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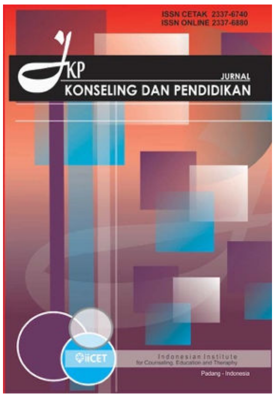

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Article

The effects of cross crawl and owl exercises on memory and focus in early childhood

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ABSTRACT

Cognitive abilities such as memory and concentration are essential for early childhood development, influencing academic readiness and social adjustment. However, many children face challenges in sustaining attention and retaining information, and existing intervention methods often lack integration and movement-based engagement. This study aims to evaluate the effectiveness of a combined Brain Gym intervention–Cross Crawl and The Owl exercises on improving memory and concentration in early childhood. A quasi-experimental design with pre-test and post-test control groups was employed, involving 60 children aged 4–6 years from Skoebi-Do Child Care Centre, Bali. Participants were randomly assigned to an experimental group (receiving both Cross Crawl and The Owl techniques) and a control group (receiving only Cross Crawl). Data were collected using structured observation instruments, which had been validated and tested for reliability to ensure accurate measurement of cognitive outcomes. The findings demonstrated significant improvements in memory and concentration among children in the experimental group compared to the control group. These results indicate that integrative Brain Gym interventions are more effective in stimulating core cognitive functions during early childhood. This study contributes to the growing evidence supporting movement-based educational strategies as a practical and accessible approach for enhancing cognitive development in early learners.

Keywords:

Combined brain gym
Memory
Preschool children
Concentration
Early childhood
Cognitive stimulation
Quasi-experimental design

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Introduction

Recent empirical studies indicate a growing concern regarding the insufficient development of memory and concentration among children in early childhood education and care (ECEC) institutions, particularly in developing countries (Lasmawan & Budiarta, 2020;Savina, 2021). Field observations and educational reports in Indonesian ECE settings show that many children struggle with retaining simple sequences, following multi-step instructions, and sustaining attention during structured play and learning activities (Sucharitha et al., 2020; Erawati, 2021). These cognitive challenges not only hinder school readiness but also increase the risk of behavioral maladjustment and learning delays (Reina, 2020; Salleg-Cabarcas et al., 2024; Shavit et al., 2018; Sinaga & Syari, 2022; Suardipa, 2020; Vásquez-Carrasco et al., 2025). Addressing this issue is crucial to ensure that foundational cognitive skills—such as working memory and attentional control—are adequately developed in the early years, a period widely recognized for its neuroplasticity and responsiveness to intervention (Margolis, E. T., et al, 2024).

Memory and concentration are core dimensions of executive function that significantly predict academic performance (He Z. et al., 2024; Markant & Amso, 2022), language acquisition, and emotional self-regulation (He, Z. et al., 2024). However, interventions in early childhood education often emphasize language and motor domains, with limited structured programs targeting cognitive stimulation through integrated movement-based approaches. Furthermore, many existing methods are either overly passive or lack empirical support for early learners, especially in non-Western educational contexts. This presents a notable research gap in the development of effective, culturally adaptable, and age-appropriate cognitive stimulation strategies for preschool-aged children.

One promising yet underexplored approach is Brain Gym, a movement-based intervention that aims to enhance neurological efficiency through coordinated physical exercises (Maniazhagu et al., 2022). Among its various techniques, Cross Crawl and The Owl have been widely discussed for their potential impact on working memory and attentional control. Cross Crawl involves alternating limb movements that are believed to stimulate interhemispheric communication and improve motor-cognitive integration (Baron, 2005). Meanwhile, The Owl exercise provides sensory stimulation through deep-pressure and neck movement, promoting relaxation and attentional modulation (Wang, Y. et al, 2023). These two techniques were chosen for their complementary mechanisms—motor activation and sensory feedback—and their practical feasibility in classroom settings (Capodieci et al., 2018).

While several studies have highlighted the general benefits of Brain Gym in improving concentration (Mendrofa et al., 2020), enhancing short-term memory (Adriani et al., 2020), and supporting academic behavior, most of this research focuses on older, school-aged children. Few studies isolate the effects of specific techniques like Cross Crawl and The Owl, and even fewer are conducted within institutional early childhood education contexts. A meta-analysis by Smith et al. (2021) underscores the lack of empirical evaluation on the simultaneous use of these Brain Gym techniques in preschool populations, particularly in culturally distinct settings such as Southeast Asia. Moreover, previous research rarely accounts for environmental and pedagogical dynamics in early childhood centers, which may affect the applicability of movement-based interventions.

