A Study on Functional Cerebral Lateralization and the Distribution of Hand Preference among Gazi University Students

Fonksiyonel Serebral Lateralizasyon ve Gazi Üniversitesi Öğrencilerinde El Tercihi Dağılımı Çalışması

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ABSTRACT

Objective: It was planned to determine the hand preference, the distribution of hand preference by sex, and the dominant cerebral hemisphere regarding hand preference among the students receiving education in the field of health in the faculties of Gazi University (Faculties of Medicine, Dentistry, Pharmacy, and Health Sciences).
Methods: A total of 765 volunteer university students, consisting of 419 female (54.77%) and 346 male (45.23%) students aged between 16-25 years, participated in the study. The study was conducted according to the Coren Stanley questionnaire and score. Statistical analysis was performed by applying the Chi-square test in SPSS 15 statistical program.
Results: The distribution of hand preference was evaluated in seven groups for each hand: strong, moderate, weak, and ambidextrous. The comparison between the sexes in terms of right- and left-hand use preference determined no statistically significant difference ($p>0.05$). However, it was revealed that the right hand was strongly preferred by a higher number of students of both sexes.
Conclusion: It was concluded that the left cerebral hemisphere could be generally preference is undoubtedly very important to express an opinion about the dominant hemisphere. However, we believe it is necessary to conduct new studies to evaluate the cerebral hemispheres according to their functions.

Keywords: Laterality, Hand preference, Functional cerebral lateralization, Right or left-hand preference

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ÖZET

Amaç: Gazi Üniversitesi'ne bağlı fakültelerde sağlık alanında eğitim gören öğrencilerde (Tıp, Diş Hekimliği, Eczacılık, Sağlık Bilimleri Fakültesi) el tercihi, el tercihinin cinsiyetlere göre dağılımı ve el tercihi ile bağlantılı olarak baskın olan beyin hemisferinin saptanması planlandı.
Yöntem: Çalışmaya; 16-25 yaşları arasında 419 kız (% 54.77) , 346 erkek (% 45.23) olmak üzere toplam 765 gönüllü üniversite öğrencisi katıldı. Çalışma, Coren Stanley anketi ve skoruna göre gerçekleştirildi. İstatistiksel analizi, SPSS 15 istatistik programında Ki kare testi uygulanarak yapıldı.
Bulgular: El tercihi dağılımı her bir el için; kuvvetli, orta, zayıf ve sağ - sol el fark etmez olmak üzere yedi grupta değerlendirildi. Cinsiyetler arasında sağ ve sol el kullanım tercihi açısından yapılan karşılaştırmada istatistiksel olarak anlamlı bir farklılığın olmadığı saptandı ($p>0.05$). Ancak her iki cinsiyette de daha fazla sayıda kuvvetli olarak sağ elin tercih edildiği anlaşıldı.
Sonuç: Fonksiyonel serebral lateraliteye göre genelde sol beyin hemisferinin baskın (uzman) olabileceği kanısına varıldı. Baskın hemisfer hakkında görüş bildirebilmek için el tercihinin saptanması şüphesiz çok önemlidir. Ancak bunun yanısıra beyin hemisferlerini fonksiyonlarına göre değerlendiren yeni çalışmaların yapılması gerektiği kanısındayız.

Anahtar sözcükler: Lateralite, El tercihi , İşlevsel serebral lateralizasyon, Sağ ve sol el tercihi

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INTRODUCTION

The human brain is the most complex structure in the universe. This structure is located in the cranial cavity. Anatomically, it consists of two hemispheres, right and left. Although these two hemispheres appear to be roughly symmetrical, it is known that the hemispheres are not completely symmetrical anatomically and functionally (1, 2).

Lateralization refers to the fact that any anatomical structure or functional condition in the human body is more in the right or left half of the body (3). The location of the heart on the left side and the location of the liver on the right side are examples of anatomical lateralization. Anatomical or functional differences between the two hemispheres of the brain are called cerebral lateralization (4). Although the fact that one of the hemispheres is heavier than the other is anatomical cerebral lateralization, hand preference is considered functional cerebral lateralization.

