10.61186/aassjournal.1535

Ann Appl Sport Sci InPress(InPress): e1535.

e-ISSN: 2322-4479; p-ISSN: 2476-4981

ORIGINAL ARTICLE

The Effect of Neurobics Exercises Based on Brain Dominance on Movement Satisfaction and the Performance Level of Some Basic Skills with the Non-Preferred Foot in Football

[1]Marwan Abdul Latif Abdul Jabbar*, [2]Mohamed Abdulqader Abdulrahman, [1]Khalil Ibrahim Suleiman

[1]College of Physical Education and Sport Sciences, University of Anbar, Anbar, Iraq.
[2]General Directorate of Education in Anbar, Anbar, Iraq.
***. Corresponding Author: Marwan Abdul Latif Abdul Jabbar**; **E-mail:** pe.w_ma1978@uoanbar.edu.iq

Submitted February 14, 2025;
Accepted May 05, 2025.

KEYWORDS
Neurobics,
Motor Satisfaction,
Football Training,
Non-Preferred Foot,
Basic Skills.

ABSTRACT

Background. Neurobics techniques have been suggested as a training tool to improve the athlete's cognitive and motor performance. These exercises may enhance coordination, brain dominance, and performance in footballers, particularly with non-preferred feet. **Objectives.** This study aimed to examine the effect of Neurobics exercises on motor satisfaction and the performance of basic skills using the non-preferred foot among football players. **Methods.** The experimental study was conducted on 24 male players, purposively selected from the southern training center affiliated with the General Directorate of Education in Anbar. Players were divided based on brain dominance, and Neurobics exercises were incorporated into the main section of the training unit for 12 weeks, with two training sessions per week. The primary outcome variables included motor satisfaction, passing accuracy, and shooting accuracy using the non-preferred foot. These variables were assessed before and after the training period. **Results.** Experimental groups participating in the exercises demonstrated improved motor satisfaction and enhanced basic football skills. Post-test improvements were statistically significant in motor satisfaction (mean difference = 7.30, $t=3.93$, $p<0.05$), passing (mean difference = 1.70, $t=7.98$, $p<0.05$), and shooting (mean difference = 2.20, $t=6.14$, $p<0.05$), indicating the effectiveness of the Neurobics training on the non-preferred foot. **Conclusion.** The study demonstrates that Neurobics exercise methods effectively improve motor coordination while supporting the development of fundamental football skills. The exercises, implemented by the team coaches, are recommended in combination with additional training methods to enhance performance across different sports activities and age groups.

INTRODUCTION

The rapid advancements in various aspects of life have led to remarkable progress in all fields, including sports in general and football in particular. Football is characterized by its high-speed gameplay and the significant physical, technical, tactical, and psychological pressures it imposes. These factors directly affect brain functions and a player's ability to maintain focus throughout training or competition. Consequently, it becomes imperative for coaches

to design mentally oriented exercises tailored to players' levels while accounting for the game's specificity, ensuring they reach higher performance levels and achieve success (1).

Relying solely on the dominant or preferred brain hemisphere in sports activities can limit players in selecting appropriate motor responses to encountered situations and delay their decision-making processes, negatively affecting their overall performance (2).

Hence, training our muscles and brains is essential for maintaining mental capacities, acquiring new motor programs, and sustaining long-term cognitive growth. As Miller et al. (3), "Mental exercises are the means to maintain optimal brain performance, especially as the brain is humanity's most distinguishing feature, elevating us to the top of the hierarchy of all creatures. Therefore, efforts must be made to stimulate and strengthen it."

Neurobics exercises represent a novel approach to brain training that contributes to rapidly expanding the cortical surface area compared to conventional (4). These exercises economize time and effort by activating the less commonly used brain hemisphere and stimulating dormant neural pathways (5). This activation facilitates faster transmission of sensory signals to the brain and enhances memory function in recall and retention (6).

Several studies have confirmed that Neurobics exercises break the monotony of traditional training routines by diversifying players' motor tasks and challenges (7). When players are exposed to novel situations they have not encountered, it stimulates neural pathways in the less-used brain hemisphere, optimizing the cortical surface area and activating neural pathways to reduce motor response time (8).

Engaging in sports activities under varying and dynamic conditions significantly enhances players' satisfaction with their performance (9). Sports psychologists emphasize this dimension as it determines future behaviors by increasing individuals' satisfaction with their level of performance, thereby contributing to achieving excellence and success (10). Researchers define motor satisfaction as an individual's contentment with motor behavior and skill execution. As noted by Iii et al., 2017 (11), "One of the most important factors contributing to superior sports performance is the feeling of satisfaction with one's performance."

