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Relationship between the short-term visual memory and IQ in the right- and left-handed subjects trained in different educational programs: I- general assessment

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The relationship between mean intelligence quotient (IQ), hand preferences and visual memory (VM) were investigated on (N=612) males and females students trained in different educational programs in viewpoint of laterality. IQ was assessed by cattle's culture Fair intelligence test-A (CCFIT-A). The laterality of the one side of the body was assessed by a questionnaire with 20 items. For VM, word lists with 15 items derived from the root of the Turkish word "to run" were projected on a screen. Subjects were allowed to see the words for 30 sec., and write down the remembered-words in 40 sec. There was any relationship between the hand preferences and IQ levels in right-and left-hander for first ten items (Q1, p>0.05), and also there was no relationship between the hand preferences and remembered words (RW) in left-hander (p>0.05). There was, however, a negative relationship between the hand preferences and RW in right-handers (p<0.05). For second ten items (Q2), there was no relationship between the hand preferences and IQ of left-handed subjects (P<0.05), but there was a positive relationship between the hand preferences and IQ in right hander (p<0.05). However, there was no relationship between hand preferences and non remembered words (NRW) (p>0.05). It was concluded that there was a relationship between the laterality, NRW and IQ in right hander.

Key words: Intelligence, laterality, education, remembering, students.

INTRODUCTION

Bilateral symmetry is a definition, which denotes the arrangement of the body in a particular order, according to the line dividing it into two similar parts in respect to dimension, shape and position on both sides (Adams et al. 1997; Tan, 1993a; Yakovlev and Rakic 1966; Yetkin, 1993). Symmetry is a physical quantity maintaining energy and balance of the body in the biologic systems (Yetkin, 1993). Symmetry may also be seen in a particular period or be lost in a phylogenetic and ontogenetic process of evolutionary development (Bakan, 1975; Tattersall, 1998; Tubiana, 1981; Tubiana 1981; Vogan and Tabin, 1999). The findings of a study by Yetkin (2002) have been supporting this hypothesis on the presence of symmetry as phylogenetic direct to morpho-logical and functional asymmetry ontogenetically. During the course of evolution, the cerebral hemispheres

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have undertaken different functions called asymmetry (Geshwind and Galaburda, 1984; Geshwind and Galaburda, 1987). The researches show that the asymmetry can see in different manners (Cohn, 2002; Coren, 1992; Yetkin, 1993).

In biologic systems, the asymmetry is seen in four different manners. They are functional, morphologic, cognitive and anatomic asymmetries. Hand, eye, foot and ear preferences are the best samples of the functional asymmetries (Annett, 1970; Annett, 1985; Annett, 1976; Napier, 1956; Oldfield, 1971; Tan, 1988; Yetkin, 1993; Yetkin, 1995; Yetkin, 2001). The differences between right-hand and left-hand, and right-left foot sizes are good samples of morphologic asymmetries (Yetkin, 1995; Yetkin, 2002). Planumtemporale in the brain (Wada et al., 1975; Westbury et al., 1999) and temporal speech regions (Geshwind and Levitsky, 1968) in left and right hemisphere are the samples of the anatomical asymmetries, and learning and memory and management of the left and right hemisphere are the samples of the cognitive asymmetries (Yetkin, 2005). Functional asymmetry is very important for humans to perform the daily activities controlled by brain asymmetry and dominancy (Knecht et al., 2000; Porac et al. 1980; Purves et al., 2001; Sperry, 1974). Since the first evidence of functional asymmetry in the human brain was put forward by Paul Broca's observations (1861), the researchers have been searching on the brain asymmetry, hand preferences (Tan, 1988; Wernicke, 1874; Wilson 1998), hemispheric dominance (McCurdy and Langford, 2005) and laterality from Broca to contemporary researchers (Geshwind, 1965, 67; Mohr, 1976; Yetkin, 1993, 2002b).

The left hemisphere in most conduction is more intimately linked to voluntary motor functions (Kilbreath and Gandavia, 1994; Long, 1981) than the other has been known for many years. However, the management of the left-right hemispheres is not evident as well as motor functions (Alder, 1999; Hammond, 1990). On the other hand, Annett (1985) studied the relationship between the left-right hand and brain, and developed his right-shift theory (Annett, 1981; Annett, 1996; Steenhuis and Bryden, 1989; Tan, 1993b). In this way, the reason of hand preferences could be expressed easier.

Humans have at least two qualitative systems of information storage referred to as declarative and procedural memory (Dudai, 2002; Hilst, 1995; Kuppferman). In addition to this qualitative classification, there is also episodic retrieval, semantic and working memories (Filley, 2001; Lisberger, 1988; Zimmer et al., 2001).

There is in fact good evidence that there are really two distinct memory stores in the brain: a long-term memory (LTM) and short-term visual memory (STVM). There is also evidence that the STVM has a lot of separate components, which retain information temporarily to cover the period during which consolidation takes place. Probably STVM involves the time from second to minutes or so (Baddely, 1983). STVM is one of three broad memory systems including iconic memory and LTM (Cherry, 2014. Iconic memory involves the memory of visual stimuli. Iconic memory is also part of the visual memory system in addition to long-term memory and visual short-term memory.Iconic memoryis the visual sensory memory (SM) register pertaining to the visual domain and a fast-decaying store of visual information. It is a component of the visual memory system which also includes visual short term memory (VSTM) and long term memory (LTM) (Dick, 1974; Coltheart, 1980). A new view point related to the basics of learning and memory was performed by psychological studies more before on the animals. This scientific area was also called as neuro-cognitive science by neuroscientists (Anderson, 1997; Penfield, 1967; Rourke, 1995).

In this study the brain asymmetry (Davidson and Hugdahl, 1995) has been investigated for the view point of functional asymmetry; for example hand preferences (Kilshaw and Annett, 1983; Kimura, 1996; Tan and Kutlu, 1992) and the laterality of the one side of the human body (Yetkin, 1993), and also has been studied cognitive processes; such as the short-term visual memory (Engelkamp and Zimmer, 1994; Engelkamp, 1995; Fuster, 1995) and nonverbal IQ (Engelkamp et al., 2001; Tan, 1991). In this study, the age, different education programs, sexuality and laterality were used as research parameters. The main aim of the present study was to evaluate the relationship between laterality, nonverbal intelligence and visual short- term memory. In addition, another objective of this work was to determine the effects of training programs on the laterality, IQ and short-term visual memory, and their contributions to individuals. According to the Tan (1989a) the cognitive and motor functions are interrelated systems; the efficiency of the spatial reasoning would depend on the degree and developmental level of cerebral lateralization.

In conclusions, the studies related to the motor, behavioral and cognitive functions in different populations are still going to lose the mystery of the brain as a contemporary research area. A numerous studies have been carried out, especially with patients and normal populations, on motor control, lateralization, behavior, dominant hemisphere, hemispheric management (Alder, 1999; Kıylık and Yetkin, 2005), and cognitive and mental functions. The present study was performed for these purposes. Thus, the relations between the parameters from hand preferences to short-term visual memory and nonverbal IQ were compared one by one. An understanding of the differences between them may be crucial for better understanding the genetic and neurobiological mechanisms underlying handedness (Snyder and Harris, 1993).

