Immediate Effects of Rhythmic Activity on Cognitive Performance in Female Adolescents: A Pilot study

Phromma W[1], Eungpinichpong W (Ph.D)[2], Wanpen S (Ph.D)[2*]

[1]Division of Exercise and Sport Sciences, Graduate School, Khon Kaen University, Thailand

[2]Deparment of Physical Therapy, Associated Medical Science, Khon Kaen University, Thailand

[*]Corresponding author: sawitri@kku.ac.th

Abstract

Introduction: Adolescence means a period where a person's mind and cognitive skills are still not fully developed, not until the person is in his mid-twenties. Previous studies reported that physical exercise may help brain development and improve cognitive capabilities in adolescents. Rhythmic activity is a form of multimodal exercise which is widely used in school's class. The students have to remember movement patterns and coordinate movement to the rhythm of music stimulates the mood and rewards center in the brain.

This study aimed to investigate immediate effect of rhythmic activity on cognitive performance by assessing Stroop test and trail making test in female adolescent's age between 14-17 years old.

Methods: Ten young female sedentary participants were randomly assigned into an experimental group and a control group. Participants in the experimental group were asked to perform rhythmic activity for 40 minutes. In the control group, the participants watched non-fiction VDO for 40 minutes. The Stroop test and trail making A and B test were used as measures for selective attention and task switching performance respectively. They were administered before and immediate after rhythmic activity.

Results: After exercise, both groups showed significant improvement of the cognitive performance in trail making A and B test ($p<0.05$). Stroop performance was increased significantly in exercise group but not in control group ($p<0.05$). However, when compared between two group, the results revealed no statistically significant different of all cognitive parameters.

Conclusions: This pilot study suggested that the immediate effect of rhythmic activity may be benefit in selective attention and task switching. Further study with adequate number of participants should be performed.

Keywords: Cognitive performance, Multimodal exercise, Adolescent

Introduction/Objective

Adolescence means a period where a person's mind and cognitive skills are still not fully developed, not until the person is in his mid-twenties. Previous studies reported that physical exercise helps brain development in adolescents. Exercise is one factor that can improve brain performance and cognition.[1)2)3)] Children between born to 19 years of age using physical activity are more likely to developed physical activity development of knowledge, learning and behavioral learning.[4)] Exercise forms that can help in the development of cognitive performance are all forms of exercise. The level of exercise intensity from light to heavy can increase the cognitive performance.[1)2)5)6)]

A number of studies reveal that aerobic exercise with moderate or low-moderate intensities resulted in better concentration, faster thinking, and better planning. [7)-17)] In youths who perform aerobic exercise regularly, it results in immediate and better performance of stoop task, and higher brain activities in dorsolateral and prefrontal lobes. However, the previous studies on performing exercises using treadmill and bicycle ergometry emphasize on working to increase cardiopulmonary duration only.[15)-20)]

Rhythmic activity is one form of dancing which orientates movement associated with music. Rhythmic activity is the combination of aerobic exercise, thinking and concentration which may provide positive effect on cognitive performance. Base on the exercise-induced arousal level hypotheses; the model the inverted-U hypothesis[21)] and other arousal theories.[22)] Cognitive performance was predicted to improve as physiological arousal increased and then deteriorate as arousal levels approached maximal levels.[23)] As there have been lack of previous studies of the immediate effects of rhythmic activity on the cognitive performance, the present study's research question is whether the single bout of rhythmic activity could provide immediate positive effect on brain activities regarding cognitive performance or not. In this study, researchers used color–word matching Stroop performance test and trail making test in testing cognitive performance. The Stroop performance and trail making test reveal the selective attention ability and task switching ability respectively. This study aimed to investigate immediate effect of rhythmic activity on cognitive performance by assessing Stroop test and trail making test in female adolescent's age between 14 – 17 years old.

Methods/Methodology

This study protocol was approved by the Human Ethics committee of Khon Kaen University (KKU). The methodology conducted is detailed as followed.

Participants

Ten sedentary female adolescent participants were recruited via advertisements. All participants were asked to complete a health screening PAR-Q questionnaire to ensure that it was safe for the participants to perform the exercise. All participants were randomly assigned into an experimental group and a control group. Participants in the experimental group were asked to perform rhythmic activity for 40 minutes. In the control group, the participants watched non-fiction VDO for 40 minutes. Cognitive performance was evaluated using Stroop test and Trail making test before and 4 minutes after the end of the session for both groups.

Rhythmic activity includes light to moderate intensity of aerobic exercise, body movement and music. The rhythmic activity in this study composed of 10 minutes warm up followed by 20 minutes dance and then 10 minutes cool down. Four selected songs with dancing choreography base on the participants preference were used for rhythmic activity in this study. Control group were watching nature documentary 40 minutes

Cognitive performance test

Participants in this study completed a computerized version of the Stroop Test and Trail making test using Inquisit software (Millisecond Software, 2001, Version 4.0.8.0 free trail) which allowed the precise assessment of response time.