To address this gap, the present study was conducted at Skoebi-Do Child Care Centre in Bali, an early childhood education institution serving children aged 4–6 years. The center was selected based on its structured curriculum, experienced staff, and willingness to implement holistic developmental interventions. The study incorporated validated observation instruments and was designed to ensure ecological validity by integrating the intervention into regular classroom routines.

Grounded in Vygotsky's sociocultural theory, which emphasizes the importance of mediated learning through interaction and tools (Bodrova & Leong, 2020), and Piaget's theory of sensorimotor and preoperational development, which underscores the role of physical activity in cognitive growth (Lasmawan & Budiarta, 2020), this research seeks to examine how movement-based activities influence memory and concentration. These theoretical perspectives support the hypothesis that combining Cross Crawl and The Owl exercises may stimulate cognitive development more effectively than a single-technique approach.

The objective of this study is to evaluate the effectiveness of the Brain Gym techniques Cross Crawl and The Owl—both individually and in combination—in improving memory and concentration in preschool-aged children enrolled in early childhood care centers in Bali. The study aims to contribute to the theoretical discourse on embodied cognition and offer practical implications for implementing non-pharmacological, movement-based interventions in early childhood education.

Method

This study employed a quasi-experimental design (Creswell, J. W., & Creswell, J. D., 2017) with a Nonequivalent Control Group Design to evaluate the effectiveness of the Brain Gym method (a combination of Cross Crawl and The Owl) in improving memory and concentration among early childhood learners. The research was conducted over a two-month period (April–May 2025) at two locations of the Skoebi-Do Child Care Centre: Canggu, serving as the experimental group that received the combined Brain Gym intervention, and Sanur, serving as the control group that received only the Cross Crawl technique. The study population consisted of 120 children aged 4 to 6 years across four classes at both childcare centers. The sample was drawn using random class sampling, resulting in 29 Kindy B students from Canggu assigned to the experimental group and 21 Kindy A students from Sanur assigned to the control group. Both sample groups shared similar age ranges and exhibited comparable difficulties with memory and concentration, allowing for accurate comparison.

The independent variable in this study was the combined Brain Gym technique (Cross Crawl and The Owl), which served as the researcher-manipulated intervention. Cross Crawl involves cross-lateral movements aimed at improving body and brain coordination, while The Owl is designed to stimulate brain activity and enhance focus. The implementation of both techniques was guided by structured instructions and timing, measured on a 1-to-4 scale. The dependent variables were memory (the ability to store and recall verbal and non-verbal information) and concentration (the ability to focus on tasks while ignoring distractions) in early childhood learners. These dependent variables were measured through structured observation using an ordinal scale ranging from 1 to 4.

Data collection involved initial observation (pre-test) and final observation (post-test) using validated observation sheets. Instrument validity was assessed through content validity, evaluated by two experts in educational psychology and early childhood education, yielding a Gregory validity index of 0.68 for memory and 1.0 for concentration. Empirical validity was tested using the Pearson product-moment correlation, with all items on the memory and concentration scales shown to be valid. Instrument reliability was tested using Cronbach's Alpha, resulting in very high reliability coefficients (0.986 for memory and 0.979 for concentration). The collected data were analyzed descriptively (frequency distributions and data visualizations) and inferentially using Multivariate Analysis of Variance (MANOVA), following normality testing (Kolmogorov-Smirnov) and homogeneity testing (Levene's test). The research procedure included the following stages: pre-test, implementation of the Brain Gym intervention, post-test, data analysis, and interpretation of results to draw conclusions and provide recommendations.

Results and Discussion

Description of Memory and Concentration in the Experimental and Control Groups

The experimental intervention consisted of Brain Gym activities focusing on Cross Crawl and The Owl movements, implemented in 40 sessions over a two-month period. Each Brain Gym session lasted approximately 15–20 minutes and was consistently conducted each morning before academic activities began. Table 1 presents the descriptive statistics of memory and concentration scores for both the experimental and control groups.

In the experimental group, there was a significant increase in both observed variables. The average memory score rose from 44.52 in the pretest to 61.28 in the posttest, with the lowest score increasing from 32 to 48. Meanwhile, for the concentration variable, the average score also experienced a significant rise from 38.17 to 61.28, with the lowest score increasing from 29 to 48. The N-Gain value for memory was 0.2904 and for concentration was 0.2637, both of which fall into the moderate category based on Hake's classification (Hake, R., 2002). Furthermore, the standard deviation in the experimental group tended to decrease after the treatment, indicating that the improvement was more evenly distributed among participants.

