

Association between the Brain Laterality, Gender and Birth Season

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Objective: in recent years different hypotheses with respect to the formation of cerebral laterality were proposed. Some of the researchers claim that cerebral dominance and laterality are determined by genetic factors, just as the case with eye color and blood type. However, another group states that in addition to genetic factors, environmental factors, too, have a remarkable role in hemispheric dominance and lateral dominance. Hence, the present research was designed to study the relationship between 1- lateral dominance and birth season 2- lateral dominance and gender.

Method: 1355(girls and boys) fifth graders from the 19 educational regions of Tehran were selected using multi stage cluster sampling in the 2003-2004 school year. Coren lateral preference and personal information questionnaire were applied.

Results: The following results were obtained at the level of $\alpha=0.05$ and probability of 95%. There were significant association between lateral dominance and birth season, between lateral dominance and gender, between ambidexterity and birth season, between non-genetic sinistrality and birth season, between dexterity and gender, between ambidexterity and gender, between genetic sinistrality and gender.

There were no significant associations between dexterity and birth season, genetic sinistrality and birth season, between non-genetic sinistrality and gender.

Conclusion: The gestational environmental factors can have significant effect on the formation of lateral dominance and cerebral laterality.

Key words: *Cerebral dominance, Functional laterality, Gender, Season of Birth*

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Although the two cerebral hemispheres are anatomically very similar, each of them is specialized for specific functions. Therefore, the mode of lateralization of human cerebral hemispheres has raised the attention of researchers in the neuropsychological field (1).

Twenty years ago, Geschwind and Galaburda developed interest in the probable effects of the gestational environmental factors on cerebral hemispherical dominance and functional asymmetry of the paired body organs and limbs. They suggested that the activity of pineal gland decreases in the winter, and leads to decreased activity of the ovaries and subsequent decreased testosterone release. Meanwhile, with the decreased activity of pineal gland in the summer, the level of testosterone elevates (2).

Eight years ago, Wisniewski and Nelson in their study of testosterone concentrations in men and women with regards to seasonal changes, concluded that testosterone concentration in women is lower in the spring and higher in the autumn (3). Based on these findings, Geschwind and some other researchers proposed a hypothesis about the association between intrauterine testosterone level and functional

asymmetries in foetus brain (4). They believed that testosterone is a primary factor that changes the brain lateralization.

At the beginning, the left hemisphere is lateralized for the hand and language dominance, but excessive exposure to intrauterine testosterone in gestational period leads to right hemisphere dominance (5).

In addition, based on this hypothesis, since the male foetus is more exposed to testosterone and there is more disorderliness of androgen receptors on the surface of cerebral cortex of men than women, more changes in right hemisphere of men develops and this mechanism increases the sinistrality among men (6).

According to Geschwind and his colleagues, impairment in left hemisphere function leads to language and reading disorders, and an increase in right hemisphere abilities that causes artistic abilities and mathematical genius. The prevalence of sinistrality among the artists is determined between 20 to 27 percent; and it may be interesting to note that some famous men including Leonardo Davinci, Michel Angelo, and Charles Chaplin were left-handed. On the other hand, the excessive intrauterine testosterone has a negative effect on the thymus gland development, and increases the probability of autoimmune diseases in

these people (7). Based on the above mentioned hypotheses, Rogerson studied the association between the handedness and birth season in 8929 male baseball players and 2234 clients of the National Health Center of the USA. The results of his study showed that the rate of sinistrality in those born in the spring and summer is more than those born in the autumn and winter(8).

Based on the above mentioned findings the present study was performed with the following general objectives:

- 1) Studying the association between cerebral laterality and birth season.
- 2) Studying the association between cerebral laterality and gender.

Materials and Method

The present study was performed on the 5th graders in all the 19 educational regions in Tehran in the 2003-2004 school year using survey method. Nearly 21000 students (N= 210717) were included in the statistical community of this study. A sample consisting of 1500 students was selected using the multi stage cluster sampling method. The samples were studied by Lateral Preference Inventory (LPI) and personal information. LPI questionnaire is a self-rating questionnaire designed by Stanley Coren. Subtests of this instrument are in the realms of hand, Foot, eye, and ear dominance. One year after its implementation, the reliability of this instrument was reported to be 98% (9). Personal information questionnaire was designed to gather data on gender, age, history of sinistrality in the family, genealogical kinship of the parents, history of illness in the mother during the child bearing period, history of substance or alcohol abuse or addiction in the mother, regularity or irregularity of the mother's menstruation before conception, history of ovarian cyst, and hirsutism in the mother. One hundred fifty five cases were excluded due to incomplete data; therefore, the final sample was decreased to 1355 students. The ethical issues were considered according

to Helsinki Convention and local legal regulations in Iran.

