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The Effect of Cerebral Lateralization on the Swimming Performance in Four Different Swimming Styles in Young Swimmers[1]

Serebral Laterizasyonun Genç Yüzücülerde Dört Farklı Stilde Yüzme Performansına Etkisi

ABSTRACT

This study aimed to examine the effect of cerebral lateralization on swimming performance in four different swimming styles in young swimmers. Our study was designed according to the lateralization test, with the participation of 30 young adult swimmers between the ages of 15-25. The subjects were divided into three groups: right-handed, left-handed and ambidextrous. Swimming performance results published by the Turkish Swimming Federation were examined and the effect of lateralization was evaluated. SPSS 22.0 program was used for statistical operations. There was no significant difference between the freestyle 50m, backstroke 50m, breaststroke 50m, butterfly style 50m, freestyle 100m, backstroke 100m, breaststroke 100m and butterfly style 100m performances of individuals with and without a left-handed family history. However, a significant difference was detected between hand preference groups in freestyle 100m performance. According to post-hoc test results, it was determined that individuals using both hands performed better than those using dominant left and right hands. In general, although there is no significant relationship between lateralization scores and swimming performance, it has been observed that individuals who use both hands swim faster in all styles and distances.
Keywords: Cerebral lateralization, swimming styles, handedness

ÖZET

Bu araştırmada serabral lateralizasyonun genç yüzücülerde dört farklı yüzme stilinde yüzme performansına etkisinin incelenmesi amaçlanmıştır. Çalışmamız, 15-25 yaş arası 30 genç yetişkin yüzücünün katılımıyla, lateralizasyon testine göre tasarlanmıştır. Denekler sağ el, sol el ve her iki elini kullananlar olarak üç gruba ayrılmıştır. Türkiye Yüzme Federasyonu'nun yayınladığı yüzme performans sonuçları incelenmiş ve lateralizasyonun etkisi değerlendirilmiştir. İstatistiksel işlemler için SPSS 22.0 programı kullanılmıştır. Ailesinde solak olan ve olmayan bireylerin serbest stil 50m, sırt üstü stil 50m, kurbağa stil 50m, kelebek stil 50m, serbest stil 100m, sırt üstü stil 100m, kurbağa stil 100m ve kelebek stil 100m performansları arasında anlamlı bir farklılık bulunmamıştır. Ancak, serbest stil 100m performansında el tercih grupları arasında anlamlı bir fark tespit edilmiştir. Post-hoc test sonuçlarına göre, her iki elini kullanan bireylerin baskın sol ve sağ el kullananlara göre daha iyi performans gösterdiği belirlenmiştir. Genel olarak, lateralizasyon puanları ile yüzme performansları arasında anlamlı bir ilişki bulunmamakla birlikte, her iki elini kullanan bireylerin tüm stiller ve mesafelerde daha hızlı yüzdükleri gözlemlenmiştir.
Anahtar Kelimeler: Serebral lateralizasyon, yüzme stilleri, el tercihi,

[1] This study is prepared from master thesis of Elif Kuzu

1. INTRODUCTION

Cerebral lateralization refers to the functional and anatomical differentiation between the left and right hemispheres of the cerebrum. While handedness is considered functional cerebral lateralization, the dominance of one side of the brain cells over the other is considered anatomical cerebral lateralization. Currently, there are three main asymmetry theories regarding cerebral lateralization.

The first theory proposes that asymmetries involve attentional influence in the opposite cerebral hemisphere. For example, the right visual field is dominant for most verbal functions, while the left visual field is dominant for other visual functions.

The second theory suggests that both hemispheres can work together for a particular task. One hemisphere may be widely dominant in a particular domain of behavior, but for a specific task, both hemispheres may contribute. For example, the perception and measurement of precise information about something we cannot see is carried out by the left hemisphere. These hemispheric functional asymmetries may be a common computational benchmark.

