

HANDEDNESS AND PHENOTYPIC CHARACTERISTICS OF THE HEAD AND FACE

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Cvetković M., and P. Vasiljević (2015): *Handedness and phenotypic characteristics of the head and face*- Genetika, Vol 47, No. 2, 723-731.

Craniofacial characteristics are used to identify similarities and differences between human populations or within a single population. The aim of this study is to provide data on the differences/similarities between two groups of subjects, left-handed and right-handed children, based on the parameters that determine the phenotypic characteristics of the head and face: head dimensions, face dimensions, hair color, eye color and earlobe shape. The study participants included 1354 students aged 7 to 15 years from regular schools of southeastern Serbia. The instruments used include: the Edinburgh Handedness Questionnaire for handedness determination, the cephalometer, and the questionnaire. 135 students (9.97%) were identified as left-handed, and the differences in the observed parameters were recorded between left-handed and right-handed girls in relation to the cephalic index, nasal index, head breadth, face breadth, and eye color.

Key words: characteristics of the head, facial characteristics, handedness

INTRODUCTION

Anisometric growth is a characteristic of postnatal human development. The craniofacial region is subject to uneven changes that occur during periods of growth and development, and the extremities grow faster when compared to the head growth (DJURAŠKOVIĆ, 2009). Characteristics of the head are partly determined by genetic factors (MCKEEVER, 2000), but they can also be affected by gender, nutrition, climatic, geographic and socioeconomic factors, and health care; so they occur as a result of interaction of genetic and environmental factors (SWAMY *et al.*, 2013).

The data obtained by studying craniofacial characteristics and other phenotypic traits (hair color, eye color) can play an important role in medicine or anthropology, pointing out the differences that occur over time (RADOVIĆ *et al.*, 2000; LITTLE *et al.*, 2006; NAJMAN *et al.*, 2011), or the differences between healthy subjects and patients (ASHA *et al.*, 2011). Some studies on the difference between left-handed and right-handed people are contradictory, especially when it

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comes to the production of melanin, the pigment that affects the hair color and eye color (Geschwind *et al.*, 1987, as cited in BRYDEN *et al.*, 1992; SCHACTER *et al.*, 1987; BRAYDEN *et al.*, 1992). DAYI *et al.* (2002) were concerned with establishing a connection between the functional characteristics of the brain (handedness) and structural characteristics of the head. OZENER *et al.* (2012) studied the relationship between extreme handedness and facial asymmetry. DANE *et al.* (2004) sought a connection between the craniofacial region and handedness by using computerized tomography.

The aim of this study is to determine a possible link between handedness and phenotypic characteristics of the head region, such as face height and breadth, head length and breadth, lower jaw breadth, nose breadth and height, hair color, eye color and shape of the earlobe.

MATERIALS AND METHODS

Sample: Respondents were regular elementary school children aged 7-15 years from Niš and Bela Palanka (southeastern Serbia). The total number of analyzed students was 1354 (705 boys and 649 girls).

Methods: Following the method of MARTIN & SALLER (1957), the head dimensions (face breadth and height, head breadth and length, lower jaw breadth, nose breadth and height) were measured by the cephalometer according to the standards set by the International Biological Programme (WEINER & LOURIE, 1969). Based on these parameters the cephalic index, nasal index and facial index were determined. For each respondent the anthropological questionnaire was filled in and it included the data on: hair color, eye color, shape of the earlobe, and date of birth. Handedness was determined by the Edinburgh Handedness Questionnaire (OLDFIELD, 1971).

Statistical analysis: The obtained data were statistically analyzed in MS Excel 2010. The mean value (X) and standard deviation (SD) for head and face measurements were determined. Based on these parameters the facial, cephalic and nasal index were determined. The statistical significance of difference between the parameters was examined by using Student's t-test ($p < 0.05$). The data on belonging to a particular type of head, face and nose were analyzed separately for male and female subjects. The chi-square test ($p < 0.05$) was used to determine the statistical significance between left-handed and right-handed subjects with regard to hair color, eye color and shape of the earlobe.

RESULTS

The results are presented in Tables 1-5.