Accordingly, the researchers proposed applying Neurobics exercises to non-dominant foot in football (1). Coaches should allocate sufficient time within training sessions for these exercises to assist players in delivering their best on the field (12). Such practices activate the less-used brain hemisphere and train dormant neural pathways to provide precise and quick motor responses, ensuring high-quality performance and enhancing players' satisfaction with their achievements (13). This process builds players' confidence, enabling them to perform at their highest potential (14).

Through the researchers' extensive experience in academic, educational, and sports fields, they have observed significant obstacles and challenges that players encounter during training and competitive matches. These challenges become particularly pronounced in high-pressure or critical situations, negatively affecting player performance and, in some cases, determining the match's outcome (15, 16).

One notable issue is players' slow decision-making and delayed effective motor responses, especially during decisive moments. This limitation often stems from a lack of self-confidence and an over-reliance on their preferred foot during play. The neglect of the non-preferred foot leads to several issues when players are forced to use it, such as:

- Delayed responses to game dynamics: Mental pressure slows response times and reduces the quality of decisions under stress (17).
- Missed opportunities to advance the play or capitalize on favorable situations: Players struggle to adapt dynamically to unexpected game conditions (18).
- Contributing to team performance lapses can ultimately result in match losses: Over-reliance on dominant skills or sides reduces adaptability in high-pressure environments (19).

To address this critical gap in performance, the researchers propose the implementation of Neurobics exercises. These exercises aim to:

- Activate the less-utilized hemisphere of the brain, fostering bilateral brain activity and coordination.
- Encourage the use of the non-preferred foot, thereby expanding players' repertoire of motor responses.
- Prepare the cerebral cortex by increasing the brain's cortical surface area, facilitating quicker and more varied motor responses.

- Enhance players' self-confidence by improving their capability to respond effectively under high-pressure scenarios.

The integration of Neurobics exercises is expected to:

- Enable players to perform with greater adaptability in fast-paced matches, reducing decision-making delays and improving execution under pressure.
- Improve satisfaction with their performance, fostering confidence and resilience.
- Contribute to optimal performance levels, allowing players to make decisive contributions that secure positive match outcomes.

This approach addresses the immediate physical and cognitive challenges faced by players and aligns with the broader goal of enhancing overall performance and resilience in competitive sports.

MATERIALS AND METHODS

Study Scope. The study was conducted at the second football field of Al-Ramadi Sports Club and included 24 male football players from the training centers for juniors aged 16-17 years, affiliated with the General Directorate of Education in Anbar. The training intervention lasted for 12 weeks, from September 2, 2024, to December 2, 2024.

Participants and Sample Selection. The research population consisted of 24 male football players aged 16-17 from the southern training center affiliated with the General Directorate of Education in Anbar. The players were selected using a purposive sampling method based on their commitment to regular training and skill level, ensuring homogeneity. They were divided into two groups according to their brain dominance patterns (right-dominant vs. left-dominant). The sample size represented 100% of the total population in the center. The lack of a traditional control group was due to feasibility constraints related to player availability and institutional schedules. Despite this limitation, the design allowed for the assessment of within-group changes and between-group differences. Future studies are encouraged to apply randomized controlled trial (RCT) frameworks to enhance scientific rigor.

Sample Homogeneity in Research Variables. Before the experiment, a statistical test was conducted to ensure group equivalence across all studied variables. Table 1 displays the homogeneity analysis results, showing no significant differences between the two groups in motor satisfaction, passing, and shooting, confirming initial comparability.

Table 1. Homogeneity of the two research groups (right control - left control) in the investigated variables.

Variables	Right Control (Mean ± SD)	Left Control (Mean ± SD)	t	p
Motor Satisfaction (Degree)	79.20 ± 9.23	80.07 ± 8.43	0.10	0.920
Passing with Non-Preferred Foot (Degree)	1.90 ± 0.73	1.78 ± 0.69	0.38	0.709
Shooting (Score)	2.80 ± 0.91	2.92 ± 0.82	0.35	0.728

The tabulated T-value is 2.074 with 22 degrees of freedom at a significance level 0.05.

Devices and Equipment. The devices used included three electronic timing stopwatches (Cronox, Korea). The equipment comprised one standard football field, 20 official-size footballs, 18 agility markers, 10 training flags, two portable football goals, 20 training jerseys, 40 pens, two whistles, one measuring tape, and a bench.

Psychological Measurements.

Motor Satisfaction Scale. Initially designed by Nelson and Alan, this scale was adapted and translated into Arabic by Mohammed Hassan Allawi. It consists of a six-point Likert scale ranging from "Very High Degree" to "Very Low Degree." The scale has been scientifically validated and was previously applied in the Kurdistan Region of Iraq.

Brain Dominance Scale. Diane Connill from the University of Michigan developed a test in 2005 to determine brain dominance. The test includes 21 items, each containing two options (A and B). Respondents must choose one option per item, with each option corresponding to one side of the brain. The scores for the left and right hemispheres are then totaled to determine dominance (20).