In contrast, the control group also showed improvement, but not as significantly as the experimental group. The average memory score increased from 46.90 to 53.67, and the lowest score only rose from 31 to 34. For the concentration variable, the average score increased from 40.19 to 48.19, with the lowest score rising from 23 to 35. The N-Gain value in the control group was 0.1333 for memory and 0.1311 for concentration, both categorized as low. Additionally, the standard deviation in the control group indicated greater variability in improvement compared to the experimental group, suggesting that the outcomes in this group were less evenly distributed.

Table 1. Descriptive Statistics of Memory and Concentration Scores for Experimental and Control Groups

			Highest Score	Lowest Score	Mean	SD
Experimental Group	Memory	Pre test	63	32	44.52	7.104
		Post test	68	48	61.28	6.745
		N-Gain		0.2904		
	Concentration	Pre test	51	29	38.17	5.372
		Post test	68	48	61.28	6.745
		N-Gain		0.2637		
Control Group	Memory	Pre test	58	31	46.90	6.316
		Post test	68	34	53.67	9.388
		N-Gain		0.1333		
	Concentration	Pre test	53	23	40.19	6.096
		Post test	58	35	48.19	6.6.329
		N-Gain		0.1311		

The following table shows the frequency distribution comparison between the experimental and control groups for the two measured variables—memory and concentration—both before and after the Brain Gym intervention.

Table 2. Frequency Distribution of Early Childhood Memory and Concentration Before and After Brain Gym Intervention at Skoebi-Do Child Care Centre

Variable	Experimental Group				Control Group			
	Before		After		Before		After	
	f	%	f	%	F	%	f	%
Memory								
Very Capable	2	6.9	16	55.2	1	3.4	5	17.2
Capable	18	62.1	13	44.8	18	62.1	14	48.3
Not Capable	9	31.0	-	-	2	3.4	2	6.9
Very Not Capable	-	-	-	-	-	-	-	-
Contration								
Very Capable	-	-	20	69.0	1	3.4	8	27.6
Capable	16	55.2	8	27.6	19	65.5	12	41.4
Not Capable	13	44.8	1	69.0	1	3.4	1	3.4
Very Not Capable	-	-	-	-	-	-	-	-
Total	29	100	29	100	21	100	21	100

Before the implementation of the experiment, only 6.9% of children in the experimental group were categorized as highly capable in memory ability, while the majority (62.1%) fell into the capable category, and 31% were still categorized as not capable. However, after receiving the intervention using the combined Brain Gym method (Cross Crawl and The Owl), a significant improvement was observed: 55.2% of the children were now classified as highly capable, and no child remained in the not capable category. This indicates a clear upward shift in the distribution of abilities within the experimental group.

In contrast, the control group also showed improvement, but to a lesser extent than the experimental group. The percentage of children classified as highly capable increased from 3.4% to only 17.2%, while the capable category experienced a slight increase from 62.1% to 48.3%. However, the not capable category still remained at 6.9%, indicating that the intervention using the single Brain Gym method (Cross Crawl) was less optimal in comprehensively improving memory ability.

A notable change was also seen in the concentration variable within the experimental group. Prior to the intervention, no child was classified as highly capable, with the majority (55.2%) falling into the capable category, and 44.8% still considered not capable. After implementing the combined Brain Gym method, 69% of the children reached the highly capable category, and only one child (3.4%) remained in the not capable category. This demonstrates a significant improvement in concentration ability as a result of the intervention.

Meanwhile, the control group experienced more moderate improvement. The number of children in the highly capable category increased from 3.4% to 27.6%, while the not capable category remained unchanged at 3.4%. Although there was some progress, the proportion of improvement in the control group remained lower compared to the experimental group, indicating that the combined Brain Gym method was more effective in significantly enhancing memory and concentration in early childhood..

Assumption Testing

Before conducting the main statistical analysis MANOVA several preliminary assumption tests were performed to ensure that the dataset met the requirements for parametric statistical analysis (Creswell, J. W., & Creswell, J. D., 2017). These assumption tests included normality testing of the N-Gain scores, homogeneity testing, and multicollinearity testing. The purpose of these tests was to validate the fundamental assumptions of parametric analysis: that the data must be normally distributed, demonstrate homogeneous variance, and not exhibit high multicollinearity among independent variables. If these assumptions are met, parametric tests can be conducted legitimately, and the results can be interpreted validly. To appropriately test the research hypothesis, preliminary evaluation of data eligibility was carried out through normality, homogeneity, and multicollinearity tests, which are elaborated below.

