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The relationship between gross motor skills and visual perception of preschoolers

Kezban TEPELI

Faculty of Vocational Education, Department of Early Child Education, Selcuk University, Konya,Turkey,(e-mail: ktepeli@selcuk.edu.tr).

Abstract

Answers were searched for these questions; "Is there a relationship between visual perceptions and gross motor skills of preschool children?", "Are preschool children's visual perceptions predictors of their gross motor skills?", "Is there any difference between visual perceptions of the children having low, average and high level of gross motor skills?" within this study where the relationship between preschool children's visual perceptions and their gross motor skills were comparatively examined. 322 children, ages ranging from 54 to 59 months, participated in this research designed in relational screening model. 52% of the children are boys, 48% of them are girls. As a data collection tool; Frostig Developmental Test of Visual Perception (FDTVP), developed by Frostig was used together with Test of Gross Motor Development-2 (TGMD-2), developed by Ulrich and Tepeli et al. adapted to Turkish. "Pearson Product Moment Correlation Coefficient", "Multiple Linear Regression" and "One-Way ANOVA" statistical methods were used in data analysis. Very high directly proportional relationships were determined between children's TGMD-2 sub test and total test scores and their FDTVP sub test and total test scores ($p<0.01$). FDTVP sub tests were determined to explain 27% of the total variance in Locomotor Skills sub test, 70% of the total variance in Object Control Skills sub test, and 60% of the total variance in Gross Motor Skills total test of TGMD-2. In addition, it was determined that FDTVP sub test and total test scores of the children differs significantly according to their gross motor skills.

Key Words: Preschoolers, visual perception, gross motor skill, object control skill, locomotor skill.

Okul öncesi çocukların büyük kas motor becerileri ile görsel algıları arasındaki ilişki

Özet

Okul öncesi çocukların görsel algıları ile büyük kas motor becerileri arasındaki ilişkinin karşılaştırmalı olarak incelendiği bu çalışmada; "Çocukların görsel algıları ile büyük kas motor becerileri arasında ilişki var mıdır?", "Çocukların görsel algıları, büyük kas motor becerilerinin yordayıcısı mıdır?", Büyük kas motor becerileri düşük, orta ve yüksek düzeyde olan çocukların görsel algıları arasında fark var mıdır?" sorularına cevap aranmıştır. İlişkisel tarama modelinde düzenlenen bu araştırmaya, yaşları 54 ile 59 ay arası değişen 322 çocuk katılmıştır. Çocukların % 52'si erkek, % 48'i kızdır. Araştırmada veri toplama aracı olarak; Frostig tarafından geliştirilen "Frostig Gelişimsel Görsel Algı Testi (FGGAT)" ile Ulrich tarafından geliştirilen ve Tepeli ve ark. tarafından Türkçeye uyarlanan "Büyük Kas Becerilerini Ölçme Testi (BüKBÖT)" kullanılmıştır. Verilerin analizinde "Pearson Momentler Çarpımı Korelasyon Katsayısı", "Çoklu Doğrusal Regresyon" ile "Varyans Analizi" istatistiksel metotları kullanılmıştır. Çocukların BüKBÖT alt test ve toplam test puanları ile FGGAT alt test ve toplam test puanları arasında doğru orantılı oldukça yüksek ilişkiler belirlenmiştir ($p<0.01$). FGGAT'nin alt testleri birlikte, BüKBÖT'ün Lokomotor Beceriler alt testindeki toplam varyansın %27' sini, Nesne Kontrol Beceriler alt testindeki toplam varyansın %70' ini, Büyük Kas Motor Beceriler toplam test puanlarındaki toplam varyansın %60' ını açıkladığı saptanmıştır. Ayrıca çocukların FGGAT alt test ve toplam test puanlarının büyük kas motor becerilerine göre anlamlı düzeyde farklılaştığı belirlenmiştir.

Anahtar Kelimeler: Okul öncesi çocuklar, görsel algı, büyük kas motor beceri, nesne kontrol beceri, lokomotor beceri.

INTRODUCTION

Motor development includes changes in motor behavior throughout the lifespan, as well as the processes responsible for those changes (5). Gross motor skills are the motor skills that compass the large, force-producing muscles of the trunk, arms,

and legs (5), and they are used to accomplish a movement task or goal such as throwing a ball to a friend or jumping over a puddle. Gross motor development often involves movement behaviors that are used to transport the body from one location to another and to project and receive objects, especially balls (40). Gross motor skills are examined as locomotor skills and object control skills in two main groups. These skills assist children control their bodies, manipulate their environment, and form complex skills and movement patterns involved in sports, dance, gymnastics, and other activities (33). Locomotor skills cover skills such as running, galloping, hoping, leaping and jumping while object control activities involve skills such as throwing, kicking, dribbling, catching, striking, and rolling (40).

The development of fundamental gross motor skills makes the basis for later movement and physical skill. Fundamental motor skills serve as the building blocks for movement, game, and sport skills (13, 12, 18, 29, 34). Fundamental gross motor skill achievement is critical to the overall development of children (13, 23, 33), and motor skills emerge and evolve during the preschool and early elementary school years (40). It is assumed that during the early elementary school years, children must develop fundamental gross motor skills to a certain proficiency lever in order to be able to perform more complex movement skills and patterns (34).

