



EFFECT OF CEREBRAL LATERALIZATION ON VOLLEYBALL SKILLSⁱ

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Abstract:

The main purpose of this study is to examine the effects of cerebral lateralization on volleyball skills comprehensively. The task distribution between the right and left hemispheres of the brain and the effects of these hemispheres on the individual's motor skills, coordination ability, and reflexes constitute an important research topic in terms of sports performance. A sociodemographic information form, lateralization test and volleyball skill questionnaire were used for the participants. A total of 108 participants were reached. The SPSS package program was used to statistically analyze the data obtained at the end of the research. When the obtained data were examined, it was seen that there was no significant difference in volleyball basic skills scores according to lateralization groups ($p>0.05$). As a result, it can be said that the dominant hand usage status does not affect volleyball basic skills.

Keywords: Volleyball, lateralization, skills

1. Introduction

Physical and physiological fitness, alongside skill and ability, are significant in all sports disciplines. Therefore, studies investigating the physical and physiological profiles based on scientific foundations for different sports are increasingly common. The physical fitness values, which include the physical and physiological characteristics of athletes, play a crucial role in talent selection. Individuals involved in a particular sport adapt

ⁱ This study is based on the master's thesis research of Habeş Kalkan.

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structurally and functionally to the physical exercises related to their sport, leading to the development of both bone and muscle tissue (10).

In every sport, the use of scientific methods to enhance performance is extremely important. The development and performance of athletes' fundamental motor characteristics, such as strength, endurance, speed, agility, flexibility, and skill, can be optimized through specialized training (9). Most researchers have shown that the percentage of left-handed athletes is higher among professional athletes in individual sports such as baseball (11), tennis (2, 3, 8), fencing (3), cricket (18), and individual combat sports like boxing (7) and wrestling (19). However, in individual sports where there is no direct confrontation (15), this percentage is not as high. The dominance of the left hand is considered a remarkable trait that can provide an advantage in many areas, from daily life skills to sports performance. However, the emergence of this advantage is closely related to the nature of the sport and the skills required for it. In some sports, athletes who use their left hand more actively and with greater control may gain an unexpected advantage over their opponents. The main reason for this is that left-handed individuals move in the game from an unusual angle, and their opponents are less familiar with this situation. For example, in individual sports like tennis or table tennis, the balls hit by left-handed athletes may follow a different curve, making it more difficult for opponents to predict and develop reflexes. Similarly, in team sports, especially in football or basketball, players who predominantly use their left hand or foot can bypass the opposing defense with surprising moves. This situation often creates an unexpected challenge for opponents who have developed strategies against players using their right hand. On the other hand, in sports that require face-to-face competition, such as boxing and fencing, athletes who use their left hand cause their opponents to encounter an unusual position and attack angle. In such sports, a player's skillful use of their left hand can create unexpected pressure on the opponent's balance and reflexes. Moreover, due to the rarity of left-handed athletes, these players face fewer opponents with similar characteristics, which gives them a strategic advantage.

Considering all these examples, the advantages of being left-handed can be seen not only as a reflection of a genetic trait but also as a superiority that changes depending on the dynamics of the sport. However, for these advantages to emerge, it is also crucial for the individual to effectively develop this natural characteristic and adapt to the requirements of the sport.

Florian et al. (2012) concluded that athletes who use their left hand are more advantaged than those who use their right hand in individual competitions (e.g., baseball, cricket, tennis, table tennis). The basis of this advantage lies in left-handed athletes approaching their opponents from an unusual angle, and most opponents have less experience with such movements. For example, in sports like table tennis and tennis, the direction of a left-handed player's shots and the curve of the ball create a situation that is harder for right-handed players to predict. Considering that right-handed athletes are the majority, opponents typically develop strategies against right-handed movements. However, when facing a left-handed athlete, these conventional strategies may fall short, and the left-handed player can gain an unexpected advantage. The

advantages of left-handed players are also evident in team-based individual performance sports such as baseball and cricket.