METHODOLOGY

Subjects

The study is part of the master thesis written by Yılmaz (Yılmaz and Yetkin, 1998), and was carried out in the department of biology, science faculty, Atatürk university, Erzurum, Turkey, on the ethical

rules. The subjects comprised 511 male (*M*) and 101 female (*F*) (*n* = 612) volunteers, between 13 - 45 years old. Most of them were students' in a high school having classical (CEP) or religious (REP) educational program. Some of them, however, were out of school that they had completed their high school education in a university who has been designated as out of school (OOS). They were also in the period of adolescence, young adult and late adults. They were no anatomical or physiological defects in their hands, fingers, feet and eyes. They were healthy and devoid of sign and symptoms of any illness. Before the beginning of the study, written permission was taken from the directorate of defense. All experiments were performed in compliance with the institutional guidelines. An informed consent was also obtained from the subjects. The following methods were applied to all subjects:

Lateralization and hand preferences

The hand preferences were assessed by using Edinburgh handedness questionnaire (EHQ; Oldfield, 1971) with first ten questions (Q1) modified by Geshwind and Behan (1984), and Yetkin Laterality Questionnaire (YLQ: Yetkin 1993) with second ten questions (Q2) was on the hand preferences. YLQ was to assess whole lateralization of the one side of the body from eye to hand, including finger and foot asymmetries (Yetkin 1993; Yetkin, 1995; Yetkin, 1996; Yetkin, 2001; 02 Yetkin, 2002). The survey comprised first ten items designed to represent a range of uni-manual and bimanual activities with minimal redundancy. Respondents were asked to indicate which hand they would use in (i) writing, (ii) drawing, (iii) throwing, or (iv) using scissors, (v) toothbrush, (vi) knife and (vii) spoon, (viii) broom (upper hand), (ix) striking a match (hand holding the match), or (x) removing a lid (hand holding the lid) in daily activities (Yetkin, 2001).

The second group of ten questions was added by Yetkin (1993) to assess the whole lateralizes on degree of one side from eye to foot and complemented the Oldfield questionnaire (1971). The survey also comprised second ten questions designed to represent a range of uni-manual and bimanual, and uni- and bipedal and left right eye activities. Respondents were also asked to indicate which hand, foot and eye they would use in (i) looking a microscope, (ii) passing a thread through a needle, (iii) kicking a ball, (iv) aiming (hand, finger, eye), (v) shaking hands and saluting, (vi) sewing (the hand holding the needle), (vii) holding a saw, (viii) throwing a hammer, (ix) carrying a suitcase, and (x) playing hop-scotch (Yetkin, 1993; Yetkin, 2001). After the assessment of laterality and performing the preferences, Geshwind scores were used for laterality (Tan 1988). Two different scores were obtained from data. One of them was from Q1 and other was from Q2 (Yetkin 1992, 1993, 2001, 2002).

For the groups, the columns were scored as +10 (always right hand), +5 (usually right hand), zero (either or mixed hand), -5 (usually left hand), and -10 (always left hand). The degree of laterality was taken as the sum of all scores. The laterality degrees obtained from Q1 and Q2 scores were taken as main values for the assessing of the hand preferences. The male and female subjects were classified as being right-handed, left-handed and mixed hand (ambidexterity) according to their laterality degrees. To this view point, the subjects who have +25 and over degrees of the lateralization (from +25 to +100) were accepted as right handed (RH), the subjects who have between -25 and + 25 degrees of laterality were accepted as mixed hand (MH), and the subjects who have -25 and under degrees (from -25 to -100) of laterality were accepted as left-hand (LH).

Nonverbal intelligence (IQ)

For this purpose, cattle's culture fair intelligence test-a form (CCFIT-A) was used. Subjects were realized the process in the time of 3 minute for test-1, of 4 minute for test -2, of 3 minute for test 3, and of 4 minute for test 4, respectively. The CCFIT-A contains 50 questions totally. After the application of the IQ test, the number of positive answers was assessed on the answer sheet firstly. The corresponding points of IQ of subjects were assessed and recorded after the ages were determined. To determine the IQ levels a scale which was accepted internationally was used.

Number of remembering words (NRW)

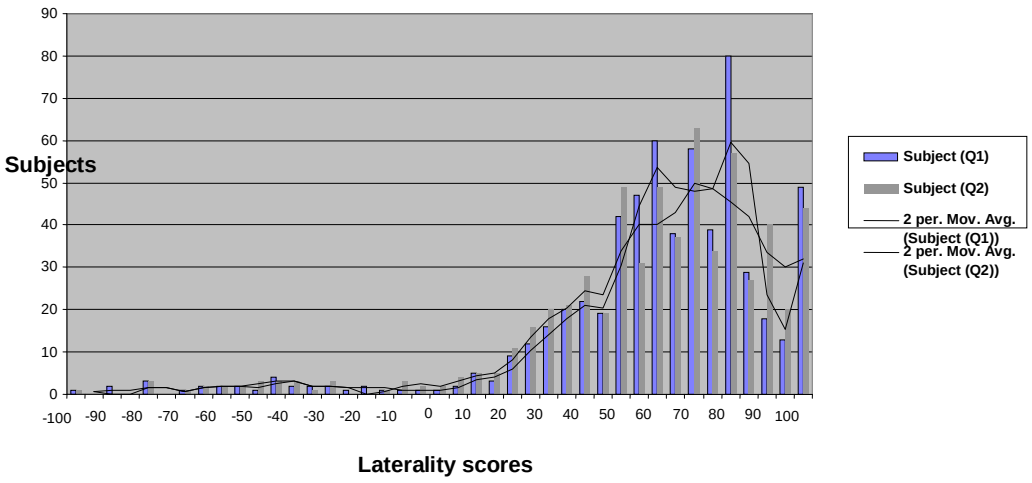
As psychological,memory is an organism's ability to store, retain, and subsequently recall information.Visual memory is part of memory preserving some characteristics of senses pertaining to visual experience.The first person to give serious consideration to visual imagery was Francis Galton (1822-1911) in the field of individual differences (Magnussen, 2000; Todd and Marois, 2004). The subjects were informed about the aim of the study and writing the successful word process; they were informed on the subject as related to that what would they perform for short-term memory. For this purpose, fifteen words derivate from a Turkish verb were projected on a screen for 30 second, and after the projection was switched off, the time of 40 seconds were given for writing words that they remembered. Turkish word "to run" was translated from Turkish language to English. The word corresponds "run", "race", "parallel", "running", "can run", "harness", "don't run", "runner", "condition", "conditional", "running about", "by running", "harnesser", "hurry", and "without running" were projected on the screen. The words were derived from the root well known in Turkish language. These words were in 3, 4, 5, 6, 7 and 8, respectively. Eight of them describe action, and others were not. The subjects were divided into two groups with 12 and 40 people. The subjects were informed about the questions, which may be formed in their mind before projection of the word. Incorrect words written by subjects were not taken to attention for the assessment.

Statistical analysis

The Student- t-test and the test of the calculation of the correlation coefficient were used for statistical analysis. The following processes, including the arrangement of different parameters; such as age, sexuality, education programs, hand, eye and foot preferences, the assessment of the needed mean values (arithmetically and statistically), drawing of the frequency tables and the graphics and assessment of the tendency lines on the graphics and making of plausibility tests of correlation coefficient, were performed by excel programs.

The correlation coefficient is a criterion, which is shown the changing together between any two parameters. If the correlation coefficient takes positive values, it means that the parameters move together; that is mean, when one of the parameters increases, the others also increases or when one of them decreases, the other also decreases. However, if the correlation coefficient takes negative values, it means that the parameters move against; that is also mean, when one of the parameters increases, the others also decrease or when one of them decreases, the other increases as well. If the greatness of the correlation coefficient gets to come close towards 1, although it means that the correlation is important or significant, the calculation value (r) should be presented for consideration with a hypothesis test not only chance or probability but also coming from a real existing correlation. To assess the importance of the correlation coefficient, the t-test was used.

