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ÜNİVERSİTESİ

The Impact of Brain Gym Exercises on Mind for The Children with Mild Level of Intellectual Disabilities

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ABSTRACT

This study has been planned to identify the impact of brain gym (BG) exercises on the mind for children with mild levels of intellectual disability and to provide the more common use of BG exercises in rehabilitation programs. A total of 24 intellectually disabled students, 10 girls, and 14 boys, aged between 6 and 18 years, studying at Bağcılar Başak Special Education and Rehabilitation Center School were included in the study. To identify the intelligence level of the students, in order they have been applied Bender Gestalt Visual Perception Test and Wechlers Intelligence Test by expert psychologist. Then while individual private training session as 6 hours per month and with the observation of the physiotherapist 15-minute sessions three times a week have been given to the experiment group, the control group received only private training session 6 times a month. Also the exercises given to the experiment group have been required as homework. After 6 weeks of training the tests which had been applied at the beginning were applied to both groups again. Participants demonstrated significant improvements in Bender Gestalt Visual Perception Test reducing the error score after working ($p<0.05$). The results obtained from the study showed that BG exercise training applied to students with intellectual disabilities positively affected cognitive abilities.

Keywords: Brain Gym, Intellectual disabilities, Learning, Neuroplast

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Hafif Düzeyde Zihinsel Engelli Çocuklarda Brain Gym Egzersizlerinin Zeka Üzerindeki Etkisi

ÖZET

Bu çalışma, hafif düzeyde zihinsel engelli çocuklarda brain gym (BG) zihin üzerindeki etkisini belirlemek ve rehabilitasyon programlarında BG'nin daha yaygın kullanılmasını sağlamak amacıyla planlanmıştır. Çalışmaya Bağcılar Başak Özel Eğitim ve Rehabilitasyon Merkezi Okulu'nda öğrenim gören, yaşları 6 ile 18 arasında değişen 10 kız ve 14 erkek olmak üzere toplam 24 zihinsel engelli öğrenci dahil edildi. Öğrencilerin zeka düzeylerini belirlemek amacıyla uzman psikolog eşliğinde Bender Gestalt Görsel Algı Testi ve Wechlers Zeka Testi uygulanmıştır. Daha sonra deney grubuna ayda 6 saat, bireysel özel eğitim ile birlikte fizyoterapist gözetiminde haftada 3 gün 15'er dakikalık BG eğitimi verilirken, kontrol grubuna sadece ayda 6 kez özel eğitim seansları verilmiştir. Ayrıca deney grubuna verilen egzersizler ev programı olarak verilmiştir. 6 haftalık eğitimden sonra başlangıçta uygulanan testler her iki gruba tekrar uygulanmıştır. Katılımcıların Bender Gestalt Görsel Algı Testi'nde çalışma sonrasında hata puanlarında azalma ile anlamlı iyileşmeler görülmüştür ($p<0.05$). Çalışmadan elde edilen sonuçlar, zihinsel engelli öğrencilere uygulanan BG eğitiminin zihni olumlu yönde etkilediğini göstermiştir.

Anahtar Kelimeler: Brain Gym, Zihinsel engellilik, Öğrenme, Nöroplastisite

1 Introduction

Intellectual disability is characterized by below-average general mental functioning and the presence of two or more deficits in adaptive behaviors, including self-care, communication, social involvement, academic abilities, health, safety, and employment (Maïano, Hue, & April, 2019). Research indicates that children and adolescents with intellectual disabilities showed significantly poorer basic mobility skills relative to their typically developing peers (Hartman, Houwen, Scherder, & Visscher, 2010; Rintala & Loovis, 2013).

