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Comparing the Effectiveness of Brain Gym and Educational Games on Improving Students' Concentration: A Follow-Up Study

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A B S T R A C T

Objective: The present study aimed to compare the effectiveness of brain gym and educational games on improving the concentration of 8-10-year-old students through a two-month follow-up study.

Methods and Materials: The present study is experimental research with a pretest-posttest-follow-up design, including a control group and two experimental groups. The research population comprised all 8-10-year-old female students in Ahvaz during the 2022-2023 academic year. From this population, 114 individuals were selected as the research sample. However, three participants were excluded from the study due to irregular attendance in educational sessions. The study included three groups: control, brain gym, and educational games. The brain gym group underwent 20 sessions, each lasting 20 minutes twice a week, with each exercise lasting between 30 to 40 seconds for children (Brown, 2012). Additionally, the educational games group participated in activities twice a week for 8 weeks, with each session lasting between 30 to 45 minutes. The games included: 1) Handclap, 2) Picture completion, 3) Role-playing, 4) Drawing with closed eyes, 5) Thankfulness, 6) Two wrists, one wrist, 7) Clay modeling, 8) Finding geometric shapes (Jafari, 2014). Participants in the control group did not receive any intervention. The Souri and Ourki Concentration Questionnaire (2014) was used to assess concentration in three stages (before, after intervention, and two-month follow-up).

Findings: The results of the Bonferroni follow-up test indicated no significant difference between the effects of brain gym and educational games on improving the concentration of 8-10-year-old students ($p>0.05$). However, there was a significant difference between the post-test scores of each group compared to the pretest stage ($p<0.01$).

Conclusion: Overall, the results of the present study suggest that both brain gym and educational games can be beneficial methods for improving both voluntary and involuntary concentration in elementary school students.

Keywords: *Brain Gym, Educational Games, Concentration, Students.*

1. Introduction

Undoubtedly, human personality development encompasses cognitive, perceptual-motor, and social growth aspects. The assessment and understanding of motor skills have long been of interest to many specialists due to their role in human life from infancy to adulthood (Aghaziarati et al., 2023; Bulut et al., 2024). One of the most significant human characteristics is the ability to learn (Witzel & Mize, 2018). Researchers state that concentration refers to an individual's ability to focus on learning activities, facilitating speed and accuracy in task performance (Lin et al., 2010). Concentration is considered a cognitive effort and a type of mental approach (Mercado et al., 2008; Mindset, 2023).

Brain-derived neurotrophic factor (BDNF) is a key protein that plays an important role in the maintenance, growth, and even survival of nerve cells. Reduced physical activity decreases its level, thereby affecting learning, memory, and a wide range of cognitive functions (Jalilinasab et al., 2022; Saleh & Mazlan, 2019). Modern exercise is not merely a simple activity; it enhances complex brain capabilities in various tasks, including learning, coordination, agility, correct functioning, and decision-making (Spaulding et al., 2010). Brain Gym consists of a series of movements aimed at connecting the body and mind, stimulating the use of brain hemispheres through physical and mental strategies, and enhancing cognitive functions for learning. It is part of kinesiology and results from applied neuroscience research studying body movements and their relationship with brain function. It stimulates and activates an individual's cognitive processes (Hoffman, 2009). The Brain Gym program is implemented through the PACE process, an acronym for Positive, Active, Clear, and Energetic, which prepares students for integrated brain learning. The selected exercises fundamentally maintain balance in daily life, following rhythm and timing (Mirza Yuda & Budi, 2021). These exercises enhance the connection between the left and right hemispheres, unlocking neural pathways and benefiting the learning process and neural synapses (Jalilinasab et al., 2022). This method also activates the reticular activating system (RAS) to aid concentration and balance. It helps us learn and understand better, reinforcing that body and mind are inseparable (Amiri et al., 2019; Amiri et al., 2021; Brown, 2012; Mirza Yuda & Budi, 2021; Spaulding et al., 2010).

Humans inherently love playing games, solving puzzles, assembling jigsaws, and engaging in motor activities. Games are powerful cultural and scientific expressions that foster group cooperation and skill enhancement (Carter et al., 2015). Researchers believe that games as teaching tools help students solve problems and provide a non-threatening environment to tackle issues and develop strategies for problem-solving. When children invent their problem-solving strategies, they gain a stronger understanding of concepts and feel better about their accomplishments. Games are generally useful for educational purposes, combining fun with learning in classroom sessions. Games are also a means of understanding tools and environments. Through games, features such as accuracy, memory, imagery, orderliness, agility, and skill develop in children (Carter et al., 2015; Hoffman, 2009). Innovative educational games have been used in recent years to achieve more effective learning at higher levels (Brown, 2012; Carter et al., 2015).

