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ORIGINAL ARTICLE

The Relation of Motor Skills and Proprioception in Children with Learning Difficulties

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ABSTRACT

Background. Proprioception is one of the necessary factors in the successful performance of fine and gross motor skills. **Objectives.** The aim of this study was to investigate the relation between motor competencies and upper extremities's proprioception sense levels in children aged 11-13 with a diagnosis of special learning difficulty. **Methods.** In the study, upper extremities proprioception sensory level measurements of a total of 20 children (16 boys and 4 girls) aged 11-13 years (12,5±0,73) with a diagnosis of special learning difficulty were made from the shoulder, elbow, and wrist joints. Motor proficiency was measured by the Bruininks-Oseretsky Test of Motor Proficiency. The parameters were analyzed to identify the relationship between motor skill and proprioception. **Results.** It has been observed that the motor skills of children with a diagnosis of special learning difficulty are related to the perception of upper extremity proprioception. No significant relationship was observed between agility and the upper extremities's proprioception, which is one of the items of the Bruininks-Oseretsky Test of Motor Proficiency. It was concluded that there is a significant relationship between shoulder and elbow flexion and wrist extension proprioception measures and motor abilities of children with a diagnosis of learning difficulty ($p<0,05$). A significant correlation was found between upper extremity proprioception, fine motor accuracy, fine motor integration, endurance, coordination, and balance. **Conclusion.** In this context, it will be useful to have activities to develop the sense of proprioception for the development of motor skills in children with special learning difficulties.

KEYWORDS: ***Spacial Learning Disability, Motor Skills, Proprioception, Balance.***

INTRODUCTION

Proprioception provides control of muscle tension, balance, and movement in the form of a continuous sensory flow that usually unconsciously comes from the muscles, tendons, joints, and skin. It has been reported that the perception of proprioception is very important in the development of motor skills. Proprioceptive information includes joint position sense and movement sense (1). Proprioception is an important feedback source that will encourage neural plasticity. Proprioception is defined as an individual's ability to determine the positions and movements of body segments in space and is based on sensory signals provided to the brain by skin, joint, and muscle receptors. In studies conducted with individuals with proprioceptive sensory deficiency, significant deficiencies have emerged in the field of sensorimotor performance. These deficits have been noted as a weakness of joint endpoint sensation, weakness in the control of multisegmental dynamics, and difficulties in performing sequential movement sequences (1, 2). The proprioceptive sense is important for coordinated movements involving locomotion (3). The role of proprioception in the motor skill development of children has been a

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subject that is remarkably brooded. It has been shown that children with learning disorders have different gross motor skills and physical activity compared to typically developing peers (4). Studies have shown problems in fine motor skills in children with proprioception disorders resulting in poor and incorrect pencil grip (5). In addition, difficulties in the development of gross motor skills such as balance and walking are observed in children with proprioceptive disorders (6).

In Sönmez's research (2017), it has been emphasized that the taxonomical classification of education methods as cognitive, sensory, psychomotor, and intuitive are related to each other; for example, related psychomotor, sensory, and intuitive behaviors develop at the end of the cognitively learned behavior (7). When the relationship between proprioceptive sense and psychomotor skills is revealed, trying to eliminate proprioceptive perception disorder with various rehabilitation strategies will provide support in other areas along with psychomotor skill development. For example, findings show that participation in PT enhances behavior reports by parents and teachers ($p<0.001$) and level of executive function ($p<0.001$) (8).

Among the tests used to evaluate proprioception, is the joint position sense matching test, which is the ability to perceive the position of the segment in space (1). Joint position sense can be tested by many different methods, such as the error rate between the target position and the re-emergence of this position (2).

Special learning difficulty is a neurodevelopmental disorder that occurs in the processing of verbal and nonverbal information because of the interaction of hereditary and environmental factors (9). Neurobehavioral problems such as delayed acquisition of reading, comprehension, speaking, arithmetic calculations, and written expression skills are seen in children with special learning disabilities (10). Psychomotor characteristics have an important place in the adaptation of children with special learning difficulties to society in the later parts of their lives (11). It is important to find and develop activities to increase motor skills. Therefore, proprioception, which is a sense of the body that needs attention, may be important.

MATERIALS AND METHODS

Participants. In our study, a total of 20 children between the ages of 11-13 who were educated in Ozel Y. Dogan Special Education and Rehabilitation Centre (in 2022) and had learning difficulties were included. Children participated in the studies one by one within the scope of pandemic measures, and the hygiene of the working areas was provided by the institution officer. The materials, tables, and chairs used in the study were cleaned with disinfectants. The room where the study was carried out was ventilated after each measurement.