During the early elementary years, a child's gross motor performance plays significant role in influencing how peers view the child (14, 44). A child who is less skilled than most of his or her peers will generally be chosen last to participate in group games during recess and after-school activities. The consequence of consistently being selected last or not at all must have negative impact on a child's physical self-concept and motivation to be active (40). Most authors agree that individuals move through the various periods at different rates, based on the confluence of multiple internal (biological, psychological, motivational, cognitive, social, etc.) and external factors (5, 27, 42).

The term visual perception makes reference to the capacity that brain has to understand and to interpret that eyes see (15, 31). Visual perception is known as the ability to recognize, distinguish and interpret visual stimulants in relation to previous experiences. Visual perception is the result of an individual's attempt at understanding the visual information obtained through seeing by meaningfully organizing, classifying and generalizing visual stimulants (9). Along with the basic visual functions and motor skills, visual perceptual skills allow us to achieve many activities of daily life (4, 7, 41), and guide our actions (17, 21).

Visual perception skills develop at early childhood and approach the level of adults around the age of eleven to twelve. Visual perception skills of children become clear till the age of nine. Figure-ground perception in children shows a rapid development between the ages of three to five, is fixed between the ages of eight to ten. Perception of more complex spatial relationships continues to develop throughout the childhood and reaches the level of adulthood at age ten (39).

Marianne Frostig (9), examined visual perception under five sub domains which are eye-motor coordination, figure ground, form constancy, position in space, spatial relations. Eye-motor coordination is the ability to co-ordinate seeing with body's movements and parts of the body. Figure-ground separation; is to perceive the selected stimuli among many stimuli and thinking over, focusing on and paying attention to it. Form constancy is, perceiving an object in various situations without changing its characteristics such as shape, position and size. Perceiving position in space is perception of an object together with its relations in space by a person who perceives. Perceiving spatial relations is observer's perception of his/her connection with two or more objects, and the relation between these objects (8).

With respect to the relationship between motor impairment and perceptual abilities, two main patterns of outcomes emerge from the literature; the first maintains that the two skills are related (20, 25, 26, 36, 46), while the second underscores the independence of the two components (19, 32).

While most studies have been conducted on children referred for motor impairments (20, 26, 28, 32); gross motor development is rarely an object of investigation in screening activities. The relationship between preschool children's visual perceptions and their gross motor skills were examined comparatively in this study. The research carries a characteristic of two different studies conducted with the same sample. However in this study the research variables (gross motor skills, visual perception) were analyzed both as affecting variable and affected variable. Answers of the following

questions were searched for within the scope of this study.

1) Is there a relationship between visual perceptions and gross motor skills of preschool children?

2) Are preschool children's visual perceptions predictors of their gross motor skills?

3) Is there any difference between visual perceptions of the children having low, average and high level of gross motor skills?

MATERIAL & METHOD

Research Model

This study that examined the relationship between preschool children's gross motor skills and their visual perceptions is in relational screening model.

Participants

Working group of the study includes children attending to 31 private and independent kindergartens situated in central districts of the province of Konya. To create a sample of the study 12 independent kindergartens were selected among others by random cluster sampling method. In order to continue the research with the same age range of six months, 322 children ages ranging from 54 to 59 months were chosen among the children attending to these 12 kindergartens and included in the study. Average age of the children is 57.3, while standard deviation is 2.28. It is determined that 36% of the children included in the study have not received any preschool education before, while 18.6% have received re-school education for more than two years, 34% for a year, 11.4% for two years; boys constitute 52%, while girls constitute 48% of the children.

Instruments

"Frostig Developmental Test of Visual Perception (FDTVP)", which was developed by Frostig (9), is used to determine visual perceptions of the children participating in the study. "Test of Gross Motor Development-Second Edition (TGMD-2)" that was developed by Ulrich (40) and adapted to Turkish with validity and reliability by Tepeli et al. (38) was used to determine gross motor kills, locomotor skills and the object control skills of children.

Frostig Developmental Test of Visual Perception (FDTVP): The Test was standardized through studies conducted on 2,116 children between the ages of 4-8. Sökmen (35) tested the reliability of the test for use on five-year-old children in Turkey and concluded that not only the general continuity coefficient but all continuity coefficients in the sub dimensions were meaningful at 0.01. Frostig Developmental Test of Visual Perception is composed of five sub tests involving Eye-motor Coordination, Figure Ground, Form Constancy, Position in Space and Spatial Relations. Eye-motor Coordination involves drawing continuous straight, curved or angular shapes within different sizes of boundaries without models and measures hand-eye coordination; Figure Ground perception involves detecting embedded figures on increasingly complex backgrounds; Form Constancy involves the perception and distinguishing of objects in different shapes, sizes, shadows and positions; Position in Space involves the identification of shapes in reversed position; and Spatial Relations involve the analysis of simple form and patterns (24).

Each sub test of Frostig Developmental Test of Visual Perception has standard scoring criteria. Raw scores obtained by children in each sub test are transformed into standard scores, which are obtained from the percentage tables developed for the test (24).

In this study, reliability coefficients of the test for children 54 to 59 months were calculated as .76 for Eye-Motor Coordination Sub Test, as .72 for Figure Ground Sub Test, as .78 for Form Constancy Sub Test, as .79 for Position in Space Sub Test, as .69 Spatial Relations Sub Test, and as .87 for the total test, respectively.