Skill Tests.

Two standardized skill tests were used to measure performance. The Football Passing

Accuracy Test assessed the passing accuracy, while the Football Shooting Accuracy Test (targeting a goal divided into marked squares) measured shooting precision (21, 22).

Field Procedures.

Pilot Study. Conducted on September 2, 2024, with 5 players to assess test clarity, tool functionality, and researcher readiness

Pre-Test. Held on September 5, 2024, at 4:00 PM under consistent environmental and equipment conditions.

Training Intervention. From September 9 to November 28, 2024, each group completed two sessions/week. Players were required to use their non-preferred foot for all Neurobics drills. Exercises were introduced by the team coaches with guidance from the researchers.

Neurobics Exercises Protocol. A 12-week training program was implemented, consisting of two sessions/week (24 sessions total). Each session incorporated 30 minutes of Neurobics exercises in the main part of the session. The focus was to activate the non-preferred foot while integrating cognitive-motor challenges to stimulate less-utilized neural pathways. The protocol is outlined in Table 2.

Post-Tests. Conducted on December 2, 2024, under the same conditions as the pre-tests to ensure comparability.

Statistical Methods. Statistical analysis was performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means and standard deviations) were calculated, and paired sample t-tests were used to evaluate differences between pre-test and post-test scores within each group. Independent sample t-tests were used to compare post-test results between the right- and left-dominance groups. The level of significance was set at $p \leq 0.05$ for all analyses.

Table 2. Neurobics exercises protocol.

Exercise Name	Skill Focus	Duration (min)	Frequency	Cognitive Element
Cross-Dominant Passing	Passing + cognitive challenge	6	Twice per week	Counting backward during passes
Cone Dribbling with Distraction	Dribbling with the non-preferred foot	6	Twice per week	Responding to colored cones
Alternating Target Shooting	Shooting precision	6	Once per week	Identifying shapes/colors at the target
Balance Board Passing	Stability and coordination	6	Once per week	Passing while balancing
Dual Task Drills	Complex motor + mental integration	6	Twice per week	Solving math while performing drills

RESULTS

Pre-Test vs. Post-Test Results for the Right-Dominance Group. The pre-test and post-test results for the right-dominance group reveal statistically significant improvements in all measured variables. Motor satisfaction increased from a mean score of 79.20 (±9.23) in the pre-test to 87.40 (±7.90) in the post-test, with a mean difference of 7.30 ($p \leq 0.05$). Similarly, passing scores improved from 1.90 (±0.73) to 3.60 (±0.96), with a mean difference of 1.70 ($p \leq 0.05$). Shooting scores also showed a significant increase, rising from 2.80 (±0.91) to 5.00 (±0.81), with a mean difference of 2.20 ($p \leq 0.05$). These improvements highlight the efficacy of neurobic exercises in enhancing motor performance, particularly for the non-preferred foot.

Table 3 and Figure 1 provide a visual and numerical comparison of the pre-test and post-test scores for the right-dominance group, further emphasizing the substantial improvements observed in all variables.

Pre-Test vs. Post-Test Results for the Left-Dominance Group. Like the right-dominance group, the left-dominance group demonstrated significant improvements in all measured variables. Motor satisfaction scores increased from 80.07 (±8.43) in the pre-test to 85.14 (±8.16) in the post-test, with a mean difference of 5.21 ($p \leq 0.05$). Passing scores rose from 1.78 (± 0.69) to 2.71 (±0.82), yielding a mean difference of 0.92 ($p \leq 0.05$). Additionally, shooting scores improved from 2.92 (±0.82) to 4.14 (±0.66), with a mean difference of 1.21 ($p \leq 0.05$). Although the left-dominance group exhibited improvements across all variables, the magnitude of these changes was less pronounced than that of the right-dominance group.

Table 4 and Figure 2 illustrate the pre-test and post-test results for the left-dominance group, demonstrating the positive impact of the intervention on motor satisfaction, passing, and shooting.

Table 3. Mean values, standard deviations, T-calculated, and T-tabulated values, and significance of differences between pre-tests and post-tests (Right Hemisphere Dominance).

Variables	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Difference (Δ)	SD of Δ	t	p
Motor Satisfaction (Degree)	79.20 ± 9.23	87.40 ± 7.90	7.30	5.86	3.93	0.004
Passing (Degree)	1.90 ± 0.73	3.60 ± 0.96	1.70	0.67	7.98	<0.001
Shooting (Score)	2.80 ± 0.91	5.00 ± 0.81	2.20	1.13	6.14	<0.001

Tabulated T-value = 2.262 at 9 degrees of freedom ($p \leq 0.05$).

