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# Effects of Motor Planning on Sensory Profile, Balance, and Academic Achievement in Children with Intellectual Disability

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**ABSTRACT**

**Aims:** Children with Intellectual Disability (ID) struggle with their motor balance and also have difficulty learning new motor skills. The present study aimed to investigate the effects of motor planning on sensory profile, balance, and academic achievement in children with ID.

**Method and Materials:** This quasi-experimental research adopted a pretest-posttest design with a control group. The statistical population included all male and female elementary school students aged 7–11 years with mild ID in Shiraz, Iran in 2021. Purposive sampling was employed to select 30 students as the research sample. They were then randomly assigned to the motor planning group (n=15) and the control group (n=15). The data were collected by using the sensory profile, static and dynamic balance tests, and academic achievement. The analysis of covariance (ANCOVA) was used for data analysis in SPSS 24.

**Findings:** According to the results, there was a significant difference between the motor planning group and the control group in sensory profile, balance, and academic achievement (P<0.01).

**Conclusion:** Since the motor planning exercises improved the sensory profile, balance, and academic achievement in children with mild ID, their parents and educators are recommended to employ these exercises to improve those skills.

**Keywords**: Motor Planning, Rehabilitation, Sensory Profile, Balance, Intellectual Disability, Children

## Introduction

Intellectual Disability (ID) is characterized by significant limitations on both intellectual ability and adaptive behavior that typically emerge by the age of 18[1]. Intellectual Disability is divided into four categories based on the severity of deficit in adaptive behavior: mild, moderate, severe, and profound [2]. Intellectual disability is more common in boys than in girls, with mild ID accounting for nearly 85% of cases[3]. Many patients with mild ID can live independently and manage their families if they are supported by others [4]. In addition to cognitive and social problems, children with ID exhibit behavioral and emotional issues, such as learning difficulties, personality issues, and maladaptive behaviors[5]. Most children diagnosed with ID can learn new things; however, they can never gain enough from they can learn a minimum of regular classes. Nevertheless, formal education and general knowledge. They can also apply what they have learned to effectively manage their lives[6]. Intellectual disability not only predisposes children to psychological and social disturbances of adolescence and even adulthood but also poses many problems and difficulties to family members and school officials [7]. One of the problems that children with ID usually face is sensory profile disturbance [8]. Many studies have demonstrated how sensory profile and perception are involved in emotional deficits [9, 10].Sensory profile is a general term that describes how the central and peripheral nervous systems manage sensory information [11-12].Initiating the learning process, sensory profile is also a crucial aspect of children's environmental experience. An sequentially receiving, modifying, and integrating sensory information [13]. Children need to be fully attentive, aware of all of their senses, and able to identify the emotions caused by a particular experience to participate in activities (behavioral responses to sensory stimuli in regular everyday activities) and do the learning at home, school, and other environments[14].

Another problem of children with ID is Developmental Coordination Disorder (DCD) [15]. Children who struggle with their motor balance also have difficulty in learning new motor skills[16]. Moreover, the balance of children with ID is lower than the average of their healthy peers[17]. Balance is a complex motor skill necessary for nearly all daily activities. Balance is defined as the ability to keep the body's center of gravity within the range of the support surface [18]. It is classified under two categories: static and dynamic[19]. Static balance refers to the ability to maintain balance in a fixed position, whereas dynamic balance is the ability to keep balance on a moving surface or while moving the body in space[20]. Any activity results from the association of an action with an environment and its objective, according to the active systems theory[21]. The combined action of the nervous and musculoskeletal systems, known as the postural control system, results in the capacity to regulate one's body posture in space[22].

Due to their cognitive differences from their healthy peers, children with ID face numerous educational and learning challenges. Nonetheless, recognizing these differences and applying proper solutions can help these children improve their academic achievement [23]. By contrast, poor knowledge of the traits of children with ID and inappropriate use of motivational techniques will result in academic failure[24]. The academic achievement of children with mild ID is one of the main indicators for evaluating education systems. Academic achievement is defined as an individual's ability to learn or gain knowledge in academic topics as assessed by standardized comprehensive assessments or teacher-made tests[25]. This term generally refers to one’s level of schooling, allowing them to be studied within the broader category of factors about individual differences as well as aspects related to the school and education system[26]. Nader-Grosbois et al.[27] showed a significant difference between children with ID and their healthy peers in the relationship between self-handicapping and academic achievement (and its dimensions).