The third theory advocates the idea that asymmetries give rise to a general advantage of one hemisphere over the other for certain abilities. For example, the left hemisphere is associated with verbal functions, while the right hemisphere specializes in visual and spatial functions. Some monkeys and birds have a single center in the left hemisphere for specific communication behaviors. Because mice exhibit asymmetries similar to those of humans, they are a useful research and study group for understanding the basis of human asymmetries. Although mice are not biologically as close to humans as monkeys, they are closer to humans than birds (Tan and Çalışkan, 1987).

Cerebral lateralization refers to the various abilities of the cerebral hemisphere to acquire, direct, and control certain neurological functions. This concept forms the basis of the scientific approach required to understand higher cerebral functions and disorders in these functions (Tan and Çalışkan, 1987).

While it was previously thought that the cerebral hemispheres showed a certain asymmetry within the cerebrum, the anatomical asymmetry was later confirmed by Broca's discoveries. In humans, verbal functions are generally more dominant in the left hemisphere and spatial functions are more dominant in the right hemisphere. Cerebral dominance occurs in the performance and control of certain neurological functions in which one of the brain hemispheres has superiority over the other. The cortical folding process occurs earlier in the right hemisphere. Asymmetries between the hemispheres have also been noticed in the rate of development. For example, the primary functional layer, such as Heschle's gyrus, becomes evident earlier on the right side, and it is known that the right side may be at least two weeks ahead of the left side. The language regions in the left hemisphere develop more slowly and stand out with a more complex structure. This long developmental period may cause areas on the left side to be more developmentally sensitive. In conditions such as developmental dyslexia, significant developmental disabilities in the left hemisphere have been observed between the 16th and 20th weeks of gestation (Foundas et al. 1994).

Some extremities and organs in the human body are called lateralization, which differs according to the dominance of the brain hemispheres. Individuals often show a preference for using their hands and feet, a preference that may arise from both social structure and anatomical bases. Considering that the majority of the world's population is right-handed, right hand and foot preference is generally more common in societies. Considering that the

rate of using both hands is 30%, the rate of right-handers can reach up to 60%, while the rate of left-handers generally remains around 5%. The rarity of left-handedness in ancient societies was considered a symbol of evil or bad luck. In modern society, left-handedness, with its various features and differences, has attracted attention for social and physical reasons and has become the subject of scientific research (Şen, 1998).

Accordingly, our study aimed to examine the effect of cerebral lateralization on swimming performance in four different swimming styles in young swimmers.

2. MATHRTIALS and METHOD

Table 2.1. Descriptive statistics of the participants

	N	Min.	Max.	Cover	Std.
Age (year)	39	12,00	19,00	15,3846	1,75642
Height (cm)	39	150,00	193,00	171,6154	11,46990
Weight (kg)	39	43,00	96,00	62,1795	12,34562
Freestyle 50m (sn)	36	24,00	38,00	28,9022	3,33352
Freestyle 100m (sn)	34	52,00	60,26	58,7435	2,10666
Backstroke 50m (sn)	26	27	60	36,28	7,303
Backstroke 100m (sn)	22	59	120	62,81	12,779
Breaststroke 50m (sn)	15	27	43	35,75	4,403
Breaststroke 100m (sn)	14	49	120	63,65	16,492
Butterfly 50m (sn)	23	25,80	3330,00	175,9374	687,58156
Butterfly 100m (sn)	19	35,00	120,01	61,9516	15,19218

2.1. Desing and Scope

Our study was designed according to the lateralization test. 30 young adult swimmers between the ages of 15-25 participated in the study. GPower 3.1 to determine the number of subjects. A priori test was applied with the program. After applying the lateralization test to the subjects, they were divided into three groups: right hand, left hand and both hands. Then, the effect of lateralization between the groups was determined by taking the results of Turkey's swimming practice (swimrank), which was created based on the Turkish Swimming Federation, which all subjects achieved in their last competitions.

