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# THE EFFECTS OF PHYSICAL ACTIVITIES ON COGNITIVE FUNCTIONS: AN EXPERIMENTAL STUDY

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***Abstract***
*This experimental study investigates the impact of physical activity on cognitive functions among adolescence. A total of 20 participants were an activity group. Over a 12-week period, the activity group engaged in structured rhythmic activity training. Cognitive functions were assessed using standardized tests before and after the intervention. Cognitive Assessment Battery (CAB)™ PRO test (CogniFit Inc., San Francisco, CA, USA). It is an online suite of neuropsychological battery tests. The outcomes of the study furnish a comprehensive report, detailing individual scores across 22 cognitive skills and well-being. The validity index of the measurements encompasses Z-scores, percentiles, and adjusted percentile scores.In the evaluation of test-retest reliability for the Cognitive Assessment Battery (CAB), RMANOVA and intergroup correlation were judiciously employed. The results from RMANOVA underscored significant distinctions in cognitive functions among the Rhythmic Activities.*

## Introduction

Cognitive functions, which encompass a range of mental processes including attention, memory, and problem-solving skills, are essential for daily functioning and overall quality of life. Emerging research suggests that physical activity may play a pivotal role in enhancing these cognitive abilities. The positive correlation between physical activity and cognitive health is increasingly recognized, particularly as populations age. This study aims to provide empirical evidence regarding the effects of structured physical activity on cognitive functions.

The hypothesis guiding this research posits that individuals engaging in regular physical activity will exhibit significant improvements in cognitive functions compared to those who do not participate in such activities. Understanding this relationship is crucial, as it can inform interventions aimed at improving mental health and cognitive resilience.

**Methodology Research Design:**This study utilized a randomized experimental design, enabling the assessment of the causal relationship between physical activity and cognitive function.

**Participants:**A total of 20 adolescence, aged 12-14, were recruited for the study. Participants were randomly assigned to either the Rhythmic activity group. Inclusion criteria included no history of neurological disorders and a willingness to participate in the physical activity program.

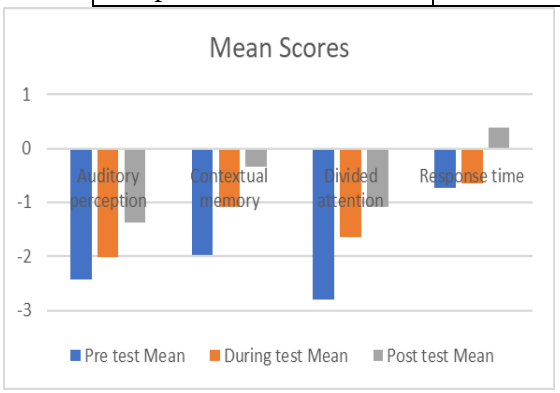
**Training Program:**The Rhythmic activity group underwent a structured physical training program that lasted 12 weeks. The program included aerobic exercises and Zumba conducted six times a week for one hour per session.

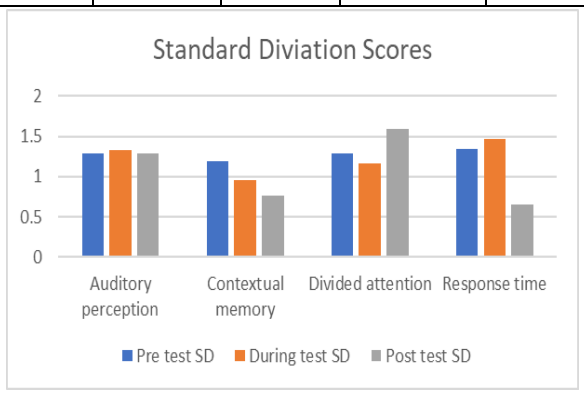
**Assessment Tool&Data Analysis:**In this study used a gamified cognitive stimulation program developed by CogniFit (CogniFit Inc., San Francisco, CA, USA). This tool is designed to enhance five key cognitive domains-reasoning, memory, attention, coordination, And perception. The program tailors each participant's training experience Based on an initial cognitive evaluation, adjusting the

difficulty level through an adaptive algorithm. This evaluation is conducted using the Cognitive Assessment Battery (CAB)™ PRO test, which yields an overall cognitive score and Individual scores for each of the five targeted domains. The recorded data was meticulously entered into an MS Excel spreadsheet, facilitating systematic organization.To scrutinize the data, a robust statistical approach, RMANOVA (Repeated Measures Analysis of Variance), was employed.

**Table 1. Mean and Standard Deviation table for Rhythmic activities group.**

| Feature | Pretest | | Duringtest | | Posttest | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Auditoryperception | -2.4298 | 1.2856 | -2.0062 | 1.3257 | -1.3654 | 1.286 |
| Contextualmemory | -1.9698 | 1.1893 | -1.0885 | 0.9606 | -0.3299 | 0.7604 |
| Dividedattention | -2.8101 | 1.2884 | -1.6456 | 1.1565 | -1.0776 | 1.5908 |
| Responsetime | -0.7376 | 1.342 | -0.6589 | 1.4674 | 0.3921 | 0.6461 |




The data presents the mean scores and standard deviations (SD) for four cognitive function measures—auditory perception, contextual memory, divided attention, and response time.

**Mean Scores:** The mean scores across all measures indicate a general trend of improvement. Initially low scores reflect cognitive challenges, but the subsequent mean values suggest significant enhancement in cognitive functions as the intervention progressed.