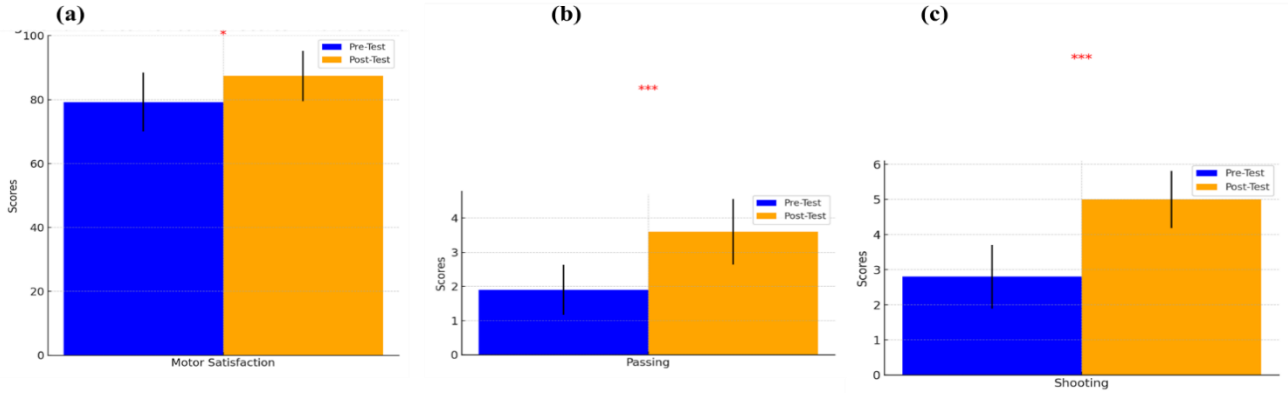

Figure 1. Pre-test vs post-test scores for the right-dominance group for (a) motor satisfaction, (b) passing, and (c) shooting. Error bars represent standard deviations. Asterisks indicate statistical significance: *: $p \leq 0.05$, **: $p \leq 0.01$, ***: $p \leq 0.001$.

Table 4. Mean values, standard deviations, T-calculated, and T-tabulated values, and significance of differences between pre-tests and post-tests (Left Hemisphere Dominance).

Variables	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Difference (Δ)	SD of Δ	t	p
Motor Satisfaction (Degree)	80.07 ± 8.43	85.14 ± 8.16	5.21	4.47	4.35	0.001
Passing (Degree)	1.78 ± 0.69	2.71 ± 0.82	0.92	0.91	3.80	0.002
Shooting (Score)	2.92 ± 0.82	4.14 ± 0.66	1.21	1.05	4.33	0.001

Tabulated T-value = 2.160 at 13 degrees of freedom ($p \leq 0.05$).

Post-Test Comparisons between Groups. Post-test comparisons between the right-dominance and left-dominance groups revealed significant differences in certain variables. While both groups achieved comparable motor satisfaction scores (87.40 ± 7.90 for the right-dominance group and 85.14 ± 8.16 for the left-dominance group; $p > 0.05$), the right-dominance group outperformed the left-dominance group in passing and shooting. The post-test passing scores were 3.60 (±0.96) for the right-dominance group compared to 2.71 (±0.82) for the left-dominance group, with a significant difference ($p \leq 0.05$). Similarly, shooting scores were higher in the right-dominance group (5.00 ± 0.81) compared to the left-dominance group (4.14 ± 0.66), with a significant difference ($p \leq 0.05$).

Table 5 and Figure 3 provide a visual and numerical representation of the post-test comparisons between the two groups, highlighting the superior performance of the right-dominant group in passing and shooting.

