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RESEARCH ARTICLE

# Effects of Sensory-Motor Perception and Movement Trainings in 2-6 Years Old Children Having Developmental Problems on Development Area and Emotional and Behavioral Problems

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**Abstract**

This study aimed to examine the effects of sensory-motor perception and movement training on the developmental areas and emotional and behavioral problems of children with neurodevelopmental problems. The sensory-motor perception and movement training program applied in this work focused on the personal and social, fine and gross motor, receptive and expressive language, emotion, and behavior issues of 15 children aged 2 to 6 years consisting of nine children with Autism Spectrum Disorder, three children having Speech Disorder, and three children having General Development Delay. The program was applied for 18 weeks, six days a week and two hours per day, for a total of 216 hours. The Denver-II development scale and the Child Behavior Checklists (separately for ages of 2-3 and 4-6) were used to create the pretest-posttest design. Using these data, the positive impacts of training on development areas as well as emotional and behavioral issues were measured. According to the Wilcoxon signed-rank test results, children's Denver-II development scale and its sub-dimensions' scores after sensory-motor perception and movement training improved significantly ($p<0.05$). When the pretest and posttest averages of Child Behavior Checklist for children aged 2-3 and 4-6 were compared, internalizing, externalizing, and overall scores decreased significantly after sensory-motor perception and movement training ($p<0.05$). In conclusion, children with developmental problems aged 2 to 6 who received sensory-motor, perception, and movement training showed significant decrease in anxiety levels, significant reduction in aggressive and destructive behavior, and significant improvement in fine- and gross-motor abilities as well as language and social skills.

**Keywords**
Disabled, Children, Behaviour, Sensory-Motor, Trainin

## INTRODUCTION

Sensory, motor perception and movement training mainly target the first stages of development, especially the 0-6 age period. During this period, some children have problems in one or more of the neurodevelopment areas (sequential thinking, motor systems, social thinking, language, attention control, memory, environmental regulation, higher thinking). Children with developmental problems appear as children with poor body and space perception, limited vocal and physical imitation skills, unable to interact with their environment and unable to create purposeful movements (Bishop, 2010; Little, 2000; Meriem et al., 2020; Samad et al., 2024).

It is important to process the knowledge of how to use our hands and body in tasks that require skill such as using any tool such as a pencil or fork, building a structure such as a house or tower from

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toy blocks, arranging the room (Blanche Erna et al., 1999). However, children who have developmental problems have difficulties in planning the movement, creating a sequence of actions, and organizing the movement. The ability to transform the received sensory information into purposeful motor movement and to organize the sequence of movements in a coordinated way is weak. When the central nervous system (CNS), deep sense, tactile, movement and balance senses perform an organized process, it becomes easier for the child to plan and organize the movement.

Predicting the force, speed and steps required for the movement, estimating the movement using the most accurate prediction for the expected result with the idea of movement, developing a strategy, establishing a bridge between thought and behavior, and the diagram drawn to perform the action are important in the interaction of the child and the environment (Blanche Erna et al., 1999; Hashemi et al., 2024).

The sensory processing ability of the central nervous system (CNS) affects the sensory-motor map development of the child's body and forms the basis for interactions with the environment. With the motor-movement ability of the CNS, it forms the basis for the development of basic movement skills and the provision of more complex movement skills. Sensory processing, motor skills and movement skills of the CNS are necessary for the development of thought and behavior skills, intention, expectation, cause-effect, object relations, and basic mental skills (such as eating, doing homework) (Ayres, 1979; Ayres et al., 1987).

Studies in the literature have generally been made on motor skills, and it has been observed that motor development affects the development of other developmental periods. Iwanaga et al. (2000) examined 10 pre-school children with Asperger's and 15 high-functioning children with autism in terms of motor problems. In the study, 50% of Asperger's syndrome and 67% of high-functioning autism patients had motor impairment, visual motor integration, visuospatial perception problems and three-dimensional perception problems. It has been emphasized that motor delay is seen more intensely in children with Asperger's in the early period.

Yanardağ (2007) attributed the motor development loss of educable mentally retarded children to insufficient physical activities and suggested that the physical fitness and motor development of children is mostly due to insufficient education and not being given the opportunity to participate in games. Piek and Dyck (2004) stated that children with developmental delay and behavioral problems should be included in activities that will develop basic motor skills appropriate to their developmental stages in a planned way. A study in the literature shows that the self-talk of the child with ASD, who was given movement training, at the beginning of the practice greatly decreased at the end of the practice and there was an increase in meaningful verbal expressions (Orhan, 2014). In another study, it was observed that the basic speaking skills and advanced speaking skills of children with ASD who do sports are more advanced than the children who do not do sports (Esen, 2010).