For example, in baseball, the angle and speed at which a left-handed batter hits the ball can challenge the positioning skills of opposing defensive players. In cricket, the balls thrown by a left-handed bowler make it more complicated for the opposing players to predict the trajectory. This situation increases the impact of left-handed athletes in the game, placing them in a more strategic position. Another important conclusion that can be drawn from Florian et al.'s study is that being left-handed is not only a physical advantage but also a factor that challenges the psychological preparation of opponents. The fact that one must move outside of usual patterns when facing a left-handed opponent can affect the focus and quick decision-making processes of right-handed athletes. This situation may provide left-handed athletes with a mental edge over their opponents. In conclusion, this study clearly highlights the advantages of left-handed athletes in individual competitions, while also demonstrating that these advantages are not just a natural trait but have the potential to create a strategic difference (14).

The main aim of this study is to examine the effects of cerebral lateralization on volleyball skills comprehensively. The division of tasks between the right and left hemispheres of the brain and the impact of these hemispheres on an individual's motor skills, coordination ability, and reflexes constitute an important research topic in terms of sports performance. Especially in a sport like volleyball, which requires a high level of coordination, agility, and quick decision-making, understanding the role of cerebral lateralization can provide a significant contribution to improving athletes' individual performance and optimizing training processes. In this regard, the study aims to evaluate the effects of cerebral lateralization on volleyball skills while also considering athletes' dominant hand and hemisphere preferences, motor control mechanisms, success levels in basic techniques such as hitting the ball, passing, and blocking, as well as decision-making processes during the game. Additionally, the study seeks to investigate whether there are performance differences between right-handed and left-handed athletes and to determine the extent to which lateralization contributes to volleyball skills. The findings obtained are expected to support the development of more scientifically grounded individual training programs for athletes, as well as help coaches develop more effective strategies by considering their players' natural abilities and lateralization characteristics. The study also aims to provide new and valuable insights into the literature regarding the role of cerebral lateralization in sports performance.

2. Method

Prior to the thesis study, ethical approval was obtained from the Gaziantep University Social and Humanities Ethics Committee. This study consists of 108 voluntary participants aged 20-25 who play volleyball. The participants were administered the Sociodemographic Information Form, Lateralization Test, and Volleyball Skill Test.

2.1 Sociodemographic Information Form

A "Sociodemographic Information Form" was prepared by the researcher to collect general information about the students participating in the study. The Sociodemographic Information Form consists of a total of three questions regarding age, gender, and occupation.

2.2 Lateralization Test

The Edinburgh Inventory Oldfield Questionnaire will be administered to determine hand preference (Oldfield, 1970). Based on the Geschwind scoring system regarding the frequency of hand use in various tasks (Geschwind and Behan, 1982), all values ranging from 0 to +100 (those marking all questions as right hand) and 0 to -100 (those marking all questions as left hand) will be identified. This questionnaire includes questions about which hand is used more frequently for 10 types of tasks.

Scores will be given regarding the frequency of hand use in each task. The questions in the questionnaire include: (1) writing, (2) drawing, (3) throwing a ball, (4) holding scissors, (5) brushing teeth, (6) holding a knife, (7) holding a fork, (8) holding a shovel handle, (9) striking a match, and (10) which hand is used to open the lid of a box. The response options are: "always right hand" (+10 points), "usually right hand" (+5 points), "both hands" (0 points), "usually left hand" (-5 points), and "always left hand" (-10 points). The results will be evaluated according to Geschwind's score (GS). The negative values obtained from the questionnaire will indicate left-handedness and the increase in negative values will indicate the degree of left-handed dominance. Conversely, positive values will indicate right-handedness and the increase in positive values will indicate the degree of right-handed dominance. The given values will be examined as the lateralization coefficient (LK) (Menteşe, 2019).

2.3 Volleyball Skill Tests

A five-point scale will be used to evaluate the serve, reception, and spike techniques. The evaluation will be conducted by three different coaches for the above-mentioned techniques. Each technique will be rated on a scale of 1 to 5, with a minimum score of 1 and a maximum score of 5. The topics to be evaluated for each technique are listed below.

2.3.1 Evaluation of Serve Performance

- a) Stance,
- b) Throwing the ball to the correct spot,
- c) Proper hitting technique,
- d) Aiming for the target.

2.3.2 Evaluation of Reception Performance

- a) Body position,
- b) Arm posture,
- c) Body rotation direction,
- d) Reception to the target.