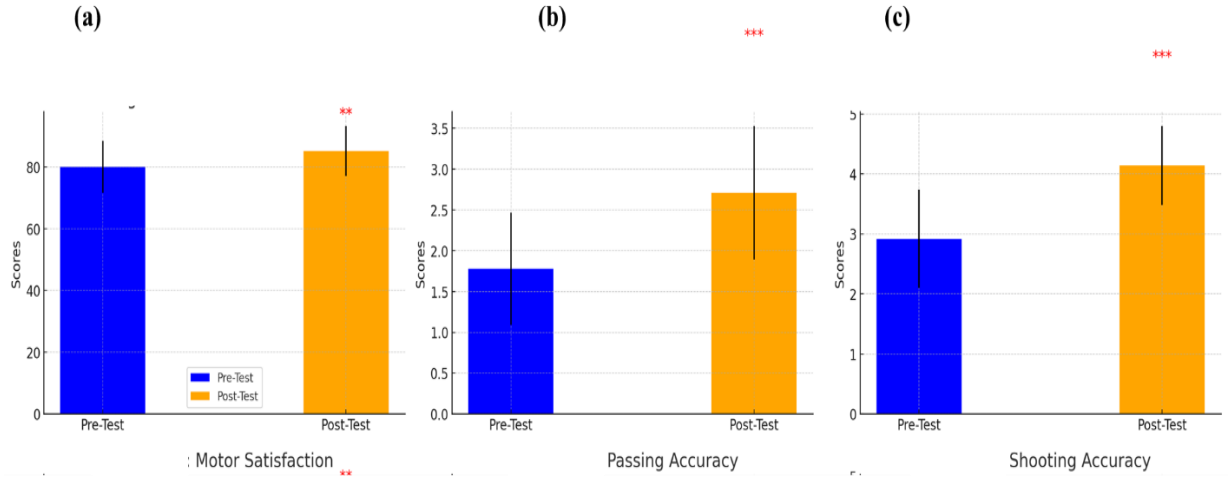

Figure 2. Pre-test vs post-test scores for the left-dominance group for (a) motor satisfaction, (b) passing, and (c) shooting. Error bars represent standard deviations. Asterisks indicate statistical significance: *: p≤0.05, **: p≤0.01, ***: p≤0.001.

Table 5. Mean values, standard deviations, T-calculated, and T-tabulated values, and significance of differences between post-tests of the two experimental groups (Right vs. Left Hemisphere Dominance).

Variables	Right Dominance (Mean ± SD)	Left Dominance (Mean ± SD)	t	p
Motor Satisfaction (Degree)	87.40 ± 7.90	85.14 ± 8.16	0.68	0.503
Passing (Degree)	3.60 ± 0.96	2.71 ± 0.82	2.36	0.027
Shooting (Score)	5.00 ± 0.81	4.14 ± 0.66	2.75	0.011

Tabulated T-value = 2.074 at 22 degrees of freedom (p≤0.05).

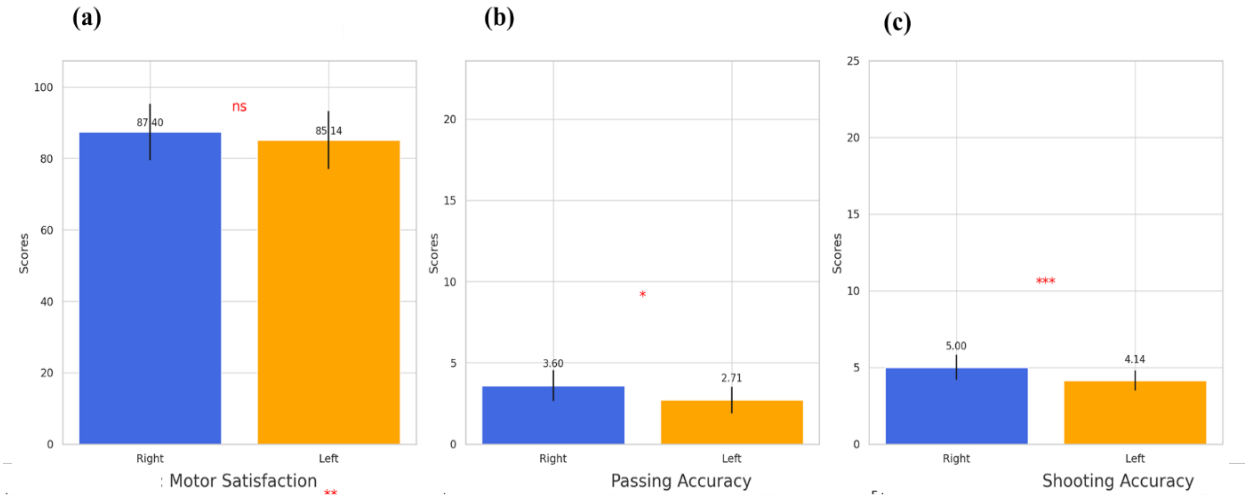

Figure 3. Post-test comparison between right- and left-dominance groups for (a) motor satisfaction, (b) passing, and (c) shooting. Error bars represent standard deviations. Asterisks indicate statistical significance: *: p≤0.05, **: p≤0.01, ***: p≤0.001. 'ns' indicates not significant (p>0.05).

DISCUSSION

The findings of this study emphasize the effectiveness of Neurobics exercises in improving motor satisfaction, passing, and shooting skills across both right-dominant and left-dominant groups. These results highlight the potential of innovative training methods to enhance motor performance, particularly in tasks requiring

bilateral coordination. Below, the key aspects of the findings are analyzed and contextualized within the broader literature.

Impact of Neurobics Exercises on the Right-Dominant Group. The results for the right-dominance group, shown in Table 3 and Figure 1, reveal significant improvements across all measured variables. Motor satisfaction increased substantially, indicating that the structured intervention positively influenced participants' confidence and proficiency in executing motor tasks. The marked gains in passing and shooting reflect enhanced technical skills and coordination, particularly with the non-preferred foot, often less developed in athletes.