2.2. Collection of Data

2.2.1. Lateralization Test

The Edinburgh Inventory Oldfield Questionnaire will be administered to participants to determine handedness (Olfield, 1970). According to the Geschwind scoring (Geschwind and Behan, 1982), which measures the frequency of the hand used in each task, values range from 0 to +100 (those who mark all questions as right hand) and from 0 to -100 (those who mark all questions as left hand). will be detected. This survey includes questions indicating which hands people use most for 10 different tasks. Questions cover the following: (1) writing, (2) drawing, (3) throwing a ball, (4) holding scissors, (5) brushing teeth, (6) holding a knife, (7) holding a fork, (8) shovel. holding the handle, (9) striking a match, and (10) opening the lid of a box. Answer options are "always with the right hand" (+10 points), "usually with the right hand" (+5 points), "with both hands" (0 points), "usually with the left hand" (-5 points) and "always with the left hand" (-10 points). The results were evaluated with Geschwind's score (GS). Negative values obtained after the survey indicate left-handedness, and an increase in this value indicates the degree of dominance of left-handedness. Positive values indicate right-handedness, and an increase in this value indicates the degree of dominance of right-handedness. These given values were examined as lateralization coefficient (LK) (Menteşe, 2019).

2.2.2. Swimming Performances

It was taken from the results of Turkey's swimmer application (swimrank), which was prepared with reference to the Turkish Swimming Federation.

2.3. Statistical Method

SPSS 22.0 program was used for statistical operations. After normality and homogeneity testing, the appropriate test method was selected to analyze the differences between applications. Values were presented as mean and standard deviation and examined at the 0.05 significance level.

3. RESULTS

The aim of the study is to investigate the effect of cerebral lateralization on performance in all swimming styles in young swimmers. In this section, the data obtained were analyzed.

Table 4.1. Analysis of freestyle 50m performances of swimmers according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	13	28,3385	3,00040	0,454
No	23	29,2209	3,53191	

In Table 4.1, the analysis of swimmers' freestyle 50m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the freestyle 50m performances of individuals with and without a left-handed family ($p>0.05$).

Table 4.2. Analysis of freestyle 50m performances of swimmers according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	25	29,4800	3,31840	0,124	-
both hands	5	26,1520	3,36980		
Dominant Left	6	28,7867	2,56842		
Toplam	36	28,9022	3,33352		

In Table 4.2, the analysis of swimmers' freestyle 50m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between handedness groups in terms of freestyle 50m performances (p>0.05).stil 50m performansları açısından anlamlı bir farklılık görülmemiştir (p>0,05).

Table 4.3. Analysis of freestyle 100m performances of swimmers according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	13	58,8908	2,07456	0,754
No	21	58,6524	2,17201	

In Table 4.3, the analysis of swimmers' freestyle 100m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the freestyle 100m performances of individuals with and without a left-handed family (p>0.05).

Table 4.4. Analysis of freestyle 100m performances of swimmers according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	24	59,2650	1,46905	0,001	Both hands - Dominant Right Both hands - Dominant Left
Both hands	5	55,7460	3,04274		
Dominant Left	5	59,2380	1,33329		
Total	34	58,7435	2,10666		

In Table 4.4, the analysis of swimmers' freestyle 100m performances according to lateralization status is given. According to the t test analysis in independent groups, there was no significant difference between the freestyle 100m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.5. Analysis of swimmers' backstroke style 50m performances according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	7	33,22	2,829	0,064
No	19	37,40	8,151	

In Table 4.5, the analysis of swimmers' backstroke style 50m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the backstroke style 50m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.6. Analysis of swimmers' backstroke style 50m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	19	37,13	7,751	0,584	-
both hands	3	32,94	2,959		
Dominant Left	4	35,33	9,074		
Toplam	26	36,28	7,303		

In Table 4.6, the analysis of swimmers' backstroke style 50m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between the hand preference groups in terms of backstroke style 50m performances (p>0.05).

Table 4.7. Analysis of swimmers' backstroke 100m performances according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	7	60,07	,073	0,506
No	15	64,08	15,475	

In Table 4.7, the analysis of swimmers' backstroke 100m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the backstroke style 100m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.8. Analysis of swimmers' backstroke style 100m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	18	63,47	14,111	0,885	-
both hands	2	59,54	,764		
Dominant Left	2	60,11	,141		
Total	22	62,81	12,779		

In Table 4.8, the analysis of swimmers' backstroke 100m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between the hand preference groups in terms of backstroke style 100m performances (p>0.05).