Table 1. Percentage of the left-handed and right-handed subjects in the sample

	Boys		Girls		Total	
Left handed	71	(10.07%)	64	(9.86%)	135	(9.97%)
Right handed	634	(89.93%)	585	(90.14%)	1219	(90.03%)
Total	705	(100%)	649	(100%)	1354	(100%)

The percentage of left-handed boys in the sample of 705 boys was 10.07%, while the percentage of left-handed girls in the sample of 649 girls was 9.86%. The total incidence of left-handed subjects in the total sample of 1354 students was 135, or 9.97%. Although the incidence of

left-handedness was higher in males than in females, there was no statistically significant difference between the sexes regarding this characteristic ($df = 1$, $c = 3.84$, $\chi^2 = 0.02$).

Table 2. Mean values of the measurements of head, face and nose with indices (girls and boys)

Parameters	GIRLS			BOYS		
	Right-handed girls N=585	Left-handed girls N=64	t p<0.05	Right-handed boys N=634	Left-handed boys N=71	t p<0.05
	X (cm) \pm SD	X (cm) \pm SD		X (cm) \pm SD	X (cm) \pm SD	
Head breadth	15.05 \pm 0.91	14.75 \pm 0.63	0.0009	15.35 \pm 0.74	15.33 \pm 0.67	0.82
Head length	18.46 \pm 0.82	18.45 \pm 0.75	0.96	19.02 \pm 0.80	18.91 \pm 0.79	0.28
Face height	10.45 \pm 0.67	10.33 \pm 0.76	0.25	10.76 \pm 0.82	10.70 \pm 0.85	0.63
Face breadth	13.18 \pm 0.82	12.91 \pm 0.69	0.004	13.49 \pm 0.72	13.52 \pm 0.66	0.71
Nose height	4.48 \pm 0.43	4.39 \pm 0.49	0.18	4.55 \pm 0.53	4.60 \pm 0.58	0.51
Nose breadth	2.97 \pm 0.26	3.05 \pm 0.38	0.09	3.08 \pm 0.34	3.08 \pm 0.42	0.91
Lower jaw breadth	10.08 \pm 0.67	9.90 \pm 0.79	0.07	10.44 \pm 0.83	10.37 \pm 0.90	0.56
			INDICES			
Facial index	79.44	80.07	0.33	79.76	79.16	0.38
Cephalic index	81.67	80.12	0.0008	80.82	81.20	0.50
Nasal index	66.69	70.28	0.03	68.17	67.66	0.71

The mean values of the measured parameters indicate that only the nose breadth values were higher in left-handed girls, while the values of face breadth and nose height were higher in left-handed boys. The other values were higher in right-handed boys and girls, but significant differences were recorded in head breadth and face breadth in girls in favor of the right-handed group. The mean values affected the indices, and a significant difference ($p < 0.05$) was found in the cephalic index and nasal index of girls. Left-handed and right-handed girls were on average mesocephalic (medium-headed) according to the cephalic index, and euryprosopic (wide-faced) according to the facial index; but based on the nasal index the left-handed girls were leptorhine (narrow-nosed), while the right-handed girls were mesorhine (medium-nosed). The boys of both groups were euryprosopic according to the facial index, and leptorhine according to the nasal index; but the left-handed boys were brachycephalic (round-headed), while the right-handed boys were mesocephalic according to the cephalic index.

The hair color, eye color and earlobe values are shown in Tables 3 and 4 by χ^2 test.

The bright eye color (green and blue eyes) was more common in left-handed girls with 37.50% compared to the right-handed where the percentage was 28.72%, with a statistically significant difference. However, this information was not recorded in boys, where the percentage ratio of the left-handed and right-handed for light eye color was 23.95%: 29.02%. For other parameters (hair

color, the shape of the earlobe) there were no significant differences between left-handed and right-handed subjects.

Table 3. Percentage of hair color, eye color and shape of the earlobe and χ^2 values (girls)

	Right handed girls		Left handed girls		χ^2 (p<0.05)
Eye color	Green	11.45%	Green	20.31%	12.71 (df=2, c=5.99)
	Blue	17.27%	Blue	17.19%	
	Brown	71.28%	Brown	62.50%	
Hair color	Light	15.2%	Light	12.50%	2.04 (df=2, c=5.99)
	Brown	75.55%	Brown	82.81%	
	Black	9.23%	Black	4.69%	
Earlobe	Free	74.87%	Free	78.13%	0.33 (df=1, c=3.84)
	Attached	25.13%	Attached	21.87%	