These improvements can be attributed to the Neurobics exercises' ability to stimulate underutilized neural pathways, reducing reliance on dominant patterns and encouraging adaptability (23). The right hemisphere's role in creativity and intuitive processing may further explain the group's greater responsiveness to these interventions (24). As noted in prior research (25), the right hemisphere is highly engaged during novel and non-verbal tasks, making it more adept at adapting to new motor challenges.

Impact of Neurobics Exercises on the Left-Dominant Group. Table 4 and Figure 2 show that the left-dominance group also significantly improved motor satisfaction, passing, and shooting. However, the magnitude of these improvements was generally lower compared to the right-dominant group. This discrepancy suggests that right-dominant participants may have a greater capacity for neural adaptation during bilateral training.

The left-dominance group's smaller gains highlight the importance of tailoring interventions to individual cognitive, motor, and psychological profiles (26). For left-dominant players, incorporating additional strategies, such as visual aids or increased repetition of non-preferred foot tasks, could help bridge the gap in performance improvements (27). These findings align with studies emphasizing the need for customized training programs that account for hemispheric differences in neural activation and motor control (28).

Comparison between Groups. Post-test comparisons between the two groups (Table 5 and Figure 3) revealed significant differences in passing and shooting, favoring the right-dominance group. Passing scores for the right-dominant group were higher, reflecting superior coordination and execution. Similarly, shooting accuracy was greater, highlighting the group's ability to perform under pressure. These results align with the idea that the right hemisphere is more adept at storing and recalling motor patterns, which are critical for executing precise, technical tasks (29).

Interestingly, both groups' motor satisfaction scores were comparable, suggesting that both right- and left-dominant participants experienced similar psychological benefits from the intervention (30). This finding underscores the potential of Neurobics exercises to enhance confidence and engagement, regardless of hemispheric dominance (26).

Various limitations exist within this research, regardless of its positive findings.

- The small number of participants (24 players) at one training center reduces the broad applicability of the study findings. Larger multirepresentative participant groups should be included in future research studies.
- The intervention spanned over 12 weeks to assess immediate effects, yet failed to examine how well the participants retained acquired skills after the program. Future investigations should use follow-up assessments to measure the persistence of obtained benefits.
- No control group implementation would restrict researchers from making effective comparisons. The lack of randomized control trials in future studies will reduce the ability to establish causal relationships between the research variables.
- The study evaluated performance outcomes but did not measure the brain mechanisms responsible for improvement changes. Neurological assessment methods such as EEG and fMRI would uncover more detailed information about Neurobics impact on brain reorganization and motor movement improvement.
- The researcher studied football players as their only subject group. Future studies should investigate the applications of Neurobics across different sports, including bilateral coordination, such as basketball or tennis, and rehabilitation programs for sports injuries.

This study leads to several proposed recommendations:

- Athletic personnel should incorporate Neurobic exercises in training sessions for all

sports where bilateral coordination is vital (such as football, basketball, and tennis).

- Training programs must incorporate non-dominant foot exercises to lower motor asymmetry levels and boost overall performance in athletic skills.
- Sports academies must utilize Neurobics interventions with different age groups since this technique supports the development of early motor skills.
- Research needs to study the retention patterns of Neurobics benefits and evaluate the subjective psychological outcomes, including confidence and satisfaction, relating to the interventions in sports training.
- Researchers should conduct interdisciplinary studies that unite sports science with neuroscience and psychology to identify the neurological origins that lead to Neurobics advantages.
- Assessments should examine the effectiveness of Neurobics in post-injury motor recovery rehabilitation programs for athlete recovery processes.
- The physical education curricula should use Neurobics-based training methods to improve motor learning skills and boost student interest in physical education classes.

Neurobics exercises represent a potential solution beyond regular physical training to improve neurological development. Combining these benefits makes Neurobics exercises a powerful tool for sports training and rehabilitation programs. More research must analyze their capability to work in various athletic environments and clinical applications.

CONCLUSION

Neurobics exercises enhanced motor satisfaction and improved fundamental football skills at passing and shooting tasks, emphasizing the non-preferred foot. Players participating in structured training gained improved coordination, enhanced confidence, and adaptability because the approach successfully corrected their bilateral asymmetry. Scientifically designed interventions show their ability to enhance motor learning and skill development, especially when dealing with high-pressure sports environments.