**Standard Deviations:** The standard deviations reveal the variability of participant scores across the measures. Initially, the SD values are relatively high, indicating considerable differences in baseline cognitive abilities among participants. As the study progressed, some measures showed decreased variability, suggesting more consistent improvements among participants, while others exhibited increased variability, indicating a range of responses to the intervention.

Overall, the analysis highlights positive cognitive changes, with mean scores reflecting substantial gains and standard deviations illustrating varying levels of consistency in participant performance throughout the study.

**POST-HOCtablesforsignificantvariablesinRhythmicactivitiesgroup**

From RMANOVA analysis, it is observed that there are several variables are significant. To enable a comprehensive exploration of nuanced differences among the tests, we employed post-hoc tests for each significant variable in the Rhythmic activities group.

**Table 2. Tukey-Kramer Post Hoc Test for Auditory perception**:
Multiple Comparison of Means – Tukey HSD, FWER=0.05

| Group 1 | Group 2 | Mean Diff. | p-adj | Lower | Upper | Reject |
|---|---|---|---|---|---|---|
| Pre test | During test | -0.4237 | 0.529 | -1364 | 0.5166 | False |
| During test | Post test | 0.6408 | 0.2384 | -0.2995 | 1.5811 | False |
| Pre test | Post test | -1.0644 | **0.0228*** | -2.0047 | -0.1241 | **True** |

**Table 4. Tukey-Kramer Post Hoc Test for Contextual memory**:
Multiple Comparison of Means – Tukey HSD, FWER=0.05

| Group 1 | Group 2 | Mean Diff. | p-adj | Lower | Upper | Reject |
|---|---|---|---|---|---|---|
| Pre test | During test | -0.8813 | **0.0117*** | -1.5948 | -0.1679 | **True** |
| During test | Post test | 0.7586 | **0.0346*** | 0.0451 | 1.472 | **True** |
| Pre test | Post test | -1.6399 | **0.0*** | -2.3534 | -0.9265 | **True** |

**Table 5.** Tukey-Kramer Post Hoc Test for **Divided attention**:
Multiple Comparison of Means – Tukey HSD, FWER=0.05

| Group 1 | Group 2 | Mean Diff. | p-adj | Lower | Upper | Reject |
|---|---|---|---|---|---|---|
| Pre test | During test | -0.1645 | **0.0163*** | -2.147 | -0.11821 | **True** |
| During test | Post test | 0.568 | 0.3534 | -0.4145 | 1.5504 | False |
| Pre test | Post test | -1.7325 | **0.0002*** | -2.7149 | -0.75 | **True** |

**Table 11.** Tukey-Kramer Post Hoc Test for **Response time**:
Multiple Comparison of Means – Tukey HSD, FWER=0.05

| Group 1 | Group 2 | Mean Diff. | p-adj | Lower | Upper | Reject |
|---|---|---|---|---|---|---|
| Pre test | During test | -0.0786 | 0.9746 | -0.9523 | 0.795 | False |
| During test | Post test | 1.0511 | **0.0145*** | 0.1774 | 1.9247 | **True** |
| Pre test | Post test | -1.1297 | **0.0079*** | -2.0034 | -0.256 | **True** |

**Table 12.** Tukey-Kramer Post Hoc Test for **Shifting**:
Multiple Comparison of Means – Tukey HSD, FWER=0.05
**Post-hoc table will help the significance of the variable over the time.**
**Summary of the post-hoc results given below:**

1. The **Auditory perception** variable is significant **During Pre-Test** to **Post-Test**.
2. The **Contextual memory** variable is significant **across the times**.
3. The **Divided attention** is significant **Pre-Test** to **During-Test** and **Pre-Test** to **Post-Test**.
4. The **Response time** is significant **during test** to **Post test** and **Pre-Test** to **Post-Test**.

**Summary of Research Hypothesis** 1:
The study investigates the impact of Rhythmic Activities on Cognitive Functions (CF) and Mental Health (MH). Hypotheses were formulated with the null hypothesis ($H_0$) positing no difference in activity over time for CF and MH variables, and the alternative hypothesis ($H_1$) suggesting a difference. Utilizing Repeated Measures Analysis of Variance (RM ANOVA), the

study identified significant variables with p-values less than 0.05. Noteworthy variables included Auditory Perception, Contextual Memory, Divided Attention and Response Time.

**Z-Score Analysis**

The cognitive and mental health measures analyzed in this study yielded Z-scores that were generally negative and close to zero, with some scores exceeding 2.5 standard deviations below the mean. This trend indicates lower-than-average performance levels among the study population in these specific areas.

**Discussion Section**

Interpretation of Negative Z-Scores:

The predominantly negative Z-scores observed may reflect specific characteristics of the adolescent population in this study. This age group often experiences developmental changes that can impact cognitive and emotional regulation, especially in under-resourced or high-stress environments, where factors such as academic pressure, family circumstances, and social dynamics may influence mental health and cognitive performance.

**Linguistic and Cultural Context**

All assessments were conducted in the participants' mother tongue to ensure comprehension and minimize any language-related bias. However, other socio-environmental factors, including the educational background and exposure to cognitive-stimulating activities, may also have contributed to the observed performance levels.

**Study Population Characteristics**

The adolescents in this study may belong to groups facing unique challenges or limitations in terms of access to resources and educational support, which could impact their performance relative to normative data. These characteristics will be elaborated upon to provide context for the lower Z-scores and highlight the importance of tailored interventions that address these specific needs.

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