased growth factor vascular, as well as the role of the factor of neurotrophic (Erickson et al., 2010; Perrey, 2013; Pinilla et al., 2008; Seifert & Secher, 2011). According to Ratey et al., (2011) shown that physical activity is associated with the increased of brain function and cognitive function during childhood and young adulthood. That study also said that aerobic activity can improve cognitive function.

Swimming exercise is a good form of aerobic activity because it involves all the major muscles of the body at the time of the move (Ray, 2008). One of the benefits of swimming are improve the ability of the brain. By increasing the ability of the brain, it can enhance psychomotor speed. Psychomotor speed is important to enhancing learning process, but there is no research about swimming exercise's effect to psychomotor speed, so the authors interest to explore more about this issues.

## II. METHOD

This research used experimental research with pre test and post test group design. The target population of this research is children, while affordable population of this study were all children who are the members of Bina Taruna Pool Club in Purwokerto that fullfilled the inclusion and exclusion criteria. This research was held for 5 weeks in November to December 2014 in Bina Taruna Pool Club Purwokerto.

No Sex Frequency Percentage (%) Mean of Block Design test Improvement

1 Male 2 15,4 2

Kelli Julianti is with Fakultas Kedokteran Universitas Jenderal Soedirman

Mumtaz Hidayar is with Fakultas Kedokteran Universitas Jenderal Soedirman

Go Goldyanta is with Fakultas Kedokteran Universitas Jenderal Soedirman

2 Female 11 84,6 1,45
Total 13 100 -

The sampling technique use total sampling technique. Criteria for inclusion in this study are children between 7-12 years old at the level of the pool preparation, willing to become respondents to fill out a letter of approval (informed consent) by the respondent's parents and informed consent with verbal assent of the respondents, the health condition measured with PAR-Q questionnaire, and able to understand the numbers and letters. The exclusion criteria in this study is resigning as respondents for any reason, the respondent did not meet in the presence undergo swimming program for 5 weeks, and respondent does not follow any of the tests that will be given by researchers.

Respondents who fullfilled the criteria for measurement of psychomotor speed will do block design test by psychologists. After performing the pretest, respondents do 5-weeks swimming exercise with the frequency of 2-3 times per week, each swimming session is 30 minutes, divided into 5 series. Each series consisted of 6 minutes swimming and 5 m inutes of rest. Swimming will be carried out in moderate exercise zone (64-76% of maximum heart rate). The speed of psychomotor was measured by block design test, before and after intervention. Analysis of data using paired t test.

## III. RESULTS

Subjects were selected according to inclusion and exclusion criteria . total sample who fullfilled the criteria were 13 children. There are the characteristics of respondents by age, sex, and educational level, explain in table 1.

TABEL I
SUBJECT CHARACTERISTIC BY AGE

| No | Age | Frequency | Percentage (%) | Mean of *Block Design test* Improvement |
|---|---|---|---|---|
| 1 | 7 years old | 2 | 15,4 | 4 |
| 2 | 8 years old | 2 | 15,4 | 0 |
| 3 | 9 years old | 4 | 30,8 | 1 |
| 4 | 10 years old | 3 | 23,1 | 1 |
| 5 | 11 years old | 1 | 7,7 | 5 |
| 6 | 12 years old | 1 | 7,7 | 0 |
| | Total | 13 | 100 | - |

Based on the table. Most subjects were in the age of 9 years that 4 children (30.8%) while the lowest frequency was in the age 11 and 12 years is 1 child (7.7%). The mean of increase in block design highest scores in children aged 7 years, while there are four children aged 8 years and 12 years that dont get improvement in the score block design.

TABEL II
UBJECT CHARACTERISTIC BY SEX

| No | Sex | Frequency | Percentage (%) | Mean of *Block Design test* Improvement |
|---|---|---|---|---|
| 1 | Male | 2 | 15,4 | 2 |
| 2 | Female | 11 | 84,6 | 1,45 |
| | Total | 13 | 100 | - |

The female subject of research are 11 people (84.6%) , more than 2 people men subject (15.4%). The mean increase in score of block design in boys (2) is more than female (1,45).