APPLICABLE REMARKS

- Coaches should incorporate Neurobics exercises into regular training sessions to stimulate underutilized neural pathways, particularly for movements involving the non-preferred foot. This approach improves bilateral coordination, technical skill execution, and motor satisfaction.
- Implementing Neurobics exercises can help reduce performance imbalances between dominant and non-dominant sides, leading to more adaptable and confident players during high-pressure situations.
- Training programs for youth athletes should emphasize non-preferred foot activities supported by cognitive engagement. This dual-task method enhances motor planning and execution, as supported by the significant improvements observed in passing and shooting accuracy.
- Sports science practitioners are encouraged to assess athletes' brain dominance before designing individualized Neurobics routines, optimizing their effectiveness, and ensuring targeted skill development.
- These exercises apply especially to team sports like football, where decision-making and precision using both limbs are critical for competitive success.
- Finally, the Neurobics protocol used in this study can serve as a model for developing training interventions across other age groups and sports that require high-level neuromuscular coordination.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the College of Physical Education and Sports Sciences – University of Anbar for their support throughout the course of this research.

AUTHORS' CONTRIBUTIONS

Study concept and design: Marwan Abdul Latif Abdul Jabbar. Acquisition of data: Mohamed Abdulqader Abdulrahman. Analysis and interpretation of data: Khalil Ibrahim Suleiman. Drafting the manuscript: Marwan Abdul Latif Abdul Jabbar. Critical revision of the manuscript for important intellectual content: Marwan Abdul Latif Abdul Jabbar, Mohamed Abdulqader Abdulrahman, Khalil Ibrahim Suleiman. Statistical analysis: Khalil Ibrahim Suleiman. Administrative, technical, and material support: Mohamed Abdulqader Abdulrahman. Study supervision: Marwan Abdul Latif Abdul Jabbar.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

FINANCIAL DISCLOSURE

The authors report no financial relationships that could influence this research.

FUNDING/SUPPORT

No specific funding grant existed for this research from the public, commercial, or not-for-profit sectors.

ETHICAL CONSIDERATION

Approval for the study was granted by the Scientific Research Ethics Committee of the College of Physical Education and Sports Sciences at the University of Anbar (Approval No. 12401, dated September 4, 2024). All participants provided informed consent before participation.

ROLE OF THE SPONSOR

No sponsors influenced study design or data collection, analysis, interpretation, or manuscript submission decision.

ARTIFICIAL INTELLIGENCE (AI) USE

This manuscript originated without the use of any AI-based tools. The authors performed all research activities for this paper and completed the analysis and manuscript writing independently.

REFERENCES

1. Hötting K, Röder B. Beneficial effects of physical exercise on neuroplasticity and cognition. Neuroscience & Biobehavioral Reviews. 2013;37(9, Part B):2243-57. [doi:10.1016/j.neubiorev.2013.04.005] [PMid:23623982]
2. Tomporowski PD, Pesce C. Exercise, sports, and performance arts benefit cognition via a common process. Psychological bulletin. 2019;145(9):929. [doi:10.1037/bul0000200] [PMid:31192623]
3. Miller K, Dye R, Kim J, Jennings J, O'Toole E, Wong J, et al. Effect of a computerized brain exercise program on cognitive performance in older adults. The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry. 2013;21 7:655-63. [doi:10.1016/j.jagp.2013.01.077] [PMid:23602310]
4. Narnavre ND, Suthar N. Effect of Neurobic Exercises on Cognitive Function in Older Adults. International Journal of Science and Healthcare Research. 2024. [doi:10.52403/ijshr.20240329]
5. Lojovich J. The Relationship Between Aerobic Exercise and Cognition: Is Movement Medicinal? Journal of Head Trauma Rehabilitation. 2010;25:184. [doi:10.1097/HTR.0b013e3181dc78cd] [PMid:20473092]
6. Hacker S, Banzer W, Vogt L, Engeroff T. Acute effects of aerobic exercise on cognitive attention and memory performance: An investigation on duration-based dose-response relations and the impact of increased arousal levels. Journal of Clinical Medicine. 2020;9(5):1380. [doi:10.3390/jcm9051380] [PMid:32397081]
7. Nair RM, Selvam DPS. Effectiveness of Neurobic Exercises on Cognitive Function among Ischemic Stroke Patients. Conference Proceedings. 2024:23-4. [doi:10.18311/DSUPHY/9788195874873/2024/012]
8. Balgaonkar AV. 493 – Effect of Neurobics on Cognition of Student. European Psychiatry. 2013;28:1. [doi:10.1016/S0924-9338(13)75810-3]
9. Zhang W, Wang X, Li X, Yan H, Song Y, Li X, et al. Effects of acute moderate-intensity aerobic exercise on cognitive function in E-athletes: A randomized controlled trial. Medicine. 2023;102. [doi:10.1097/MD.0000000000035108] [PMid:37800783]
10. Hillman C, Erickson K, Kramer A. Be smart, exercise your heart: exercise effects on brain and cognition. Nature Reviews Neuroscience. 2008;9:58-65. [doi:10.1038/nrn2298] [PMid:18094706]
11. Iii R, Montecalbo-Ignacio R, Cardenas R. The Relationship between Perceived Coach Leadership Behaviors and Athletes Satisfaction. International Journal of Sports Science. 2017;2017:196-202.
12. Smith P, Blumenthal J, Hoffman B, Cooper H, Strauman T, Welsh-Bohmer K, et al. Aerobic Exercise and Neurocognitive Performance: A Meta-Analytic Review of Randomized Controlled Trials. Psychosomatic Medicine. 2010;72:239-52. [doi:10.1097/PSY.0b013e3181d14633] [PMid:20223924]