Rosenthal-Malek and Mitchell (1997) stated that after the exercise program applied to five adolescents with autism, self-stimulating behaviors decreased, children's attention span and personal performance increased, and abnormal behaviors and self-harming behaviors decreased. İlhan (2007) applied a special physical training program to educable mentally retarded children aged 8-12, 88 experimental and 57 control groups. According to the results of the pre-test and post-test results, it is observed that there was a decreasing difference in the neurotic and behavioral problems of the children in the experimental group compared to the control group.

In another study, it was observed that the perception and interpretation of the world of children with ASD is different from the perception and interpretation of the world of children with normal development, and when the incoming information cannot be received through the senses in a healthy way, children have difficulties in interpreting this information and giving their feedback. It has also been observed that sensory-motor activities applied to individuals with ASD have a positive effect on their skills in development areas (Fazlıoğlu-Özlü, 2004).

In this direction, in this study, we aim to examine the effects of sensory-motor perception and movement training on the developmental areas and emotional and behavioral problems of 2–6 years old children with neurodevelopmental problems, in line with the development principles outlined above.

## MATERIALS AND METHODS

### *Research Model/Design*

The research, using a semi-experimental design, was carried out with the approval of the ethics committee of T. C. Istanbul Arel University, with the letter numbered 10432314-200.00.00-15 on 21/05/2014. Participants were provided with informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adheres to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. Families were included in the study on a voluntary basis by giving information about the research. The research was carried out at the Duyusal Bütünleme Özel Eğitim Merkezi (Sensory Integration Special Education Center) in Bahçelievler, Istanbul. The environment has been prepared in accordance with individuals with developmental problems.

### *Research Sample*

The research group consists of a total of 15 children, 9 boys with Autism Spectrum Disorder (ASD), 3 boys with Language Disorder (LD) and 3 boys with General Developmental Delay (GDD), between the ages of 2-6, who are in neurodevelopmental disorder according to the DSM-5 diagnostic scale, from the departments of child psychiatry and child development neurology in Istanbul.

### *Data Collection Tools*

Denver II Developmental Test and Child Behavior Rating Scale (CBRS) 2-3 years and Child Behavior Rating Scale (CBRS) 4-18 years old were used in the pre-test and post-test to the research sample (Yalaz et al., 2013).

### *Research Instruments and Procedures*

### *Sensory-Motor Perception and Movement Training Protocol*

We planned the practice of sensory-motor perception and movement training as 2 stages. In stage 1, we applied one-to-one individual activities. In stage 1, we performed the basic movement skills of the activities will be taught in stage 2. In stage 2, we applied specially prepared study activities on 13 objectives under 3 headings. Stage 1 (One-to-one individual activities) lasted 2 weeks and Stage 2 (Group activities) lasted 16 weeks. The sensory-motor perception movement training included Raising Motor Skills (Gross motor movements, Fine motor movements, Motion control, and Body flexibility), Social Organization (Queue taking skill, Queue waiting skill, Adaptation, and Collaborative action), and Independence (Self-confidence, Independent chain motor development, Creating continuity, Generalization, and Taking independent action).