Given that children are the future builders of the nation, ensuring their mental and physical health and creating better learning conditions is crucial for a better and healthier society. Considering that cognitive growth is associated with brain control, parents and educators can stimulate children's brains to help improve their thinking and problem-solving skills. Previous studies have primarily focused on the impact of brain gyms on learning aspects of students, children with learning disabilities, or older adults. Limited research on these exercises in Iran and the effectiveness of educational games on cognitive and motor factors, improving working memory, concentration, and academic achievement, and the complexity of social relationships in modern societies highlight the need to address children's social characteristics and related factors. Therefore, this study aims to compare the effectiveness of brain gym and educational games on improving the concentration of 8-10-year-old students through a follow-up period.

2. Methods and Materials

2.1. Study Design and Participants

The present study is experimental, examining the relationship between variables using a pretest-posttest-follow-up design. The research population included all 8-10-year-old female students in Ahvaz during the 2022-2023 academic year, selected based on research entry criteria. The multi-stage sampling method was used, and participants were selected randomly from primary schools in District 1 of Ahvaz. From the chosen classes, 114 second to fourth-

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grade students were randomly selected and then randomly assigned to experimental and control groups.

The study procedure involved informing participants that the study aimed to compare the effectiveness of brain gyms and educational games on their concentration. Participation was entirely voluntary. After an explanatory session, informed written consent was obtained from parents. Participants received their respective interventions, completed the questionnaire before and after the intervention, and were reassessed two months later to evaluate the intervention's sustainability. The pretest, posttest, and follow-up results were compared.

2.2. Measures

2.2.1. Concentration Skills

Developed by Souri and Oraki in 2014, this questionnaire consists of 13 questions aimed at evaluating various aspects of concentration skills (voluntary and involuntary). It uses a 5-point Likert scale for scoring. The validity of this scale was confirmed by university professors, and its reliability was established using Cronbach's alpha, with a coefficient of 0.74 (Asadi Rajani, 2023).

2.3. Interventions

2.3.1. Educational Games

After the pretest, the experimental group participated in 8 weeks (twice a week, 30-45 minutes each session) of independent variable intervention through games such as:

Handclap Game: Requires a ball and open space, dividing students into groups of three. Two students stand facing each other while the third stands in the middle, trying to catch the ball. When the middle student catches the ball, they switch places with the student who lost the ball.

Picture Completion: Uses dice and two sets of a picture. The image is divided into parts numbered with a sequence, like 1-root, 2-stem, 3-leaf, 4-fruit. After answering a question correctly, the dice is rolled, and the group proceeds if the correct number appears.

Role-playing (Khale Bazi): A group activity where children create a story based on their creativity, continuing it according to their understanding of their surroundings.

Drawing with Closed Eyes: Promotes creativity, interpersonal relationships, social responsibility, empathy, optimism, joy, self-esteem, independence, realism, problem-solving, impulse control, pressure tolerance, focus, and balance. Requires blindfolds, paper, and pencils for groups of 3-5 children to draw collaboratively.

Thankfulness Game: Children sit in a circle, passing a hat while music plays. When the music stops, the child holding the hat engages in a polite exchange with another child.

Two Wrists, One Wrist: Aims for group coordination and consideration, requiring ropes or fabric strips to tie children's ankles together in groups.

Clay Modeling: Children manipulate clay to form various shapes, progressing from simple pressing to complex modeling of objects like bowls or animals.

Finding Geometric Shapes: Children form different shapes using various geometric figures, following the teacher's instructions (Carter et al., 2015).

2.3.2. Brain Gym

The experimental group underwent 20 sessions based on previous research (Amiri et al., 2019; Amiri et al., 2021; Brown, 2012; Hafez, 2017; Jalilinasab et al., 2022; Mirza Yuda & Budi, 2021; Saleh & Mazlan, 2019; Spaulding et al., 2010; Tootak et al., 2019), with each session lasting 20 minutes, twice a week. Each exercise, drawn from the brain gym protocol, lasted 30 to 40 seconds for children (Brown, 2012). Detailed instructions were given before intervention. In all 20 sessions, selected exercises were repeated, guided by the experimenter. The formal validity of these exercises was confirmed by university faculty members.

2.4. Data analysis

Descriptive and inferential statistics were used to analyze the raw data. Central indices like mean and standard deviation described the data. Shapiro-Wilk and Levene's tests examined normal distribution and variance equality, respectively. Analysis of variance with repeated measures (ANCOVA) and Bonferroni post hoc test compared the groups. Data analysis was conducted using SPSS 24 at $\alpha \leq 0.05$.

3. Findings and Results

In this study, all subjects in both groups were aged between 8 and 10 years and were in elementary school. The following tables present the data for the measured variables, divided into the three groups: control, brain gym, and educational games.