Test of Gross Motor Development Second Edition (TGMD-2): Test of Gross Motor Development-2 (TGMD-2), which was developed by Dale A. Ulrich (40). The test was adapted to Turkish and examined in terms of validity and reliability by Tepeli, Arı and Büyüköztürk (38). The measure is comprised of locomotor (run, gallop, hop, leap, horizontal jump, and slide) and object-control (striking a stationary ball strike, stationary dribble, catch, kick, overhand throw, and underhand roll) subtests, each assessing six skills (40). The TGMD-2 assesses the skill performance process (skill components) rather than the outcome or product of performance. Each motor skill placed in subtests includes behavior sections

ranging from 3 to 5 given as performance criteria. There are 24 motor skill criteria in the Locomotor Skills subtest and also 24 motor skills in the Object-Control Skills subtest. The child tries to do each skill two times and both attempts are scored. If the child performs any behavior section correctly; s/he gets a score of 1, but if s/he cannot, then s/he gets 0. Following the scoring for both trials, the researcher counts up the scores of both trials in order to obtain the raw score related to each skill (running, hopping, etc.). Subtest scores are obtained by summing up skill scores. The maximum score which can be taken from both subtests is 48. Raw subtest scores are converted to age- and, for the object control sub test, gender-adjusted standard scores using the appropriate conversion tables. Sub test standard scores are then summed and converted to calculate each child's Gross Motor Quotient (GMQ).

Procedure

After obtaining the necessary permissions for the research from Konya Provincial Directorate of National Education 54-59 months old children were identified through meeting with the administration of 12 independent kindergartens. Test of Gross Motor Development-2 was applied to these identified children by the researcher. Then Frostig Developmental Test of Visual Perception was applied with the help of preschool teaching fourth-grade students under the control of the researcher. Data collection of the research took four weeks.

TGMD-2 and FDTVP are the tests that assessment of children is made according to norm values. While determining norm values for both of the tests in order to make statistical analysis with the raw scores obtained from total test and sub tests of the tests applied within the scope of the study, referenced age range, which was 54-59 months, was influential in determining the age range of children.

While testing the third sub-objective of the study; norm values of *Test of Gross Motor Development-2* identified for Turkey (38) were used in order to determine children with low, average and high level of locomotor skills, object control skills and gross motor skills. Distribution of children with three different levels of gross motor development is given in table 1.

When table 1 is examined, it is seen that locomotor skills of 26% of the children participating in the study is in low level, while 49% is in average level and 25% is in high level; 33% of the children have low level of object control skills, 47% have average, 20% have high level; 30% is in low level of gross motor skills, 53% is in average level and 17% is in high level.

Data Analysis

For the first sub objective of the study, the relationship between TGMD-2 sub test and total test scores and FDTVP sub test and total test scores were identified by "Pearson Product Moment Correlation Coefficient".

For the second sub objective of the research, "Multiple Linear Regression" was used to analyze how FDTVP sub test and total test scores predict TGMD-2 sub test and total test scores.

For the third sub objective of the research, the difference between FDTVP sub test and total test mean scores of the children who are divided into low, average and high levels according to their TGMD-2 sub test and total test scores was tested with "One-Way Anova (F)". Tukey's test was used to elucidate the interpretation of the difference between the groups.

Children participating in the study are 54-59 months old. This age range is a referenced age range in both TGMD-2 and FDTVP norm studies. For this reason, statistical analyzes were made by using raw scores the children received from total and sub tests of these two tests. The level of statistical significance was set to $p<0.05$. Data were tested by SPSS-17 package program.

RESULTS

In this section findings related to the answers of the research questions are given.

Table 1. Descriptive statistics about children with low, average and high locomotor skills, object control skills and gross motor skills.

	High Motor Ability 13-16 Standard Scores 111-130 Gross Motor Quotient			Average Motor Ability 8-12 Standard Scores 90-110 Gross Motor Quotient			Low Motor Ability 1-7 Standard Scores 70-89 Gross Motor Quotient		
	n	$\overline{X}$	SD	n	$\overline{X}$	SD	n	$\overline{X}$	SD
Locomotor Skills	80	42.55	2.06	158	35.56	2.84	84	24.05	5.64
Object Control Skills	66	34.94	2.40	148	27.29	2.93	108	17.42	3.45
Gross-Motor Skills	54	76.22	3.66	170	63.44	5.13	98	43.57	8.48

Correlations between FDTVP and TGMD-2

In table 2 it's seen that, there are positive significant relationships at 0.01 level between TGMD-2 sub test and total test scores of the children. Similarly, it is determined that there is a positive statistical relationship between FDTVP sub test and total test scores of children ($p<0.01$; $p<0.05$).

Examining correlation values between children's TGMD-2 sub test and total test scores and their FDTVP sub test and total test scores; it is observed that there is directly proportional high relationship between the scores($p<0.01$). If ranking is made according to the size of correlation values; it is seen that the highest relationship is between children's object control skill scores and their FDTVP subtest and total test scores. It is followed by the relationship between gross motor skills and FDTVP subtest and total test scores, and then the relationship between locomotor skills scores and FDTVP subtest and total test scores.

Visual Perception as Predictors of Gross Motor Development

When table 3 is examined, Eye-Motor Coordination, Figure Ground, Form Constancy, Position in Space and Spatial Relations sub tests of FDTVP together present highly significant relationships with TGMD-2 sub test and total test scores (for Locomotor Skills $R=0.52$, $R^2=0.27$, $p<.001$; for Object Control Skills $R=0.83$, $R^2=0.70$, $p<.001$; for Gross-Motor Skills $R=0.77$, $R^2=0.60$, $p<.001$). FDTVP sub tests together explain 27% of the total variance in Locomotor Skills sub test, 70% of the total variance in Object Control Skills sub test, and 60% of the total variance in Gross-Motor Skills total test of TGMD-2. This finding indicates that FDTVP sub test scores predicts object control skill scores at most. Object Control Skills are followed by Gross-Motor Skills and Locomotor Skills, respectively.