The Stroop Test

The computerized Stroop Test consisted of three types of trials: neutral, congruent and Incongruent. In neutral trials, stimuli consisted of one color patches (red, green, blue and black). In the congruent trials, stimuli consisted of one of color words in which the name of the word was the same as the color of ink. In the incongruent trials, the stimuli consisted of one of the same three color words; however, the color of the word's ink did not match the word meaning. In all conditions, the participant was asked to identify the color of the ink by pressing the keyboard by using the certain assigned keys: "d" for red, "f" for green, "j" for blue, and "k" for black. The participants were to place index and middle fingers of both hands on keys "d", "f", "j" and "k" respectively.

Trail making test

The Trail making test was evaluated 2 parts; TMT part A and TMT part B. The TMT part A was draw for number 1 – 15 and TMT part B was draw for switch number and word, for example 1 to A to 2 to B…to H to finished, less time was better.[24)]

Statistical analyses were conducted using the STATA Statistics software (version 10) to calculate averages and standard deviations. The data were expressed as the mean ± standard deviation (SD). The significance level was set to α=0.05 when performing the paired and unpaired t-test.

Results and Discussion

Table 1 Demographic and baseline characteristics

Variable	Rhythmic Activity (n=5)	Control group (n=5)	Diff.	p-value
	mean±S.D.	mean±S.D.		
Age (years)	15.00±1.22	15.20±0.84	-0.20	0.77
Weight (kg)	47.70±3.46	47.60±3.29	0.10	0.96
Height (cm)	155.20±2.28	153.20±3.35	2.00	0.30
BMI (kg/m^2)	19.82±1.65	20.28±1.46	-0.46	0.65
Heart rate (beats/ min.)	83.40±13.54	86.00±14.40	-2.60	0.78

Note: Diff. is mean difference of 95 % CI, per min. is per minute

* Statistic significant p-value < 0.05

In table 1 show general characteristic of participants in this study all variable show not significant between groups.

Table 2 Comparison of reaction time in each Stroop condition and Trail Making Test results; comparison within and between groups

Variable	Rhythmic activity (n=5)			Control group (n=5)			Compare bet group
	Pretest mean±S.D.	Posttest mean±S.D.	p-value	Pretest mean±S.D.	Posttest mean±S.D.	p-value	p-value
ST congruent(ms)	1581.67 ±153.25	1107.96 ±109.44	0.00**	1359.58 ±238.93	1149.36 ±349.54	0.14	0.81
ST incongruent(ms)	1983.98 ±326.56	1326.24 ±235.53	0.01**	1930.11 ±642.42	1388.09 ±390.70	0.07	0.77
TMT part A(ms)	73563.00 ±8859.04	47952.60 ±21434.02	0.05*	85824.80 ±17195.51	56931.80 ±5009.10	0.01**	0.39
TMT part B(ms)	98742.60 ±16019.32	67985.40 ±5964.62	0.01**	100191.40 ±23820.13	63292.00 ±16152.17	0.05*	0.56

Note: ST is Stroop test., TMT is trail making test., ms is millisecond.

* statistic significant p-value < 0.05

** statistic significant p-value < 0.01

Table 2 show the comparison of reaction times between control and experimental groups. There were no statistically significant differences found in all parameters both before and after the experiment sessions (p>0.05). After exercise, both groups showed statistically significant improvement of the cognitive performance in trail making A and B test (p<0.05). However, only in the rhythmic activity group, the reaction times in all conditions of the Stroop test decreased significantly after exercise.

The findings of this study reveal that, following the cessation of exercise, both groups showed statistically significant improvement of the cognitive performance in trail making A and B test (p<0.05). Stroop performance increased significantly in exercise group but not in control group (p<0.05). However, when compared between two groups, the results revealed no statistically significant different of all cognitive parameters.

By performing the rhythmic activity move, participants were required to dance in the assigned patterns accompanying the melody and rhythms of the music. This required the working coherences between motor and sensory system. The participants were working on dancing patterns in the correct steps through the rhythms provided. Besides the characteristic of the rhythmic activity in the present study which activated several brain areas.[25)26)]

The average intensity according to the participants' Borg Rating of Perceived Exertion (RPE) levelduring 20 minutes of the rhythmic activity was light (data not show). For the cognitive benefit, Kamijo (2004) reported that light to moderate exercise intensity can increase arousal level whereas high intensity of exercise will decreased arousal level. However, the exercise intensity used in the present study were somehow, not the best intensity for optimize the arousal level. Yerkes and Dodson, (1908) stated that a certain amount of arousal can be benefit for cognitive performance while too much or too little amount will work against it. The mid-level point of arousal provides the benefit for cognitive performance. The arousal level cause by this exercise intensity could benefit for cognitive performance.

The limitation of this study was the small sample size. The non-significant results related to the differences between groups are probably due to a Type II error because of the small sample size. A larger sample size can be looked to provide more significant results in future studies.

Conclusions

This pilot study suggested that the immediate effect of rhythmic activity may provide beneficial effect in selective attention and task switching in this specific population.

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