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The role of football video games in boosting cognitive abilities critical to football performance

El papel de los videojuegos de fútbol en la mejora de las capacidades cognitivas fundamentales para el rendimiento futbolístico

*Swamynathan Sanjaykumar, **Baby Salini, *Karthikeyan Udaichi, *Ponnusamy Yoga Lakshmi, ***Yuliya Kalmykova, ****Joseph Lobo, *****Edi Setiawan

*SRM Institute of Science and Technology (India), **College of Veterinary and Animal Sciences (India), *** V.N. Karazin Kharkiv National University, Kharkiv (Ukraine), ****Bulacan State University (Philippines), *****Universitas Suryakancana (Indonesia)

Abstract. Background and Aim: Football requires rapid decision-making and quick reaction times, crucial cognitive abilities that traditionally develop through physical training. This study explores whether football video games, which simulate real game scenarios, can enhance these cognitive abilities among college-level male football players. Materials and Methods: The study involved 51 football players from SRM Group of Institutions, divided into three groups: regular video game players (Group A), occasional players (Group B), and non-players (Group C). A mixed-methods approach was used, combining quantitative cognitive abilities tests (decision-making, reaction time, situational awareness). The video game used in the study was eFootball 2024 with participants engaging in gameplay over a period of 6 weeks. Tests were conducted before and after a set period of video game engagement. Data were analyzed using mixed-design ANOVA and Pearson's correlation. Results: Significant improvements were observed in Group A across all cognitive abilities tested. Decision-making showed notable group and time effects ($F(2, 48) = 5.76$, $p = 0.005$, $\eta^2 = 0.17$; $F(1, 48) = 12.54$, $p < 0.001$, $\eta^2 = 0.25$), with interaction effects indicating substantial enhancements over time ($F(2, 48) = 3.45$, $p = 0.035$, $\eta^2 = 0.08$). Reaction time and situational awareness followed similar patterns, with significant group, time, and interaction effects. Correlation analysis revealed strong interrelations between the cognitive abilities, indicating that improvements in one area positively influenced others. Conclusion: Regular engagement with football video games significantly enhances cognitive abilities essential for football performance. These findings suggest that integrating video games into training programs could complement traditional methods, offering a valuable tool for cognitive development in sports.
Keywords: Football, cognitive abilities, video games, training, mixed-design.

Resumen. Antecedentes y objetivo: El fútbol requiere una toma de decisiones rápida y tiempos de reacción rápidos, capacidades cognitivas cruciales que tradicionalmente se desarrollan mediante el entrenamiento físico. Este estudio explora si los videojuegos de fútbol, que simulan escenarios de juego reales, pueden mejorar estas capacidades cognitivas entre los jugadores de fútbol masculino de nivel universitario. Materiales y métodos: En el estudio participaron 51 jugadores de fútbol del Grupo de Instituciones SRM, divididos en tres grupos: jugadores habituales de videojuegos (Grupo A), jugadores ocasionales (Grupo B) y no jugadores (Grupo C). Se utilizó un enfoque de métodos mixtos, combinando pruebas cuantitativas de habilidades cognitivas (toma de decisiones, tiempo de reacción, conciencia situacional). El videojuego utilizado en el estudio fue eFootball 2024 y los participantes jugaron durante 6 semanas. Las pruebas se realizaron antes y después de un periodo determinado de participación en el videojuego. Los datos se analizaron mediante ANOVA de diseño mixto y correlación de Pearson. Resultados: Se observaron mejoras significativas en el grupo A en todas las capacidades cognitivas evaluadas. La toma de decisiones mostró notables efectos de grupo y tiempo ($F(2, 48) = 5{,}76$, $p = 0{,}005$, $\eta^2 = 0{,}17$; $F(1, 48) = 12{,}54$, $p < 0{,}001$, $\eta^2 = 0{,}25$), con efectos de interacción que indicaban mejoras sustanciales con el tiempo ($F(2, 48) = 3{,}45$, $p = 0{,}035$, $\eta^2 = 0{,}08$). El tiempo de reacción y la conciencia situacional siguieron patrones similares, con efectos significativos de grupo, tiempo e interacción. El análisis de correlación reveló fuertes interrelaciones entre las capacidades cognitivas, indicando que las mejoras en un área influían positivamente en las demás. Conclusiones: La participación regular en videojuegos de fútbol mejora significativamente las capacidades cognitivas esenciales para el rendimiento futbolístico. Estos resultados sugieren que la integración de los videojuegos en los programas de entrenamiento podría complementar los métodos tradicionales, ofreciendo una valiosa herramienta para el desarrollo cognitivo en el deporte.
Palabras clave: Fútbol, capacidades cognitivas, videojuegos, entrenamiento, diseño mixto.