Fundamental motor skills, including basic motor functions, are crucial for neurological health and can influence neurotransmitter release and neuroplasticity via multiple pathways (Müller, Duderstadt, Lessmann, & Müller, 2020). Studies demonstrate that brain gym exercises that include simple movements can facilitate the release of neurotransmitters like dopamine and serotonin, which are essential for cognitive functions such as attention and memory (Chan, Jang, & Ho, 2022). Brain Gym (BG) exercises aim to enhance cognitive function by facilitating the integration of both hemispheres of the brain and activating various brain regions involved in learning and emotional regulation. These exercises are based on the premise that coordinated physical movements can lead to improved brain activity and cognitive abilities (Selano, 2023). Research conducted across various age groups supports these findings (Adriani, Imran, Mawi, Amani, & Ilyas, 2020). Dhokpatil's research emphasizes that these activities facilitate relaxing and eliminate neurotoxic waste from the brain, consequently improving cognitive performance (Dhokpatil, Deshmukh, Varghese, Palekar, & Salekar, 2023). In this context, the purpose of this study is to assess the impact of BG activities on the intelligence of children with intellectual disabilities.

2 Methods

The study was approved by İstanbul University Non-Invasive Clinical Research Ethics Committee (60116787-020/68911). The study was conducted in accordance with the principles of the Declaration of Helsinki. Adolescents with intellectual disabilities and their families were informed about the study, permission was obtained through signed informed consent forms.

2.1 Participants

Thirty-three students with mild intellectual disabilities between the ages of 6 and 18 participated in the study. Participants were mildly intellectually disabled. Information about the level of intellectual disability was obtained from the medical health reports available at the participants' schools.

A priori power analysis was conducted using G*Power version 3.1.9.7 (Faul et al., 2009) to determine the required sample size for detecting a medium effect size (*Cohen's d* = 0.59) with an alpha level of 0.05 and statistical power of 0.80 ($1-\beta$). The analysis indicated that a minimum of 33 participants (approximately 16–17 per group) would be sufficient to detect a statistically significant difference using an independent samples t-test (two-tailed). The achieved power with the initially planned sample size (N = 33) was approximately 0.82, suggesting that the study was adequately powered to detect a moderate effect.

Students who met the inclusion criteria participated in the study.
Inclusion criteria:
1. Have a mild intellectual disability,
2. Being able to take verbal commands,
3. Being able to do BG exercises.
Exclusion criteria;
1. Insufficient cooperation for exercise training,
2. Presence of hearing and/or visual impairment,
3. Having a health condition that prevents participation in the exercise program

Patients meeting the study criteria were prospectively randomized into the experimental or control group, using a random-number generator.

2.2 Exercise training

The mildly mentally disabled participants in the study were evaluated by a physiotherapist (M.K.) who would apply the BG exercises. Because 2 out of 33 students had other health problems; three additional students were excluded from the study due to insufficient motor skills required for the exercises. The remaining 28 students were randomly assigned to one of two groups: the experimental (BG) group and the control group.

2.3 Brain Gym exercises program

The BG training program was determined by a research physiotherapist (MK) who has exercise and research experience with mentally disabled individuals, using the Brain Gym Exercise book (Dennison & Dennison, 1986). Students performed BG exercise training in pairs under the supervision of the same physiotherapist.

The BG exercise program consists of foot bending, arm activation, abdominal breathing, ear turning, neck rotation, crawling, the Lazy 8, the Elephant movement, the Alphabet 8, and bilateral crunch exercises, each performed for five repetitions. The BG exercise program was conducted 15 minutes a day, three days a week for 6 weeks with 6 hours of individual private education lessons per month. Participants attended the program except in cases of health problems (e.g., flu) or during public holidays.

The control group received only 6 hours of individual private education lessons per month for 6 weeks.

2.4 Assessment

Participants were evaluated before and after six weeks of exercise training. Sociodemographic data of the participants were recorded using a standardized form. The form included information about gender, age, height, weight, diagnosis and medications taken.

Wechsler Intelligence Scale for Children (WISC-R) and Bender-Gestalt Visual Motor Perception Test (BGT) were used to assess intelligence.

While the BGT was administered to each student by an expert psychologist, the 'Picture Completion' (WRT) and 'Picture Arrangement' (WRD) subtests of the Wechsler Intelligence Scale Test were administered to fourteen students based on their cognitive levels. The scores they received in the first evaluation were noted as BGT1, WRT1 and WRD1. Last evaluations were made at the end of the 6 weeks training and the scores were noted as BGT2, WRT2 and WRD2.

