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Research Paper

Comparison of the Effect of Interventions based on Spark Perceptual-Motor Exercises, Neurofeedback and Mindfulness on the Sensory Integration of Children in the Second Grade of Elementary School with ADHD

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Abstract

Aim: The aim of this study was to compare the effect of interventions based on spark-perceptual-motor exercises, neurofeedback and mindfulness on sensory integration. This study was a quasi-experimental study. It was performed using pre-test, post-test and follow-up design with the control group. The present study population consisted of all children in the second grade of elementary school with ADHD in Isfahan. A total of 60 people were purposefully selected based on entry and exit criteria and after matching based on gender, amount and type of drug were

divided into four groups of 15: mindfulness, perceptual-motor training, neurofeedback and control group. Hanschu and Risman (1992) questionnaire were used to measure sensory integrity. For data analysis, repeated measures analysis of variance was used using SPSS-24 software at a significance level of less than five percent. Findings showed that there was a significant difference in sensory integration of neurofeedback and spark treatment compared to the control group ($p < 0.01$) but this difference was not observed in the mindfulness group ($p < 0.05$). The results also showed that in the treatment of mindfulness, pre-test scores were not significantly different from post-test ($p < 0.05$), but post-test scores and follow-up of neurofeedback and spark treatment groups were significantly different from pre-test scores ($p < 0.05$).

Keywords*: Spark Perceptual-Motor Exercises, Neurofeedback, Mindfulness, Sensory Integrity, Attention Deficit Hyperactivity Disorder*

Introduction

Attention deficit hyperactivity disorder (ADHD) is a serious disorder detected during childhood(Göbel, Baumgarten, Kuntz, Hölling, & Schlack, 2018). Several factors, including processing deficits and a lack of sensory integration lead to the clinical manifestations of ADHD. Sensory integration refers to the ability to regulate and organize responses in behavior (Smith, Mruzek, & Mozingo, 2015), a deficit of which disrupts the level of arousal, attention, affect, and functions(Chu & Reynolds, 2007), and contributes to behavioral problems in children with ADHD(Izawa et al., 2012).

The Sports, Play and Active Recreation for Kids (SPARK) exercises were designed to promote perceptual-motor processing(Deng, 2017). According to (Shekan, Gorji, Zahedi, Raisi, & Zarrin, 2021), the SPARK exercises improve perceptual-motor processing.

Neurofeedback is another technique aiming to improve the neuropsychological activities of the brain (Faller, Cummings, Saproo, & Sajda, 2019). Via abnormal wave patterns in the sensory-motor, motor, and cingulate cortex, neurofeedback helps the formation of normal wave patterns (Holtmann et al., 2018).

Mindfulness is another psychological intervention that, if adapted to children's age, can enhance their sensory awareness (Dunning et al., 2019).

Most interventions for ADHD aim to mitigate the signs and symptoms of the disorder, while few studies have examined comorbidities or disorders that affect it, including a lack of sensory integration (Gajria et al., 2014). The other shortcomings of the existing interventions include the transience of therapeutic effects, medication side-effects, and people’s unwillingness to take medication (Holbrook et al., 2017). Conventional interventions for ADHD are categorized in three domains of physical education,

neuropsychology, and psychology, but their effectiveness and persistence of effects have not been compared. Therefore, the present study aimed to compare the effectiveness of SPARK sensory-motor exercises, neurofeedback, and mindfulness interventions on the sensory integration of 4-6-grade students with ADHD in Isfahan, Iran.

Methodology

This was a controlled quasi-experimental study with pretest-posttest and follow-up design conducted in three experimental groups of mindfulness, neurofeedback, and SPARK exercises. The statistical population comprised girls and boys with ADHD aged 9-11 years in Isfahan (2019). A sample of 60 was purposively selected based on the inclusion criteria. After matching the groups in terms of sex, type and dosage of medication, the participants were randomly allocated to four groups of mindfulness intervention, neurofeedback, SPARK exercises, and a control group. The three experimental groups (n = 15 each) received either mindfulness intervention, neurofeedback, or SPARK exercises for 10 weeks, while the control group received no intervention. Sensory integration was assessed via Reisman and Hanschu's (1992) Sensory Integration Inventory which comprises 104 questions scored on a three-point Likert scale (0 to 2) to examine tactile, vestibular, proprioceptive, and general reactions(Reisman & Hanschu, 1992). The researcher translated this inventory, which obtained content validity of 0.79 among child psychologists. In the current study, Cronbach's alpha coefficient was used to assess the overall reliability of the inventory (0.94) and that of the subscales (0.90, 0.89, 0.79, and 0.79 for tactile, vestibular, proprioceptive, and general reactions, respectively). The data were analyzed via a repeated measures analysis of variance (ANOVA) in SPSS.