**Table 1.** Application activity program

| Activity No | Activity Name | Activity Goal | Purpose of the Activity | Weeks of the Activity | Total Time |
|---|---|---|---|---|---|
| 1 | Disabled road exercises | Improving walking ability and height perception | Increasing motor skills | 1 | 60 min. |
| 2 | Disabled road exercises with the group | Improving walking ability, height perception and joint attention | Increasing motor skills | 1 | 90 min. |
| 3 | Targeted road exercises | Improving walking ability and height perception, creating motion control | Increasing motor skills | 1 | 60 min. |
| 4 | Targeted road exercises with the group | Improving walking ability, height perception and joint attention | Increasing motor skills | 1 | 90 min. |
| 5 | Targeted road exercises with sandbags | Developing the ability to walk in different directions and depth perception | Increasing motor skills | 1 | 60 min. |
| 6 | Targeted road exercises using sandbags with the group | Developing the ability to walk in different directions, depth perception and joint attention | Increasing motor skills | 1 | 90 min. |
| 31 | Creating a tactile stimulus with a brush | Recognizing body parts, creating bodily awareness and self-confidence | Building social organization, independence | 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16 | 960 min. |
| 7 | Imitation on the trampoline | Recognizing body parts and improving body perception | Increasing motor skills | 2-3 | 120 min. |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Imitation on the trampoline with the group | Recognizing body parts, increasing body perception, and developing joint attention | Increasing motor skills, building social organization | 2-3 | 180 min. |
| 9 | Stair climbing exercise | Recognizing body parts, developing body perception and fine-gross motor muscle | Increasing motor skills, building social organization | 2-3 | 120 min. |
| 10 | Stair climbing exercise with the group | Recognizing body parts, developing body perception, fine-gross motor muscle, joint attention and queue taking skills | Increasing motor skills, building social organization | 2-3 | 180 min. |
| 11 | Hammock exercise | Creating spatial awareness, developing gross motor muscle | Increasing motor skills | 3 | 60 min. |
| 12 | Sticker sticking exercise | Creating body and directional awareness, developing fine-gross motor muscle | Increasing motor skills | 3-4 | 120 min. |
| 13 | Sticker sticking exercise with the group | Creating body and directional awareness, developing fine-gross motor muscle, waiting time, and joint attention | Increasing motor skills, building social organization | 4 | Sticking 120 stickers |
| 14 | Twist exercise | Increasing spatial and temporal awareness, developing hand-eye coordination and gross motor | Increasing motor skills | 4 | 60 reps |
| 15 | Object matching exercise with the group by making a twisting motion | Increasing spatial and temporal awareness, developing hand-eye coordination and gross motor, queue taking and queue waiting skills | Increasing motor skills, building social organization | 4-5 | 24 reps |
| 16 | Colored cube insertion exercise with somersaults | Increasing spatial and temporal awareness, developing hand-eye coordination and gross motor | Increasing motor skills | 5 | 60 reps |
| 17 | Colored cube insertion exercise with somersaults with the group | Increasing spatial and temporal awareness, developing hand-eye coordination and gross motor, queue taking and queue waiting skills | Increasing motor skills, building social organization | 5-6 | 24 reps |
| 18 | Sticker sticking exercise by doing a camel walk | Developing body, spatial and temporal awareness, hand-eye coordination and gross motor | Increasing motor skills | 6 | 30 reps |
| 19 | Sticker sticking exercise by doing a camel walk with the group | Developing body, spatial and temporal awareness, hand-eye coordination and gross motor, queue taking and queue waiting skills, collaborative skills | Increasing motor skills, building social organization | 6-7 | 24 reps |
| 20 | Sticker sticking exercise by doing a spider walking motion | Developing body, spatial and temporal awareness, hand-eye coordination and gross motor | Increasing motor skills | 7-8 | 60 reps |
| 21 | Sticker sticking exercise by doing a spider walking motion with the group | Developing body, spatial and temporal awareness, hand-eye coordination and gross motor, queue taking and queue waiting skills, collaborative skills | Increasing motor skills, building social organization | 7-8 | 24 reps |
| 22 | Build a tower with colored cubes by making a snake move | Increasing body, spatial and temporal awareness, developing fine-gross motor | Increasing motor skills | 8-9-10 | 90 reps |
| 23 | Build a tower with colored cubes by making a snake move with the group | Developing body, spatial and temporal awareness, developing fine-gross motor, queue taking and queue waiting skills, adaptive behavior and collaborative skills | Increasing motor skills, building social organization | 9-10 | 60 reps |
| 24 | Standing exercise while walking the camel | Increasing awareness of the place, creating movement control, ensuring the adaptation process to the group, increasing waiting time | Building social organization, independence | 9-10 | 84 min. |
| 25 | Chain movement exercise | Creating continuity, developing independent chain movement | Building social organization, independence | 10-11-15-16 | 72 reps |
| 26 | Chain movement exercise with the group | Creating continuity, developing independent chain movement, queue taking and queue waiting skills | Building social organization, independence | 11-15 | 24 reps |

| | | | | | |
|---|---|---|---|---|---|
| 27 | Ringing exercise with the group | Developing the ability to act independently, increasing self-confidence, creating continuity | Building social organization, independence | 11-12-13-14-15-16 | 108 reps |
| 28 | Opening and closing activity with the group | Developing space awareness, collaborative skills, balance, self-confidence, independent action | Building social organization, independence | 12-13-15-16 | 120 reps |
| 29 | Build towers and attach stickers to objects with spider walking with the group | Developing body awareness, joint attention, collaborative skills, queue taking and queue waiting skills, creating continuity | Building social organization, independence | 12-13-14-16 | 48 reps |
| 30 | The activity of throwing the ball to the circle with the group | Developing body and space awareness, throw-holding skills, joint attention, queue waiting skills, creating continuity, generalization | Building social organization, independence | 13-14-15-16 | 240 reps |
| 32 | Model imitation exercises with the group | Developing body awareness, collaborative skills, queue waiting skills, increasing attention span and generalization | Building social organization, independence | 8-9-10-11-12-13-14-15-16 | 432 reps |

### *Data Analysis*

In our research, we analyzed the data with the Denver II Developmental Test and behavioral scales of Child Behavior Rating Scale (CBRS) 2-3 years and Child Behavior Rating Scale (CBRS) 4-18 years old, using the Wilcoxon signed-rank test in the SPSS 21.0 statistical software. We evaluated the analyzes in two parts as 2-3 years old and 4-6 years old groups. We used frequency and percentage values, which are descriptive statistics, to determine the socio-demographic characteristics of all age group subjects and their families. Due to the small sample size (less than 30), we used the Wilcoxon signed-rank test, which is a non-parametric alternative to the t-test.