The t-statistical calculating was compared with the table t-value. If the p-value corresponding t-value above mentioned was less than 0.05 ($p<0.05$), it was thought that r-the efficient was significant. The other purpose was to investigate whether the difference between



Scores	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	10	15	20	25	30	35	40	45	50
Subject (Q1)	1	0	2	0	3	0	1	2	2	2	1	4	2	2	2	1	2	1	1	1	1	2	5	3	9	12	16	20	22
Subject (Q2)	1	0	0	0	3	0	1	2	2	2	3	3	3	1	3	0	0	1	3	2	2	4	5	5	11	16	20	21	28

Figure 1. General distribution of ages of subjects.

arithmetical means was significant or not. The t-test was used for significance of the difference between the means. In the realization, it was hypothesized that the variance of population and double tail was different. This program for related series gives p-values (ratio of the error) corresponding t-test. The difference was found significant when p-value was $p<0.05$, and on the other hands the difference was found insignificant when p-value was $p>0.05$.

RESULTS

After the information obtained from subjects (***n***=612) and the application of the questionnaires on the subjects, the mean age was 16 years (Figure 1). According to different education programs which were used on the students with classical program (CEP) and with religion program (REP) in Erzurum (Turkey) and in the out-off school (OOS), the distributions of the hand preferences about three groups were assessed statistically. Table 1 and Table 2 show the distribution of the hand preferences from Q1 and Q2, respectively. In the same manner, the mean values of the age, IQ and number of successful words assessed as related to the different education programs was shown in Table 3**.** The t-test was used for that whether the difference between the means in the Table 3 was significant or not (Table 4).

The difference between mean ages of educational groups

There was not any important difference between mean ages of CEP and REP ($p>0.05$). However, there was a significant difference between the mean ages of the CEP and OOS ($p<0.05$), and of REP and OOS ($p<0.05$).

The difference between mean IQs of educational groups

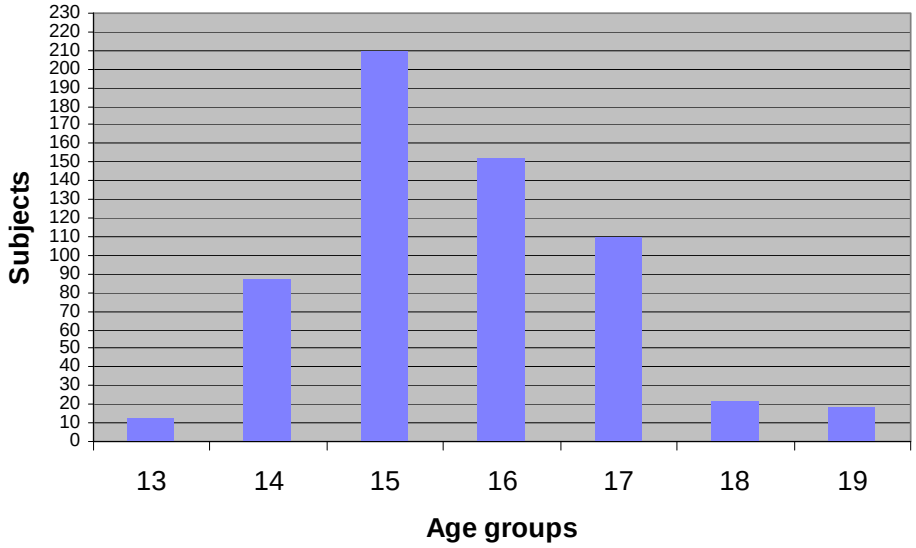
In the assessment between the mean IQ points; the difference between IQ points of the CEP and REP was not found significant ($p>0.05$). In the same manner the difference between IQ points of the CEP and OSS ($p>0.05$), and the difference between IQ points of the REP and OSS was not found significant ($p>0.05$; Table 4).

The difference between the numbers of the remembered words of educational groups

In assessing the number of the words remembered by subjects (NRWs), the difference between mean NRWs of the CEP and REP was found to be significant ($p<0.05$). In the same manner, the difference between mean NRWs of the OOS and REP was also significant ($p<0.05$), but the difference between mean NRWs of the OOS and CEP was insignificant ($p>0.05$).

The distribution of the hand preferences and laterality

The distribution of the laterality obtained from Q1 and Q2



Age groups	13	14	15	16	17	18	18<
Subjects	13	87	210	152	110	22	18

Figure 2. The distribution of the laterality obtained from Q1 and Q2 scores.

Table 1. Percentage of the left-hand, mixed-hand and right-hand preferences obtained from Q1 scores of the subjects trained in different education programs.

Education programs	N	Hand preferences (%)		
		LH	MH	RH
The students trained in classical education program (CEP)	366	4.09	4.37	91.54
The students trained in religious education program (REP)	232	4.374	3.89	91.74
The subjects, out of school or education (OOS)	14	-	7.14	92.86

LH; Left hand, MH; Mixed hand, RH; Right hand

Table 2. Percentage of the hand preferences obtained from Q2 scores of the subjects trained in different education programs

Educational programs	N	Hand preferences (%)		
		LH	MH	RH
The students trained in classical education program (CEP)	366	3.27	6.55	90.18
The students trained in religious education program (REP)	232	4.74	3.87	91.39
The subjects, out of school or education (OOS)	14	7.14	-	92.86

LH; Left hand, MH; Mixed hand, RH; Right hand

was shown by a histogram containing the total sample. The frequencies of the Geshwind scores from Q1 and Q2 (Figure 2) was shown together in one histogram. The correlation coefficient between laterality scores assessed by Q1 and Q2 was found (r=0.795). For this coefficient the significance test was made (t= 32.3). A positive linear significant relation (p<0.0001) was assessed between two parameters (Table 5). This relation between Q1 and Q2 means also a factor analysis for Q2; that is mean, the questions in the Q2 are significant for laterality as well as Q1 (Figure 2).

A comparison in the laterality of sexual differences

In the same way, the correlation coefficient between the

Table 3. General means of the parameters (age, IQ and RW) of subjects trained in different educational programs.

Education programs	Parameters (Mean)		
	Age	IQ	Remembered-words (RWs)
The students in classical education program (CEP)	15.61	77.67	8.53
The students in religious education program (REP)	15.50	76.27	6.33
The subjects, out of school or education (OOS)	34.42	90.42	7.92

Table 4. The relationship between the parameters (age, IQ and mean RW) of subject groups trained in different educational programs according to the t-test results.

Parameter	Subjects group I	n_1	Subjects group II	n_2	p-value	Significance*
Educational programs						
	CEP	366	REP	228	0.268	-
Mean age	CEP	366	OOS	18	7.00E-09	+
	REP	228	OOS	18	6.30E-09	+
	CEP	366	REP	228	0.263	-
Mean IQ	CEP	366	OOS	18	0.141	-
	REP	228	OOS	18	0.103	-
	CEP	366	REP	228	1.00E-32	+
Mean NRW	CEP	366	OOS	18	0.132	-
	REP	228	OOS	18	0.0006	+
Age groups						
	13 to 15	310	16 to 18	284	0.001	+
Mean IQ	15 to 15	310	18<	18	0.363	-
	16 to 18	284	18<	18	0.139	-
	13 to 15	310	16-18	284	0.986	-
Mean NRW	15 to 15	310	18<	18	0.544	-
	16 to 18	284	18<	18	0.551	-

* (+) significance and (-) insignificance; CEP, classical education program; REP, religious education program; RW, remembered words; OOS, out of school

scores from Q1 and Q2 for female (r=0.794) and for male (r=0.796) were found respectively. This means that there was a positive linear important relation (p<0.0001) between the data from Q1 and Q2 for female and male. The ratios of the relation for female and male were seemed to be approximating similar.

A comparison in the laterality of different age groups

A hard linear relation between the scores from Q1 and Q2 was also seemed to be same ratios approximately in all importance degrees of comparison performed for age groups (13-15, 16-18, 18<) and different education levels (CEP, REP and OOS) (Table 5).