Anatomical differences between the right and left hemispheres of the brain (especially in volume or size of a particular area), in other words, structural hemispheric asymmetries can be found in a wide range of brain regions. For example, the left hemisphere has more gray matter (substantia grisea) than the right hemisphere, the lateral fissura (sulcus) is longer, the left occipital lobe and the left temporal plane are three times larger than the right. On the contrary, the right hemisphere is heavier, and the right frontal lobe is wider (1,2). In a sense, these structural asymmetries contribute to the functional differentiation of the hemispheres (5). In humans, the left hemisphere is dominant for verbal functions, while the right hemisphere is dominant for non-verbal and spatial functions. The left hemisphere is specialized for abilities such as speech, literature, and oratory, whereas the right hemisphere is specialized for visual abilities such as painting and geometry (Table 1).

Table1: Right-left hemisphere functions

HEMISPHERES	
RIGHT HEMISPHERE	**LEFT HEMISPHERE**
-Control of the left side of the body	-Control of the right side of the body
-Use of the left hand	-Use of the right hand
-Awareness of the situation	-Conscious use of language
-Tactile sensation	-Speaking, spelling, reading, writing
-Interpretation of facial expressions	-Creating the content of the speech
-Emotional and melodic speech	-Verbal thinking
-Singing, poetry reading	-Verbal intelligence
-Music content, emotion, body language, and perception of environmental sounds	-Verbal memory -Rhythm, sequential knowledge processes
-Visual, emotional, creative and mystical thoughts	*Scoring in football *Walking (like a military march)
-Comprehension ability, distance vision, seeing details in pictures	*Mathematics *Typewriting
-Visual-spatial process; dancing, throwing or holding the ball, three-dimensional thinking ability.	*Learning and using grammar rules
-Imagination of visual symbols	
-Manipulation ability	
-Management of sexuality	

It has been found that the motor control areas, sensory speech center (Wernicke area) and motor speech center (Broca's area) are generally better developed in one cerebral hemisphere than the other in the vast majority of people. This better developed hemisphere is called the dominant hemisphere. The left hemisphere is more dominant than the right hemisphere in approximately 95% of people (6). In the studies, the strongest functional hemispheric asymmetry in the human brain was the left hemisphere dominance for language, which was detected in 95% of right-handed people and 75% of left-handed people (7,8,9,10).

As demonstrated in many functional neuroimaging, electrical stimulation, and lesion studies, the left hemisphere is specialized for language function and is of critical importance, especially for speech production (11,12,13,14). For example, it has been reported that left hemisphere damage in congenitally deaf and sign language speakers makes it difficult to understand and use sign language (15).

It has been argued that the right hemisphere, which was originally called the silent hemisphere due to the dominance of the left hemisphere for language functions, has numerous behavioral specializations, owing to a large number of pieces of clinical and experimental evidence, and that these specializations can be divided into various functional areas such as complex non-linguistic perceptual functions (visual-spatial skills), distribution of attention to space, paralinguistic features of communication, facial recognition and processing of emotions (16).

In fact, the essence of the concept of cerebral dominance is the fact that two brain hemispheres with similar structures can display very different functions from each other. The concept first emerged with the statements of Dax, "Disease of the left side of the brain tends to cause speech loss," based on his observations of patients with right-sided paralysis in the 1830s, and it was supported by Broca's presentation of lesions causing speech loss in the left hemisphere in the 1860s. When Wernicke and Dejerine found the causes of comprehension, reading, and writing disorders in the same brain half, this idea was confirmed, and the first basic practical view of the concept of cerebral dominance emerged. For many years, this concept was intended only to mean that one hemisphere is more dominant than the other hemisphere in language functions of the brain. As a consequence of this understanding, the cerebral hemispheres started to be divided into two as dominant and nondominant. Nowadays, it is considered that some of the higher cerebral functions are primarily related to the left cerebral hemisphere, while another part is primarily related to the right cerebral hemisphere (17,18, 19). In a sense, the concept of cerebral lateralization, which refers to anatomical and functional differentiations between the right and left hemispheres of the brain, includes all organically significant factors and mechanisms involved in the formation of hemispheric asymmetry. This theory and clinical examples have been demonstrated through anatomical, embryological, pathological, chemical, and hormonal studies. The asymmetries in the human brain are macroscopic, pathway-related, and cytoarchitectonic asymmetries (17,18,19,20).