Table 2. Correlation between gross motor skills and visual perception of children.

	$\overline{X}$	SD	1	2	3	4	5	6	7	8	9
1-Locomotor Skills	34.29	7.65	--	.53**	.88**	.43**	.38**	.32**	.13*	.24**	.51**
2-Object Control Skills	25.25	7.26		--	.87**	.71**	.64**	.46**	.24**	.43**	.82**
3-Gross-Motor Skills	59.53	13.06			--	.64**	.58**	.44**	.20**	.38**	.75**
4-Eye-Motor Coordination	5.89	3.56				--	.53**	.34**	.18**	.29**	.78**
5-Figure Ground	10.94	5.73					--	.13*	.43**	.25**	.82**
6-Form Constancy	7.96	4.42						--	.13*	.13*	.58**
7-Position in Space	2.64	1.35							--	.15*	.40**
8-Spatial Relations	2.15	1.32								--	.40**
9-Total Visual Perception	25.58	11.12									--

* $p < 0.05$; ** $p < 0.01$

Table 3. Multiple linear regression analyses results of predicting gross motor skills of children according to their visual perception.

Groups	Model Summary					*B*	*β*	t
	R	R^2	Adj. R^2	F				
Locomotor Skills	.52	.27	.26	22.97**	Intercept	24.40		20.59*
					Eye-Motor Coordination	.46	.21	3.52*
					Figure Ground	.30	.23	3.60*
					Form Constancy	.35	.20	3.96*
					Position in Space	.05	.01	.19
					Spatial Relations	.57	.10	1.92
Object Control Skills	.83	.70	.70	147.83**	Intercept	9.87		13.72*
					Eye-Motor Coordination	.75	.37	9.41*
					Figure Ground	.46	.36	8.97*
					Form Constancy	.44	.27	8.18*
					Position in Space	.06	.01	.30
					Spatial Relations	1.07	.19	5.98*
Gross-Motor Skills	.77	.60	.58	90.50**	Intercept	34.27		22.62*
					Eye-Motor Coordination	1.21	.33	7.22*
					Figure Ground	.76	.33	7.08*
					Form Constancy	.79	.26	6.98*
					Position in Space	.01	.00	.01
					Spatial Relations	1.64	.17	4.34*

* $p<0.01$; ** $p<0.001$

Analyzing the results of t-test for significance of regression coefficients; it is seen that, in order of importance, Figure Ground, Eye-Motor Coordination and Form Constancy subtests are important predictors of Locomotor Skills sub test scores. For Object Control Skills sub test scores, in order of importance, Eye-Motor Coordination, Figure Ground, Form Constancy and Spatial Relations sub tests are important predictors. For Gross-Motor Skills sub test scores, in order of importance, Eye-Motor Coordination, Figure Ground, Form Constancy and Spatial Relations sub tests are important predictors. However Position in Space sub test of FDTVP does not have any significant impact on TGMD-2 sub test and total test scores.

Performances at the Frostig Developmental Test of Visual Perception According to Gross Motor Ability

Examining table 4 which shows FDTVP sub test and total test mean scores of children with low, average and high locomotor skills; it is observed that children's FDTVP sub test and total test mean scores increase as their level of locomotor skills increase. According to the results of the variance analysis all FDTVP sub test and total test mean scores, except Position in Space sub test ($F_{(2,319)}$= 2.78, $p>0.05$), differ depending on children's locomotor skills ($p<0.001$).

According to the results of Tukey test, which was made in order to test the significance of difference between the groups, the difference between FDTVP Eye-Motor Coordination, Figure Ground, sub test and total test mean scores of the children with three different levels of locomotor skill was found statistically significant ($p<0.01$). In Form Constancy and Spatial Relations sub tests of FDTVP, relevant sub test mean scores of the children with low level of locomotor skills ($\overline{X}_{\text{Form Constancy}}$=6.07; $\overline{X}_{\text{Spatial Relations}}$=1.62) are significantly lower than mean scores of the children with average level ($\overline{X}_{\text{Form Constancy}}$=8.24; $\overline{X}_{\text{Spatial Relations}}$=2.22) and high level ($\overline{X}_{\text{Form Constancy}}$= 9.38; $\overline{X}_{\text{Spatial Relations}}$ = 2.58) of locomotor skills ($p<0.05$).

Table 5 indicates that FDTVP Eye-Motor Coordination ($F_{(2,319)}$= 85.55, $p<0.001$), Figure Ground ($F_{(2,319)}$= 64.68, $p<0.001$), Form Constancy ($F_{(2,319)}$= 25.26, $p<0.001$), Position in Space ($F_{(2,319)}$= 5.00, $p<0.01$), Spatial Relations ($F_{(2,319)}$= 48.97, $p<0.001$) sub test and total test ($F_{(2,319)}$= 141.84, $p<0.001$) mean scores of children with low, average and high level of object control skills significantly differs.

According to the results of Tukey test, which was made in order to test the significance of difference between the groups, the difference between FDTVP Eye-Motor Coordination, Figure Ground, Form Constancy sub test and total test mean scores of the children with three different levels of object control skill was found statistically significant ($p<0.01$). In FDTVP Position in Space and Spatial Relations sub scales, relevant sub test mean scores of the children with high level of object control skill are significantly higher than mean scores of the children with low and average level of object control skill ($p<0.01$).