A comparison in hand preferences of the Q1 and Q1 groups

According to the scores obtained from the first group questions (Q1), an important positive linear relations (p<0.0001) were assessed between the scores from the Q1 and Q2 of left-handed (r=0.859), mixed hand (r=0.579) and right-handed (r=0.514) subjects. Similarly, according to the scores obtained from the second group questions (Q2) an important positive linear relations (p<0.0001) were also assessed between the scores from the Q1 and Q2 of left- (r=0.559), mixed (r=0.561) and right-handed (r=0.508) subjects. In every dual assessing above mentioned, the relation ratios between Q1 and Q2 was found the lowest in right-handed subjects, while it was seemed the highest in left-handed subjects. The relation ratio for mixed hands was found between those of left-and right handed subjects (Table 5).

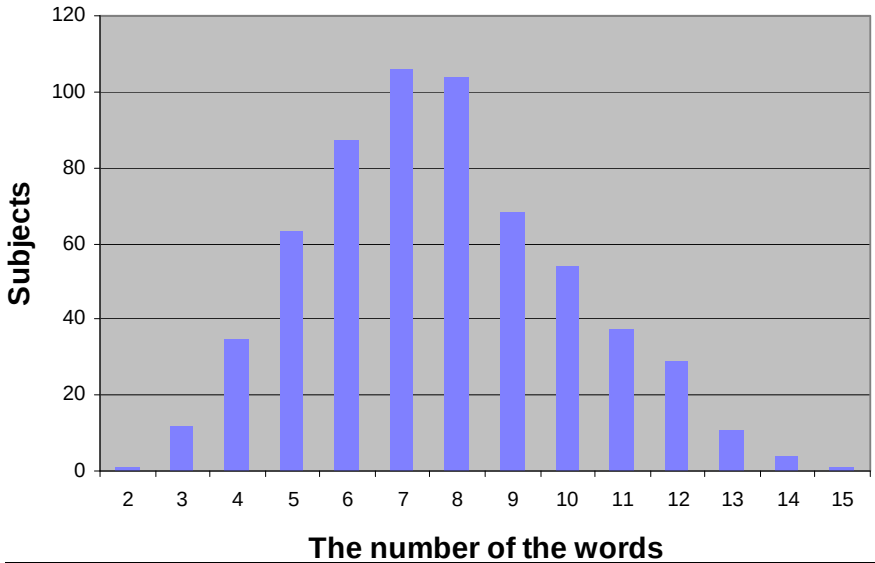
The distribution of the short-term visual memory and IQ

For all population, the number of mean success word was assessed as 7.685. The histogram in Figure 3 shows

Table 5. The correlations between Q_1 and Q_2 scores in general population.

N	df	Q1	Q2	r	t-value	Significance
612	610	**General population**		0.795	32.3	p<0.05
100	98	F	F	0.794	12.9	+
512	510	M	M	0.796	29.6	+
Age groups						
310	308	13-15	13-15	0.767	20.97	+
264	262	16-18	16-18	0.812	23.00	+
18	16	18<	18<	0.760	4.67	+
Education programs						
366	364	CEP	CEP	0.784	24.00	+
232	230	REP	REP	0.815	21.30	+
14	12	OOS	OOS	0.767	4.14	+
Laterality: according to the scores taken from Q1						
25	23	LH	LH	0.859	8.04	+
25	23	MH	MH	0.579	3.40	+
562	560	RH	RH	0.514	14.20	+
Laterality: according to the scores taken from Q2						
24	22	LH	LH	0.559	3.10	+
33	31	MH	MH	0.516	3.30	+
555	553	RH	RH	0.508	13.80	+

N= the number of subjects; df= degree of freedom, r= Correlation coefficient; (+) = the data is moving significantly together at important degree and (-) = the data is moving free from one another in the correlations. *(+) significance and (-) insignificance; CEP, classical education program; REP, religion education program; NRW, number of remembered words; OOS, out of school; RH, right hand; LH, left hand ; MH, mixed hand.



Words	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Subject	1	12	35	63	87	106	104	68	54	37	29	11	4	1

Figure 3. The distribution of remembered-word numbers in general population

Table 6. The correlation between age and IQ, Age and RW.

N	df	Age	IQ/RW	r	t-value	Significance*
General population						
612	610	Age	IQ	-0.019	0.46	-
612	610	Age	RW	0.003	0.07	-
Laterality: according to the scores observed from Q1						
25	23	LH-age	LH-IQ	0.249	1.23	-
25	23	LH-age	LH-RW	0.030	0.14	-
25	23	MH-age	MH-IQ	0.198	0.96	-
25	23	MH-age	MH-RW	0.156	0.75	-
562	560	RH-age	RH-IQ	0.015	0.35	-
562	560	RH-age	RH-RW	0.001	0.023	-
Laterality: Assessment according to the scores observed from Q2						
22	22	LH-age	LH-IQ	0.179	0.85	-
25	23	LH-age	LH-RW	0.104	0.49	-
25	23	MH-age	MH-IQ	-0.086	0.48	-
25	23	MH-age	MH-RW	-0.001	0.005	-
562	560	RH-age	RH-IQ	0.014	0.32	-
562	560	RH-age	RH-RW	-0.001	0.023	-

N= the number of subjects; df= degree of freedom, r= Correlation coefficient; (+) = the data is moving significantly together at important degree, and (-) = the data is moving free from one another in the correlations. *(+) significance and (-) insignificance; RH, right hand; LH, left hand; MH, mixed hand; RW, remembered words**.**

the distribution of the different NRW of the subjects in total sample

Correlation between age groups and NRWs

In the separation into groups formed by scores from the first group questions (Q1), the correlation coefficients have shown that there was significant relations (p>0.05) calculated between the ages and NRW of left-handed (r=0.03), mixed hand (r=0.156) and right-handed (r=0.001) subjects (Table 6). In the same way, in the separation into groups formed by scores from the second group questions (Q2), the correlation coefficients have shown that there was any significant relations (p>0.05) calculated between the ages and NRW of left-handed (r=0.104), mixed hand (r=0.001) and right-handed (r=0.001) subjects (Table 6).

Correlation between IQ and NRWs

The correlation coefficient between IQ and NRW was calculated as r=0.241, and as a result of coefficient tested (t=6.13), a positive relations (p<0.0001) was assessed between them.

Relation between sexual differences

The subjects were separated into two groups as female (F) and male (M) according to sexuality. It was assessed that there was a significant positive relation between IQ and NRW (r=0.219; p<0.01) of females. There was also a positive relation between IQ and NRW (r=0.219; p<0.0001) of males (Table 7).

Relation between educational differences

The subjects were separated into three groups according to different education programs (CEP, REP and OOS). The correlation coefficients between IQ and NSW were assessed for CEP (r=0.347), REP (0.075) and OOS (r=0.410), respectively. However, as results of these coefficients tested, it was shown that the coefficients for CEP was found significant (p<0.0001) only (Table 7). It was assessed that the relation between IQ and NRWs of the students with CEP was seen to be much stronger than those total samples.

Relation between the laterality groups

The subjects were grouped to their scores taken from Q1. According to the result of the correlation coefficients, the relation between IQ and NSWs of the left handed (r=-0.05) and mixed hand (r=-0.04) subjects was found insignificant (p>0.05), whereas, a positive important linear relation was found between IQ and NRWs of the right

Table 7. The correlations between IQ and RWs of general population, age groups, education programs and laterality.