2.3.3 Evaluation of Spike Performance

- a) Footwork,
- b) Moment of meeting the ball in the air,
- c) Weight transfer,
- d) Target point.

2.4 Statistical Method

At the end of the study, the data obtained were statistically analyzed using the SPSS software package (SPSS for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA). The data were presented as arithmetic mean and standard deviation. The Shapiro-Wilk test was used for normality testing, and the Levene test was applied for homogeneity testing. For data sets that did not show normal distribution, skewness and kurtosis values were checked, and data sets within the ± 2 value range were considered to follow a normal distribution. A one-way ANOVA test was applied to analyze the differences between multiple groups. Tukey's correction test was used to determine which variable showed the difference. Statistical results were evaluated at a significance level of $p < 0.05$. Additionally, Pearson correlation analysis was used to determine the relationship between the Service, Smash, Reception, and Lateralization Coefficient scores.

3. Results

At the end of the study, the data obtained were statistically analyzed using the SPSS software package (SPSS for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA). The data were presented as arithmetic mean and standard deviation. The Shapiro-Wilk test was used for normality testing, and the Levene test was applied for homogeneity testing. For data sets that did not show normal distribution, skewness and kurtosis values were checked, and data sets within the ± 2 value range were considered to follow a normal distribution. A one-way ANOVA test was applied to analyze the differences between multiple groups. Tukey's correction test was used to determine which variable showed the difference. Statistical results were evaluated at a significance level of $p < 0.05$.

Table 1: Descriptive Statistics

	Avg.	SS
Age	23.2	2.07
Serve	13.6	4.70
Pass	13.0	4.55
Spike	12.8	4.71
LC	59.9	52.53

When the descriptive characteristics of the participants were examined, it was found that the average age was 23.2 ± 2.07 years; the average serve performance score was 13.6 ± 4.70 points, the average pass performance score was 13 ± 4.55 points, the average spike

performance score was 12.8 ± 4.71 points, and the average lateralization coefficient was 59.9 ± 52.53 points.

Table 2: The Statistical Analysis of Serve, Spike, and Pass performance Scores According to Dominant Hand Type

		Avg.	SS	F	p
Serve	Right	13.7	4.71	0.043	0.958
	Left	13.5	5.52		
	Both hands	13.3	3.65		
Pass	Right	13.0	4.60	0.148	0.863
	Left	13.6	4.77		
	Both hands	12.6	4.07		
Spike	Right	12.9	4.68	0.663	0.518
	Left	13.2	5.39		
	Both hands	11.0	3.96		

In Table 2, the comparison of the average service, pass, and spike performance scores of the participants in the volleyball skill tests based on their dominant hand preferences is presented. According to the results of the one-way analysis of variance (ANOVA), no statistically significant differences were found within the groups for service, pass, and spike performance scores ($F = 0.043$, $p = 0.958$; $F = 0.148$, $p = 0.863$; $F = 0.663$, $p = 0.518$).

Table 3: The Correlation Analysis of the Parameters of service, Spike, Pass, and Lateralization Coefficient

		Serve	Pass	Spike
Pass	r	0.851	-	
	df	106	-	
	p	0.001	-	
Spike	r	0.805	0.838	-
	df	106	106	-
	p	<0.001	<0.001	-
LC	r	-0.027	-0.080	-0.044
	df	106	106	106
	p	0.785	0.413	0.652

According to the results of the Pearson correlation analysis applied to determine the relationship between the service, spike, pass, and lateralization coefficient scores, a statistically significant positive high-level relationship ($r > 0.8$) was found between the service, spike, and pass scores. However, no statistically significant relationship was found between the lateralization coefficient score and the performance scores obtained from the volleyball skill test ($p > 0.05$).

4. Discussion and Conclusion

The results of the research on the impact of cerebral lateralization on volleyball skills are as follows:

When examining the descriptive characteristics of the participants, it was found that the average age was 23.2 ± 2.07 years, the average service performance score was 13.6 ± 4.70 points, the average pass performance score was 13 ± 4.55 points, the average spike performance score was 12.8 ± 4.71 points, and the average lateralization coefficient was 59.9 ± 52.53 points.

