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Original Article

Asymmetry relations between laterality IQ memory and management of dominant hemispheres in twins

Ozlem Ergul Erkec* and Yalçın Yetkin

Department of Physiology, Yuzuncu Yil University, Medical Faculty, Van, Turkey

Abstract. Lateral preferences in humans may be a key to many important topics in biology and physiology. However, less information is known about genetic and environmental factors for lateral preference. Comparisons of MZ (monozygotic) and DZ (dizygotic) twins can indicate which characters are hereditary or environmental. The aim of this study is to investigate morphological, functional and cognitive lateralities in twins in terms of hereditary and environmental factors. For this aim, the handedness, body laterality (motor), IQ (mental), hemispheric dominance (cognitive) and morphological properties such as head diameter, hand and foot dimensions (anatomical) were measured to determine asymmetry traits on 100 MZ, 92 DZ twin pairs. As compared with DZ twins, the correlations among the studied traits (IQ, visual memory, anatomical features, brain lateralization and handedness) were found higher in MZ twins.

Key words: Handedness, IQ, laterality, dominant hemispheres, twins

1. Introduction

Lateral preferences of humans are very important topics in biology and physiology (1). Broca, (2) observed that body laterality is related to brain asymmetry. After his finding, handedness is recognized as a marker of brain lateralization and many studies focused on the association of handedness and specialized hemisphere (3-6). Handedness which can be observed easily is a good marker for brain lateralization.

About 90 to 95% of the human population is right-hander (5,7). Some studies (8,9) suggested that hand preference was more related to inheritance. In contrast, other studies noted the importance of environmental effects on hand preference: According to Geschwind-Behan-Galaburda (GBG) left handedness theory (10) genetics has a very small effect on left hand preference. Su et al. (11) additionally supported that environmental effects were more important to hand preference among twin members who do not share the same environment. Vuoksimaa's (12) study on coerce to behavior of the right-hand preference in elderly twins showed that only environmental effects could explain the observed alteration on hand preference at childhood or adult.

Galton (13) suggested studying on twins for determining the effects of heredity and environment on a feature. According to Galton's findings, MZ and DZ twins have been the subject of many studies on handedness and lateralization (14-16).

Less knowledge is known about genetic and environmental influences on lateral preferences (17). However there were studies about hemisphere dominance and handedness or IQ and hand preference (18), We examined lateral preferences (hand, foot, and eye preferences, management of dominant hemispheres), IQ and visual memory and anatomic traits (head diameter, height, hand and foot sizes) using a twin design study to understood the effects of heredity and environment. In our study, we also aimed to determine anatomical, cognitive and functional traits together on the scope of lateralization.

2. Materials and methods

2.1. Subjects

The present study was carried out with a subject group of healthy volunteer twins (n=384

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*Correspondence: Ozlem Ergul Erkec

Department of Physiology, Yuzuncu Yil University, Medical Faculty, Van, Turkey

Tel: 0533 743 2495

E-mail: oerkec@hotmail.com

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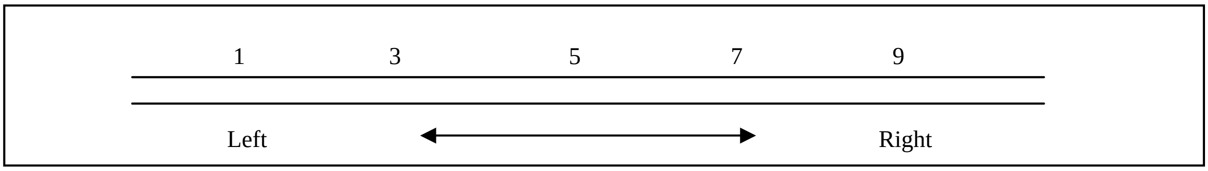

Fig 1. Management of dominant hemisphere rating scale

subjects: 100 monozygotic (MZ), 92 dizygotic (DZ) twins) from various ages, specifically primary school students.

2.2. Hand preference and body laterality degree (eyedness, footedness, handedness)

Hand preference and laterality degree was assessed by questionnaire including twenty tasks. The test consists of two parts; the first part (Q1=EHI) is Edinburgh Handedness Inventory (19) and the second part (Q2=YLQ) is Yetkin Lateralization Questionnaire, developed by Yetkin (20). The first ten tasks were consisted of (Q1) application items (such as writing hand) to determine hand preference. The second ten tasks (Q2) contain the applications to determine foot and eye preference as well as hand preference. The subjects hand preferences were observed during performing the tasks (14). The columns of the questionnaires were scored as “+10 (always right hand: AR-H)”, “+5 (usually right hand: UR-H)”, “zero point (either hand/or side: EH-S)”, “-5 (usually left hand: UL-H)”, and “-10 (always left hand: AL-H)”. The hand preference degrees are determined as "always right hand", "usually right hand", " ambidexterity", "usually left hand" and "always left hand". The laterality degrees were assessed by Geschwind scores (21).