N	Df	IQ	RW	r	t-value	Significance*
612	610	-	-	0.241	6.13	+
100	98	F	F	0.219	2.22	+
512	510	M	M	0.225	5.20	+
Age groups						
310	308	13-15	13-15	0.192	3.43	+
284	282	16-18	16-18	0.290	5.08	+
18	16	18<	18<	0.527	2.48	+
Education programs						
366	364	CEP	CEP	0.347	7.05	+
232	230	REP	REP	0.075	1.14	-
14	12	OOS	OOS	0.410	1.55	-
Laterality: Assessment according to the scores observed from Q1						
25	23	LH	LH	-0.05	0.240	-
25	23	MH	MH	0.04	0.191	-
562	560	RH	RH	0.261	6.39	+
Laterality: Assessment according to the scores observed from Q2						
24	22	LH	LH	0.012	0.05	-
33	31	MH	MH	0.005	0.02	-
555	553	RH	RH	0.262	6.38	+

N= the number of subjects; df= degree of freedom, r= Correlation coefficient; (+) = the data is moving significantly together at important degree and (-) = the data is moving free from one another in the correlations. CEP, classical education program; REP, religious education program; RW, number of remembered words; OOS, out

handed (r=-0.261) subjects. It was assessed that relationship between IQ and NRWs of the right-handers was seen to be much stronger than those total samples (Table 8). The subjects were grouped to their scores taken from Q2. According to the result of the correlation coefficients was found for left handed (r=-0.012), mixed hand (r=-0.005) and right handed (r=-0.262) subjects. According to the result of the correlation coefficients, there was a positive significant relation between IQ and NRWs of the right-handers ($p<0.0001$), whereas, there was not any significantly relationship between IQ and NRWs of the left- and mixed handed subjects ($p>0.05$; Table 7). The distribution of the NRW in total sample shows in Figure 3.

Distribution of IQ between Q1 and Q2

The IQ points related to the total population were recorded as 77.436. The histogram formed by IQ shows the general distribution of the different IQ points in total samples (Figure 4).

Relationship between age and IQ

In this study, the correlation coefficient between age and IQ levels was found as r=-0.019), and there was not any significantly relationship between age and IQ levels ($p>0.05$; Table 6).

Relationship according to laterality groups

The subjects were separated into left-, mixed and right handed according to their scores taken from Q1. The correlation coefficient assessed between IQ point and age were found and tested for left- (r=0.249), mixed ((r=0.198) and right handed (r=0.015) subjects. A significantly relationship between age and IQ levels was not assessed in each group (Table 6). The subjects were separated into left-, mixed and right handed according to their scores taken from Q2. The correlation coefficient assessed between IQ point and age were found and tested for left- (r=0.179), mixed ((r=0.086) and right handed (r=0.014) subjects. A significant relationship

Table 8. The correlations between laterality scores observed from Q1 and Q2 and RWs

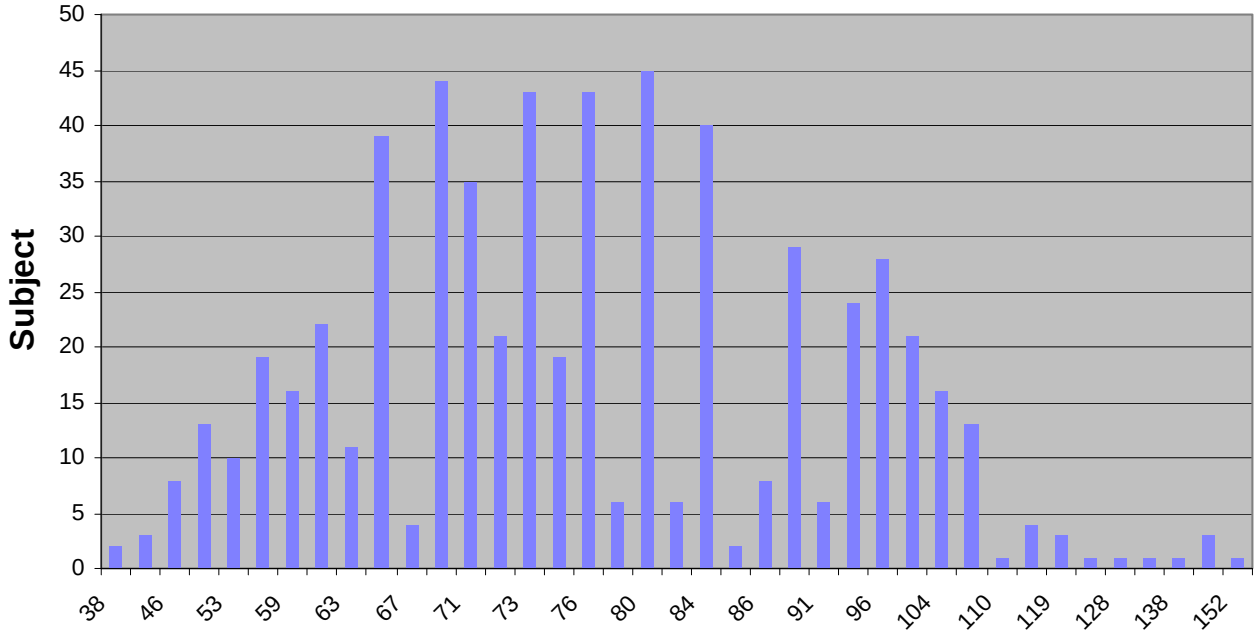
N	df	Q1	NRW	r	t-value	Significance*
General population						
612	610			-0.037	0.91	-
100	98	F	F	-0.106	1.05	-
512	510	M	M	-0.017	0.38	-
Age groups						
310	308	13-15	13-15	-0.036	0.63	-
284	282	16-18	16-18	-0.242	0.70	-
18	16	18<	18<	0.057	0.22	-
Education programs						
366	364	CEP	CEP	-0.036	0.68	-
232	230	REP	LREP	0.045	0.68	-
14	12	OOS	OOS	0.009	0.03	-
Laterality						
25	23	LH	LH	-0.05	1.26	-
25	23	MH	MH	0.04	1.18	-
562	560	RH	RH	0.261	2.40	+
General population						
612	610	Q2	NRW	0.027	0.66	-
Age groups						
310	308	13-15	13-15	0.048	0.84	-
284	282	16-18	16-18	-7E-04	0.01	-
18	16	18<	18<	0.194	0.79	-
Education programs						
366	364	CEP	CEP	0.011	0.20	-
232	230	REP	REP	0.085	1.29	-
14	12	OOS	OOS	0.070	0.24	-
Laterality						
25	23	LH	LH	-0.199	0.97	-
25	23	MH	MH	0.040	0.36	-
562	560	RH	RH	0.261	0.28	-

N= the number of subjects; df= degree of freedom, r= Correlation coefficient; (+) = the data is moving significantly together at important degree and (-) = the data is moving free from one another in the correlations. CEP, classical education program; REP, religious education program; RW, number of remembered words; OOS, out of school; LH, left hand; MH, mixed hand; RH, right hand; *Q1* and *Q2,* two group questions with ten items.

between age and IQ levels was not also assessed in each group (p>0.05; Table 6).

Findings obtained from the age groups

In different age groups (13 to15, 16 to 18, over 18), the distribution of the laterality was assessed by scores provided from Q1 and Q2 (Figure 5, 6 and 7). General arithmetical means and the results of the assessment were performed by using the sexual difference of the groups like in table 9. According to the data in table 9, the difference between mean IQ levels and NRW was found less important. Uprightness degrees of these results were



38	42	46	50	53	56	59	61	63	65	67	68	71	72	73	75	76	79	80	81	84
2	3	8	13	10	19	16	22	11	39	4	44	35	21	43	19	43	6	45	6	40
85	86	88	91	92	96	100	104	109	110	114	119	124	128	133	138	141	152	-	-	-
2	8	29	6	24	28	21	16	13	1	4	3	1	1	1	1	3	1	-	-	-

Figure 4. The distribution of the IQ points according to the results of the CCFIT-A.