In computerized tomographic examinations, it was determined that the left frontal lobe is wider than the right in right-handed people, and the right frontal lobe is wider than the left in left-handed people (20). Hemispheric asymmetry is a concept that includes the organic mechanisms involved in the formation of the asymmetric functions of the brain. In individuals, one hemisphere is usually more dominant than the other, and personal characteristics are formed according to the dominant hemisphere. Accordingly, the centers in the left cerebral hemisphere control the right side of the body, and the centers in the right cerebral hemisphere control the left side of the body. Hand preference is the best indicator of cerebral functional asymmetry (21).

In the brain, the left hemisphere is more dominant in events such as the control of the right side of the body, use of the right hand, conscious use of language, speaking, spelling, reading-writing, verbal thinking, verbal intelligence and verbal memory, rhythm, sequential knowledge processes, mathematics, and perception of details. The right hemisphere is more dominant in events such as the control of the left side of the body, use of the left hand, awareness of the situation, tactile sensation, interpretation of facial expressions, emotional and melodic speech, singing, poetry reading, body language, perception of environmental sounds, visual-emotional mystical thinking, comprehension ability, dancing, seeing details in pictures, manipulation ability, and the management of sexuality (22). Hand preference is the best indicator of cerebral functional asymmetry. Lateralization means that one hemisphere is predominantly responsible for a particular process. Many behavioral asymmetries that occur as a result of hemispheric asymmetry have been described. The most prominent of them is hand preference, which is an important issue that has aroused great interest for centuries and on which various studies have been conducted. Although we have a lot of information about the behavioral and cognitive specializations of the hemispheres nowadays, each study can provide more detailed and new results related to this field.

The aim of our study was to investigate the distribution of hand preference, which is the best indicator of cerebral functional asymmetry, in male and female students, identify the difference between males and females in terms of hand preference, and thus, obtain information about the dominant hemisphere by examining the hand preference rates of young people receiving higher education in the field of health.

Within the scope that we have not encountered in other studies, this research was conducted on students receiving education in different disciplines in the field of health in four faculties of Gazi University, including the Faculties of Medicine, Dentistry, Pharmacy, and Health Sciences. The aim of the study was to determine the hand preference in the field of health, the distribution of hand preference by sex, and the dominant cerebral hemisphere regarding hand preference. In conclusion, it was considered that it would contribute to similar studies to be conducted on individuals studying in fields other than health and there might also be a chance for comparison.

METHOD

This study was approved by "Gazi University Non-Interventional Clinical Research Ethics Committee" and was conducted on a voluntary basis. A total of 765 volunteer university students, consisting of 419 female (54.77%) and 346 male (45.23%) students aged between 16-25 years, studying in the field of health at Gazi University, participated in the study. All of the students who voluntarily participated in the study were healthy. The study was conducted according to the Coren Stanley questionnaire and score (23). Statistical analysis was performed by applying the chi-square test in SPSS 15 statistical program.

The Turkish translation of the Coren Stanley questionnaire was used while determining the hand preference. The questions were ordinary questions that could be repeated in daily life. The hand preferred while performing these functions was determined. For example, the hand preferred in actions such as writing, drawing a picture, throwing the ball at the target, throwing the stone at the target, brushing teeth, cutting something with a knife, hammering a nail, holding the matchstick to light the match, erasing a text with an eraser, stirring the tea in the glass with a spoon, holding the thread to insert the thread in the needle, and reaching out while shaking hands was determined.