## RESULTS

As seen in Table 2, there are 8 children in total who are 2-3 years old, and 7 children in total who are between 4-6 years old. A total of 15 children participated in the study.

In the examination performed according to the diagnosis, we determined that 2 children in the 2-3 age group had Language Disorder, 2 children had General Developmental Delay and 4 children had Autism Spectrum Disorders. In the 4-6 age group, we also determined that the majority (5 children) were diagnosed with ASD, and thus most of the participants (9 children) were children diagnosed with ASD.

**Table 2.** Demographic characteristics of the research group by age

| Diagnosis | Age | | | | | |
|---|---|---|---|---|---|---|
| | 2-3 Years | | 4-6 Years | | Total | |
| | *f* | % | *f* | % | *f* | % |
| Language Disorder (LD) | 2 | 25.00 | 1 | 14.29 | 3 | 20.00 |
| General Developmental Delay (GDD) | 2 | 25.00 | 1 | 14.29 | 3 | 20.00 |
| Autism Spectrum Disorders (ASD) | 4 | 50.00 | 5 | 71.43 | 9 | 60.00 |
| Total | 8 | 100.00 | 7 | 100.00 | 15 | 100.00 |

Table 3, we applied Wilcoxon Signed Rank Test to test whether there was a significant difference between the pre-test and post-test in the overall score of 4-18 age CBCL, which are the sub-dimensions of the scale, internalizing and externalizing, applied before and after the sensory-motor perception and movement training given to the participants in the 4-6 age group. As a result of the analysis, we detected the statistically significant difference in the internalizing sub-dimension ($z = -2.366$, $p<0.05$), the externalizing sub-dimension ($z = -2.371$, $p<0.05$) and the CBRS overall ($z = -2.366$, $p<0.05$) scores. When is examined, it is seen that the observed positive ranks are in favor of the post-test score when the average and the total of the rank are considered. According to the results, it can be said that the sensory-motor perception and movement training has a positive effect on children's emotional and behavioral problems (negative rank is 7, positive rank is 0).

**Table 3.** Wilcoxon signed rank test analysis results applied to 4-6 age research group, 4-18 CBRS internalizing, externalizing, overall pre-test and post-test scores

| | | n | Average | Total | z | p |
|---|---|---|---|---|---|---|
| Age 4-18 Post-test internalizing score<br>Age 4-18 Pre-test internalizing score | Negative Ranks[a] | 7 | 4.00 | 28.00 | -2.366 | .018 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 7 | | | | |
| Age 4-18 Post-test externalizing score<br>Age 4-18 Pre-test externalizing score | Negative Ranks[a] | 7 | 4.00 | 28.00 | -2.371 | .018 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 7 | | | | |
| Age 4-18 Post-test CBRS Overall score<br>Age 4-18 Pre-test CBRS Overall score | Negative Ranks[a] | 7 | 4.00 | 28.00 | -2.366 | .018 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 7 | | | | |

a- Age 4-18 Post-test < Age 4-18 Pre-test, b- Age 4-18 Post-test >Age 4-18 Pre-test, c- Age 4-18 Post-test = Age 4-18 Pre-test

Table 4 shows the results of the Wilcoxon Signed Ranked Test performed to test whether there is a difference in the internalization and externalization scores, which are the sub-dimensions of the scale, as well as the CBRS (Child Behavior Rating Scale) applied before and after the sensory-motor perception and movement training given to 2-3 years old. As a result of the analysis, there is a statistically significant difference between the pre-test and post-test values in the internalizing sub-dimension ($z = -2.524$, $p<0.05$), externalizing sub-dimension ($z = -2.521$, $p<0.05$), and CBRS overall ($z = -2.527$, $p<0.05$) scores. Considering the average and total of the ranks, it is seen that the observed positive ranks are also in favor of the post-test score. According to the results, it can be said that the applied sensory-motor perception and movement training has a positive effect on children's emotional and behavioral problems (negative rank is 8, positive rank is 0).