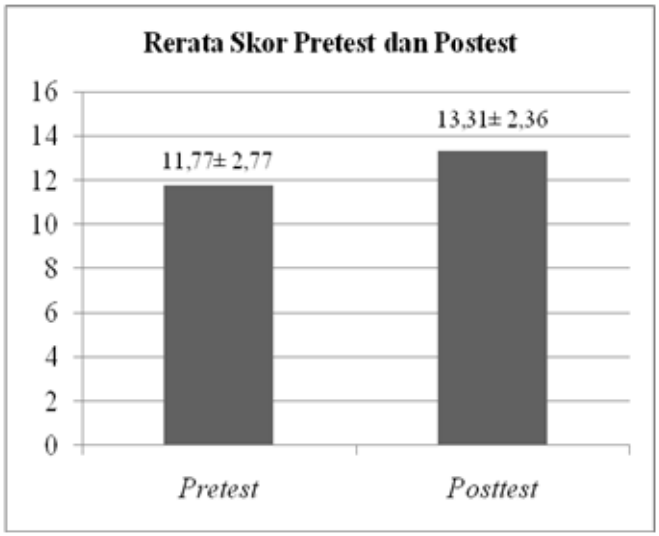
TABEL III
SUBJECT CHARACTERISTIC BY EDUCATION LEVEL

| No | Education Level | Frequency | Percentage (%) | Mean of *Block Design test* Improvement |
|---|---|---|---|---|
| 1 | 2nd Grade | 2 | 15,4 | 4 |
| 2 | 3rd Grade | 2 | 15,4 | 0 |
| 3 | 4th Grade | 5 | 38,5 | 0,8 |
| 4 | 5th Grade | 2 | 15,4 | 1,5 |
| 5 | 6st Grade | 1 | 7,7 | 5 |
| 6 | 8th Grade | 1 | 7,7 | 0 |
| | Total | 13 | 100 | - |

Based on education level, most participant are in 4th Grade (38.5%), and the fewest participant are on 6st and 8th Grade (7.7%). The highest Mean of *Block Design test* Improvement on 6th grade student, and there are no improvement on 6th grade and 8th group.

Mean of *Pretest* dan *Postest Block Design Score* are shown on Chart 1 . Post Test Score has a higher score compared than Pretest (13,31± 2,36).

Chart 1. Mean of *Pretest* dan *Postest Block Design Score*




TABEL IV
RESULT OF BIVARIAT TEST WITH PAIRED T-TEST

| | N | Mean ± SD | Mean Difference ± SD | CI 95% | *P-value* |
|---|---|---|---|---|---|
| *Pretest Score* | 13 | 11,77 ± 2,77 | 1,54 ± 2,06 | 2,79 – 2,89 | 0,020 |
| *Posttest Score* | 13 | 13,31 ± 2,36 | | | |

Normality Test using *Saphiro-Wilk*. The value of *block design pretest* is p=0,610, showed that the pre test data distributed normally (p>0,05). Otherwise, data block design posttest score distributed normally with p value =0,159 (p>0,05). Both of data are distributed normally, so it can be tested using bivariat test, t-paired test. Based on table 4 showed value of p=0,020 (p<0,05). The result show that there

is significant difference between block design score before and after intervention of 5 weeks Swimming Exercise.

## IV. DISCUSSION

The characteristic feature of respondents by age, sex, and level of education can be seen in Table 1, Table 2 and Table 3. Age is one of the factors that can affect a person's psychomotor speed. As the age increase, psychomotor speed increased along with the development of nerve function. Psychomotor speed will only decrease after passing through the maximum point of physical development, that is around the age of 30 years (Beth & White, 2000). The level of education is also a factor that affects psychomotor speed. Along with the entry of children into the primary school level, the cognitive ability is experiencing rapid development. In this study, the subject of research at the level of grade 2 to grade 8. The theory of synaptic reserve hypothesis explains that people with higher education have more synapses in the brain than those with lower education (Dash et al., 2005).