13. Tomporowski P. Effects of acute bouts of exercise on cognition. Acta psychologica. 2003;112 3:297-324. [doi:10.1016/S0001-6918(02)00134-8] [PMid:12595152]
14. Wilke J, Giesche F, Klier K, Vogt L, Herrmann E, Banzer W. Acute Effects of Resistance Exercise on Cognitive Function in Healthy Adults: A Systematic Review with Multilevel Meta-Analysis. Sports Medicine. 2019;49:905-16. [doi:10.1007/s40279-019-01085-x] [PMid:30838520]
15. Parkin BL, Walsh V. Gunslingers, poker players, and chickens 3: Decision making under mental performance pressure in junior elite athletes. Prog Brain Res. 2017;234:339-59. [doi:10.1016/bs.pbr.2017.08.011] [PMid:29031471]
16. Stepanyan L, Lalayan G. Stress resilience and decision-making under pressure: enhancing athletic performance in competitive sports. Georgian medical news. 2024;352-353:32-7.
17. Hepler T. Decision-making in Sport under Mental and Physical Stress. International Journal of Kinesiology and Sports Science. 2015;3:79-83. [doi:10.7575/aiac.ijkss.v.3n.4p.79]
18. Araújo D, Hristovski R, Seifert L, Carvalho J, Davids K. Ecological cognition: expert decision-making behaviour in sport. International Review of Sport and Exercise Psychology. 2017;12:1-25. [doi:10.1080/1750984X.2017.1349826]
19. Matias CJ, Greco PJ. Cognition and action in team ball sports. Ciências & Cognição. 2010;15(1):252-71.
20. Connell JD. Brain-based strategies to reach every learner: Surveys, questionnaires, and checklists that help you identify students' strengths—plus brain-based lessons and activities for engaging every learner. New York: Scholastic Teaching Resources; 2005.
21. Kridasuwarso B, Fachrezzy F, Azmi. Development of a football passing test tool. Gladi : Jurnal Ilmu Keolahragaan. 2024.
22. Praveen A, Mathavan S. Effect of core training on cardio respiratory endurance and shooting for accuracy variables of football players. ZENITH International Journal of Multidisciplinary Research. 2012;2:24-30.
23. Davidson T, Gerguis M, Tremblay F. P684: Neural adaptations following a short-term strength training period: a TMS pilot study. Clinical Neurophysiology. 2014;125:S239. [doi:10.1016/S1388-2457(14)50778-X]
24. Hegner YL, Lee Y-J, Grodd W, Braun C. Comparing tactile pattern and vibrotactile frequency discrimination: a human FMRI study. Journal of neurophysiology. 2010;103 6:3115-22. [doi:10.1152/jn.00940.2009] [PMid:20457848]
25. Noufi T, Zeev-Wolf M. Activating the Right Hemisphere Through Left-Hand Muscle Contraction Improves Novel Metaphor Comprehension. Frontiers in Psychology. 2021;12:729814. [doi:10.3389/fpsyg.2021.729814] [PMid:34744897]
26. Shalabi KM. Neuroscience Of Motor Learning In Adults With Non-Dominant Hand. Journal of Critical Reviews. 2020;7(6):27-30. [doi:10.31838/jcr.07.06.07]
27. Mikheev M, Mohr C, Afanasiev S, Landis T, Thut G. Motor control and cerebral hemispheric specialization in highly qualified judo wrestlers. Neuropsychologia. 2002;40:1209-19. [doi:10.1016/S0028-3932(01)00227-5] [PMid:11931924]
28. Werner S, Hasegawa K, Kanosue K, Strüder HK, Göb T, Vogt T. Martial arts training is related to implicit intermanual transfer of visuomotor adaptation. European journal of neuroscience. 2021;53(4):1107-23. [doi:10.1111/ejn.15034] [PMid:33140877]
29. Coleman S, Zenhausern R. Processing speed, laterality patterns, and memory encoding as a function of hemispheric dominance. Bulletin of the psychonomic society. 1979;14:357-60. [doi:10.3758/BF03329478]
30. Hartikainen KM. Emotion-attention interaction in the right hemisphere. Brain sciences. 2021;11(8):1006. [doi:10.3390/brainsci11081006] [PMid:34439624]