**Table 4.** Wilcoxon signed rank test analysis results applied to 2-3 age research group, CBRS internalizing, externalizing, overall pre-test and post-test scores

| | | n | Average | Total | z | p |
|---|---|---|---|---|---|---|
| Age 2-3 Post-test internalizing score<br>Age 2-3 Pre-test internalizing score | Negative Ranks[a] | 8 | 4.50 | 36.00 | -2.524 | .012 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 8 | | | | |
| Age 2-3 Post-test externalizing score<br>Age 2-3 Pre-test externalizing score | Negative Ranks[a] | 8 | 4.50 | 36.00 | -2.521 | .012 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 8 | | | | |
| Age 2-3 Post-test CBRS Overall score<br>Age 2-3 Pre-test CBRS Overall score | Negative Ranks[a] | 8 | 4.50 | 36.00 | -2.527 | .012 |
| | Positive Ranks[b] | 0 | .00 | .00 | | |
| | Equal[c] | 0 | | | | |
| | Total | 8 | | | | |

a- Age 2-3 Post-test < Age 2-3 Pre-test, b- Age 2-3 Post-test >Age 2-3 Pre-test, c- Age 2-3 Post-test = Age 2-3 Pre-test

Table 5 shows the results of the Wilcoxon Signed Ranked Test performed to test whether there is a difference in the personal social development, fine motor development, gross motor development and language development scores, which are the sub-dimensions of the scale, as well as the Denver II Developmental Scale applied before and after the sensory-motor perception and movement training given to 4-6 age group (children included in the abnormal development group: children with two or more developmental delay score). As a result of the analysis, there is a statistically significant difference between the pre-test and post-test values in the personal social development ($z = -2.032$, $p<0.05$), fine motor development ($z = -2.023$, $p<0.05$), language development ($z = -2.366$, $p<0.05$), gross motor development ($z = -2.366$, $p<0.05$), and Denver II overall ($z = -2.375$, $p<0.05$)

scores. Considering the average and total of the ranks, we observed that there is a significant difference in favor of the post-test between pre-test and post-test developmental delay scores of personal social development, fine motor development, gross motor development, language development subscales of sensory-motor perception and movement training.

**Table 5.** Wilcoxon signed rank test analysis results applied to 4-6 age research group, Denver II developmental scale sub-dimensions and overall pre-test and post-test scores

| | | n | Average | Total | z | p |
|---|---|---|---|---|---|---|
| Post-test personal social development<br>Pre-test personal social development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 5<br>0<br>1<br>7 | 3.00<br>.00 | 15.00<br>.00 | -2.032 | .042 |
| Post-test fine motor development<br>Pre-test fine motor development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 5<br>0<br>2<br>7 | 3.00<br>.00 | 15.00<br>.00 | -2.023 | .043 |
| Post-test language development<br>Pre-test language development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 7<br>0<br>0<br>7 | 4.00<br>.00 | 28.00<br>.00 | -2.366 | .018 |
| Post-test gross motor development<br>Pre-test gross motor development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 7<br>0<br>0<br>7 | 4.00<br>.00 | 28.00<br>.00 | -2.366 | .018 |
| Post-test Denver II Overall<br>Pre-test Denver II Overall | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 7<br>0<br>0<br>7 | 4.00<br>.00 | 28.00<br>.00 | -2.375 | .018 |

a- Post-test < Pre-test, b- Post-test > Pre-test, c- Post-test = Pre-test

**Table 6.** Wilcoxon signed rank test analysis results applied to 2-3 age research group, Denver II developmental scale sub-dimensions and overall pre-test and post-test scores

| | | n | Average | Total | z | p |
|---|---|---|---|---|---|---|
| Post-test personal social development<br>Pre-test personal social development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 8<br>0<br>0<br>8 | 4.50<br>.00 | 36.00<br>.00 | -2.521 | .012 |
| Post-test fine motor development<br>Pre-test fine motor development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 6<br>0<br>2<br>8 | 3.50<br>.00 | 21.00<br>.00 | -2.207 | .027 |
| Post-test language development<br>Pre-test language development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 6<br>0<br>2<br>8 | 3.50<br>.00 | 21.00<br>.00 | -2.201 | .028 |
| Post-test gross motor development<br>Pre-test gross motor development | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 8<br>0<br>0<br>8 | 4.50<br>.00 | 36.00<br>.00 | -2.524 | .012 |
| Post-test Denver II Overall<br>Pre-test Denver II Overall | Negative Ranks[a]<br>Positive Ranks[b]<br>Equal[c]<br>Total | 8<br>0<br>0<br>8 | 4.50<br>.00 | 36.00<br>.00 | -2.521 | .012 |

a- Post-test < Pre-test, b- Post-test > Pre-test, c- Post-test = Pre-test

Table 6 shows the results of the Wilcoxon Signed Ranked Test performed to test whether there is a difference in the personal social development, fine motor development, gross motor development

and language development scores, which are the sub-dimensions of the scale, as well as the Denver II Developmental Scale applied before and after the sensory-motor perception and movement training given to 2-3 age group (children included in the abnormal development group: children with two or more developmental delay score).