Research subjects in this study are mostly women, that are 11 subjects (84.6%). Gender differences can affect a person's psychomotor speed. Males have a slightly faster pace than women, but the difference is very small. It is caused by differences in the activities undertaken by men and women. Men tend to have more severe activity and requires more speed when compared to women (Anindya, 2009). In this study, researchers took the entire sample of both women and men. The mean increase in score of block design in boys is larger (2) compared to girls is

(1.45).

Analysis of the balanced block design in this study showed a mean score after swimming exercises during a 5 week higher at 13.31 ± 2.36 compared with the average scores before exercise is 11.77 ± 2.77. Statistical analysis used is paired t test that shows there is suitability with the study hypothesis that there is a relationship between outdoor activity and psychomotor speed of children that is member of Pool Club Bina Taruna Purwokerto. By paired t-test p value = 0.020 ($p < 0.05$), which means that there is a significant difference in the score block design before and after outdoor activities (in this case is swimming exercise) for 5 weeks.

The study results are consistent with Gligoroska et al., (2010), which compares level of activity with psychomotor speed. Gligoroska et al., (2010) stated there were significant differences in psychomotor speed test results between groups with low activity, medium, and high. Subjects in the group with low activity proved to take longer time to complete tests of psychomotor speed compared to groups of moderate physical activity and height.

The results of this study also support previous research, Masley et al., (2009) and Utami (2012) which proves the existence of a relationship between physical activity with psychomotor speed. Masley et al., (2009) divide physical activity into minimal aerobic exercise (control group), moderate aerobic exercise and high aerobic exercise. The results showed significant differences in psychomotor speed, attention, and cognitive flexibility in the group of moderate aerobic exercise and high aerobic exercise. Next Study, Utami (2012) divide groups that perform aerobic activity and no. Results of the study stated that individuals who engage in aerobic activity have better psychomotor speed compared to individuals who do not perform aerobic activity.

Aerobic physical activity such as swimming can improve the function of the nervous system of a person. Improved functions of the nervous system will affect psychomotor speed also someone through a variety of mechanisms. According to Erickson et al., (2010); Perrey (2013); Churcchill et al., (2002) Physical activity can affect brain function by mechanisms increase cerebral blood flow, neurogenesis and synaptic plasticity. Physical activity can also influence brain function through the process of angiogenesis, increased vascular growth factors, and the role of neurotrophic factors mediated by brain-derived neurotrophic factor (BDNF) (Pinilla et al., 2008; Seifert & Secher, 2011).

During physical exercise, metabolism in the brain increased in line with increased need for oxygen for aerobic metabolism, so that there will be an increase of Cerebral Blood Flow (CBF) (Perrey, 2013; Seifert & Secher, 2011; Ogoh & Ainslie, 2009). Dynamic movement closely associated with cortical activation and increased blood flow to the supplementary motor area and primary sensorimotor area, so as to train the coordination process in the formation of a person's movement on psychomotor abilities (Ogoh & Ainslie, 2009). Increase in CBF during physical activity can supply enough oxygen to the brain, and setting the CBF is essential for the maintenance of cardiovascular homeostasis (Perrey, 2013).

Aerobic exercise can increase neurogenesis in certain brain areas, these conditions lead to an increase in the gyrus dentatus in the hippocampus. Rodent studies in animals showed the effects of physical exercise to increase the number of folds gyrus dentatus in the hippocampus, which indicates an increase in the production and survival of new neurons (Van Praag, 2008). Neurogenesis process is influenced by biochemical substrates such as serotonin and Brain derived neurotrophic factor (BDNF) (Chaouloff, 1989). Besides a role in metabolic processes in the hippocampus is a major mediator of neurogenesis, BDNF also play a role in neuronal growth, resilience neurons, the efficacy of synaptic, linking neurons and plasticity of synapses (Pinilla et al., 2008; Van Praag, 2009; Chaouloff, 1989). In particular neurotrophin BDNF is able to support synapse plasticity. Synaptic plasticity refers to the ability of the brain and CNS to adapt to environmental change, respond to injury, and to obtain new information by modifying neural connectivity (Knaepen et al., 2010).