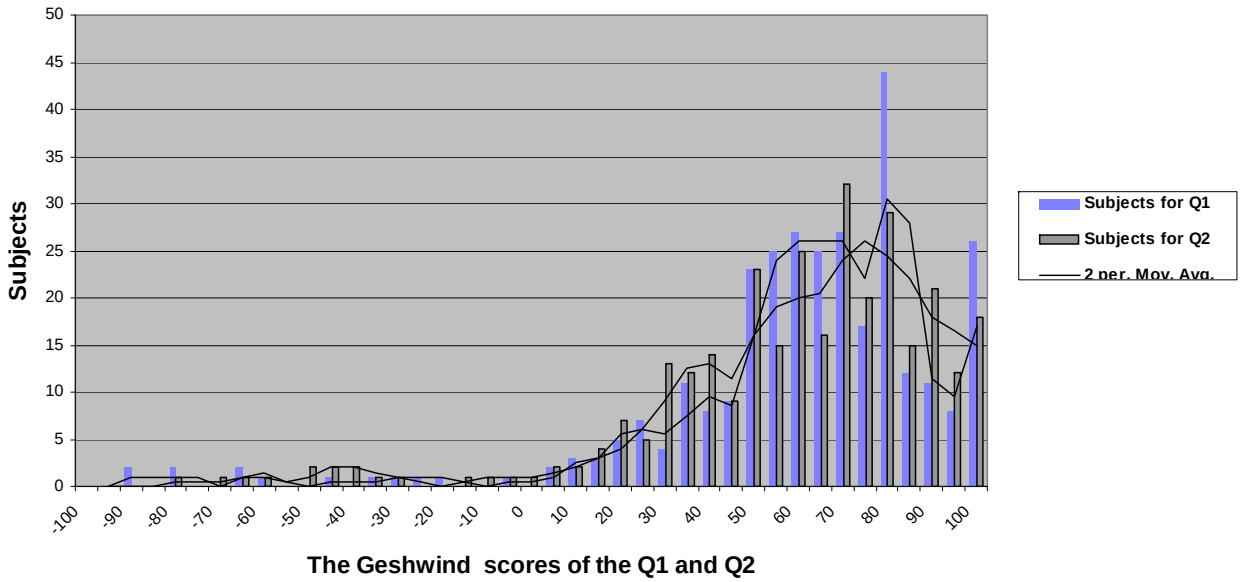
controlled by t-test (Table 10). According to the results of t-test, the relationship between IQ and NRW were as follows:

In the general assessment, the difference between IQ points of the age ranging from 13 to 15 and of age in ranging from 16 to 18 was found significant ($p<0.05$). However, it was understood that there was any significant between the differences of the NRW of three age groups ($p>0.05$; table 11).

Sexual differences in age groups

In the assessing performed by using sexual difference in age groups, the differences between mean IQ points from females ranging from 13 to 15 and from males ranging from 16 to 18 was found significantly ($p<0.05$). In the same way, the differences between mean IQ points from males ranging from 13 to 15 and from males ranging from 16 to 18 was found significant ($p<0.05$). The differences between NRW of females ranging from 13 to 15 and of males in other three age groups (13-15, 15-18, 18<) was found significant ($p<0.05$), and the differences between the mean NSW of females ranging from 16 to 18 and of males in other three age groups (13 to 15, 15 to 18, 18<) was also found significant ($p<0.05$).

After the separation into the left-, mixed and right handed of the subjects in age groups, the mean values taken from assessment of the

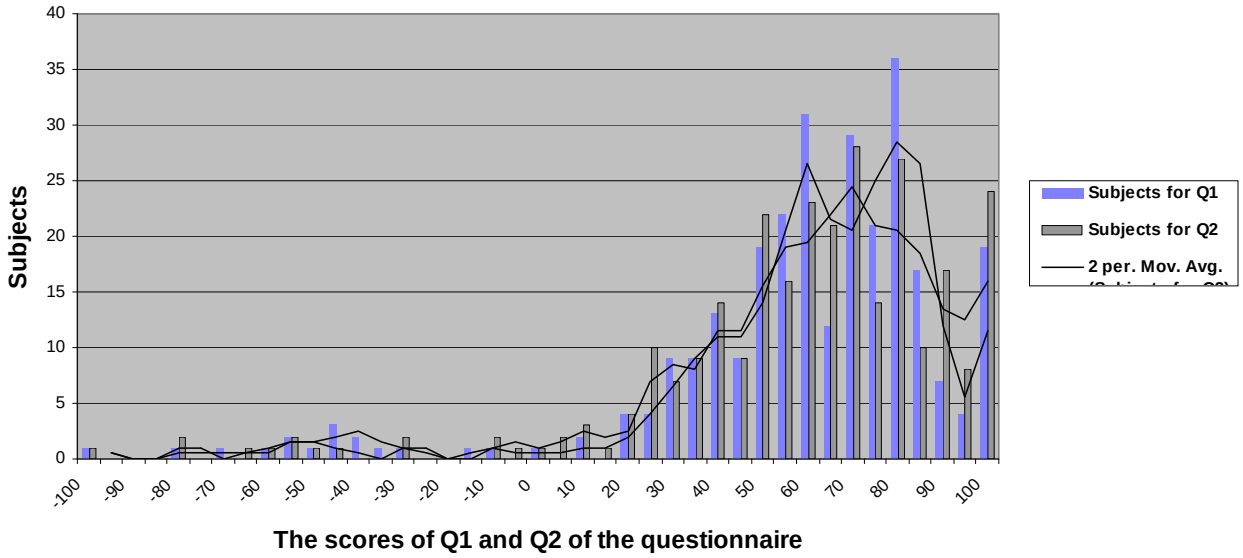


G Scores	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-	-	-
Subjects for Q1	0	0	2	0	2	0	0	2	1	0	0	1	0	1	1	1	1	0	0	-	-	-
Subjects for Q2	0	0	0	0	1	0	1	1	1	0	2	2	2	1	1	0	0	1	1	-	-	-
G Scores	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Subjects for Q1	1	0	2	3	3	5	7	4	11	8	9	23	25	27	25	27	17	44	12	11	8	26
Subjects for Q2	1	1	2	2	4	7	5	13	12	14	9	23	15	25	16	32	20	29	15	21	12	18

Figure 5. The distribution of the laterality according to the scores observed from the questions of Q1 and Q2 in age group of 13 to 15 years.

separation are shown in Table 12. The importance of the differences between arithmetic means in tables 12 was assessed by t-test. The results related to the tests are shown in (Table 10). According to the scores taken from Q1, the differences between mean IQ points of the left-, right- and mixed handed subjects in age group from 13 to 15 and in age group from 16 to 18 was found important ($p<0.05$). According to the mean NRW, the differences between the mean NRW of the subjects in age from 16-18 and ambidextrous subjects in age from 16-18 was found significant ($p<0.05$). The differences between means were not found important in other parameters of subjects ($p>0.05$). According to scores taken from Q2, the differences between mean IQ points of left- and right handed subjects were found important ($p<0.05$) for the age group from 13 to 15 and from 16 to 18. The differences between means were also not important in comparisons of other parameters of subjects ($p>0.05$).

In present work, the correlation coefficient between age and NSW was calculated as r=0.003, and the correlation between them was found insignificant ($p>0.05$; Table 6). On the other hand, significant between IQ and NRW were investigated in different age groups. Between IQ and NRW there was a correlation coefficients that was calculated for the age group from 13 to 15 (r=0.192) from 16 to 18 n(r=0.29) and from over 18 years (r=527), respectively. To these results an important positive correlation were found between IQ and NRW. However, this correlation was found at highest levels in over 18 years old subjects, but in age group of 16 to 18 years, it shows some decreasing with lowest level in age group of 13 to



Scores	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	-5
Subjects for Q1	1	0	0	0	1	0	1	0	1	2	1	3	2	1	1	0	0	1	1	0
Subjects for Q2	1	0	0	0	2	0	0	1	1	2	1	1	0	0	2	0	0	0	2	1

Scores	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Subjects for Q1	1	0	2	0	4	4	9	9	13	9	19	22	31	12	29	21	36	17	7	4	19
Subjects for Q2	1	2	3	1	4	10	7	9	14	9	22	16	23	21	28	14	27	10	17	8	24

Figure 6. The distribution of the laterality according to the scores observed from the questions of Q1and Q2 in age group of 16-18 years.