As a result of the analysis, there is a statistically significant difference between the pre-test and post-test values in the personal social development ($z = -2.521$, $p<0.05$), fine motor development ($z = -2.207$, $p<0.05$), language development ($z = -2.201$, $p<0.05$), gross motor development ($z = -2.524$, $p<0.05$), and Denver II overall ($z = -2.521$, $p<0.05$) scores. Considering the average and total of the ranks, we observed that there is a significant difference in favor of the post-test between pre-test and post-test developmental delay scores of personal social development, fine motor development, gross motor development, language development subscales and pre-test and post-test developmental delay scores of sensory-motor perception and movement training (negative rank is 8, positive rank is 0).

## DISCUSSION

In this study, we aim to examine the effects of sensory-motor and movement training on social and personal development, fine motor development, gross motor development, language development, emotion and behavior problems in children aged 2-6 years diagnosed with Autism Spectrum Disorder, Language Disorder, General Developmental Delay, which are defined in Neurodevelopmental Disorders according to the DSM-5 diagnostic scale.

We evaluate the data analysis of the research group in two groups as 2-3 years old and 4-6 years old. In the Denver II Developmental Scale, we consider social and personal development, fine motor development, gross motor development, language development and general development as subscale. We apply the Child Behavior Rating Scale (CBRS) for 2-3 years old and 4-18 years old children in order to determine whether there is a difference between the internalizing, externalizing sub-test and general behavioral problem pre-test and post-test average scores regarding children's behavioral problems.

In the results section and the Denver II Developmental Test, we found a significant difference in favor of post-test between the pre-test developmental delay scores and the post-test developmental delay scores regarding the personal and social development subscale of sensory-motor perception and movement training applied to the 2-3 years old and 4-6 years old research group children diagnosed with Autism Spectrum Disorder, Language Disorder, and General Developmental Delay.

It can be said that sensory-motor perception and movement training studies are positively effective in personal and social sense in children with developmental problems. Our findings are in parallel with the studies in the literature. Findings of exercise, sensory motor and movement training and physical training practices in the literature show that they have positive effects on personality and social development in children with developmental problems and normally developing (Aksay & Alp, 2014; Babkes, 1999; Beyazoğlu, 2014; Çelik et al., 2010; Erol, 2014; Esen, 2010; Fazlıoğlu-Özlü, 2004; İlhan, 2007; Namlı, 2012; Orhan, 2014; Rosenthal-Malek & Mitchell, 1997; Yanardağ, 2007).

In the Denver II Developmental Test, we find a significant difference in favor of post-test between the pre-test developmental delay scores and the post-test developmental delay scores of the fine motor and gross motor development subscales of sensory-motor perception and movement training applied to children aged 2-3 years and 4-6 years with a diagnosis of Autism Spectrum Disorder, Language Disorder and General Developmental Delay. We also observe that the most significant improvement in the research group was in motor skills. We detect that the motor skill development of 12 children in the 15-child research group reached the normal level of development, and a delay between 2% and 5% in 3 children. Our findings seem to be consistent with the results of many previous studies. Studies have generally been carried out on motor skills, and it has been observed that motor skills development affects the development of other developmental periods. Iwanaga et al. (2000) examined 10 pre-school children with Asperger's and 15 high-functioning autistic children in terms of motor problems. In the study, motor impairment was observed in 50% of those with Asperger's syndrome and 67% of those with high-functioning autism, and it was also observed that these children had visual motor integration, visuospatial perception problems and three-dimensional perception problems. It has been

emphasized that motor delay is seen more intensely in the early period in Asperger children. Yanardağ (2007) attributed the motor development loss of educable mentally retarded children to insufficient physical activities, and suggested that the physical fitness and motor development of children was mostly due to insufficient education and lack of opportunity to participate in games. Piek and Dyck (2004) stated that children with developmental delays and behavioral problems should be included in activities that will develop basic motor skills appropriate to their developmental stages in a planned way.