2.4.1 Wechsler Intelligence Scale for Children (WISC-R)

Wechsler created the Wechsler Intelligence Scale for Children (WISC) in 1949, and it underwent revisions in 1974. Savaşır and Şahin did a standardization research to convert WISC-R to Turkish. The WISC-R has 12 subtests in total, divided into verbal and performance categories. These are six performance (Picture Completion, Picture Arrangement, Block Design, Object Assembly, Digit Symbol, and Labyrinths) and six verbal (General Information, Similarities, Arithmetic, Judgment, Vocabulary, and Digit Span) scale subtests (Savaşır & Şahin, 1995).

2.4.2 Bender-Gestalt Visual Motor Perception Test (BGT)

Nine geometric forms make up the Bender-Gestalt Test (BGT). The Bender developmental scoring system developed by Koppitz in 1963 is used to assess Bender-Gestalt protocols. Every protocol evaluates an error type as "0" or "1," that is, "present" or "absent." For each protocol, the Bender total error score is the sum of the errors. The BGT is used to evaluate visual motor development and associated ideas of time and location, memory, and organizing abilities. These characteristics allow the BGT to be utilized as an intelligence test as well (Yalın & Sonuvar, 1987).

2.5 Statistical analysis

The findings were evaluated using SPSS 15 software. The significance value of statistical tests was accepted as $p < 0.05$. Prior to the main analyses, the normality of the data distribution was assessed using the Shapiro–Wilk test. Parametric tests were applied when the assumption of normality was met. The Fisher's Exact Test was used to determine whether the experimental and control groups significantly differed at baseline. The difference in intelligence test scores between the experimental and control groups before and after the study was statistically analyzed using an independent samples t-test.

3 Results

Students with mild intellectual disabilities, aged between 6 and 18 years participated in the study. At the beginning of the study, all students enrolled in the school were evaluated for eligibility to participate. A total of 33 students with intellectual disabilities met the study's inclusion and exclusion criteria. Two individuals were excluded from the study due to an inability to perform BG exercises, while three others were excluded due to neurological disorders. Twenty-eight participants who completed the study's requirements were separated into two groups of fourteen at random. Four participants voluntarily withdrew from the study. The study was completed with 24 participants. Based on age classification, the control group consisted of 13 students (ages 6–17), while the experimental group consisted of 11 students (ages 7–18). The mean ages of the students in Experimental Group and Control Group were 12, SD=0.32 and 10.53 SD= 2.75 years, respectively. Experimental Group consisted of 4 (36.4%) female and 7 (63.6%) male students. In control group, there were 6 (46.2%) female and 7 (53.8%) male students. Additional participant demographic data is included in Table 1.

Table 1: *Participant gender distribution by study groups*

Sex	Experimental Group	Control Group	Total
Female	4 36.4 %	6 46.2 %	10 41.7 %
Male	7 63.6 %	7 53.8 %	14 58.3 %
Total	11 100 %	13 100 %	24 100 %

Fisher Chi-Square Test =0.697, p=0.473

No significant differences were observed between pre- and post-exercise training WRT and WRD scores. However, the experimental group showed improvement by making fewer errors in the BGT after the study (p=0.002) (Table 2).

Table 2: *Comparison of WRD,WRT and BGT scores of participants.*

	Experimental Group M±SD			Control Group M±SD		
	Before training program	**After training program**	**P***	**Before training program**	**After training program**	**P***
WRD	2.35±1.52	2.75±2.06	0.22	2.17±1.86	2.46±2.14	0.35
WRT	3.66±3.32	4.00±2.96	0.53	3.28±2.62	4.14±3.67	0.28
BGT	12.81±4.99	9.90±4.88	0.002	11.23±3.03	11.92±3.54	0.16

M: Mean, SD: Standard Deviation, WRT:Wechsler Picture Completion ,WRD:Wechsler Picture Arrangement, BGT: Bender-Gestalt Visual Motor Perception Test
* Independent Sample T- Test

4 Discussion

The purpose of this study was to examine how children with intellectual disabilities may benefit from BG training incorporating specific movement patterns. Findings suggest that BG training improved cognitive function by the end of the trial. However, although there was improvement in BGT, no change was observed in WRT and WRD score.