Normality Test

Table 3 presents the results of the Kolmogorov-Smirnov normality test for the two main variables–memory and concentration–conducted on both the experimental and control groups. The goal of the normality test was to determine whether the data distribution for each variable followed a normal distribution, which is a critical assumption in applying parametric tests such as MANOVA.

Table 3. Normality Test Results for Experimental and Control Groups

	Significance Value (N-Gain)	
Variable	Experimental Group	Control Group
Memory	0.200	0.066
Concentration	0.061	0.200

Based on the results of the normality test on the N-Gain scores, it was found that all variables–both memory and concentration–in both groups showed significance values greater than 0.05 (the experimental group scored 0.200 for memory and 0.061 for concentration, while the control group scored 0.066 for memory and 0.200 for concentration). This indicates that the data are normally distributed and meet the assumptions required for conducting parametric analysis.

Homogeneity Test

The results of the homogeneity test, presented in Table 4, aimed to determine whether the variances between the two groups were equal (homogeneous). Homogeneity of variance is one of the prerequisites for conducting subsequent parametric tests.

Table 4. Homogeneity Test Results for N-Gain

Variable	Significance Value
Memory	0.051
Concentration	0.120

The results of the homogeneity test showed that the significance (Sig.) values for the N-Gain of both memory and concentration variables were above 0.05. For the memory variable, the significance value was 0.051, and for concentration, it was 0.120. This indicates that the data have homogeneous variances between the experimental and control groups. Therefore, the assumption of homogeneity is met, allowing the use of parametric tests to validly analyze the differences between the groups.

N-Gain Calculation

The results of the N-Gain calculation and interpretation for both groups are presented in Table 5.

Table 5. N-Gain Calculation Results for Experimental and Control Groups

Variable	Experimental Group		Control Group	
	Memory	Concentration	Memory	Concentration
Highest Score	0.52	0.43	0.38	0.29
Lowest Score	0.00	0.04	0.00	0.00
Mean	0.2904	0.2637	0.1333	0.1311
SD	0.1537	0.1093	0.1112	0.0759

Based on the calculations presented in Table 5, the average N-Gain scores for the experimental group showed a higher increase compared to the control group, in both memory and concentration variables. In the experimental group, the average N-Gain for memory was 0.2904 and for concentration was 0.2637, both of which fall into the moderate category according to Hake's classification (1999). In contrast, the control group's average N-Gain was only 0.1333 for memory and 0.1311 for concentration, both of which are categorized as low.

These results indicate that the combined Brain Gym intervention (Cross Crawl and The Owl) administered to the experimental group was more effective in enhancing cognitive function in early childhood than the single Brain Gym intervention (Cross Crawl) given to the control group. The N-Gain score range in the experimental group also demonstrated more positive and evenly distributed improvements, with the highest score reaching 0.52 for memory and 0.43 for concentration. Furthermore, the lowest score recorded in the experimental group was 0.00 for memory, indicating that no participant experienced a decline in learning outcomes after the intervention.

This condition reinforces the effectiveness of the intervention, supported by relatively low standard deviations—0.1537 for memory and 0.1093 for concentration—suggesting that the improvement within the experimental group was more stable, consistent, and evenly distributed among all participants. On the other hand, the control group had slightly lower standard deviations (0.1112 for memory and 0.0759 for concentration), but with significantly lower average gains, indicating that the intervention's overall effect was still considered suboptimal.

Since there were no negative N-Gain scores in either group, it can be concluded that all participants at least maintained or improved their previous scores. However, the improvements achieved by the experimental group were both statistically and practically more significant. Therefore, the combined Brain Gym program can be recommended as a more viable and superior approach to enhancing memory and concentration in early childhood education (Anggraini & Dewi, 2022).

MANOVA Analysis

The first hypothesis in this study focused on the differences in memory and concentration abilities between two groups of early childhood learners at the Skoebi-Do Child Care Centre. The null hypothesis (H_0) stated that there is no simultaneous significant difference in memory and concentration between the group that received the combined Brain Gym method (Cross Crawl and The Owl) and the group that received the single Brain Gym method (Cross Crawl only). Mathematically, this is formulated as H_0: $\mu_1 Y_1 = \mu_2 Y_1$. Conversely, the alternative hypothesis (H_1) proposed that there is a simultaneous significant difference in these two cognitive abilities between the two groups. This is mathematically formulated as H_1: $\mu_1 Y_1 \neq \mu_2 Y_1$.

To test this hypothesis, a multivariate statistical analysis was performed using the MANOVA test. A summary of the results is presented in Table 6.