Table 2: Coren Stanley laterality test

COREN STANLEY LATERALITY TEST	Left	Doesn't matter	Right
1. With which hand do you write?	[1]	[2]	[3]
2. With which hand do you draw a picture?	[1]	[2]	[3]
3. With which hand do you throw the ball toward a target?	[1]	[2]	[3]
4. With which hand do you throw a stone toward a target?	[1]	[2]	[3]
5. In which hand do you hold the toothbrush while brushing your teeth?	[1]	[2]	[3]
6. In which hand do you hold the knife to cut something?	[1]	[2]	[3]
7. In which hand do you hold the hammer while nailing?	[1]	[2]	[3]
8. In which hand do you hold the matchstick while lighting the match?	[1]	[2]	[3]
9. Which hand do you use while erasing something? (While cleaning your desk, erasing a line or writing with an eraser, etc.)	[1]	[2]	[3]
10. Which hand do you use while stirring the sugar in your glass with a spoon?	[1]	[2]	[3]
11. In which hand do you hold the thread while inserting the thread into the needle?	[1]	[2]	[3]
12. Which hand do you extend to the other person while shaking hands?	[1]	[2]	[3]

The sum of the numbers in the lines marked in the questions in Table 2 was scored according to the given intervals and evaluated.

33-36 = Strongly right-handed
29-32 = Moderately right-handed
25-28= Weakly right-handed
24 = Ambidextrous
20-23 = Weakly left-handed
6-19 = Moderately left-handed
12-15 = Strongly left-handed

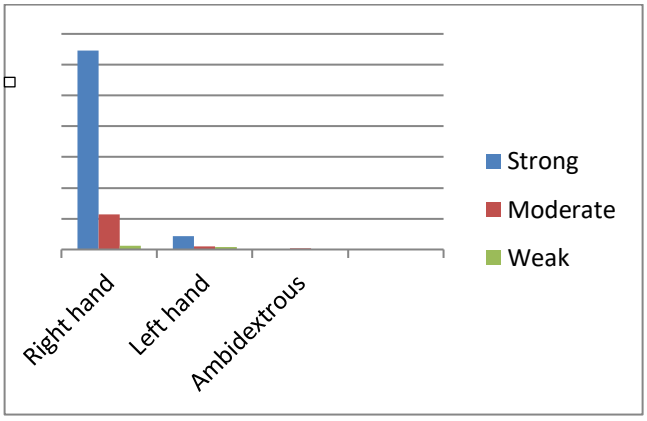
RESULTS

The distribution of hand preference was evaluated in seven groups for each hand: strong, moderate, weak, and ambidextrous (equally handed). The distribution of hand preference among male and female students is presented in Table 3 in numerical and percentage terms. In female students, the following values were determined for the right hand: Strong: 323 (77.1%), moderate: 57 (13.6%), weak: 6 (1.4 %), ambidextrous (equally handed): 2 (0.5%), for the left hand: Strong: 22 (5.3%), moderate: 5 (1.2%), and weak: 4 (1.0%) (Graph 1).

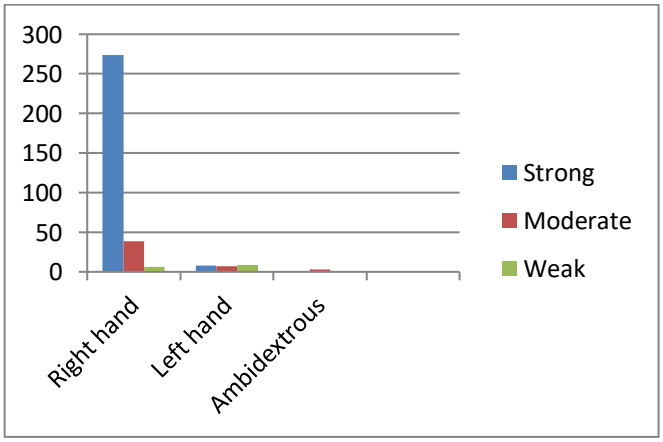
In male students, the following values were determined for the right hand: Strong: 274 (79.2%), moderate: 39 (11.3%), weak: 6 (1.7%), ambidextrous (equally handed): 3 (0.9%), for the left hand: Strong: 8 (5.3%), moderate: 7(2.0%), weak: 9 (2.6%). When the distribution of hand preference according to the Coren Stanley (CS) questionnaire was examined in all students regardless of sex, the following values were determined for the right hand, strong: 597 (78.0%), moderate: 96 (12.5%), weak: 12 (1.6%), ambidextrous (equally handed): 5 (0.7%), for the left hand: Strong: 30 (3.9%), moderate: 12(1.6%), weak: 13(1.7%). When the relationship between the distribution of hand preference and sex was examined, no significant difference was observed ($x2 = 9.50$ $p= 0.14$). According to the results obtained, the ratio of ambidextrous individuals was the lowest, the left-hand preference was slightly higher compared to ambidextrous individuals, and the right-hand preference was the highest with a significant difference.