Table 9. The means of the age, IQ and RW regarding to age groups and sex difference.

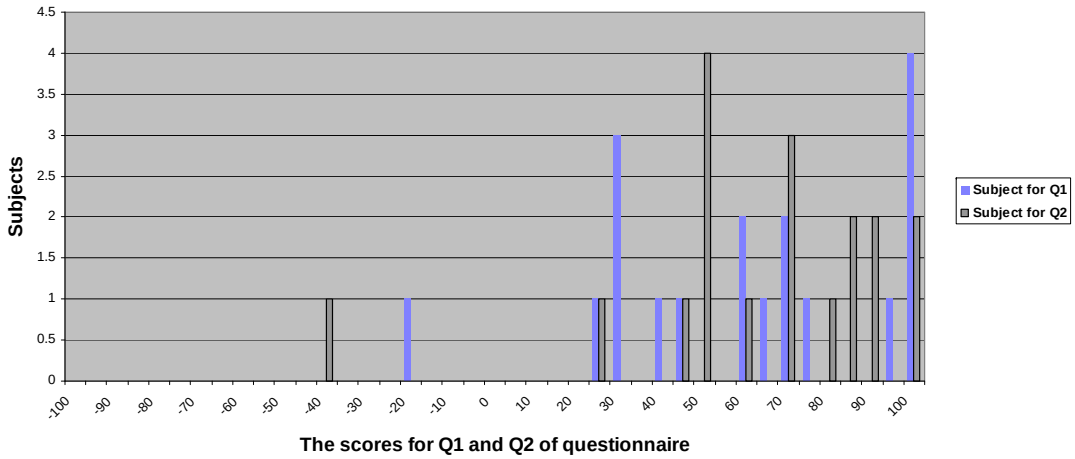
Age groups	N	Parameters		
		Mean Age	Mean IQ	Mean RW
13 to15	310	14.63	79.18	7.69
16 to18	284	16.54	75.01	7.69
18<	18	31	85.55	7.44
13 to15 F	60	14.78	81.43	8.71
13 to15 M	250	14.6	78.62	7.44
16 to18 F	35	16.28	79.51	8.71
16 to18 M	249	16.57	74.38	7.54
18< F	6	34.10	99.50	7.66
18< M	12	29.41	78.57	7.33

F, female; M, male; RW, number of remembered words.

15 (Table 7).

DISCUSSION

The principle objectives of this present study were to investigate the relationship between the functional asymmetry (Glick and Shapiro, 1985; Hellige, 1990) of the one side of the body and nonverbal intelligence and short term visual memory. Another objective of this investigation was to compare the qualitative difference between the education in the classical program and in the religious



scores	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
Subject for Q1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	3	0	1	1	0
Subject for Q2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	4

Figure 7. The distribution of the laterality according to the scores observed from the questions of Q1 and Q2 in age group of over 18 years.

program policy of the national education of Turkey.

This is the first study showing a relationship between the degree of laterality and the effect of the genetics (Previc, 1991; Reeves, 2000) and external environmental factors such as education and hand preference (Napier, 1956; Rothwell, 1994; Simon-Thom et al., 2005). Hand preferences is a significantly example of the human behavioral differences (Phillips, 1986; Previc, 1991; Yetkin, 2002b). Symmetry is also an important phylogenetic feature of the body in biological systems maintaining a physical quantity such as the disposal of energy and balance (Lewis, 1989; Yetkin, 1993). There is an evolutionary relationship between laterality and symmetry (Eccles, 1989; Jordan, 1999; Tattersall, 1995). Evolution is a fact (Charlesworth and Charlesworth, 2003) and the earth is estimated over 4 billion years old. The theory of evolution is a valid scientific theory which goes a long way to explain the diversity of life that is seen on present planet. It was accepted that these are right process because they were well supported by evidence from a number of scientific disciplines, such as geology, chemistry, physics and biology (Charlesworth and Charlesworth, 2003). The right of continuity is considered a keystone of most scientific theories of learning, memory and knowledge. The fact is that the memory and emotions are closely connected, and it is part of daily activities (Kluweet al., 2003). Neural plasticity (Shaw and McEachern, 2001) adapts functional and structural organization to current requirements. This is known as results from studies in visual and motor systems which were reviewed, and findings were discussed.

Despite the validity of Broca's and Wernicke's observation on the motor, expressive and sensory aphasia, the whole functional lateralization is considerably more complex. At the beginning of 1950s and early 1960s the investigations above mentioned was concluded by Geshwind (1968) correctly. This study provides additional evidence for hemispheric differences in the processing of laterality and voluntary motor and mental tasks. In the view point of the asymmetry, this study also includes the first assaying of parameters such as hand preferences, short-term visual memory,

Table 10. The correlation between scores from Q1and Q2 and IQ according to the sex, age and education groups.

N	df	Q1	IQ	r	t-value	Significance*
612	610	General Population		-0.037	0.91	-
Sex						
100	98	F	F	-0.05	0.49	-
512	510	M	M	0.062	1.4	-
Age						
310	308	13 to15	13 to15	-0.023	0.4	-
284	282	16 to18	16 to18	0.061	1.02	-
18	16	18<	18<	0.315	1.32	-
Education						
366	364	CEP	CEP	-0.033	0.62	-
232	230	REP	REP	0.113	1.72	-
14	12	OOS	OOS	0.287	1.03	-
Laterality						
25	23	LH	LH	0.204	0.99	-
25	23	MH	MH	-0.239	1.18	-
562	560	RH	RH	0.049	1.16	-
Q2						
612	610	General Population		0.058	1.43	-
Sex						
100	98	F	F	-0.034	0.33	-
512	510	M	M	0.077	1.75	-
Age						
310	308	13 to15	13 to15	-0.034	0.59	-
284	282	16 to18	16 to18	0.073	1.22	-
18	16	18<	18<	0.155	0.62	-
Education						
366	364	CEP	CEP	-0.005	0.09	-
232	230	REP	REP	0.128	1.95	-
14	12	OOS	OOS	0.070	0.24	-
Laterality						
25	23	LH	LH	0.377	1.95	+
25	23	MH	MH	-0.097	0.46	-
562	560	RH	RH	0.078	1.86	-

The abbreviations are same as other tables.

education and nonverbal intelligence excepting common works on the laterality. The method of this work is most probably first investigation on this subject.

CONCLUSIONS

A few different tests have been used by different researchers for the assessment of the hand preferences (Annett 1970; Oldfield 1971; Porac and Coren 1980; Beukelaar and Kronenberg 1983; Tan 1988; Yetkin 1993, 1995, 2001). In present work, the questions composed by Edinburg handedness inventory (Oldfield, 1971) modified by Geshwind and Behan (1982) and Yetkin Handedness Inventory or Yetkin Laterality Questionnaire (YLQ) developed by Yetkin (1993) was used.

There are rather different ideas on the subject of the assessment of the hand preferences; some researchers

Table 11. The assessment according to the distributions of the laterality between age groups: Mean age, IQ and RW as related to the results of Q1 scores.