Table 4. Percentage of hair color, eye color and shape of the earlobe and χ^2 values (boys)

	Right handed boys		Left handed boys		χ^2 (p<0.05)
Eye color	Green	12.62%	Green	11.27%	0.88 (df=2, c=5.99)
	Blue	16.40%	Blue	12.68%	
	Brown	70.98%	Brown	76.05%	
Hair color	Light	12.31%	Light	18.31%	2.73 (df=2, c=5.99)
	Brown	73.34%	Brown	71.83%	
	Black	14.35%	Black	9.86%	
Earlobe	Free	77.92%	Free	77.46%	0.008 (df=1, c=3.84)
	Attached	22.08%	Attached	22.54%	

Table 5. Percentage of hair color, eye color and shape of the earlobe and χ^2 values (the total sample)

	Left handed (total)		Right handed (total)		χ^2 (p<0.05)
Eye color	Green	15.55%	Green	12.06%	1.53 (df=2 c=5.99)
	Blue	14.82%	Blue	16.82%	
	Brown	69.63%	Brown	71.12%	
Hair color	Light	15.55%	Light	13.70%	2.55 (df=2, c=5.99)
	Brown	77.04%	Brown	74.41%	
	Black	7.41%	Black	11.89%	
Earlobe	Free	77.77%	Free	76.46%	0.12 (df=1, c=3.84)
	Attached	22.23%	Attached	23.54%	

The comparison of the total number of left-handers with the total number of right-handers with regard to hair color, eye color and shape of the earlobe did not record a significant difference.

DISCUSSION

Broca's discovery in the 19th century that the brain is lateralized in relation to the center of speech has initiated other research on the subject. Nowadays it is known that functional lateralization of the brain also relates to motor skills, such as handedness. The dominance of one of the cerebral hemispheres leads to the occurrence of right-handedness or left-handedness, so it also seems to be a result of natural variation. From an evolutionary perspective, if neither of the two variants conferred any greater advantage than the other, a 50:50 distribution in the population would be expected. However, if either of them were more advantageous than the other, then the less advantageous one would be expected to decline in prevalence and then eventually die out (RAYMOND *et al.*, 2004). About 8% to 10% of the population has been left-handed for at least the last 200000 years or so, but detailed data only began to become available for those born in the nineteenth century. People, regardless of geographical differences, are mostly right-handed, as was recognized as long ago as 1837 by Sir Thomas Watson (MCMANUS, 2009). Today, the percentage of left-handers is 5% -25.9% depending on the geographical area, and the data also show that left-handedness is more common in males than females (MCMANUS, 1991; RAYMOND *et al.*, 1996; MCKEEVER, 2000). The percentage of left-handed people in Serbia is 5-10%, and the percentage also varies by region (MILENKOVIĆ *et al.*, 2010). In the present study, similar data were obtained – the percentage of left-handers in the total sample did not exceed 10%, and the phenomenon was more common in males but with no statistically significant difference.

Various studies have aimed to determine the possible relationships between handedness and other phenotypic characteristics. The emphasis has been mainly placed on the relationship between handedness and speech ever since Broca discovered that the speech center was located mainly in the left hemisphere (PHAN *et al.*, 2010; TZOURIO-MAZOYER *et al.*, 2010; VAN ETTINGER-VEENSTRA *et al.*, 2010; SZAFIARSKI *et al.*, 2012), then on the relationship between handedness and various cognitive disorders (COREN *et al.*, 1980; COREN *et al.*, 1986; COREN, 1989; GESCHWIND *et al.*, 1987, as cited in BRYDEN *et al.*, 1992), on handedness and dyslexia (SCERRI *et al.*, 2011), as well as on a possible connection between left-handedness and certain diseases, such as epilepsy, schizophrenia, autism (KIM *et al.*, 2001; DRAGOVIĆ, 2001; DRAGOVIĆ *et al.*, 2005; FRANCK *et al.*, 2007; DANE *et al.*, 2007) and developmental characteristics (CVETKOVIĆ *et al.*, 2014). Other phenotypic characteristics, such as body size, some body parts, hair color, eye color, are generally observed at the level of the whole sample, primarily taking into account the gender of the respondents. GESCHWIND and GALABURDA 1987 (as cited in BRAYDEN *et al.*, 1992) hypothesized that lower production of melanin was more common in left-handers, so a higher incidence of light colored hair and light colored eyes was recorded in left-handers. Our study indicated that the light eye color (blue and green) was found more frequently in left-handed girls but not in boys and this result does not go in favor of the assumption that left-handedness and reduced production of melanin are in an unambiguous relationship. Then, the level of melanin affects hair color, but our study did not indicate a possible link between these two phenomena. The prevalent hair and eye color in this part of Europe is brown, as it was also noted in this study.