Table 3: Distribution of right and left-hand preference in females and males

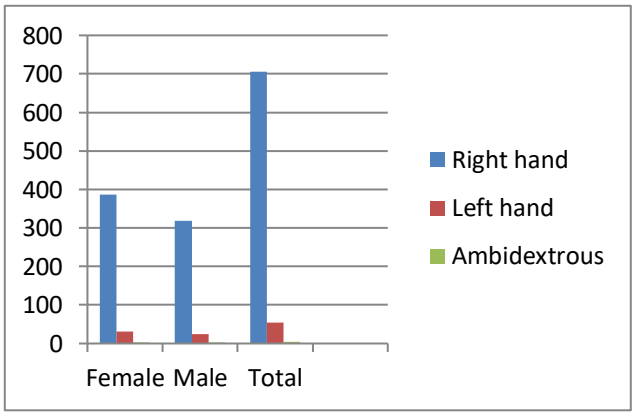
	FEMALE		MALE		TOTAL	
HAND	n	%	n	%	n	%
Right						
Strong	323	77,1	274	79,2	697	78
Moderate	57	13,6	39	11,3	96	12,5
Weak	6	1,4	6	1,7	12	1,6
Ambidextrous	2	0,5	3	0,9	5	0,7
Left						
Strong	22	5,3	8	2,3	30	3,9
Moderate	5	1,2	7	2	12	1,6
Weak	4	1	9	2,5	13	1,7



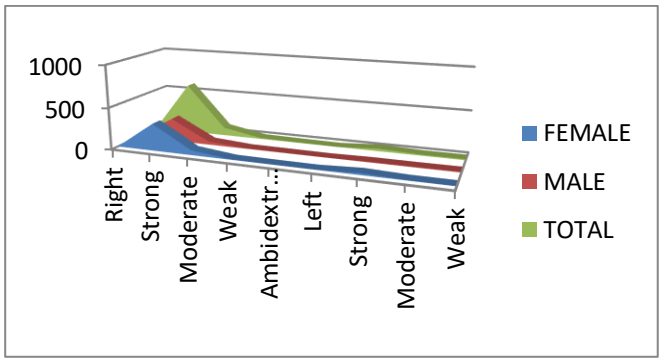
Graph 1: Distribution of right and left-hand preference for females



Graph 2: Distribution of right and left-hand preference for males



Graph 3: Distribution of right and left-hand preference for females and males



Graph 4: Total distribution of right and left-hand preference for females and males

DISCUSSION

There are many factors that affect hand preference. It is observed that these factors are grouped under two headings, genetic and non-genetic. Non-genetic factors incl season, pregnancy, age, birth-specific characteristics, and cultural and ethnic differences. Considering genetic factors, if the mother, father, or both are left-handed, the probability of the child being left-handed increases. It has been reported that especially the mother being left-handed increases the probability of the child being left-handed (24). The studies have determined that survivors of traffic accidents that may result in death have a higher risk of being left-handed for the rest of their lives and left-handed people have more accidents. In this case, the importance of determining the level of coordination disorder in left-handed people is emphasized once again. However, it is reported to be unknown which of these factors and how effective these factors are; therefore, they will continue to be relevant as a topic of discussion (25).