Procedures. The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) was developed to measure the motor functions of children aged four and a half to fourteen and a half (12). BOTMP's long form consists of 8 subtests and a total of 46 items. It also measures both gross and fine motor skills as well as being a comprehensive motor proficiency indicator. Bruininks-Oseretsky Test of Motor Proficiency was updated in 2005 and became Bruininks-Oseretsky Test 2 (BOT2). BOT2 has become applicable for children aged 4-21 years. The validity and reliability of the BOT2 long form were conducted by Ballı in 2012 on healthy children aged 5 years (13). BOT2-SF was updated in 2010. BOT2-SF consists of 8 subtests and 12 items in total. The application of the test takes approximately 15-20 minutes. A person can get 72 processed points at most.

Motor Proficiency Form. Bruininks-Oseretsky Motor Proficiency Short Form 2 to be used for motor proficiency measurements consists of the following items:

- Fine Motor Accuracy 1. Completing the Inside of the Star 2. Drawing a Line along a Path
- Fine Motor Integration 1. Copying Nested Circles 2. Copying a Diamond Shape
- Manual Dexterity – Tying Blocks on a String
- Bilateral Coordination 1. Touching the Tip of the Nose with the Index Finger (Eyes Closed) 2. Creating a Square with the Index and Thumbs
- Balance –Walking forward Heel-to-toe on a Line
- Speed and Agility - Jumping on One Foot
- Coordination of Upper Extremities 1. Catching a Thrown Ball (with one hand) 2. Dribbling
- Durability 1. Full Push-up (For Boys) 2. Above Knee Push-Up (For Girls)

The first five items were conducted at the desk. Therefore, these tasks were applied on a table and

chair suitable for the child's ergonomic characteristics. The scores that the participants received in return for their performance on each task were recorded using a Likert scale.

Upper extremity proprioception measurements are carried out in the position of the joint placed by measuring the shoulder flexion and abduction, elbow flexion, and wrist extension movements of the dominant side upper extremities with a digital goniometer while the eyes are open. On the other hand, the other upper extremities were actively brought to the same joint position with closed eyes and the extremities in this position were measured in degrees through a digital goniometer. The measurements were recorded as degrees, and the relation between the differences and the motor proficiency test scores was evaluated by statistical analysis methods.

Data Analysis. Data analysis was performed in SPSS version 22.0. The Spearman correlation test was used because the variables did not conform to the normal distribution. Spearman correlation analysis was performed to determine the relation between the variables. In addition, a table of descriptive statistics values was created.

RESULTS

The results; a moderately significant positive correlation was found between the Completing the Inside of the Star (Fine Motor Accuracy) variable and the L.S. Flexion variable ($p<0.05$). A moderately significant positive correlation was found between Full Push-up (For Boys) / Above Knee Push-Up (For Girls) (Durability) and L.E. Flexion ($p<0.05$). A moderately significant positive correlation was found between Copying Nested Circles (Fine Motor Integration) and the L.S. Flexion variable ($p<0.05$). A moderately significant positive correlation was found between Dribbling (Upper Extremities Coordination) and L.E. Flexion ($p<0.05$). A moderately significant positive correlation was found between Catching a Thrown Ball (with one hand) (Upper Extremities Coordination) and L.E. Flexion ($p<0.05$). A moderately significant positive correlation was found between Walking forward Heel-to-toe on a Line (Balance) and L.W. Extension ($p<0.05$). No statistically significant relation was found between other variables ($p>0.05$). It was concluded that L.S. Flexion, L.E. Flexion, and L.W. Extension grades are more effective on the motor skills of children with learning difficulties than other ROM grades (Table 1).

DISCUSSION

Specific learning difficulty refers to difficulties in listening, thinking, understanding, self-expression, or academic skills, although children do not have mental retardation. In addition to these difficulties, posture and coordination disorders and delays in motor development can be observed (14).

It was stated in our study that proprioceptive perception of shoulder flexion is related to fine motor accuracy/fine motor integration tasks such as painting the inside of the star and copying the nested circles. Accordingly, it can be thought that proprioceptive studies will increase fine motor activity skills in children with learning difficulties. Fine motor activities play a role, especially in the development of cognitive and academic skills in children with learning difficulties.

In the results of our study, we tried to show that the proprioceptive perception of elbow flexion is associated with activities that require upper extremities coordination and balance (progression of a line), such as doing push-ups (endurance), catching a thrown ball, and dribbling. In line with our study, we try to emphasize that proprioceptive activities should also be considered to support children with learning difficulties to develop both motor skills and academic skills.

In line with our study Salter et al stated that although the current results mainly lend support to the motoric view concerning coordination performance, there was some evidence to suggest that the perceptual information influenced motor control (15).