The earlobe, as another of the observed characteristics, is an inherited trait. It may occur as attached or free earlobe and the ratio of 3: 1 is in favor of the free earlobe. Free earlobes were also more common in the observed sample in the ratio of approximately 3: 1 in both sexes and in both types of handedness, indicating the lack of a link between these two phenomena.

The dimensions of the head, face and nose are mainly observed in the overall population and in relation to the secular trend and gender of the respondents (RAĐOVIĆ *et al.*, 2000; BURETIĆ

et al., 2004; GRBEŠA *et al.*, 2007; GODINA, 2011; SWAMY *et al.*, 2013; CVETKOVIĆ *et al.*, 2014). A small number of studies have examined the relationship between handedness and shape of the head. DAYI *et al.*, (2002), by examining the relationship between the functional characteristics of the brain and skull structure, came to the conclusion that these two characteristics may have origins in the parallel development of the craniofacial skeleton and the brain under the influence of homeobox genes. OZENER *et al.* (2011) noted that the extreme handedness may affect the level of facial asymmetry, while DANE *et al.* (2004), by using computerized tomography, indicated that handedness was in association with the width of the left side of the face only in women. The data obtained by measuring the population of students (regardless of handedness) in southeastern Serbia (CVETKOVIC *et al.*, 2014) showed that both boys and girls were mainly mesocephalic according to the cephalic index. The present study also revealed that both left-handed and right-handed subjects were mainly mesocephalic, except for the left-handed boys who had slightly higher cephalic index that classified them into to the brachycephalic category. Although there was a significant difference between the left-handed and right-handed in the cephalic index, both groups were mesocephalic, that is they had a medium round face. In addition, the left-handed boys were brachycephalic, so this index cannot be taken as a predictor of handedness. In both sexes and in both types of handedness broad face usually occurred (euryprosope), while the incidence of leptorhine and mesorhine was recorded according to the nasal index. The nasal index was also one of the most significant differences being recorded among girls, since only the right-handed girls had a medium broad nose, while other respondents, on average, had a narrow nose.

It can be concluded that handedness cannot be fully linked to the observed phenotypic characteristics, except perhaps when it comes to females, where some important differences (the nasal index, cephalic index, eye color) can serve as a benchmark for future studies that include a significantly larger sample of girls. Since a certain percentage of students were converted from being left-handed to being right-handed in early childhood (these students were not part of the sample), education systems should provide special training in order to explain to parents and teachers that left-handers are *not different*.

ACKNOWLEDGMENT

The authors would like to thank the students of elementary schools who participated in this study, as well as principals and teachers of these schools in Niš and Bela Palanka (southeastern Serbia).

Received March 13th, 2015

Accepted June 29th, 2015

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Izvod

Kraniofacijalne karakteristike se koriste da bi se utvrdile sličnosti i razlike između humanih populacija ili unutar jedne populacije ljudi. Cilj ovog rada je dobijanje podataka o razlikama/sličnostima između dve grupe dece, levorukih i desnorukih dečaka i devojčica, na osnovu parametara koji određuju fenotipske karakteristike glave i lica: dimenzije glave, dimenzije lica, boje kose, boje očiju i oblika ušnog reznja. 1354 učenika regularnih škola jugoistočne Srbije uzrasta 7-15 godina je učestvovalo u ovom istraživanju. Kao instrumenti upotrebljeni su Edinburg upitnik za određivanje rukosti, kefalometar i anketni list. Levorukost se javlja kod 135 učenika (9,97%), a razlike u posmatranim parametrima su zabeležene između levorukih i desnorukih devojčica u odnosu na cefalični indeks, nazalni indeks, širinu glave, širinu lica i boju očiju.

Primljeno 18. III. 2015.

Odobreno 29.VI. 2015.