For data analysis, descriptive statistical methods, Chi square test and Cramer ϕ index were used.

Results

The observed and expected distribution of frequency in students according to lateral dominance for every birth season is shown in Table 1. With regards to the results of the data analysis, there was a significant association (with 95% probability) between the lateral dominance and birth season.

In order to determine the rate and degree of association between the various variables of the study, ϕ index was calculated (it was 0.91). Moreover, the association between the types of lateral dominance and birth season was studied separately , and the results are as follows :

There was no signification association between dexterity and birth season. There was a significant association between ambidexterity and birth season.

There was no significant association between genetic sinistrality and birth season. There was a significant association between non-genetic sinistrality and birth season With regards to the results of the above table, there is a significant association between the lateral dominance and gender with 95% probability. Associations between the various kinds of lateral dominance and gender were studied and the following results at $\alpha = 0.05$ levels and 95% probability were observed:

There was a significant association between dexterity and gender. There was a significant association between ambidexterity and gender. There was a significant association between genetic sinistrality and gender.

There was no significant association between non-genetic sinistrality and gender.

Table 1. Distribution of Frequency In Students According To Lateral Dominance For Every Birth Season.

Aral Dominance Birth Season	Dexteral		Ambidexter		Sinistral				Sum
	Observed	Expected	Observed	Expected	Genetic		Non-genetic		
					Observed	Expected	Observed	Expected	
Spring	252	267.51	5	4.59	20	24.48	58	38.32	335
Summer	279	269.90	11	4.74	17	24.70	31	38.66	338
Automn	326	317.01	1	5.57	38	29.01	32	45.41	379
Winter	225	227.58	2	3.99	24	20.82	34	32.60	258
Total	1082		19		99		155		1355

$\chi^2 = 33.70$; $df = 9$; $\alpha = 0.05$

Table 2. Distribution of Observed and Expected Frequency Of Lateral Dominance According To Gender

Lateral Dominance Gender	Dexteral		Ambidexter		Sinistral				Sum
	Observed	Expected	Observed	Expected	Genetic		Non-genetic		
					Observed	Expected	Observed	Expected	
Girls	570	545.39	5	9.58	39	49.90	69	78.13	683
Boys	512	536.61	14	9.42	60	49.10	86	76.87	672
Total	1082		19		99		155		1355

$\chi^2 = 14.56$; $df = 3$; $\alpha = 0.05$

Discussion

The results of the present study suggest that there is no significant association between dexterity and students' birth season. The results of the study on the association between ambidexterity and birth season showed that the rate of the ambidexter students born in the summer is greater than those born in other seasons. In addition, there is no significant association between genetic sinistrality and students' birth season. This finding supports the hypotheses of the researchers who believed in genetical theories of lateral dominance. For example, Annett, states that lateralization is due to the effect of a dextrality transmitting gene, and also believes in the environmental factors that can influence this gene and produce interpersonal changes (10).

More to the point, this study suggested that there is a significant association between non-genetic sinistrality and birth season. This finding supports the Geschwind and Galaburda hypothesis (2) and also is in favor of the results found by Wisniewski and Wilson studies as the majority of non-genetic sinistral students were born in the spring and their first gestational trimesters were in the autumn or summer. Therefore, it can be concluded that seasonal differences, and consequently, the changes in the rate of testosterone release are among the most important gestational environmental factors in determining the lateral dominance. This part of our results is in accordance with the study of Martin and Gregory. They stated that the rate of sinistral students born in the spring and summer is greater than dextral students born in these seasons. It should be noted, however, that there are methodological differences between the present study and Martin & Gregory's study. These researchers did not discriminate genetic and non-genetic sinistrals, and used the hand preferred for writing as the indicator of cerebral dominance (11). Another important finding of this research is the relationship between lateral dominance and gender, that is, the rate of dextrality is greater in girls than in boys. However, ambidexterity and genetic sinistrality are more common in boys than in girls.

Polmikos and Papaeliou studied the lateral dominance in the students of public schools in Greece, and found that dextrality is more common in girls and ambidexterity is more common in boys (12). Annett gathered data on the handedness of 7476 British students and their family members, and after data analysis stated that, with high probability, the lateralizing factor (right shift gene = rs) in women is more frequent than in men because the prevalence of sinistrality in women is lower than in men (13). Moreover, data analysis suggests that there is no significant association between non-genetical sinistrality and gender.

As one of the limitations of this study, the current investigation has been focused on the fifth grade students in Tehran. Studying students at different age groups from different parts of Iran, and also from Talented and Exceptional Schools and from general population can lead to new conclusions. We hope that

by using structural and functional methods of brain imaging in the future we could explore more precise associations between brain laterality, gender, and birth season. However, we wish that the results of this research produce a background for studying the fundamental causes of lateral dominance.

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