Disruption in the execution of coordinated movements as well as the sensory profile, balance, reaction time, and academic achievement of children with mild ID has always been a concern of parents, educators, teachers, and researchers of human movement and rehabilitation sciences. Accordingly, the theory of motor planning was developed concerning the relationship between neurology and behavioral sciences [28]. The neurocognitive threshold continuum, which ranges from low to high thresholds, shows how much input the nervous system requires before it can react[29]. At the same time, the behavioral threshold continuum, which ranges from passive to active self-regulation mechanisms, demonstrates the variety of responses that an individual can show to a task or an environment[30]. The intersection of these two continuums creates four motor planning patterns, such as sensory registration, sensory seeking, sensory sensitivity, and sensory avoidance, all of which may be observed in all age groups, from infancy to adulthood[31]. Niklasson et al.[32] reported that sensorimotor stimulation helped children with DCD improve their motor coordination. Quinzi et al.[33] also indicated that motor planning-based interventions positively affected the gross and fine motor skills of children with Down syndrome.

Physical exercise can likely have many benefits for children with ID, given their poor motor skills and the importance of these skills, as well as the fact that physical activities improve intellectual performance, physical health, behavior perception, and personality. Therefore, it is necessary to analyze the motor development of such children and also the effects of physical exercises on their motor development. In addition, since motor skills serve as the basis of all body movements, the best time to develop these skills is during childhood and early adolescence. Accordingly, this study aimed to investigate the effects of motor planning on sensory profile, balance, and academic achievement in children with ID.

## Method and Materials

This applied quasi-experimental research adopted a pretest-posttest design with a control group. The statistical population included all male and female elementary school students aged 7–11 years with mild ID in Shiraz, Iran in the academic year 2020–21. Purposive sampling was employed to select 30 students as the research sample. They were then randomly assigned to the motor planning group (n=15) and the control group (n=15). The inclusion criteria encompassed being diagnosed with mild DI by a psychologist applying DSM-5 criteria, having non-affliction with other disorders, and giving informed consent. The exclusion criteria included unwillingness to continue the study, participation in concurrent treatment programs, and incomplete submission of research questionnaires.

The measurement tools were as following:

Children’s Sensory Profile Questionnaire: Dunn et al.[34] developed this questionnaire to measure the effects of sensory information on children's performance. This 124-item questionnaire is completed by parents, and the items are scored on a 5-point scale (0: Never, 25: Rarely, 50: Sometimes, 75: Often, and 100: Always). Mirzakhani et al.[35] reported that Cronbach's α coefficient was 0.79 for the Children’s Sensory Profile Questionnaire.

Static and Dynamic Balance Tests: The stork test (static balance) requires the participants to stand on one leg on a flat surface and elevate the free leg to the level of the knee while both hands are freely placed next to the body. The tester tracks the maximum time that the participants can stand on their feet (the time is recorded when the participants put their free foot on the ground). The best time is recorded after this test is repeated twice for each leg. The heel-to-toe walking test measures the participants’ ability to walk in a straight path (dynamic balance). In this test, the participants take 15 steps in a straight line from heel to toe. The maximum score for this test is 15. If the participants deviate from the straight line before completing 15 steps, the test is terminated and the number of steps is recorded. This test is taken twice, and the highest score is recorded for each participant[36].

Academic Achievement: In this study, the Grade Point Average (GPA) of students in the first and second semesters was compared to assess their academic achievements.

The Intervention which applied for this study was motor planning. Motor planning in this study included twelve 50-minute sessions (two sessions per week) over eight weeks. In each session, students completed various physical activities with an emphasis on the deep and vestibular senses. In each session, students performed various physical activities with an emphasis on the deep and vestibular senses. These exercises included swinging, bouncing on a trampoline, circling oneself, circling the trainer, stepping on the floor with the hips, rolling a ball on the back in the palm position, hauling the entire body, stepping on a balance stick, and walking up and down a ramp[37].

Descriptive statistics (i.e., mean and standard deviation) and inferential statistics (i.e., ANCOVA) were used for data analysis in SPSS 24. The significance level was determined to be α=0.05.

## Findings

The participants were 30 children having mild ID with a mean age of 10.31±2.85. Descriptive data showed that the posttest mean score of the sensory profile, balance, and academic achievement in the motor planning group significantly increased in comparison with the pretest scores. However, there were no significant differences between the pretest and posttest scores of these variables in the control group (Table 1).

In addition, the Kolmogorov–Smirnov test demonstrated the normal distribution of data. In conclusion, all ANCOVA assumptions were established for the research variables at the pretest and posttest stages. The ANCOVA results revealed a significant difference between the motor planning group and the control group in terms of sensory profile, balance, and academic achievement. The research results indicated that motor planning significantly improved the sensory profile (F=608.71, P<0.001) and balance (F=681.82, P<0.001) of students with mild ID.

In addition, the motor planning intervention significantly and positively affected the academic achievement of participants F=7.23, P=0.018). These results suggest that the motor planning intervention significantly improved the sensory profile, balance, and academic achievement of children with mild ID in comparison with the control group (Table 2).