2.3. Measuring of height, hand and foot sizes, and head diameter

In order to compare hereditary and environmental effects on anatomical features, the subjects' hand and foot size (width and length), the height and head diameter were measured. For this measurements, anthropometric devices [mechanic and sensible electronic compass (±0.01 mm) and tape measure] were used.

2.4. IQ levels

IQ levels was determined using Cattell ‘’Culture Free’’ Test (22). IQ test administered to 13 year-old and over subjects.

2.5. Brain lateralization

Alder’s (23) test consisting of 35 items was used to determine the management of dominant hemisphere. This test was conducted to 11 year-old and over subjects. The total scores were divided to the number of questions. The obtained result was assessed on 1-9 score range (Figure 1). These scores were used to evaluate lateral dominance.

2.6. Visual memory status

For measuring visual memory status, 15 words were shown for 40 seconds to the subjects. Then the subjects were asked to write the remembered words in another 40 seconds.

2.7. Statistical analysis

Descriptive statistics for studied variables (characteristics) were presented as mean, standard deviation, minimum and maximum values. Paired t test was used to compare twins for the studied variables. Interclass correlation and Pearson correlation analysis was carried out to examine linear relationships among the variables. Statistical significance levels were considered as 5%. The SPSS (ver. 13) statistical program was used for all statistical computations.

3. Results

Table 1 shows the measured anatomical features between twin members. The highest correlation was found as 98.4% in terms of length between MZ twin members while the lowest correlation was observed as 70.5% for head diameter between DZ members.

Table 2 shows the correlations between EHI and YLQ (hand preference/ hand preference, eye preference and foot preference) for MZ and DZ twin members separately. The difference between EHI average and YLQ average was statistically significant in all combinations; EHI/YLQ same MZ member ($p<0.01$), EHI/YLQ DZ member ($p<0.05$).

The correlation of MZ twins was higher than that of in DZ twins with regard to EHI and YLQ. The highest correlation was 73.1% in MZ twin members and 19.7% in DZ twin members.

Differences between twin members for cognitive functions (IQ, memory and management of dominant hemisphere), were not statistically significant for both MZ and DZ twins (Table 3). The correlations of MZ twins were higher than that of DZ twins with regard to all traits. The highest correlation was 82.1% in MZ twin members for visual memory ($p<0.01$) and 43.7% in DZ twin members for hemisphere dominance ($p<0.01$).

Correlation between MZ twin members was found as 73.1% for EHI lateralization (p<0.01, Table 4). However, correlation coefficient between lateralization (EHI) and management of dominant hemisphere was not statistically significant (Table 4).

Likewise, correlation between the lateralization (EHI) and management of dominant hemisphere was not statistically significant (Table 5).

Table 1. Descriptive statistics, comparison results and correlation coefficients for the studied variables