Our study aimed to contribute to the current knowledge about which hemisphere is dominant by determining the hand preference of students receiving undergraduate education in the field of health at Gazi University from different regions of Turkey, different cultures, with a different understanding of health and conditions.

When the left-handed tendency is noticed in children who are approaching or have just reached school age, right-handed preference is established by force as a result of pressures imposed by family elders and teachers in order to direct children to the right hand, which is called "inhibited left-handedness." In our study, the distribution of "inhibited left-handedness" was also aimed since it is important in establishing the quality of life. However, there were only two students who remembered it. These two students were excluded from the evaluation.

Inhibited left-handedness leads to "dyslaterality." In this case, a group of pathologies may occur starting at about six years old in childhood and continuing until advanced ages. The reason is that the child who is forced to use his right hand exercises the irrational left hemisphere instead of the rational right hemisphere (26). Therefore, the character structure will be shaped in this way. For instance, the most common pathologies include the tendency to anger and jealousy at the ages of 6-12; dyslexia, writing disorder, stuttering, and forgetfulness at the ages of 12-18; anxiety, fear of exams, tachycardia, and constipation at the ages of 18-20; and gastric ulcer, diabetes, psoriasis, and eczema at the ages of 40-45 (26).

Since hand preference provides an important clue about the functional asymmetry of the brain, researchers on this issue created various questionnaires for this purpose as a healthy method (27,28,29).

In our study, hand preference was discussed in three main groups as right, left, and ambidextrous. The results regarding the distribution of hand preference by sex and without sex discrimination are presented in Graphs 1–4. The distribution of hand preference among male and female students was in the form of "J," as seen in Graphs 1 and 2. This distribution was similar to the studies by Tan (1991), Annett (1989), and Gündoğan et al. (2007) (30).

In the studies conducted in different regions of our country, the distribution percentages related to the use of the right hand, left hand, and two hands were similar. However, a study including 10,314 participants from countries where ancient cultures lived, e.g., China, determined that the right-hand preference was 90.84%, two-handed preference was 8.90%, and the left-hand preference was 0.26%. While the results found in that study in China and the results of our study were observed to be generally close to each other, it was remarkable that the left-hand preference was lower in China compared to our study. The low rate of left-handed preference in other studies conducted in China indicates that the traditional culture of the East applies pressure on the right-handed preference. The studies conducted in European countries reported the incidence of left-handedness as 8-10% in the general population. On the other hand, there are studies emphasizing that the cultural effect does not change the hand preference (31). In our study, left-hand preference, which was determined without sex discrimination, was found to be strong by 3.9%, moderate by 1.6%, and weak by 1.7%. In this sense, we believe that it is similar to European countries.

In the comparison between sexes in terms of right and left-hand use preference, no statistically significant difference was determined in our study. However, it was revealed that the right hand was strongly preferred by a higher number of students of both sexes.

It was concluded that the left cerebral hemisphere could be generally dominant (expert) according to functional cerebral laterality. Determining hand preference is undoubtedly very important to express an opinion about the dominant hemisphere. However, we believe it is necessary to conduct new studies to evaluate the cerebral hemispheres according to their functions.

This study determined no significant difference between sexes in terms of right and left-hand use. However, the right hand was strongly preferred by both sexes. Many genetic and environmental factors are effective in right and left-hand preferences. In this context, it is considered that high right-handed preference may be related to the cultural suppression of left-handedness (until left-handedness turns into right-handed (22).

CONCLUSION

Cerebral lateralization forms the left and right dominance in many organs with right and left characteristics, especially hand preference. Hence, we believe that conducting studies on cerebral lateralization, a common subject of many disciplines, supported by adapting the preference scale to Turkish and investigating its reliability with different parameters and comprehensively in all relevant fields will make significant contributions to human health and quality of life.

Conflict of interest
No conflict of interest was declared by the authors.

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