Table 6. Summary of MANOVA Analysis Results

Multivariate Statistic	Value	F	Sig	Partial Eta Squared
Pillai's trace	0.230		0.002	
Wilk's lambda	0.770	7.020	0.002	0.986
Hotelling trace	0.299		0.002	
Roy's largest root.	0.299		0.002	

Based on the results of the multivariate MANOVA test shown in the table above, there was a statistically significant simultaneous difference in memory and concentration scores of early childhood children between the intervention group and the control group after the treatment was administered. This indicates that the learning method applied to the intervention group had a significantly different impact compared to the control group in terms of improving the combined cognitive aspects of memory and concentration. The difference suggests that the type of intervention contributed significantly to the overall learning outcomes of the children in these areas.

This finding is supported by a significance (Sig.) value of 0.002 across all four multivariate test methods—Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root—all of which are below the 0.05 significance threshold. Pillai's Trace value was 0.230 and Wilks' Lambda was 0.770, with an F-value of 7.020, indicating that group differences contributed meaningfully to the combined variation of the two dependent variables. Furthermore, the Partial Eta Squared value of 0.986 shows that approximately 98.6% of the variability in the combined outcomes of memory and concentration can be explained by differences in treatment between the groups.

Thus, the results of this analysis strengthen the conclusion that the combined Brain Gym intervention administered to the experimental group was significantly more effective in enhancing memory and concentration in early childhood compared to the single Brain Gym intervention used in the control group.

Following the multivariate results, an additional analysis was conducted to assess the specific impact on memory performance. The null hypothesis (H_0) stated that there is no significant difference in memory ability between early childhood learners receiving the combined Brain Gym method (Cross Crawl and The Owl) and those receiving the single Brain Gym method (Cross Crawl only), formally: H_0: $\mu_1 Y_2 = \mu_2 Y_2$. The alternative hypothesis (H_1) proposed that a significant difference exists between the two groups in memory ability: H_1: $\mu_1 Y_2 \neq \mu_2 Y_2$.

To test this hypothesis, a Between-Subjects Effects analysis was used, aimed at examining whether the post-intervention memory scores differed significantly across groups. The results are summarized in Table 7.

Table 7. Between-Subjects Effects for Memory Variable

Variable	F	Sig	Partial Eta Squared
Memory	11.148	0.002	0.188

Based on the results of the Between-Subjects Effects test for the memory variable, a significance value of 0.002 was obtained with an F-value of 11.148. This indicates that there is a statistically significant difference between early childhood children who received learning through the combined Brain Gym method (Cross Crawl and The Owl techniques) and those who received the single Brain Gym method (Cross Crawl only) in terms of memory ability after the intervention. The Partial Eta Squared value of 0.188 indicates that the difference between the groups had a moderate effect on the improvement of children's memory. Therefore, the null hypothesis (H_0), which states that there is no significant difference, is rejected, and the alternative hypothesis (H_1) is accepted. These findings suggest that using two Brain Gym techniques simultaneously is more effective in enhancing memory ability in early childhood than using a single technique alone.

Finally, the third hypothesis addressed differences in concentration ability. The null hypothesis (H_0) stated that there is no significant difference in concentration ability between the two groups of early childhood learners, formulated as H_0: $\mu_1 Y_3 = \mu_2 Y_3$. The alternative hypothesis (H_1) stated that a significant difference exists: H_1: $\mu_1 Y_3 \neq \mu_2 Y_3$. This hypothesis was also tested using the Between-Subjects Effects analysis, as presented in Table 8 below:

Table 8. Between-Subjects Effects for Concentration Variable

Variable	F	Sig	Partial Eta Squared
Concentration	13.101	0.001	0.214

The results of the Between-Subjects Effects test for the concentration variable showed a significance value of 0.001 with an F-value of 13.101. This means there is a statistically significant difference between early childhood children who received the combined Brain Gym intervention and those who received the single Brain Gym intervention in terms of improvement in concentration ability. The Partial Eta Squared value of 0.214 indicates that the effect of group differences on the improvement of concentration falls within the moderate to strong category. Therefore, the null hypothesis (H_0), which states that there is no difference, is rejected, and the alternative hypothesis (H_1) is accepted. This finding reinforces the conclusion that combining two Brain Gym techniques has a greater impact on enhancing children's concentration abilities compared to using only one technique.

Differences in Memory and Concentration Abilities Between Children Receiving Combined Brain Gym and Single Brain Gym Interventions

The MANOVA test results indicated a significance value of 0.002, meaning that there is a statistically significant difference in memory and concentration between the experimental group (which received Cross Crawl and The Owl) and the control group (which received only Cross Crawl). Children in the experimental group showed greater improvement in both areas.