Results

The main assumptions of repeated measures ANOVA were first tested and confirmed.

Table 1. Repeated measures ANOVA for sensory integration

Sources of variation	Sum of Squares	Df	Mean of Squares	F value	Significance level	Eta squared	Power
Intragroup factor	1982.411	3	991.206	16.670	0.001	0.229	1.00
Time effect	483.376	6	80.561	1.355	0.239	0.068	0.512
Time x	204.292	3	68.097	1.130	0.345	0.057	0.288

group effect					

Table 2. Bonferroni test to compare the groups in terms of sensory integration on posttest and follow-up

	Group A	Group B	Differences in means A-B	Standard error	Significance level
Posttest	Mindfulness	Control	-4.272	2.620	0.109
	SPARK exercises	Control	-10.899	2.618	0.001
	Neurofeedback	Control	-8.463	2.617	0.002
	Mindfulness	Neurofeedback	4.191	2.620	0.115
	Mindfulness	SPARK exercises	6.627	2.624	0.014
	Neurofeedback	SPARK exercises	2.236	2.618	0.356
Follow-up	Mindfulness	Control	-3.824	2.507	0.133
	SPARK exercises	Control	-7.321	2.505	0.005
	Neurofeedback	Control	-5.801	2.504	0.024
	Mindfulness	Neurofeedback	1.978	2.506	0.433
	Mindfulness	SPARK exercises	3.497	2.510	0.169
	Neurofeedback	SPARK exercises	1.519	2.505	0.547

There was a significant difference among SPARK, neurofeedback, and control groups on the posttest ($p < 0.01$). Although the sensory integration scores of the mindfulness group increased on posttest, this increase was insignificant ($p > 0.05$). On the posttest, the results revealed the greater effectiveness of SPARK exercises on the sensory integration of children with ADHD ($p < 0.05$). On follow-up, the SPARK and control groups ($p < 0.01$) and the neurofeedback and control groups ($p < 0.05$) significantly differed. Although the sensory integration scores of the mindfulness group were increased on follow-up, this increase was insignificant ($p > 0.05$). Despite the greater effectiveness of SPARK exercises on the sensory integration of children with ADHD, no significant difference was observed among the three experimental groups on follow-up ($p > 0.05$).

Discussion and conclusion

Based on the findings, the mindfulness intervention had no significant effect on the sensory integration of children with ADHD on posttest ($p > 0.05$); on

follow-up, however, the acquired mindfulness skills improved the sensory integration scores ($p < 0.05$). Neurofeedback and SPARK exercises significantly mitigated the lack of sensory integration of children with ADHD ($p < 0.05$). Inadequate motor experiences in different developmental stages disrupt the nervous system. SPARK exercises, therefore, improve the midbrain, pons, medulla oblongata, and its cortex, while also enhancing sensory, perceptual, and cognitive functions (Halperin and Holly, 2011).

Herein, neurofeedback was administered to C1, C5, and FCz points of the frontal and parietal lobes, thereby increasing the beta waves and the sensorimotor rhythm (SMR), and decreasing theta waves which, in turn, affected the sensory-motor cortex and mitigated sensory processing problems. Similarly, Faller et al.(2019) and (Omura & Kanoh, 2017). reported that neurofeedback leads to sensory-motor integration in people who undergo the intervention.

When testing sensory integration, the participants' perception of sensory experience, vestibular, and proprioceptive senses are usually processed (not their mentality), and this explains the small and insignificant effect of mindfulness intervention in this study. These findings are inconsistent with those of (Gu, Xu, & Zhu, 2018) reporting that individuals who receive psychological mindfulness intervention acquire better neuropsychological functions compared to the control group.

Overall, the results confirmed the effectiveness of brain stimulation and cerebral ability enhancement as the main techniques for mitigating the lack of sensory integration in children with ADHD. Whether through neurofeedback or physical exercises (e.g., SPARK exercises), these stimulations promote sensory integration-related cerebral functions and thus mitigate problems. This study was limited by the use of a questionnaire for assessing the sensory integration of children with ADHD. As such, future studies are recommended to use performance tests to examine these problems and compare the results with those of the current study.

Conflict of interest

None to declare

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