In the Denver II Developmental Test, we find a significant difference in favor of post-test between the pre-test developmental delay scores and the post-test developmental delay scores of the language development subscales of sensory-motor perception and movement training applied to children aged 2-3 years and 4-6 years with a diagnosis of Autism Spectrum Disorder, Language Disorder and General Developmental Delay. We observe that sensory-motor perception and movement training applied to the research group activates the receptive language and expressive language as language development. We also observe that there are improvements in expressive verbal language as a result of the increase in understanding in the receptive language. In a study supporting our findings, it was found that the self-talk of the child with ASD who received movement training at the beginning of the application was greatly reduced at the end of the application and there was an increase in their meaningful verbal expressions. (Orhan, 2014). In another study, it was observed that the basic speaking skills and advanced speaking skills of children with ASD who do sports are more advanced than the children who do not do sports (Esen, 2010).

In the Denver II Developmental Test, we find a significant difference in favor of post-test between the pre-test developmental delay scores and the post-test developmental delay scores of the general development scale of sensory-motor perception and movement training applied to children aged 2-3 years and 4-6 years with a diagnosis of Autism Spectrum Disorder, Language Disorder and General Developmental Delay. After the sensory-motor perception and movement training, there were positive improvements in self-care skills, pencil holding skills, understanding and applying commands as general improvement in the sample group. In gross motor skills, we observe that developmental gaps are completed in the developmental points of basic movement schemes such as displacement activities (running, jumping), manipulative movements (catching, throwing), and balance movements (walking on a balance board, standing on one leg). In addition, we find that 10 children have reached the normal development level, and 5 children have a developmental delay between 2-14%. In a study, it was observed that swimming techniques can be taught to a child with autism by teaching with a fixed time delay, and according to the results of the research, it was stated that there was a great increase in the rate of responding appropriately to the cues with a fixed time delay given to the autistic individual. With the individualized swimming and physical activity program applied, it was observed that the individual with autism acquired basic swimming skills compared to their peers and could swim in free, backstroke and breaststroke styles. In addition to these gains, it has been observed that the program implemented contributes to the reduction of the intensity of autism symptoms and to increase the performance in developmental areas in individuals with autism (Kafkas & Özen, 2014). In another study, the effect of movement training on the social skills of a child with autism was examined. A child with autism participated and during 12 lessons of 30 minutes, double-leg forward multiple jumps, right-left multiple forward multiple jumps and zigzag forward multiple jumps of these movements were studied. In the evaluation of the development of social behavior during education, analysis was conducted by reporting the observations, opinions and comments of three independent observers and practitioners. After the movement training applied to the autistic child, it was observed that the child with autism improved some physical characteristics, as well as increased attention span, improved the cooperative skills, and a significant increase in the child's self-confidence (Orhan, 2014).

We find that there is a significant difference between the pre-test and post-test average scores in the evaluation of internalizing, externalizing and general behavior in relation to children in the 2-3 year and 4-18 age Children Behavior Rating Scale. In line with the findings of our research, we find that sensory-motor perception and movement trainig provides positive developments in the emotional and problematic behaviors of the children in the

research group. Before the study, we observed that, in general, the sample group had high levels of anxiety, low attention span, exhibited emotional behaviors, intensely engaged in self-stimulation behaviors, and some children had destructive and aggressive behaviors. After sensory-motor perception and movement training, we observe that their anxiety levels decrease, their attention span increases, they adapt to the environment, their self-stimulation behaviors are mostly over, and there are decreases in other children. In addition, we find that children who exhibit destructive and aggressive behavior before training provide movement control. In this context, there are studies in the literature that support our findings. In their study, Rosenthal-Malek and Mitchell (1997) observed that after the exercise program applied to five adolescents with autism, the individuals' self-stimulating behaviors decreased, their attention span and personal performance increased, and their abnormal and self-harming behaviors decreased. In another research, İlhan (2007) applied a special physical training program to educable mentally retarded children aged 8-12, 88 experimental and 57 control groups. According to the pre-test and post-test results, it was stated that there was a decreasing difference in the neurotic and behavioral problems of the children in the experimental group compared to the control group.

Orhan (2014) stated that movement training not only improves some physical characteristics of children with autism, but also reduces some behavioral problems, increases attention span, improves the ability to act jointly, and provides a significant increase in the self-confidence of children with ASD. In the observation analysis performed on a child diagnosed with autism, it was observed that play and water therapies increased behavioral problems in the first weeks of the application but reduced some of the behavioral problems and eliminated some behavioral problems after the application was completed (Beyazoğlu, 2014).