Table 4. F test results regarding frostig developmental test of visual perception total and sub test scores of children with low, average and high locomotor skills.

Visual Perception	Locomotor Skills	n	$\overline{X}$	S	F	p
Eye-Motor Coordination	Low Motor Ability	84	3.95[c]	2.95	33.49	p<0.001
	Average Motor Ability	158	5.81[b]	3.06		
	High Motor Ability	80	8.10[a]	3.85		
Figure Ground	Low Motor Ability	84	7.43[c]	4.94	29.75	p<0.001
	Average Motor Ability	158	11.46[b]	5.49		
	High Motor Ability	80	13.63[a]	5.17		
Form Constancy	Low Motor Ability	84	6.07[b]	4.29	13.02	p<0.001
	Average Motor Ability	158	8.24[a]	4.30		
	High Motor Ability	80	9.38[a]	4.13		
Position in Space	Low Motor Ability	84	2.36	1.49	2.78	p>0.05
	Average Motor Ability	158	2.70	1.38		
	High Motor Ability	80	2.83	1.08		
Spatial Relations	Low Motor Ability	84	1.62[b]	1.30	11.95	p<0.001
	Average Motor Ability	158	2.22[a]	1.24		
	High Motor Ability	80	2.58[a]	1.31		
Total Visual Perception	Low Motor Ability	84	21.42[c]	10.27	50.38	p<0.001
	Average Motor Ability	158	30.41[b]	9.24		
	High Motor Ability	80	36.50[a]	10.04		

a, b, c: Difference between the averages indicated with different letters is statistically significant ($p<0.05$).

Table 5. F test results regarding frosting developmental test of visual perception total and sub test scores of children with low, average and high object control skills.

Visual Perception	Object Control Skills	n	$\overline{X}$	S	F	p
Eye-motor Coordination	Low Motor Ability	108	3.78[c]	2.78	85.55	p<0.001
	Average Motor Ability	148	5.94[b]	3.03		
	High Motor Ability	66	9.58[a]	2.74		
Figure Ground	Low Motor Ability	108	7.66[c]	5.25	64.68	p<0.001
	Average Motor Ability	148	11.29[b]	4.88		
	High Motor Ability	66	16.09[a]	3.93		
Form Constancy	Low Motor Ability	108	6.22[c]	4.59	25.26	p<0.001
	Average Motor Ability	148	8.13[b]	4.12		
	High Motor Ability	66	10.70[a]	3.07		
Position in Space	Low Motor Ability	108	2.36[b]	1.63	5.00	p<0.01
	Average Motor Ability	148	2.72[ab]	1.07		
	High Motor Ability	66	2.97[a]	1.23		
Spatial Relations	Low Motor Ability	108	1.73[b]	1.33	48.97	p<0.001
	Average Motor Ability	148	1.91[b]	1.43		
	High Motor Ability	66	3.39[a]	0.78		
Total Visual Perception	Low Motor Ability	108	21.75[c]	8.96	141.84	p<0.001
	Average Motor Ability	148	30.00[b]	8.29		
	High Motor Ability	66	42.73[a]	5.79		

a, b, c, ab: Difference between the averages indicated with different letters is statistically significant (p<0.05).

Table 6. F test results regarding frosting developmental test of visual perception total and sub test scores of children with low, average and high gross motor skills.

Visual Perception	Gross Motor Skills	n	$\overline{X}$	S	F	p
Eye-motor Coordination	Low Motor Ability	98	3.16[c]	2.50	107.28	p<0.001
	Average Motor Ability	170	6.18[b]	2.82		
	High Motor Ability	54	9.96[a]	3.04		
Figure Ground	Low Motor Ability	98	6.78[c]	4.64	68.36	p<0.001
	Average Motor Ability	170	11.76[b]	5.10		
	High Motor Ability	54	15.93[a]	4.07		
Form Constancy	Low Motor Ability	98	5.37[b]	3.95	29.43	p<0.001
	Average Motor Ability	170	8.88[a]	4.22		
	High Motor Ability	54	9.74[a]	3.79		
Position in Space	Low Motor Ability	98	2.37[b]	1.49	4.50	p<0.05
	Average Motor Ability	170	2.67[ab]	1.34		
	High Motor Ability	54	3.04[a]	0.97		
Spatial Relations	Low Motor Ability	98	1.67[c]	1.27	16.42	p<0.001
	Average Motor Ability	170	2.19[b]	1.30		
	High Motor Ability	54	2.89[a]	1.08		
Total Visual Perception	Low Motor Ability	98	19.35[c]	8.07	143.04	p<0.001
	Average Motor Ability	170	31.68[b]	8.49		
	High Motor Ability	54	41.56[a]	6.78		

a, b, c: Difference between the averages indicated with different letters is statistically significant (p<0.05).

Examining table 6 where results of Variance Analysis regarding Frostig Developmental Test of Visual Perception sub test and total test mean scores of children with low, average and high gross motor skills are given; it is determined that children's FDTVP sub test and total test mean scores significantly differ according to their gross motor skills.

According to the results of Tukey test, which was made in order to test the significance of difference between the groups, the difference between FDTVP Eye-Motor Coordination, Figure Ground, and Spatial Relations sub test and total test mean scores of the children with three different levels of gross motor skills was found statistically significant (p<0.01). In FDTVP Form Constancy sub scale, relevant sub test mean scores of the children with low ($\overline{X}$=5.37) level of gross motor skills are significantly lower than mean scores of the children with average ($\overline{X}$=8.88) and high ($\overline{X}$=9.74) level of gross motor skill (p<0.05). In FDTVP Position in Space sub test relevant sub test mean scores of the children with high level ($\overline{X}$=3.04) of gross motor skill is significantly higher than mean scores of the children with low level ($\overline{X}$=2.37) of gross motor skills (p<0.05).