This aligns with the theory that movements involving both sides of the body can enhance communication between the brain hemispheres, thus improving memory and concentration (Serra et al., 2021;Chen et al., 2021). Such coordinated activities may facilitate the activation of neural pathways critical for cognitive performance (Srinivas et al., 2021;Dawood et al., 2022). While the N-Gain score was categorized as moderate, this outcome still reflects meaningful improvement. However, caution must be taken in interpreting this result as it may not necessarily represent a substantial real-world effect, and further research should explore the long-term impacts and effect sizes.

These findings also resonate with Piaget's theory of cognitive development, which emphasizes the role of motor activity in building knowledge structures (Ramesh, 2022), and Vygotsky's perspective on the importance of social and environmental stimuli in supporting children's cognitive growth (Habsy et al., 2023). Nevertheless, individual differences were not addressed in depth, which may influence the overall effectiveness of the intervention in varied contexts.

Effectiveness of Combined Brain Gym (Cross Crawl and The Owl) in Improving Memory and Concentration in Early Childhood

The results indicate that the combination of Cross Crawl and The Owl is more effective than Cross Crawl alone in enhancing cognitive abilities. This might be due to the way these exercises stimulate cross-hemispheric integration and promote both focus and retention (Adriani et al., 2020). The bilateral and sensory-rich nature of these activities may support neuroplasticity (Dian et al., 2022), enabling more efficient brain function related to attention and memory (Markant & Amso, 2022).

However, the study did not present effect size data, which limits the understanding of the magnitude of the difference between groups. In addition, there was no behavioral observation or follow-up to verify whether improvements in test scores translated into better academic or social performance. The absence of such data reduces the applicability of the results for educational practitioners.

Moreover, cultural factors may also play a role. The Balinese context, where traditional learning often includes movement, dance, and rhythm, could have made children more receptive to this type of intervention. Unfortunately, this sociocultural dimension was not explored in the study, which may affect the generalizability of the findings.

Contribution of Brain Gym Interventions in Early Childhood Education Practices

The study contributes to the understanding of movement-based cognitive interventions in early childhood education. By demonstrating significant differences in memory and concentration, the research supports the incorporation of Brain Gym as part of classroom strategies to support cognitive development (Devayanti et al., 2024;Anggraini & Dewi, 2022;Fathy Ahmed Dawood et al., 2022). These findings can help educators to implement more dynamic and developmentally appropriate learning methods.

Nonetheless, the discussion lacks a critical comparison with studies that question or contradict the effectiveness of Brain Gym. This omission may result in a biased interpretation of the results. Research such as Mendrofa et al. (2020) suggests that more rigorous empirical evidence is needed to validate Brain Gym claims. Including such perspectives would enhance the academic robustness of the discussion. Furthermore, the implications of Brain Gym beyond cognitive domains were not explored. Movement-based interventions may also affect emotional regulation, motivation, and classroom behavior (Joo et al., 2020; Adimayanti, E., et al., 2022) elements that are critical in early childhood development (El Khuluqo, 2020). Addressing these broader impacts would enrich the educational relevance of the study. Lastly, the short duration of the intervention and the limited sample size raise questions about the sustainability and scalability of the results. Future research should include larger populations, diverse educational contexts, and longitudinal assessments to determine whether such cognitive gains are retained over time.

While this study provides valuable insights into the effectiveness of combining Brain Gym techniques (Cross Crawl and The Owl) in enhancing memory and concentration among young children, several limitations must be acknowledged. First, the study involved a relatively limited sample drawn from only two childcare centers in Bali, namely Skoebi-Do Child Care Centre in Canggu and Sanur. Consequently, the generalizability of the findings to the broader population of early childhood learners in Indonesia or beyond this specific context may be restricted. Second, the use of a quasi-experimental design—specifically the Nonequivalent Control Group Design—although practical in educational settings, does not allow for full control over all extraneous variables as would a true experimental design. This raises the possibility that external factors unrelated to the Brain Gym intervention may have influenced the outcomes.

Third, the duration of the intervention (two months) and the limited daily frequency (15–20 minutes) may not fully reflect the potential long-term or maximal effects of a more intensive Brain Gym program. Fourth, the measurement of memory and concentration relied solely on observational assessments using ordinal scales, which—despite having undergone content and empirical validation—may still carry a degree of subjectivity compared to standardized, objective cognitive measurement tools. Nevertheless, the study contributes meaningfully to the growing body of evidence supporting Brain Gym as an effective cognitive stimulation method for early childhood education in Indonesia. By integrating multiple techniques into a single intervention program, the results demonstrate the potential of a more holistic and evidence-based educational strategy to support the comprehensive development of children′s cognitive functions.