It was observed that 18.5% of the research sample was 20 years old, 13% was 21 years old, 5.6% was 22 years old, 9.3% was 23 years old, 3.7% was 24 years old, and 50% was 25 years old.

According to the frequency analysis of the participants' lateralization coefficient, right-handedness was found to be higher than left-handedness. According to the ex post facto experimental design, those with scores below -20 were considered left-handed, scores between -20 and +55 were considered ambidextrous, and scores above +55 were considered right-handed.

The comparison of the average service, pass, and spike performance scores of participants according to their dominant hand preference was conducted. According to the results of the one-way analysis of variance, no statistically significant differences were found in the service, pass, and spike performance scores between the groups ($F = 0.043$, $p = 0.958$; $F = 0.148$, $p = 0.863$; $F = 0.663$, $p = 0.518$).

The results of the Pearson correlation analysis to determine the relationship between service, spike, pass, and lateralization coefficient scores revealed a high positive statistically significant relationship between the service, spike, and pass scores ($r > 0.8$), while no statistically significant relationship was found between the lateralization coefficient and performance scores from the volleyball skill test ($p > 0.05$).

Apart from the perceptual advantages or disadvantages related to hand preference, studies in the literature largely support the hypothesis that left-handed individuals tend to have larger right hemispheres and thus exhibit more developed motor and spatial functionality abilities (6, 12), as well as shorter reaction delay times (16, 1, 3, 4).

However, Williams and Ericsson (2005) have stated that such hand preference-based differentiation is unlikely to reflect true performance in sports (17). While the fact that one hemisphere is heavier than the other is considered an anatomical cerebral lateralization, hand preference is regarded as functional cerebral lateralization (13).

In a study by Gabbett (2007), the ability to distinguish talent based on physiological, anthropometric, and volleyball technical skill test results was measured among 28 young volleyball players. The results revealed significant differences in the technical skills based on the data collected from the athletes' service and finger pass tests. While the present results clearly show that service and pass techniques are important for predicting a skilled athlete, the prediction equations developed in this study, as well as any models derived, may not be directly applicable to elite volleyball players because they are most suitable for the population from which they were derived (5).

Gabbett, Georgieff, Anderson, Cotton, Savovic, and Nicholson (2006) examined changes in volleyball-specific basic technical skills following 8 weeks of volleyball-specific skill-based training. The subjects underwent skill measurements (pass, pass,

serve and spike technique), standard anthropometry (height, standing reach, body mass, and the sum of 7 skinfolds), lower extremity muscle strength (vertical jump), upper extremity muscle strength (overhead medicine ball throw), speed (5 and 10 m sprints), agility (T-test), and maximum aerobic power (multistage fitness test). The training results showed significant ($p < 0.05$) improvements in spike, pass, and finger pass technique, while no significant difference was found in body mass, skinfold thickness, lower extremity muscle strength, upper extremity muscle strength, and maximal aerobic power before and after the training. The research has shown that skill-based volleyball training significantly improves players' technical abilities, particularly in basic volleyball movements like spike, pass, and finger pass, with noticeable improvements in their accurate and effective execution. It has been clearly observed that such training elevates players' in-game skills to a higher level. However, the same studies also indicate that these technique-focused workouts do not have a significant effect on players' physiological and anthropometric characteristics. In other words, changes and improvements in players' physical structures are shaped by external factors such as genetic factors, nutrition, sleep quality, and overall health status, independent of skill development training. Therefore, these findings highlight that training is highly effective in increasing technical skills, but it has a limited impact on changing players' body measurements, muscle structure, or endurance. This situation underscores the necessity of conducting both technical and physical training simultaneously in athlete development (5).

As a result, success in volleyball is not solely based on physical strength; it is a process where technical skills, tactical abilities, and proper training habits come together. Teaching fundamental movements such as passing, receiving, blocking, spiking, and serving correctly based on a solid foundation allows athletes to perform at higher levels both individually and as part of a team. This process is a factor that directly impacts both the athlete's career development and the overall success of the team. Therefore, addressing both technical and tactical components together in volleyball training plays an important role in advancing the sport at both individual and societal levels.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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