Age groups	N	Parameters		
		Mean age	Mean IQ	Mean RW
13 to15 LH	11	14.72	83.00	7.09
13 to15 MH	15	14.75	82.90	7.73
13 to15 RH	284	14.62	78.80	7.71
16 to18 LH	14	16.64	70.57	7.57
16 to18 MH	9	16.22	69.00	6.88
16 to18 RH	261	16.60	75.60	7.69

RH, right hand; LH, left hand; MH, mixed hand; NRW, number of remembered words

Table 12. The assessment according to the distributions of the laterality between age groups: Mean age, IQ and RW as related to the results of Q2 scores.

Age groups	N	Parameters		
		Mean age	Mean IQ	Mean RW
13 to15 LH	12	14.66	83.08	7.08
13 to15 MH	19	14.70	77.00	7.47
13 to15 RH	279	14.66	79.16	7.73
16 to18 LH	11	16.54	70.18	7.36
16 to18 MH	14	16.78	73.78	7.78
16 to18 RH	259	16.52	75.28	7.69

RH, right hand; LH, left hand; MH, mixed hand; RW, remembered words.

have put forward an idea that two groups of the hand preference could be presented in any population as left- and right-handed called dichotomy (Beukelaar and Kronenberg, 1983), while some others have put forward (Hardyck and Petronovich, 1977; Oldfield, 1971) that three groups of the hand preferences could be presented as left, right and mixed handed. According to the previous ideas there are two side of everything while according to second idea the side of same thing may be multiple. In a previous study, the rate of right, left and mixed handedness called thricotomy were 66.2, 3.4 and 30.4%, respectively (Yetkin, 1993). However, it was seen in study that the rate of those who prefer their right hands was 96.6% while this was only 3.4% for those who prefer their left hands in dichotomy. In the present study, dichotomy and thrichotomy were assessed separately (Tables 2 and 3). The distribution of different percentages arisen from the result of the using the laterality performed on the different population more before was explained by socio-cultural factors (Annett, 1972; Tan 1988). It is reality that the environment has a certain influence over hereditary tendencies in the developmental process of laterality (Yetkin, 1993). Education has also a great influence over right hand preference.

In the study, the left handedness was 4.08%. This ratio was reported 3.7% by Annett (1972) and 3.4% by Tan (1988). According to the education programs, there was the difference between the percentages of the laterality degrees as related to the CEP and REP (Tables 1 and 2). The graphical distribution of the hand preferences was shown into “J” shape by Annett (1985) and it was supported by the research performed more after (Tan, 1988). In this study, the result of the hand preference was exhibited “J” shape in the age groups of 13 to 15 (Figure 5) and of 16 to18 (Figure 6). The graphical representation of hand preferences was also shown in ”J” shape after the separation of male and female according to the sexual differences. In over 18 years, a result was not obtained because of the insufficient subjects (Figure 7). The interactions between hand preferences and intellectual functions were also investigated by different authors (Annett, 1972; Marzke, 1997; Tan, 1989a). There were not any differences between IQ levels of the patient with the lesions of the left hemisphere. Annett (1970) admitted that the right hemisphere involves in same ratios to the development of the intellectual functions. In this work,

there was no relationship between the Geshwind scores from Q1 and Q2 and IQ levels. The result from total sample was found to be similar to the studies performed by Annett (1972) and Tan (1988). For the verbal and nonverbal skills, Annett (1985) reported that the mails were inclined to use the right hemisphere and females were inclined to use the left hemisphere.

The neuro-cognitive systems, including learning and memory, are the special areas for the species. However, some learning methods, for example reading, exhibits cultural differences (Pinker and Bloom, 1990; Witelson, 1987), but the biological factors are widely effective to put into a form the areas of the some contents (Geary, 1995). The learning capacity is related to the complexity of the nervous system. In humans, the learning and memory capacities is related to the development of the speaking language.For this,in the process ofevolution, cultural evolutionis as important asthe previousdegree.(Richard et al, 1988). The biological principle of adaptive specialization applies to learning and memory mechanisms just as much as it applies to other biological mechanisms (Kluwe et al., 2003).

In this study there was not any relationship between age and IQ interactions and between age and NRW in the total sample. However, it was found that there was a positive linear relation between IQ levels and NRWs (Table 2)

Difference between NRWs from the REP and from the CEP was found significantly, and the difference between NRWs from the REP and from the OOS was also found important (Table 1). It was thought that this significant difference may be coming from the absent of the female students in the classesof the religion programs. It was also controlled that whether the difference between male subjects from every two educational program was significant or not, and the difference between them was found significant. This difference may be a result of the cultural practices and educational experiences in the classroom. However, the difference between mean IQ levels of every two subject groups was found insignificant.

In this work, the correlation between the Geshwind scores obtained from different results (Q1 and Q2) was investigated whether there was harmony between them or not. While Q1 questions, as it is known, was only related to the hand preference, Q2 questions was not only on the hand preferences but also about eye, foot , finger and the lateralization of the one side of the body. In general population, there was a positive correlation coefficient (r=0.795) between the laterality degrees observed by different inventories (EHI and YLQ). This correlation can accept a factor analyze for Q2. Thus, it was assessed that the scores from Q1 and Q2 were getting parallel in the ratio of 80 % (Table 2). After the separation according to the different laterality groups of the hand preferences, the harmony between the scores coming from Q1 and Q2 was studied. The correlation for *Q1* were found 95 % (r=0.859), 57 % (r=0.579) and 51 % (r=0.514) in the left-, mixed and right handed subjects, respectively. In contrast to this findings, the correlation for *Q2* were assessed as 55 % (r=0.559), 51 % (r=0.516) and 50 % (r=0.50) in left, ambidexterous and right handed subjects.

The brain functions have been subjected for numerous neuro-physiologic studies because the brain functions are the basisfor understanding, learning, motor movement and. Tan (1988) has separated (grouped) the lateralization degrees into powerful (strong), middle and weak (poor), and has researched the interactions between laterality degrees and IQ levels; Tanhas also put forward a relationship between IQ and the degree of left hand preference, and has assessed that both higher IQ levels and left hand preference with middle level have been developing together.

In the left handed subjects who use their left hands to write, both powerful and poor hand preference were found to be disadvantage for spatial reasoning: the left hand preference at middle level was found to be related to higher mental ability for spatial reasoning. In the left handed subjects who use their right hands to write, left hand preference showed lower degrees than those use left hands to write. To these results it was put forward that (Tan, 1989a) the relationship between the motor (practice) and cognitive (conceptual) skills may depend on higher motor activities such as writing.

The distribution of left- and right-hand preference in left hander and the relation between learning and IQ were investigated, and motor learning also was found better in higher IQ levels than lower IQ levels (Tan 1989b): in addition, a linear relation between motor learning and testosterone level was a direct relation between IQ levels and testosterone levels. However, according to the results from Q1between the laterality scores and IQ for right, left- and mixed hand groups was not found a positive significantly relationship ($p>0.05$). In contrast to this, to the results from Q2 a positive significant relationship was assessed between IQ levels and laterality scores for left and right handed, while a significant relation was not assessed in mixed handed. In the assessment of the NRWs, a significantly relationship was not found between NRWs and laterality scores from Q1 in left-and mixed handed. However, there was a negative significant relation between NRW and laterality scores in right hander. Contrarily, an important relation was not found between NRWs and laterality scores in right-hand, mixed-hand and left-handed subjects.

In a comparison of the results obtained from Q1 and Q2 scores, the difference between the mean IQ points in left-and right handed subjects was not found significant. In the same way, the difference between mean NRWs was found insignificant. The results show that it was found that the laterality scores from Q2 was found functional in laterality investigation as well as the scores taken from Q1, and it can be used not only lateralization related to the hand preference but also the relations between

laterality and short term visual memory or other kinds of memory. To put forward the relationship between laterality and IQ levels, it has been found that to evaluate a wider preference group (hand, eye, foot, finger or one side of the body) could have been more available.

Conflict of Interests

The authors have not declared any conflict of interests.

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