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Table 1

Descriptive Statistics of Research Variables

Group	Variable	N	Minimum	Maximum	Mean	SD
Control	Pre-test Concentration	37	33	61	44.84	5.956
	Post-test Concentration	37	35	60	45.30	6.275
	Follow-up Concentration	37	32	62	44.92	6.043
	Pre-test Voluntary Concentration	37	21	40	28.54	5.097
	Post-test Voluntary Concentration	37	21	40	28.68	5.159
	Follow-up Voluntary Concentration	37	20	40	28.78	5.175
	Pre-test Involuntary Concentration	37	9	25	16.30	4.162
	Post-test Involuntary Concentration	37	9	24	16.54	4.147
	Follow-up Involuntary Concentration	37	8	25	16.22	4.171
Brain Gym	Pre-test Concentration	37	24	53	37.19	7.568
	Post-test Concentration	37	33	59	43.00	5.667
	Follow-up Concentration	37	31	54	40.22	6.477
	Pre-test Voluntary Concentration	37	14	32	21.62	5.095
	Post-test Voluntary Concentration	37	18	35	25.16	4.450
	Follow-up Voluntary Concentration	37	18	32	23.65	4.424
	Pre-test Involuntary Concentration	37	8	23	14.95	4.339
	Post-test Involuntary Concentration	37	11	24	17.89	3.160
	Follow-up Involuntary Concentration	37	10	23	16.57	3.863
Educational Games	Pre-test Concentration	37	24	59	41.46	9.167
	Post-test Concentration	37	28	60	46.08	6.954
	Follow-up Concentration	37	32	60	44.70	7.356
	Pre-test Voluntary Concentration	37	10	40	24.92	7.868
	Post-test Voluntary Concentration	37	12	38	27.62	6.448
	Follow-up Voluntary Concentration	37	14	38	26.62	6.264
	Pre-test Involuntary Concentration	37	8	23	16.54	4.266
	Post-test Involuntary Concentration	37	11	23	18.19	3.213
	Follow-up Involuntary Concentration	37	9	22	17.81	3.230

The Shapiro-Wilk test was used to test the normality assumption of the distribution of data, examining the components and total score of concentration for each group in the pre-test, post-test, and follow-up stages. Levene's test assessed the homogeneity of variance assumption for the error components and total concentration score among the groups. Mauchly's test was used to evaluate and confirm the sphericity or equality of the covariance matrix of errors.

Table 2

Repeated Measures ANOVA and ANCOVA for Subscales of Students' Concentration in Brain Gym and Educational Games Groups

Variable	Source	Sum of Squares	df	Mean Square	F	Sig.	Effect Size
Voluntary Concentration	Control	1.099	2	0.550	0.558	0.575	0.015
	Brain Gym	233.532	2	116.766	33.212	0.001	0.480
	Educational Games	138.180	2	69.090	19.344	0.001	0.350
Involuntary Concentration	Control	2.108	2	1.054	0.808	0.450	0.022
	Brain Gym	161.099	2	80.550	37.280	0.001	0.509
	Educational Games	55.189	2	27.595	10.164	0.001	0.220
Voluntary Concentration	Post-test	240.559	2	120.279	4.101	0.019	0.071
	Follow-up	491.892	2	245.946	8.620	0.001	0.138
Involuntary Concentration	Post-test	57.135	2	28.568	2.285	0.107	0.041
	Follow-up	51.946	2	25.973	1.823	0.167	0.033

The repeated measures ANOVA showed that brain gym and educational games significantly improved both voluntary and involuntary concentration subscales, whereas no significant difference was observed in the control group.

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Table 3

Bonferroni Post Hoc Test for Subscales of Students' Concentration in Control, Brain Gym, and Educational Games Groups

Variable	Group	Stage (I)	Stage (J)	Mean Difference	SD	Sig.
Voluntary Concentration	Control	Pre-test	Post-test	-0.135	0.242	1.000
		Follow-up	-0.243	0.203	0.715	
		Post-test	Follow-up	-0.108	0.244	1.000
	Brain Gym	Pre-test	Post-test	-3.541	0.512	0.001
		Follow-up	-2.027	0.446	0.001	
		Post-test	Follow-up	1.514	0.330	0.001
	Educational Games	Pre-test	Post-test	-2.703	0.498	0.001
		Follow-up	-1.703	0.436	0.001	
		Post-test	Follow-up	1.000	0.376	0.035
Involuntary Concentration	Control	Pre-test	Post-test	-0.243	0.281	1.000
		Follow-up	0.081	0.264	1.000	
		Post-test	Follow-up	0.324	0.251	0.615
	Brain Gym	Pre-test	Post-test	-2.946	0.397	0.001
		Follow-up	-1.622	0.246	0.001	
		Post-test	Follow-up	1.324	0.364	0.003
	Educational Games	Pre-test	Post-test	-1.649	0.412	0.001
		Follow-up	-1.270	0.379	0.006	
		Post-test	Follow-up	0.378	0.356	0.884

The Bonferroni post hoc test confirmed the significant effects, showing no significant difference between any two stages in the control group. Significant differences were found between the control group and brain gym group, and between brain gym and educational games groups, particularly in the follow-up stage.