DISCUSSION

Answers of the questions such as "Is there a relationship between visual perceptions and gross motor skills of preschool children?", "Are preschool children's visual perceptions predictors of their gross motor skills?", "Is there any difference between visual perceptions of the children having low, average and high level of gross motor skills?" within this study where the relationship between preschool children's visual perceptions and their gross motor skills is comparatively examined. Findings of the research are discussed in this chapter in the light of the literature.

Correlations between FDTVP and TGMD-2

According to the findings of the research very high directly proportional relationships were determined between children's TGMD-2 sub test and total test scores and FDTVP sub test and total test scores ($p<0.01$). This finding indicates that visual perception skills of children improve as their gross motor skills increase; also their gross motor skills degrade as their visual perception skills decrease. The study of sensory-motor development suggested that there is a dynamic system of self-organization (22), where perception and action are strictly related. Also Glencross and Piek (16) described the distinction between sensorial process and motor functioning as an artificial dichotomy because they constitute a circular phenomenon (perception–action–perception) where structures operate parallel to each other, with interactions at increasing levels of complexity.

In relation to the study Bonifacci (2) examined the relationship between visual perception and motor skills of 141 children between ages of 6-10. A positive significant relation of .28 was found only between locomotor skill and visual-motor coordination at the end of the study. Findings of this study, which does not support the results of this research, may be caused by the working group of Bonifacci. Because while examining the literature presenting development of visual perception and gross motor skills, it is seen that both visual perception skills and gross motor skills reach the level of maturity around the age of 10. Bonifacci worked with children of 6-10 years of age in above mentioned research. Therefore, as gross motor skill and visual perception are exhibited almost in a perfect level in this group, absence of the relationship between these two skills may be unobserved.

An important point about correlation values between TGMD-2 sub test and total test scores and FDTVP sub test and total test scores is that correlation values between object control skill scores of the children and FDTVP subtest and total test scores are higher. Correlation values between FDTVP sub test and total test scores and Object Control Skill sub test scores are followed by Locomotor Skills and Gross Motor Skill, respectively. As the skills that the children were asked to exhibit in object control skill test included more visual perception skills, it can be indicated as a reason of higher correlation values between TGMD-2 Object Control Skills sub test and FDTVP sub test and total test scores. Object control skill sub test includes ball skills such as striking a stationary ball, catching, dribbling, kicking, overhand throwing, and underhand rolling. Child does not have to ensure coordination between only parts of body and eye but she/he has to keep coordination between eye, the object (ball) and parts of the body.

Visual Perception as predictors of Gross Motor Development

Prediction of FDTVP sub test scores on TGMD-2 subtest and total test scores have been examined with regression analysis. According to the research findings FDTVP sub test together explain 27% of the total variance in Locomotor sub test, 70% of the total variance in Object Control Skills sub test, and 60% of the total variance in Gross-Motor Skills sub test of TGMD-2. This finding shows that FDTVP sub test scores predict object control skill scores most of all. Gross Motor Skills and Locomotor Skills follow Object Control Skills, respectively.

Wilson and McKenzie (46) found a general minor efficiency in information processing in children with developmental coordination disorder, with more significant deficits in visual-spatial processing, either with or without a motor component. Recently, also Sigmundsson et al. (36) found, in developmental coordination disorder participants, impairment in tasks of visual sensitivity (motor and form). Motor correction, which is achieved through the movements of the sense organs, probably plays a role in the perception processes analogous to that of sensory correction in the control of complex movements (47).

According to the results of t-test regarding significance of regression coefficients; It is seen that, in order of importance, Figure Ground, Eye-motor Coordination and Form Constancy subtests are

important predictors for Locomotor Skill sub test scores. In order of importance, Eye-Motor Coordination, Figure Ground, Form Constancy and Spatial Relations sub tests are determined as important predictors for Gross-Motor Skills sub test scores. Also in order of importance, Eye-Motor Coordination, Figure Ground, Form Constancy and Spatial Relations sub tests are determined as important predictors for Gross-Motor Skills sub test scores. It was indicated that Position in Space sub test of FDTVP does not have an important effect on TGMD-2 sub tests and total test scores.

According to this result, Eye-Motor Coordination, Figure Ground and Form Constancy concepts, which determine visual perception skill, are more effective on gross motor development.

Eye-motor coordination is the ability to coordinate vision with movements or parts of the body (10). When a person holds an item, his hands are managed by his sense of sight. Movements of his feet are directed by his eyes when he runs, jumps, kicks a ball or pays attention to an obstacle (11).

An object or a thing can be perceived only in relation with the ground. For example, in cases when the ball is in continuous relationship with the playfield and the ground composed of things limiting it, the child will not perceive its status and will have difficulty catching it (30).

By means of perception constancy, perceiving characteristics of things such as shape, situation and size is provided without changing them despite of the different retinal image. This way, the child can arrange his hands in a position of holding the ball by creating the size of the ball thrown at him (without staying under the influence of image of the ball coming toward him) in his mind (11).

Another interesting finding of the study is that "Position in Space" subtest of FDTVP has no effect on any of TGMD-2' sub test and total test scores, while Spatial Relations sub test has no effect on Locomotor Skill sub test scores. This was not an expected result. However perception of spatial relationship of an object and its position is required for creation of gross motor skills. For example, the boy trying to hit the stationary ball with a bat in a baseball game should perceive position of the ball in the space and the spatial relationship between the ball and the bat so that he can establish the skill in a right way.