	N	Mean	Std. Deviation	Difference	p	Correlation
Height DZ member	85	140.94	14.520	.465	.505	.900**
Height DZ other member	85	140.47	14.098			
Height MZ member	92	136.00	18.835	.6924	.060	.984**
Height MZ other member	92	135.304	19.2832			
Lenght of right hand DZ member	85	15.2541	1.60009	-.03024	.755	.838**
Lenght of right hand DZ other member	85	15.2844	1.52470			
Lenght of right hand MZ member	92	14.737	2.0736	-.0188	.758	.960**
Lenght of right hand MZ other member	92	14.756	1.9635			
Lenght of left hand DZ member	85	15.0824	1.78607	-.06976	.425	.896**
Lenght of left hand DZ other member	85	15.1521	1.71820			
Lenght of left hand MZ member	92	14.6920	2.02884	.01446	.822	.953**
Lenght of left hand MZ other member	92	14.6775	1.95260			
Lenght of right foot DZ member	85	20.189	2.1177	-.08600	.589	.761**
Lenght of right foot DZ other member	85	20.2748	2.11169			
Lenght of right foot MZ member	91	19.643	2.8865	.12209	.215	.946**
Lenght of right foot MZ other member	91	19.5209	2.69309			
Lenght of left foot DZ member	85	20.3285	2.15500	.00929	.949	.799**
Lenght of left foot DZ other member	85	20.319	2.0679			
Lenght of left foot MZ member	92	19.589	2.6964	.05054	.573	.951**
Lenght of left foot MZ other member	92	19.5386	2.76811			
Head diameter DZ member	85	51.80	2.200	-.169	.344	.705**
Head diameter DZ other member	85	51.97	2.064			
Head diameter MZ member	92	51.74	2.292	.145	.268	.850**
Head diameter MZ other member	92	51.60	2.241			
Width of the right-hand DZ member	85	6.7579	.69580	.03600	.430	.825**
Width of the right-hand DZ other member	85	6.7219	.71509			
Width of the right-hand MZ member	92	6.5612	.97259	.01837	.686	.895**
Width of the right-hand MZ other member	92	6.5428	.86863			
Width of the left-hand DZ member	85	6.6713	.64025	-.01118	.824	.745**
Width of the left hand DZ other member	85	6.6825	.65238			
Width of the left hand MZ member	92	6.5512	.88099	.03522	.326	.923**
Width of the left hand MZ other member	92	6.5160	.85428			
Width of right foot DZ member	85	7.2471	.93717	-.10835	.128	.738**
Width of right foot DZ other member	85	7.3554	.84210			
Width of right foot MZ member	92	7.18	1.076	.0292	.477	.934**
Width of right foot MZ other member	92	7.147	1.0913			
Width of left foot DZ member	85	7.1786	.83431	-.01224	.839	.774**
Width of left foot DZ other member	85	7.1908	.81064			
Width of left foot MZ member	92	7.002	1.1130	.0716	.224	.866**
Width of left foot MZ other member	92	6.93	1.042			

*: p<0.05. **: p<0.01

Table 2. The correlation coefficients among functional properties for twins

	Mean	N	Std. Deviation	Difference	p	Correlation
Lateralization. EHI. MZ first member	81.45	100	25.988	-0.950	.617	.731**
Lateralization. EHI. MZ other member	82.40	100	25.707			
Lateralization. EHI. DZ first member	66.20	92	50.161	-6.739	.287	.131
Lateralization. EHI. DZ other member	72.93	92	40.770			
Lateralization. EHI. MZ first member	81.45	100	25.988	14.100	.000	.538**
Lateralization. YLQ. MZ same member	67.35	100	34.167			
Lateralization. EHI. DZ first member	66.20	92	50.161	5.435	.050	.851**
Lateralization. YLQ. DZ same member	60.76	92	42.941			
Lateralization. EHI. MZ second member	82.40	100	25.707	12.750	.000	.586**
Lateralization. YLQ. MZ same member	69.65	100	29.235			
Lateralization. EHI. DZ second member	72.93	92	40.770	6.902	.002	.887**
Lateralization. YLQ. DZ same member	66.03	92	43.831			
Lateralization. YLQ. MZ first member	67.35	100	34.167	-2.300	.495	0.449
Lateralization. YLQ. MZ other member	69.65	100	29.235			
Lateralization. YLQ. DZ first member	60.76	92	42.941	-5.272	.360	.197
Lateralization. YLQ. DZ other member	66.03	92	43.831			

*: p<0.05. **: p<0.01

Table 3. The correlation coefficients for cognitive and functional properties between the twin members

	N	Mean	Std. Deviation	Difference	p	Correlation
IQ. MZ member	23	75.91	16.059	-1.652	.648	.251
IQ. MZ other member	23	77.57	11.167			
IQ. DZ member	17	78.65	17.660	.588	.900	.009
IQ. DZ other member	17	78.06	7.119			
Management of dominant hemisphere. MZ member	42	4.8807	.52914	.01810	.832	.515**
Management of dominant hemisphere. MZ other member	42	4.8626	.58366			
Management of dominant hemisphere. DZ member	31	4.8352	.43092	.06065	.511	.437**
Management of dominant hemisphere. DZ other member	31	4.7745	.51553			
Visual memory. MZ member	22	3.77	1.744	-.136	.602	.821**
Visual memory. MZ other member	22	3.91	2.114			
Visual memory. DZ member	10	3.00	1.764	.60000	.382	.054
Visual memory. DZ other member	10	2.4000	1.17379			

*: p<0.05. **: p<0.01

4. Discussion

According to our results, the correlations of MZ twins were higher than that of DZ twins for IQ, visual memory, anatomical features and laterality. All correlation coefficients were statistically significant for MZ twin members except IQ and YLQ. According to Fraga et al. (24) differences between MZ twins increase with age. Strong right hand preference increases with age and left hand preference decreases with age (25) similarly our results showed that differences were lower and correlations were higher.