According to the pre-test results of the research group, we observe that children's recognizing their bodies, receiving and interpreting incoming stimuli, motor skill development, and behavioral reactions differ from those of children with normal development. These differences make it difficult for children to interact with the social environment. A study has revealed that the perception and interpretation of the world of children with ASD is different from the perception and interpretation of the world of children with normal development, and that when the incoming information cannot be received through the senses in a healthy way, children have difficulties in interpreting this information and giving their feedback. It has been stated that sensory-motor studies applied to individuals with ASD positively affect their skills in the areas of development (Fazlıoğlu-Özlü, 2004).

In another study, it is emphasized that programs that develop motor skills are important for individuals with autism, and that children with autism continue training programs to improve their motor skills, which is effective in reducing the problems of selectivity in perception (Connor, 1990). Günal (2007) stated that there are significant sensory integrity, motor and cognitive problems in children with ASD, that these problems negatively affect the level of independence and quality of life of children in daily living activities, and that fine and gross motor skills of children with ASD affect the level of independence in daily living activities.

Yanardağ (2007) studied 8 male children with autism in the 5-7 age range for the research sample group and divided the group into two according to their average age. A specially prepared exercise program for 40 minutes, 3 days a week, for 12 weeks was applied to the groups divided into pool group and land group, and the errorless teaching technique was used. Pre-test and post-test were applied to the sample groups. When the test results of both groups were compared before and after the training, a statistically significant difference was found between the motor ability test and physical fitness test results, except for balance and bilateral coordination tests. After the training, the self-stimulation behaviors of the subjects in the land group decreased by 52.8%, while there was a decrease of 34% in the pool group. In the study, it was argued that the motor development loss of trainable mentally retarded children was attributed to insufficient physical activities, and the physical fitness and motor development of children was mostly caused by insufficient education and not being given the opportunity to participate in games. It has been observed that children who do not participate in activities or are not taken into the game by their friends regress in terms of physical and motor fitness factors and suffer from skill loss to a large extent.

Trainings programs prepared in line with the needs of children with ASD, GDD and Language Disorder are important for special children to know themselves developmentally and to perceive the environment.

Adapting the educational practices prepared for individuals to the developmental problems experienced by children is important in terms of entering the inner world of the child who is disconnected from communication and perceiving his/her own existence in the social-environmental life.

When evaluated in terms of lack of communication and intense anxiety-fear, repetitive self-stimulation movements, perceptual distortions, and obsessive behaviors, which are evident in ASD symptoms, we see that these situations that emerged in the pre-test in our study contain significant differences in the post-test. As a result of the examinations, we can say that there is a significant change in children's anxiety-fear levels, increase in their self-confidence, openness to communication, and adaptation to the environment, there is extinction in internal-impulsive and repetitive movements, and obsessive behaviors decrease.

Overcoming these problems, which are the most challenging for the families of children with ASD in social and environmental life, are the most important topics in terms of family-child, child-environment, family and environment. The fact that these problems can be overcome is an important motivation for families, and it is very important for the environment to accept the child and family. As a result, the methods created aim to rehabilitate the individual with ASD and to include the child in social-environmental life. It is important that these contributions of our research to children can be transformed into social-environmental experiences. The use of methods that can affect outside of limited time and areas and contribute to the lives of children in the outside world will be an important gain for individuals with ASD.

We observe that at the end of the sensory-motor perception and movement training applied to the development problems experienced by children with Language Disorder and General Developmental Delay, which are the other two diagnoses of our study, children generally complete their personal-social, language, fine-gross motor development stages and their behavior problems decrease.

Finally, we present some recommendations:

For Research,

In the field of special education, experimental studies can be conducted on sensory-motor perception and movement education for other diagnoses in neurodevelopmental disorders. The effect of sensory-motor perception and movement training on cognitive development can be examined. New studies can be carried out by increasing the number of research groups within the framework of the sensory-motor perception and movement training program. Sensory-motor perception and movement training program can be examined by forming a control group from children with developmental problems to whom special education methods are applied.

For Practice,

We think that working in cooperation with experts in studies for children with developmental problems will be more effective in the education of children with developmental delays. By establishing cooperation with the families of children with developmental problems, a sensory-motor perception and movement training program can be created in which the family will be present and the diagnostic characteristics of the children are taken into account, and individual and group studies can be carried out. The sensory-motor perception and movement training program should be included in the education processes of children with developmental problems.

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***Conflict of Interest***

Authors declare that they have no conflict of interest.

***Ethics Statement***

The study protocol was approved by the ethics committee of T. C. Istanbul Arel University, with the letter numbered 10432314-200.00.00-15 on 21/05/2014. Participants were provided with informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adheres to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

***Author Contributions***

Conception and Design of the Study, EY; Data Collection, RG; Data Analysis and

Interpretation, RG and EY; Drafting the Article, RG. All authors have read and agreed on the published version of the manuscript.

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