4. Discussion and Conclusion

This study aimed to compare the effectiveness of brain gym and educational games on improving the concentration of 8-10-year-old students through a two-month follow-up study. The results indicated no significant difference between the effects of brain gym and educational games on improving the concentration of 8-10-year-old students. However, a significant difference was found between the groups in the follow-up stage, with no significant difference observed in the post-test stage. The follow-up comparison revealed significant differences between the control and brain gym groups and between brain gym and educational games groups, with no significant differences found among other groups. The post-test comparison of voluntary concentration showed a significant difference between the control group and brain gym group, and in the follow-up stage, significant differences were found between the control and brain gym groups as well as between brain gym and educational games groups. These findings align with the results of Tootak et al. (2020), which showed that a period of brain gym training significantly improved working memory in the elderly. Additionally, they demonstrated that brain gym training significantly impacted sustained concentration in elderly men (Tootak et al., 2019). Brain gym is beneficial not only for physical fitness but also for brain health. Participation in brain gym can stimulate both hemispheres and improve concentration. It can also enhance the concentration and learning of elementary students. This method is a non-pharmacological alternative treatment that is simple, easy, low-cost, and can be performed anytime without special equipment. Teachers can use these exercises in schools to help improve students' concentration and increase learning. Brain gym enhances neuroplasticity through the interaction of body movements and brain stimulation, significantly improving learning and concentration. For example, cross-body movements effectively stimulate and produce neurons, enhancing learning, concentration, and memory (Hafez, 2017). Overall, the present study's results suggest that brain gym training can be a beneficial method for improving voluntary and involuntary concentration in elementary school students.

Although children learn all motor skills as they age, educational games are entertaining and attractive to children. The benefits of educational games include enhancing intelligence, improving concentration, creating better balance and maintaining it, strengthening large and small muscles, increasing interest in group activities, and enhancing sensory-motor skills in children (Jalilinasab et al., 2022). For example, the "Two Wrists, One Wrist" game

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involves hopping and jumping movements that strengthen gross motor skills, teaching balance and coordination. Therefore, games are an important aspect of elementary education, helping students learn motor skills better and develop gross motor skills. The development of skills is crucial, improving balance, and catching and throwing abilities. Structured and educational games are suitable physical activities for children, improving motor skills and body control.

5. Limitations & Suggestions

The limitations of the present study include:

The mental and psychological states of the subjects during the testing days and hours were uncontrollable.

The test duration was long, which might have caused fatigue.

Subjects had different physical and physiological characteristics (individual differences).

The subjects' nutrition and sleep status were uncontrollable.

Overall, based on the findings, it is suggested that brain gym movements and exercises be used as a low-cost and entertaining method to improve concentration, concentration, and efficient information processing, thereby enhancing students' learning and academic achievement. Teachers and parents should use these exercises to benefit from their advantages. Additionally, considering the positive impact of these movements on improving children's social and motor skills, fostering better interactions with peers, and strengthening essential body-brain connections for all functions in children, teachers are encouraged to use these movements to improve these traits. Teachers can dedicate a few minutes to performing these movements in the classroom or outdoors, using the benefits of brain gym to improve the quality of life and prevent and treat children's physical and psychological injuries.

Regarding educational games, it is suggested to use them as a method to address some educational deficiencies. This educational method can help solve learning problems, increase concentration, and improve and enhance social and motor skills. Teachers and school instructors can use educational games to improve these traits. Teachers can design and plan a game-filled environment for leisure time, when students are tired in class, or during physical education hours. Considering that all students actively participate in games with interest and motivation, teachers and instructors can engage them in learning using game-based teaching methods. Educational games are interesting and approved by students, allowing them to participate without stress or anxiety in a non-competitive environment without the fear of failure.

Finally, it is suggested to investigate the impact of these interventions on male students, considering gender roles. It is also recommended to study these interventions in different age ranges. Additionally, it is suggested to compare these interventions with other standard physical activities. Further research could compare these interventions with creative motor games or rhythmic exercises. Finally, it is suggested to investigate the effects of these interventions on students with disorders such as ADHD and autism.

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Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

This article is derived from the first author's doctoral dissertation. All authors contributed equally.

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