**Table 1)** Mean and standard deviation of the research variables in motor planning and control groups

| Variables | Phases | Motor planning group | Control group |
|---|---|---|---|
| | | Mean ± SD | Mean ± SD |
| Sensory profile | Pretest | 1886.67 ± 162.80 | 1978.33 ± 83.38 |
| | Posttest | 4663.33 ± 371.15 | 1971.67 ± 61.86 |
| Balance | Pretest | 11.80 ± 1.20 | 12.33 ± 1.75 |
| | Posttest | 29.87 ± 1.88 | 13.13 ± 1.45 |
| Academic achievement | Pretest | 11.47 ± 0.92 | 11.07 ± 1.03 |
| | Posttest | 15.40 ± 0.51 | 11.53 ± 0.99 |

The homogeneity of regression slopes, homogeneity of variances, and normality of distribution were examined before ANCOVA was performed. The pretest and posttest results of examining the homogeneity of regression slopes indicated that the regression slopes were homogeneous in both groups. Levene's test confirmed the homogeneity of variances of dependent variables in both groups.

**Table 2)** Results of analysis of covariance on research variables in intervention and control groups

| Variables | SS | df | MS | F | P | $\eta^2$ | Power |
|---|---|---|---|---|---|---|---|
| Sensory profile | 84281321.01 | 1 | 84281321.01 | 608.71 | <0.001 | 0.96 | 1.00 |
| Balance | 2713.06 | 1 | 2713.06 | 681.82 | <0.001 | 0.97 | 1.00 |
| Academic achievement | 23.79 | 1 | 23.79 | 7.23 | 0.018 | 0.24 | 0.85 |

## Discussion

This study aimed to investigate the effects of motor planning on sensory profile, balance, and academic achievement in children with ID. The research findings demonstrated a significant difference between the motor planning group and the control group, as the motor planning intervention significantly improved the sensory profile, balance, and academic achievement of children with mild ID. In terms of motor skills and development, children with ID lag behind peers of the same age. This can negatively affect such children's development in a variety of ways as well as how well they perform in everyday activities. The natural development and perceptual-motor abilities of children are influenced by heredity and environment in varying degrees. One of the most important environmental elements affecting the development of these skills is the availability of learning opportunities and active environments for acquiring perceptual and motor experiences during critical developmental stages, particularly childhood[5].

Sensory integration and processing deficits are among the major factors causing such children's motor problems. Therefore, motor planning interventions can help enhance their motor skills by improving the ability of the central nervous system to process and integrate information. According to the research results, some sensory-motor problems of children with ID can be alleviated if they are allowed to participate in activities. Consistent with the findings of this study, Keklicek et al.[38] and Lust et al.[39] also reported the positive effects of motor planning exercises on the motor skills of children with cerebral palsy. According to Zhang et al.[40] repeated displacement and balance exercises included in a training protocol stimulated the sensory, nervous, and motor systems of participants. This also improved neuromuscular coordination, further stimulated the deep sensory receptors of muscles, and improved routine performance in participants.

Furthermore, unlike their healthy peers, children with ID cannot perform high-level muscle exercises. In other words, they begin these exercises slowly. Deficits in muscle activation are associated with motor problems in children with ID [16]. These deficits are caused by disruptions in the cerebral cortex, which is responsible for preserving muscle tension. Following the motor planning exercises, the body will make concerted efforts to repair any previous injuries by initiating the mechanisms of targeted exercises. Thus, it probably enhances cerebral cortex function, which in turn improves motor skills [30]. The development of fine and gross motor skills is crucial for the rehabilitation and occupational therapy of children with ID, as it might improve their overall performance [39]. It seems that the motor planning intervention performed in this study can positively improve the sensory profile, balance, and academic achievement of such children. The regular repetition of such interventions in rehabilitation programs will stimulate the brain's sensory receptors to process more comprehensive information. In this case, the establishment of communication between several receptors will affect more neurons. As a result, the processing and sensory integration deficits in these children can be partially improved by providing simultaneous stimuli.

## Conclusions

The research findings demonstrated the positive effects of the motor planning exercises on the sensory profile, balance, and academic achievement of students with mild ID. Therefore, teachers and educators, especially those who communicate with such children, are recommended to employ these exercises to improve the foregoing skills in these children. Considering the constraints of entertaining and managing children with mild ID in patient care and rehabilitation centers, therapists, trainers, and officials of rehabilitation centers can use motor planning as a safe and effective method for treating such children.

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## Authors ' Contribution

MF conducted all stages of the study. RH supervised the study. HJ advised the study.

## Conflict of Interests

There is no conflict of interest for this study.

## Ethical Permission

The study was approved by the Ethics Committee of Islamic Azad University, Ahvaz branch (code: IR.IAU.AHVAZ.REC.1400.033).

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