Performances at the Frostig Developmental Test of Visual Perception according to Gross Motor Ability

According to the findings of the third study conducted in order to exhibit the interaction between gross motor skills and visual perception, FDTVP subtest and total test scores differ depending on locomotor, object control, and gross motor skills of children.

Studies (6, 28) have shown that children with developmental coordination disorder perform worse in tasks that comprise visual memory, spatial relationship and temporal speed components. Other studies (3, 45) underscored that sequencing difficulties are an important element in identifying clumsy children.

Tsai et al. (39) have considered that the visual perceptual assessment in children with delays in the development of motor coordination has great significance for the processing and implementation of strategies for better performance on tasks of daily life.

Şahin Arı (37) reported that Whilall et al. examined relationship between motor process and perception. As a result of the study, findings of the study showed that motor processes influenced ability of the child's perception. Moreover, it was also determined that physical skills were found to be important in perception. Akdemir (1) reported that Lord and Hulme compared the visual perception skills of children with and without the clumsy. They reported that clumsy children were more behind in determining the bigness of the figures occupy space, positions in space and figures stood distances relative to each other.

These Literature data support findings of the research. Research findings that are inconsistent with these data also exist. Waelvelde et al. (43) examined the relationship between visual perception disorders, visual motor integration disorders and motor skills in children with developmental coordination disorder. Motion Assessment Series that include catching a ball, jumping, responding to a moving visual stimuli in a certain period of time, and Beery Developmental Test of Visual Motor Integration which include copying, visual parsing and monitoring were applied to children between ages of 9-10. No significant relationship was found between visual parsing and motor tasks. The relationships between visual timing task and ball catching task in a group

with developmental coordination disorder was determined to be significant, as well as the relationship between copying task and the tasks included in motion assessment series.

The recommendations developed in the light of the results of the survey are as follows:

- Researches should be planned to examine effect of gross motor or object control skill training integrated with visual perception on children's object control skills.
- Researches should be conducted with children of different age groups from infancy in order to determine visual perception development level and effects of educational programs
- Activities enhancing visual perception should be expanded in preschool period as visual perception deficiencies adversely affect the development of children's gross motor skills.
- Social and academic work should be done in order to create public awareness about importance of development of visual perception and gross motor skills.
- Parents can create a home environment that helps to develop children's visual perception and gross motor skills. Awareness-raising activities should be organized for parents about the topic (conference, meeting, panel ...).

REFERENCES

1. Akdemir B. Visual apprehension ability evaluating gouger, mentally defective students in between 6-12 years. *Unpublished Master's Thesis*, Konya: Selcuk University, 2006.
2. Bonifacci P. Children with low motor ability have lower visual-motor integration ability but unaffected perceptual skills. *Human Movement Science*, 2004; 23:157-168.
3. Bruininks VL, Bruininks RH. Motor proficiency of learning disabled and nondisabled students. *Perceptual and Motor Skills*, 1977; 44: 1131-1137.
4. Chaikin LE, Downing-Baum S. Functional visual skills. In: *Functional Visual Behavior: A Therapist's Guide to Evaluation and Treatment Options*, Gentile, M, ed. Rockville, MD: American Occupational Therapy Association, 1997: 105-132.
5. Clark JE. Motor development. In: *Encyclopedia of Human Behavior*, Ramachandran, VS, ed. San Diego: Academic Press, 1994; 3: 245-255.
6. Dwyer C, McKenzie BE. Impairment of visual memory in children who are clumsy. *Adapted Physical Activity Quarterly*, 1994; 11: 179-189.
7. Erhardt RP, Duckman RH. Visual-perceptual-motor dysfunction and its effects on eye-hand coordination and skill development. In: *Functional Visual Behavior in Children: An Occupational Therapy Guide to Evaluation and Treatment Options*, Gentile, M, ed. Rockville, MD: American Occupational Therapy Association, 2005: 171-228.
8. Frostig M, Lefever W, Whittlesey J. Disturbances in visual perception, *The Journal of Educational Research,* 1963; 57(3): 87-100.
9. Frostig M. *Developmental Test of Visual Perception*. Palo Alto, CA: Consulting Psychologist Press, 1964.
10. Frostig M. *Pictures and Patterns: Teacher's Guide.* Consulting Psychologist Press, 1968.
11. Frostig M. Five questions regarding my past and future and the past present and future of learning disabilities. *Journal of Learning Disabilities*, 1978; 11(9): 9-12.
12. Gabbard CP. *Lifelong Motor Development.* 3rd ed. Madison, Dubuque, IA: Brown & Benchmark, 2000.
13. Gallahue DL. *Understanding Motor Development in Children.* New York: John Wiley & Sons, 1982.
14. Gallahue DL, Omzun JC. *Understanding Motor Development: Infants, Children, Adolescents, Adults*. 4th ed. Boston: McGraw-Hill, 1998.
15. Gardner MF. *Test of Visual-Motor Skills*. Seattle, WA: Special Child Publications: 1986.
16. Glencross DJ, Piek PP, Eds. *Motor Control and Sensory-Motor Integration*, Volume 111: Issues and Directions. North-Holland: Elsevier Science, 1995.
17. Goodale MA, Milner AD. Vision for action and perception. *Encyclopedia of Neuroscience*, 2009: 203-210.
18. Haywood KM, Getchell N. *Lifespan Motor Development*. 3rd ed. Champagne, IL: Human Kinetics, 2002.
19. Henderson SE, Barnett A, Henderson L. Visual spatial difficulties and clumsiness: On the interpretation of conjoined deficits. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 1994; 35: 961-969.
20. Hulme C, Smart A, Moran G. Visual-perceptual deficits in clumsy children. *Neuropsychological*, 1982; 20: 475-481.
21. Jeannerod M. *Motor Cognition*. Oxford: Oxford University Press, 2006.
22. Kelso JAS, Mandell AJ, Shlesinger MF, Eds. *Dynamic Patterns in Complex Systems.* Singapore: World Scientific, 1988.