There were no statistically significant differences among the measurements for anatomical asymmetry among MZ twin members and also DZ twin members (Table 1). The results clarified that hereditary and environmental factors are in effective for anatomical features. Concordances between measured anatomical features were higher in MZ members than in DZ members. Therefore, hereditary effects may be stronger than environmental effects on anatomical features. Handedness discordant MZ twin were not included to this study for ensuring the identical MZ twins group. Therefore the highest concordance between MZ twin members can be explained by being identical.

Vuoksimaa et al (12) indicated that left handedness was more common in twins (8.1%) and triplets (7.1%) than singletons (5.8%).

Ambidexterity was more common in triplets (6.4%) than in twins (3.4%) and singletons (3.5%). In the present study, the incidence of left handedness was 5.9% in DZ and similar to the incidence that have seen in singletons. Therefore our results were supported by previous studies (26).

The concordance of MZ twins was higher than DZ twins with regard to handedness (EHI and also YLQ). MZ twins have identical genes and more likely to be concordant for handedness than DZ twins (27). The cause of this concordance was explained by a genetic basis of hand preference (27).

In this study there were no statistically significant differences in terms of the management of dominant brain hemispheres between MZ members and also DZ members. The correlation was higher between MZ twins than between DZ twin members. The results indicated that genetics was more effective than environmental factors on hemisphere lateralization. The results were consistent with the findings of Kıylık (28).

Broca (2) suggested that a person's handedness was opposite to the dominant hemisphere. Geschwind et al (10) further pointed out that cerebral dominancy was strongly correlated with handedness. In the present study, there was no statistically significant correlation among lateralization (EHI) and management of dominant hemisphere in MZ members and also in DZ twin members (Table 4 and 5).

Ronalds's (29) study showed that twins have generally lower IQ levels than their non twin siblings. Similarly in this study, IQ average is 77.42 (76.73 in MZ twins and 78.35 in DZ twins). In contrast, Posthuma et al (30) suggested that there was no significant difference between twins and singletons in terms of intellectual ability. Reason behind this dissimilarity between Posthuma et al (30) and ours may because of our insufficient subject number.

There was no statistically significant difference with regard to the degree of visual memory between twin members. DZ twin pair showed extreme value. MZ twin pairs, except for one MZ twin pair, are almost concordant for visual memory. Our results also suggests that genetics was effective on visual memory.

In conclusion, there was no statistically significant difference except EHI and YLQ. The results demonstrated a higher correlation in MZ twin members as compared with DZ twins for all measured traits.

Table 4. The correlation coefficients among lateralization and management of dominant hemisphere in MZ twins

	Lateralization. EHI. MZ Member	Lateralization. EHI. MZ Other Member	Management of dominant hemisphere. MZ (other member)	Management of dominant hemisphere. MZ (other member)
Lateralization. EHI. MZ Member	1			
Lateralization. EHI. MZ Other Member	.731**	1		
Management of dominant hemisphere. MZ (member)	.022	.093	1	
Management of dominant hemisphere. MZ (other member)	.117	.026	.515**	1

Correlation is significant at the 0.01 level (2-tailed). **: p<0.01

Table 5. The correlation coefficient for lateralization and management of dominant hemisphere in DZ twins

	Lateralization. EHI. DZ (member)	Lateralization. EHI. DZ (other member)	Management of dominant hemisphere. DZ (member)	Management of dominant hemisphere. DZ (other member)
Lateralization. EHI. DZ (member)	1			
Lateralization. EHI. DZ (other member)	.131	1		
Management of dominant hemisphere. DZ (member)	-.164	.005	1	
Management of dominant hemisphere. DZ (other member)	.058	.013	.437*	1

Correlation is significant at the 0.05 level (2-tailed). **: p<0.05

Management of dominant brain hemisphere average was detected as 4.87 in MZ twins and 4.80 in DZ twins. The results revealed that Turkish society mentality gradually approaching to left hemisphere dominance.

There was statistically significant difference between EHI and YLQ in MZ twins and DZ twins. The cause of this difference was as a result of that EHI was determined hand preference degree and YLQ was determined body laterality degree.

According to our results it can be suggested that YLQ is useful to determine body lateralization (hand preference, eye preference, foot preference).

According to our results on IQ degree, to accomplish this goal, a larger number of subjects are needed. It is suggestible to use wider subject groups in future studies.

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