Recent research has increasingly focused on the relationship between bilateral limb movements and interhemispheric activity, particularly in individuals with intellectual disabilities (ID).According to Morita et al., synchronized movement training over an extended period of time can improve the structural integrity of interhemispheric networks (Morita, Takemura, & Naito, 2023). Clinical manifestations of interhemispheric dysfunction include language impairments, reading and comprehension difficulties, poor detail memory, trouble performing complex mathematical computations, and difficulties with motor tasks (Fisher, Murray, & Bundy, 1991).

Movement training is essential for individuals with intellectual disabilities, as it improves physical fitness while also enhancing cognitive and environmental awareness. (Cenikli, Dalkılıç, & Kaya, 2018; Jalilinasab, Saemi, & Abedanzadeh, 2022). According to the literature, several studies have shown that both typically developing children and those in special education who undergo BG training experience improvements in basic abilities (Panzilion, Padila, Setyawati, Harsismanto, & Sartika, 2020; Pratiwi & Pratama, 2020). The study's findings demonstrated that BG exercise training, which consists of basic body motions, improves central nervous system functions by facilitating hemispheric cooperation (Sele, 2019). Donezik used basic crawling movements to facilitate interhemispheric communication with pupils who struggled with reading in his study. He discovered that after a year of research, reading errors decreased, reading fluency improved, and the horizontal eye tracking lapses that are commonly observed in youngsters while they read were fixed (Donczik, 2001). In our study, the children in the experimental group showed improvement in the BGT, where vision is at the forefront, after the BG exercise training.

Furthermore, the effectiveness of BG appears to diminish when scrutinized under controlled experimental conditions. For instance, researches indicates that while some participants may report subjective improvements, objective measures of cognitive function do not consistently support these claims (Ekerer, Ince, & Över, 2024; Ferree, 2001; Watson & Kelso, 2014). In the findings of the current study, no improvement was found in the WRT and WRD score types of the experimental group.

5 Conclusion

In this study, the findings show that BG exercise training applied to children with intellectual disabilities improved cognitive performance. Based on the findings of this study, we recommend implementing a long-term training program that incorporates simple gross motor movements to enhance the cognitive abilities of children with mild intellectual disabilities. Future studies should examine the long-term effects of exercises involving body and bilateral extremity movements, such as BG, on individuals with intellectual disabilities. Findings from this research offer an alternate strategy for meeting children' requirements both at school and at home through the provision of suitable learning stimuli by administrators, instructors, and parents.

6 Declarations

6.1 Study Limitations

The most significant limitation of this study is that it was conducted with a small sample size. Another limitation of the study was the absence of long-term assessments on cognitive function.

6.2 Acknowledgements

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6.3 Funding source

No financial support was received for this research.

6.4 Competing Interests

There is no conflict of interest in this study.

6.5 Authors' Contributions

Define the contribution of each researcher named in the paper to the paper.

Corresponding Author Makbule KARCI : Contribution to the article planning the materials and methods to reach the results, taking responsibility for the experiments, organizing and reporting the data, taking responsibility for the explanation and presentation of the results, taking responsibility for the literature review during the research, taking responsibility for the creation of the entire manuscript or the main part, reworking not only in terms of spelling and grammar but also intellectual content

2. Author Bilsen SİRMEN: Contribution to the article developing ideas or hypotheses for the research and/or article, planning the materials and methods to reach the results, taking responsibility for the experiments, taking responsibility for the creation of the entire manuscript or the main part, reworking not only in terms of spelling and grammar but also intellectual content.

7 Human and Animal Related Study

7.1 Ethical Approval

The study was approved by İstanbul University Non-Invasive Clinical Research Ethics Committee (60116787-020/68911). The study was carried out by the principles of the Declaration of Helsinki. Children with intellectual disabilities and their families were informed about the study, permission was obtained by signing an informed consent form.

7.2 Informed Consent

Informed consent form was obtained from all participants for the study that they agreed to participate in the study.

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