23. Kogan S. *The Relationships between Formal Movement Education in the Elementary School and Increased School Competency*. ERIC Document Reproduction Service No: ED300107, 1982.

24. Lockowandt O. *Frostig Entwicklung Test Der Visuellen Wahrnehmung*. Bettz: Few Deutsche Fraudis, 1974.

25. Lord R, Hulme C. Perceptual judgments of normal and clumsy children. *Developmental Medicine and Child Neurology*, 1987; 29: 250-257.

26. Lord R, Hulme C. Visual perception and drawing ability in clumsy and normal children. *British Journal of Developmental Psychology*, 1988; 6: 1-9.

27. Malina RM. Factors influencing motor development: Introductory comments. In: *A Textbook of Motor Development*, Corbin, CB, ed. Dubuque, IA: William C. Brown, 1980: 198-199.

28. Parush S, Yochman A, Cohen D, Gershon, E. Relation of visual perception and visual motor integration for clumsy children. *Perceptual and Motor Skills*, 1998; 86: 291-295.

29. Payne VG, Isaacs LD. *Human Motor Development*. 5th ed. Mountain View, CA: Mayfield, 2002.

30. Reinartz A, Reinartz E. *Wahrnehmungstraining*. Won Marianne Frostig, David Horne und Ann-Marie Miler, Dortmund: An Weisung Self, 1975.

31. Scheiman M. *Understanding and Managing Visual Deficits: A Guide for Occupational Therapists*. Thorofare, NJ: Charles B. Slack, 1997.

32. Schoemaker MM, Van der Wees M, Flapper B, Verheij JN, Scholten JS, Geuze RH. Perceptual skills of children with developmental coordination disorder. *Human Development Science*, 2001; 20: 111-133.

33. Seefeldt V. Developmental motor patterns: Implications for elementary school physical education. In: *Psychology of Motor Behavior and Sport,* Nadeau, C, Holliwell, W and Roberts, G, eds. Champaign, IL: Human Kinetics, 1980: 314-323.

34. Seefeldt, V. The concept of readiness applied to motor skill acquisition. In: *Children in Sport*, Magill, RA, Ash, MJ and Smoll, FL, eds. Champagne, IL: Human Kinetics, 1982: 335-348.

35. Sökmen S. Perception development in 5 years old: A reliability study for Frostig Visual Perception Test. *Unpublished Master's Thesis*, İstanbul: Marmara University, 1994.

36. Sigmundsson H, Hansen PC, Talcott JB. Do_clumsy_children have visual deficits? *Behavioural Brain Research*, 2003; 139: 123-129.

37. Şahin Arı AN. A study of the relationship between visual perception behavior of the children, attending preschool education institutions, with age five- six, and teacher behavior. *Unpublished Master's Thesis*, Ankara: Gazi University, 2007.

38. Tepeli K, Arı R, Büyüköztürk Ş. Test of gross motor skills. *International Conference on Educational Science*, Famagusta, North Cyprus: Department of Educational Sciences, Faculty of Education, Eastern Mediterranean University, 2008: 1907-1922.

39. Tsai CL, Wilson PH, Wu SK. Role of visual-perceptual skills (non-motor) in children with developmental coordination disorder. *Human Movement Science,* 2008; *27*(4): 649-664.

40. Ulrich DA. *Test of Gross Motor Development*, Texas: Pro.ed, 2000.

41. Van Waelvelde H, De Weerdt W, De Cock P, Smits-Engelsman BC. Association between visual perceptual deficits and motor deficits in children with developmental coordination disorder. *Developmental Medicine and Child Neurology*, 2004; 46: 661-666.

42. Wade MG, Whiting HTA. eds. *Motor Development in Children: Aspects of Coordination and Control.* Dordrecht, The Netherlands: Martinus Nijhoff, 1986.

43. Waelvelde HV, Weerdt WD, Cock PD, Smiths-Engelsman BCM. Association between visual perceptual deficits and motor deficits in children with developmental coordination disorder. *Developmental Medicine and Child Neurology*, 2004; 46(10): 661-666.

44. Weise MR. Self-esteem and achievement in children's sport and physical activity. In: *Advences in Pediatric Sport Sciences*, Gould, D and Weise, MR, eds. Champaign, IL: Human Kinetics, 1987; 2: 87-117.

45. Williams HG, Temple IG, Bateman NJ. Perceptual-motor and cognitive learning in young children. In: *Psychology of Motor Behavior and Sport Champaign*, Landers, DM and Christina, RW, eds. IL: Human Kinetics Publishers, 1977: 471-493.

46. Wilson PH, McKenzie BE. Information processing deficit associated with developmental coordination disorder: A meta-analysis of research findings. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 1998; 39: 829-884.

47. Zaporozhets AV. The development of perception in the preschool child. *Monographs of The Society for Research in Child Development*, 1965; 30(2): 82-101.