Conclusion

This study concludes that the Brain Gym approach combining the Cross Crawl and The Owl techniques has a positive impact on improving memory and concentration in early childhood. Although the results show a statistically significant improvement, the effectiveness of the intervention is quantitatively categorized as moderate based on the N-Gain values. Therefore, further research with longer intervention durations and the use of more objective cognitive assessment tools is needed to evaluate the sustainability and long-term effects of this method.

References

Adimayanti, E., Siyamti, D., & Irwasih, S. (2022). The Effectiveness of Brain Gym on the Development of Preschool are being Hospitalized. Proceedings of Conference on Health Universitas Ngudi Waluyo, 1(1 SE-Articles), 20–25. https://callforpaper.unw.ac.id/index.php/ICH-UNW/article/view/15

Adriani, D., Imran, Y., Mawi, M., Amani, P., & Ilyas, E. I. I. (2020). Effect of Brain Gym® exercises on cognitive function and brain-derived neurotrophic factor plasma level in elderly: a randomized controlled trial. *Universa Medicina*, *39*(1), 34–41.

Anggraini, S., & Dewi, S. K. (2022). Effect of Brain Gym in Increasing the Learning Concentration of 6th Grade on Online Learning during the Covid-19 Pandemic. *Malaysian Journal of Medicine & Health Sciences*, *18*.

Baron, J. (2005). *Rationality and intelligence*. Cambridge University Press.

Bodrova, E., & Leong, D. J. (2020). The Impact of Psychological Sciences on Early Childhood Education: Child's Mind in Society–A Vygotskian Approach to Early Childhood Education. In *Scientific Influences on Early Childhood Education* (pp. 79–92). Routledge.

Capodieci, A., Gola, M. L., Cornoldi, C., & Re, A. M. (2018). Effects of a working memory training program in preschoolers with symptoms of attention-deficit/hyperactivity disorder. *Journal of Clinical and Experimental Neuropsychology*, *40*(1), 17–29.

Chen, W., Wang, X., Gu, X., & Chen, J. (2021). The impacts of coordinated-bilateral ball skills intervention on attention and concentration, and cardiorespiratory fitness among fourth-grade students. *International Journal of Environmental Research and Public Health*, *18*(21), 11634.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Dawood, R. F. A., MostafaDarweesh, H. A., & ELdesoky, H. A. (2022). Impact of brain gym training on cognitive performance of undergraduate nursing students. *Egyptian Journal of Health Care*, *13*, 1036–1051.

Devayanti, R., Redjeki, S., Suryaman, R., Rahayu, E. R., Fitrianingsih, N., Yosali, M. A., Rasid, H. Al, & Rahmawati, A. F. (2024). The effect of brain gym on learning concentration for school age children. *International Research Journal of Pharmacy and Medical Sciences*, *7*(5), 12–16.

Dian, D., Mediani, H. H., & Minnatillah, M. (2022). Brain Games and Gymnastics on Increasing Concentration Power of Early Childhood. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(6), 5615–5620.

El Khuluqo, I. (2020). Brain Gym Optimization Methods in Improving Early Age Child Fine Motor Skills. *1st International Conference on Early Childhood Care Education and Parenting (ICECCEP 2019)*, 37–41.

Fathy Ahmed Dawood, R., Ahmed Mostafa Darweesh, H., & Ahmed ELdesoky, H. (2022). Impact of Brain Gym Training on Cognitive Performance of Undergraduate Nursing Students. *Egyptian Journal of Health Care*, *13*(1), 1036–1051.

Habsy, B. A., Rachmawati, A. P., Wiyono, R., & Rakhmanita, A. (2023). Penerapan perkembangan kognitif Jean Piaget dan perkembangan bahasa Vygotsky dalam pembelajaran. *TSAQOFAH Jurnal Penelitian Guru Indonesia*, *4*, 143–158.

Hake, R. (2002). Lessons from the physics education reform effort. *Conservation Ecology*, *5*(2).

He, Z., Lin, W., Zheng, H., Zhang, F., Jones, M., Aitchison, L., Xu, X., Liu, M., Kristensson, P. O., & Shen, J. (2024). Human-inspired Perspectives: A Survey on AI Long-term Memory. ArXiv Preprint ArXiv:2411.00489.