## V. CONCLUSION

The result showed that there are significant differences ($p < 0.05$) between the scores of block design before and after outdoor activities for 5 weeks. It can be concluded that There is an effect of swimming exercise to psychomotor speed in

children.

## ACKNOWLEDGMENT

We would like to thanks our lecturers, students of Faculty of Medicine, University of Jenderal Soediman, who have given support in completing this research. Our colleagues in Margono Soekarjo Hospital of Purwokerto for all kindness guidance, moral support and remarkable fellowship.

## REFERENCES

[1] Anindya TH. 2009. Pengaruh Latihan Fisik Terprogram Terhadap Waktu Reaksi Tangan pada Siswi Sekolah Bola Voli Tugu Muda Semarang Usia 9-12 Tahun. Skripsi: Fakultas Kedokteran Universitas Diponegoro.

[2] Beth A, White DA. 2000. Exploring the relationship between age, executive abilities, and psychomotor speed. Journal of the International Neuropsychological Society. 6(01): 76-82.

[3] Chaouloff T. 1989. Physical Exercise and Brain Monoamines : a review. ActaPhysiologica Scandinavian.137(1):1-13.

[4] Churchill JD, Galvez R, Colcombe S, Swain RA, Kramer AF, Greenough WT. 2002. Exercise, experience and the aging brain.Neurobiology of Aging. 23: 941–955.

[5] Dash P, Villemarette-Pittman. 2005. Alzheimer's Disease. New York: Demos Medical Publishing Inc.

[6] Erickson KI, Ruchika SP, Michelle WV, Laura C, Susie H, Molly ML, Brandt DP., et al. 2010. Brain derived neurotropic factor is associated with age-related decline in hipocampal volume. Journal of neurosciences. 30(15): 5368-5375.

[7] Gligoroska JP, Sanja M, Ljiljana B. 2010. Psychomotor Speed in Young Adults with Different Level of Physical Activity.Medical Archives. 64(3): 139-143.

[8] Knaepen K, Maaike G, Elsa MH, Romain M. 2010. Neuroplasticity – Exercise-InducedResponse of Peripheral Brain-DerivedNeurotrophic Factor. Sports Medicine. 40(9): 765-801.

[9] Masley S, Roetzheim R, Gualtieri T. 2009. Aerobic Exercise Enhances Cognitive Flexibility. Journal Clinical Psychology Medical Settings. 16: 186-193.

[10] Ogoh S, Ainslie PN. 2009. Cerebral Blood Flow During Exercise: Mechanism of Regulation. Journal Applied Physiology. 107: 1370-1380.

[11] Perrey S. 2013. Promoting Motor Function by Exercising the Brain. Brain Sciences. 3(1): 101-122.

[12] Pinilla G, Vaynman S, Ying S. 2008. Brain-derived neurotrophic factor functions as a metabotrophin to mediate the effects of exercise on cognition. European Journal of Neuroscience, 28(11): 2278-2287.

[13] Ratey JJ, James EL. 2011.The positive impact of physical activity on cognition during adulthood: a review of underlying mechanisms, evidence, and recommendation. Reviews in the Neurosciences. 22(2): 171-185.

[14] Ray AD, Pendergast DR, Lundgren CE. 2008. Respiratory Muscle Training Improves Swimming Endurance at depth. Undersa Hyperbaric Medical Society. 35(3): 185-196.

[15] Santrock JW. 2002. Life Span Development "PerkembanganMasaHidup". Jakarta: Erlangga.

[16] Seifert T, Secher NH. 2011. Sympathetic influence of cerebral blood flow and metabolism during exercise in humans. Progress in Neurobiology.95(3): 406–426.

[17] Utami RF. 2012. Hubungan antara Latihan Fisik dengan Kecepatan Psikomotor pada Dewasa Muda. Skripsi: Fakultas Kedokteran Universitas Jenderal Soedirman.

[18] Whitbourne SK, Stacey BW. 2011. Adult Development and Aging Biopsychosicoal Perspective 4th Edition. Hoboken: John Wiley & Sons.

[19] Van Praag, Henriette. 2009. Exercise and the brain: something to chew on. Trends Neurosciences. 32(5): 283-290.