Balakrishnan et al. (2007) also used the BOTMP test to study Indian children. According to their research, no significant gender differences ($p=0.776$) were observed. This is consistent with Thomas & French's (1985) findings that the differences in motor performances are not obvious before puberty in boys and girls in Indian children. They stated that it is important to observe that the bilateral coordination subtest primarily examines the coordination between the nervous and muscular systems in the arms and legs or on both sides of the body (16, 17).

Table 1. Correlation Values of Variables

Questions		LSFLEX	LSABD	LEFLEX	LWEXT
TheCompletingthe Inside of the Star (Fine Motor Accuracy)	rho	-0.108	0.031	0.063	0.524*
	p	0.649	0.897	0.791	0.018
	N	20	20	20	20
Drawing lines on a path (Fine Motor Accuracy)	rho	-0.111	-0.001	-0.189	0.383
	p	0.642	0.996	0.425	0.095
	N	20	20	20	20
Copying intermediate circles (Fine Motor Integration)	rho	0.589**	0.258	0.286	-0.232
	p	0.006	0.272	0.222	0.326
	N	20	20	20	20
Diamond shape copying (Fine Motor Integration)	rho	-0.156	0.194	0.325	0.118
	p	0.511	0.412	0.162	0.620
	N	20	20	20	20
Stringing blocks (Dexterity)	rho	-0.124	0.006	0.291	0.099
	p	0.603	0.980	0.213	0.678
	N	20	20	20	20
Touching the tip of the nose with the forcing fingers (Eyes Closed) (Dual Coordination)	rho	-0.084	-0.144	-0.196	0.113
	p	0.725	0.545	0.408	0.635
	N	20	20	20	20
Creating a square with the forcer and big finger (Bilateral Coordination)	rho	-0.069	0.142	0.075	0.256
	p	0.772	0.551	0.752	0.276
	N	20	20	20	20
I gave on a line playing (Balance)	rho	-0.357	-0.029	0.081	0.520*
	p	0.122	0.905	0.736	0.019
	N	20	20	20	20
Jump on one foot (Speed and Agility)	rho	-0.053	0.137	0.277	-0.034
	p	0.825	0.563	0.238	0.888
	N	20	20	20	20
Catching the shooled ball (One-Handed) (Upper Extremity Coordination)	rho	0.194	0.358	0.456*	-0.121
	p	0.412	0.122	0.043	0.612
	N	20	20	20	20
Driving (Upper Extremity Coordination)	rho	0.228	0.385	0.528*	-0.142
	p	0.334	0.093	0.017	0.550
	N	20	20	20	20
Full push-ups (men) / knee push-ups (girls) (Endurance)	rho	-0.039	0.133	0.477*	0.039
	p	0.870	0.575	0.034	0.872
	N	20	20	20	20

L.S.Flex: Left Shoulder Flexion; L.S. Abd: Left shoulder abduction; L.E.Flex: Left Elbow Flexion; L.W.Ext: Left Wrist Extension; *: p<0.05; **:p<0.01

In studies conducted with people who have a lack of proprioceptive sense, important information was obtained about proprioceptive feedback during sensorimotor performance, and although the motor systems of these people were not damaged, serious deficiencies were observed in their motor control. These deficiencies include poor endpoint sense accuracy, reduced control of multisegmental dynamics, and failures to perform extended motion sequences (18, 19).

Our limitations were that; the sample size was small. We included children with learning disabilities in only one center. We did not include younger than 11 and older than 13 years old children.

CONCLUSION

Considering that the development of fine and gross motor skills and academic skills are parallel to each other in children with learning difficulties, adding fine and gross motor activities to the therapy processes may also support an increase in academic skills. We think that proprioception is one of the necessary factors in the successful performance of fine and gross motor skills. We believe that the healthy development of motor skills and the inclusion of proprioceptive activities in therapy programs will lead to the development of academic skills.

APPLICABLE REMARKS

- In this study, we have established a noteworthy association between proprioception measures of shoulder and elbow flexion as well as wrist extension and the motor abilities of children diagnosed with learning difficulties, denoted by a statistically significant relationship.
- Furthermore, our findings unveil compelling correlations between upper extremity proprioception and a range of motor skills, including fine motor accuracy, fine motor integration, endurance, coordination, and balance.

AUTHORS' CONTRIBUTIONS

Study concept and design: Fatih Tezel, Serap Çolak. Acquisition of data: Fatih Tezel. Analysis and interpretation of data: Serap Çolak. Drafting the manuscript: Fatih Tezel, İrem Ekinci. Critical revision of the manuscript for important intellectual content: Fatih Tezel. Statistical analysis: Serap Çolak. Administrative, technical, and material support: İrem Ekinci, Fatih Tezel. Study supervision: Serap Çolak.

CONFLICT OF INTEREST

The authors declared no conflicts of interest.

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