Table 4.9. Analysis of swimmers' breaststroke style 50m performances according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	6	34,00	5,025	0,221
No	9	36,91	3,785	

In Table 4.9, the analysis of swimmers' breaststroke style 50m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the frog style 50m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.10. Analysis of swimmers' breaststroke style 50m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	9	35,21	3,214	0,311	-
both hands	4	34,69	6,845		
Dominant Left	2	40,28	,389		
Total	15	35,75	4,403		

In Table 4.10, the analysis of swimmers' breaststroke style 50m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between handedness groups in terms of frog style 50m performances (p>0.05).

Table 4.11. Analysis of swimmers' breaststroke style 100m performances according to left-handedness in the family.

Left-Handed in the Family	N	Cover	Std.	p
Yes	7	58,58	4,224	0,266
No	7	68,73	22,613	

In Table 4.11, the analysis of swimmers' breaststroke style 100m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the frog style 100m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.12. Analysis of swimmers' breaststroke style 100m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	10	65,05	19,629	0,898	-
Both hands	2	60,06	,035		
Dominant Left	2	60,27	,021		
Total	14	63,65	16,492		

In Table 4.12, the analysis of swimmers' breaststroke style 100m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between handedness groups in terms of frog style 100m performances (p>0.05).

Table 4.13. Analysis of butterfly style 50m performances of swimmers according to left-handedness in the family

Left-Handed in the Family	N	Cover	Std.	p
Yes	7	29,5286	3,41405	0,062
No	16	33,9475	5,43235	

In Table 4.13, the analysis of swimmers' butterfly style 50m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the butterfly style 50m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.14. Analysis of swimmers' butterfly style 50m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	16	33,2825	5,12810	0,642	-
Both hands	4	30,5850	7,66470		
Dominant Left	3	31,6667	2,30940		
Total	23	32,6026	5,25564		

In Table 4.14, the analysis of swimmers' butterfly style 50m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between the hand preference groups in terms of butterfly style 50m performances (p>0.05).

Table 4.15. Analysis of butterfly style 100m performances of swimmers according to left-handedness in the family

Left-Handed in the Family	N	Cover	Std.	p
Yes	6	55,8900	10,23418	0,248
No	13	64,7492	16,60458	

In Table 4.15, the analysis of swimmers' butterfly style 100m performances according to left-handedness in the family is given. According to the t test analysis in independent groups, there was no significant difference between the butterfly style 100m performances of left-handed and non-left-handed individuals (p>0.05).

Table 4.16. Analysis of swimmers' butterfly style 100m performances according to lateralization groups.

	N	Cover	Std.	p	Significant Difference
Dominant Right	14	64,4179	16,00130	0,439	-
Both hands	2	51,7267	14,48577		
Dominant Left	3	60,0250	,03536		
Total	19	61,9516	15,19218		

In Table 4.16, the analysis of swimmers' butterfly style 100m performances according to lateralization status is given. According to the one-way analysis of variance, there was no significant difference between the handedness groups in terms of butterfly style 100m performances (p>0.05).

4. DISCUSSION

In this study, we aimed to examine the effect of cerebral lateralization on performance in all swimming styles in young swimmers. The data obtained as a result of various analyzes conducted in our research provide important clues to clarify the relationship between handedness and swimming performance. According to the t test analysis conducted in independent groups, there was no significant difference between the freestyle 50m and 100m performances of individuals with and without left-handed family history (p>0.05). Similarly, it was determined that left-handedness in the family had no effect on the 50m and 100m performances of the backstroke, frog and butterfly styles (p>0.05).

When looking at the performance differences between handedness groups, a one-way analysis of variance showed that there was no significant difference in most styles and distances (p>0.05). However, a significant difference was found between hand preference groups in freestyle 100m performance (p<0.05). LSD post-hoc test results performed to determine which group this difference was in favor of, revealed that individuals using both hands performed in a significantly shorter time than individuals using the dominant left and dominant right hands.