Joo, Y. S., Magnuson, K., Duncan, G. J., Schindler, H. S., Yoshikawa, H., & Ziol-Guest, K. M. (2020). What Works in Early Childhood Education Programs?: A Meta–Analysis of Preschool Enhancement Programs. *Early Education and Development*, *31*(1), 1–26. https://doi.org/10.1080/10409289.2019.1624146

Lasmawan, I. W., & Budiarta, I. W. (2020). Vygotsky's zone of proximal development and the students' progress in learning (A heutagogcal bibliographical review). *JPI (Jurnal Pendidikan Indonesia)*, *9*(4), 545–552.

Maniazhagu, D. (2022). Effect of two modes of integrative neuromuscular training on explosive power. *International Journal of Physical Education Sports Management and Yogic Sciences*, *12*(2), 18-26.

Margolis, E. T., Davel, L., Bourke, N. J., Bosco, C., Zieff, M. R., Monachino, A. D., ... & Gabard-Durnam, L. J. (2024). Longitudinal effects of prenatal alcohol exposure on visual neurodevelopment over infancy. *Developmental Psychology*, *60*(9), 1673.

Markant, J., & Amso, D. (2022). Context and attention control determine whether attending to competing information helps or hinders learning in school-aged children. *Wiley Interdisciplinary Reviews: Cognitive Science*, *13*(1), e1577.

Mendrofa, F. A. M., Iswanti, D. I., & Hani, U. (2020). Efficacy of Brain Gym on the Cognitive Function Improvement of People with Dementia. *Jurnal Keperawatan Jiwa*, *8*(4), 557.

Ramesh, S. (2022). The theories of cognitive development. In *The Political Economy of Human Behaviour and Economic Development: Psychology and Economic Development* (pp. 143–180). Springer.

Reina, A. L. V. (2020). Early Stimulation in Learning Activation on Early Childhood. *International Journal of Psychosocial Rehabilitation*, *24*(2 SE-Articles), 579–590. https://doi.org/10.61841/edgst377

Salleg-Cabarcas, M. J., Robledo-Castro, C., & Monsalve-Vertel, C. P. (2024). Effect of Hit-Sport-Game Exercise Training on Self-Control and Regulation in Children With Attention Deficit Hyperactivity Disorder (ADHD). *Global Pediatric Health*, *11*, 2333794X241287095.

Savina, E. (2021). Self-regulation in preschool and early elementary classrooms: Why it is important and how to promote it. *Early Childhood Education Journal*, *49*(3), 493–501.

Serra, L., Raimondi, S., Di Domenico, C., Maffei, S., Lardone, A., Liparoti, M., Sorrentino, P., Caltagirone, C., Petrosini, L., & Mandolesi, L. (2021). The beneficial effects of physical exercise on visuospatial working memory in preadolescent children. *AIMS Neuroscience*, *8*(4), 496.

Shavit, Y., Friedman, I., Gal, J., & Vaknin, D. (2018). *Emerging Early Childhood Inequality: On the Relationship between Poverty, Sensory Stimulation, Child Developement, and Achievement*. Taub Center Jerusalem, Israel.

Sinaga, E. S., & Syari, M. (2022). The Effect of Brain Gym on Improving Fine Motoric and Gross Motoric Skills in Pre-School Children. *International Journal of Public Health Excellence (IJPHE)*, *2*(1), 318–323.

Smith, N., Georgiou, M., King, A. C., Tieges, Z., Webb, S., & Chastin, S. (2021). Urban blue spaces and human health: A systematic review and meta-analysis of quantitative studies. *Cities*, *119*, 103413.

Srinivas, N. S., Vimalan, V., Padmanabhan, P., & Gulyás, B. (2021). An overview on cognitive function enhancement through physical exercises. *Brain Sciences*, *11*(10), 1289.

Suardipa, I. P. (2020). Proses Scaffolding Pada Zone Of Proximal Development (ZPD) Dalam Pembelajaran. *Widyacarya: Jurnal Pendidikan, Agama Dan Budaya*, *4*(1), 79–92.

Vásquez-Carrasco, E., Gómez, C. S., Valdés-Badilla, P., Hernandez-Martinez, J., Villagrán-Silva, F., Aravena-Sagardia, P., Sandoval, C., & Miralles, P. M. (2025). Effectiveness of Combined Cognitive Stimulation and Physical Activity Interventions on Activities of Daily Living, Cognitive Function, and Physical Function in Older People with Mild Cognitive Impairment: A Systematic Review with Meta-Analysis. *Journal of Clinical Medicine*, *14*(7), 2261.

Wang, Y., Liu, H., Zeng, P., Ji, L., Zhou, Y., Zhou, L., & Tao, Y. (2023). Electrical nerve stimulation for sensory-neural pathway reconstruction in upper-limb amputees. *Frontiers in Neuroscience*, *17*, 1114962.