According to Pearson correlation analysis, no significant relationship was observed between lateralization scores and performances in any swimming style (p>0.05). In light of these findings, although the relationship between handedness and swimming performance was not found to be statistically significant in general, it is noteworthy that individuals using both hands exhibited superior performance in freestyle 100m performance. This provides an important clue that using both hands can improve swimming performance. Therefore, supporting these findings with more comprehensive research may contribute to our better understanding of the effect of handedness on swimming performance.

In a study conducted by Loffing et al., 18 volleyball players were examined using video analysis method. In this study, it was determined that left-handed volleyball players were more successful in predicting the direction of shots from close and long distances. As a result, it has been revealed that left-handed volleyball players have superior visual perception abilities than right-handed players (Loffing et al 2012).

A research conducted by Çingöz has once again revealed that left-handed athletes stand out. In the study, it was observed that left-handed female athletes were interested in branches such as karate and taekwondo and were more successful in winning medals with their dominant hand preference (Çingöz, 2017).

In their study on ice hockey, Puterman et al. found that right-handed goalkeepers were more successful in saving shots than left-handed ones. This finding shows that the right hand is advantageous (Puterman, 2010).

Ziyagil and Gürsoy also contributed to the studies conducted to learn the effects of handedness on sports branches. In their studies at the Istanbul and Greece world wrestling championships held in 2010, they reported that wrestlers who used their left hand dominantly won more matches, achieved more degrees and received more medals (Ziyagil et al 2010).

In a study on the dominant hand, Sachlikidis and Salter examined the shooting techniques of elite cricketers under the age of 17 and 19 with their dominant and non-dominant arms through kinematic analysis. In this study, they determined that the athletes' hits increased in fast throws made by the dominant hand, but there was no such increase on the non-dominant arm side. Similarly, other researchers have emphasized the potential of both hands to improve shooting performance (Sachlikidis and Salter, 2007).

Özdemir (2004) conducted a different study on left-handed individuals and revealed various observations about those who prefer the left hand. In his research, he stated that left-handers had difficulty using the keyboard and scissors and reported that the rates of divorce and polygamy were higher in left-handed individuals. He also claimed that the rate of left-handers was higher among homosexuals than in the general population, and that left-handed individuals' life expectancy was approximately 8-10 years less than right-handers (Özdemir and Soysal, 2004).

In studies on handedness, possible relationships between handedness and immune diseases have also been examined. There are controversial views in the literature on this subject. According to the Geschwind hypothesis, high testosterone levels in fetal life inhibit the development of the left hemisphere, leading to left-handedness, which negatively affects thymus development, causing immune hypersensitivity and autoimmune diseases. In addition, Geschwind and Behan discovered that autoimmune diseases are more common in left-handed individuals and their first-degree relatives (Geschwind and Behan, 1982).

Dane and Kaynar determined that COPD, pneumonia and asthma diseases were seen at higher rates in left-handed individuals than in right-handed individuals (Dane, 2006).

Some studies in the literature suggest that there is a relationship between left-handedness and some diseases. Among these diseases, epilepsy, migraine, schizophrenia, autism, obsessive-compulsive disorders, attention deficit and hyperactivity disorder, autoimmune diseases, Alzheimer's disease, allergic diseases, antisocial behavior disorders, immune system diseases, alcohol and drug addiction are the most emphasized (Özdemir and Soysal, 2004).

In another study by Stanton et al., in a case-control study conducted in New Zealand, the hand preferences of children aged 7-13 with urticaria, eczema, allergic asthma and allergic rhinitis were examined, but no significant difference was found (Stanton et al, 1991).

A similar study by Bishop failed to identify any cases of allergies (hay fever, eczema, asthma, psoriasis) associated with left-handed preference in a British children's population (Bishop, 1986).

Studies in the literature on the effect of cerebral lateralization on the swimming performance of young swimmers in four different styles have revealed that there is no significant relationship between hand preference. Performance in whole-body sports such as swimming relies heavily on training and technical development. Future research may support these findings and provide a broader perspective by conducting similar analyzes across different sports.

As a result, the effect of cerebral lateralization did not show a significant difference in the 50 meter freestyle, back, breaststroke, butterfly and 100 meter back, breaststroke, butterfly performances. However, it is noteworthy that individuals who use both hands demonstrate superior performance in the freestyle 100 meters performance.

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