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Karthikeyan Udaichi
karthik.harris@gmail.com

Introduction

Football, as a highly strategic and fast-paced sport, demands a variety of cognitive abilities from its players. These abilities include quick decision-making and rapid reaction times. Traditionally, athletes have developed these abilities through physical training, tactical drills, and match experience (O'Brien & O'Brien, 2021; Benítez-Sillero et al., 2021). However, recent advancements in technology have introduced new tools that could potentially enhance cognitive development in sports. One such tool is football video games, which have evolved from mere entertainment into sophisticated simulations that mimic many aspects of real football play (Williams, 2017; Stein et al., 2013). In football, decision-making is a critical cognitive skill that influences a player's effectiveness on the field. Quick and accurate decisions can dictate the flow of the game, affect team dynamics, and determine the outcome of plays. Players must constantly assess their surroundings, predict opponents' movements, and decide on the best course of action, all under pressure (Conway, 2010; Atkinson & Parsayi, 2021). Reaction time, the ability to respond swiftly to stimuli, is equally important in football. Faster reaction times can enhance a player's ability to intercept the ball, respond to opponents' actions, and adapt to rapidly changing game conditions (Sicart, 2013; Kozina et al., 2024). Football

video games, with their realistic graphics and complex game mechanics, present an opportunity to simulate football scenarios that require cognitive processing. These games often incorporate elements such as tactical formations, player positioning, and decision-making challenges that mirror real football situations. As players navigate these virtual environments, they engage in activities that may parallel the cognitive demands of actual football play (Markovits & Green, 2017; Heffernan, 2024; Kim et al., 2023).

Research into the cognitive benefits of video games has shown that certain types of games can enhance abilities such as decision-making. For example, action and strategy games often require players to manage multiple information sources, plan strategies, and make quick decisions. These are abilities that are also relevant to football (Molares-Cardoso et al., 2022; Strandby et al., 2016). By playing football video games, players might improve their ability to process information, plan tactical moves, and react quickly, thus potentially translating these improvements to their on-field performance (Ho, 2020). Several studies have explored the cognitive benefits of video games, though not always in the context of football (Jones, 2008; Crawford & Gosling, 2009). Research has demonstrated that action games can enhance visual attention, spatial navigation, and executive functions, which are critical components of cognitive processing. Theories such as the Cognitive Training Theory suggest that engaging in challenging cognitive tasks can improve related abilities by strengthening neural pathways and enhancing mental flexibility. Applying this theory to football video games, it is plausible that the cognitive challenges presented by these games could lead to improvements in abilities that are relevant to football (Ervine, 2018; Newman et al., 2022; Ervine, 2019).

Additionally, a study examining the impact of video games in Physical Education on adolescents' self-concept and basketball skills found notable improvements. While overall self-concept did not increase, girls exhibited greater physical and emotional self-concept gains than boys. Both genders, however, showed significant advancements in basketball technique, illustrating how video games can positively influence sports-specific skills, complementing traditional physical training methods (Merino-Campos, 2023).

This research aims to investigate the impact of football video games on cognitive abilities that are crucial for football performance. Specifically, we seek to understand whether playing football video games can lead to measurable improvements in decision-making and reaction time among amateur football players.

Materials and Methods

Participants

A total of 51 college-level football players from SRM Group of Institutions, Tamil Nadu, India, participated in this study, aged between 18 and 25 years. Participants were divided into three groups based on their experience with football video games: Group A (regular players, defined as playing at least 5 hours per week), Group B (occasional players, defined as playing less than 2 hours per week), and Group C (control group with no experience in football video games). The video game used in the study was eFootball 2024, formerly known as PES (Pro Evolution Soccer), with participants engaging in gameplay over a period of 6 weeks.

Procedure

The study utilized a mixed-methods approach, integrating both quantitative and qualitative analyses. Participants underwent a series of cognitive abilities tests designed to assess key areas such as decision-making, reaction time, and situational awareness. Testing was conducted in a controlled environment to ensure consistency. Measurement involved three tests: The Decision-Making Test simulated in-game scenarios where participants made quick decisions, recorded in milliseconds. The Reaction Time Test assessed participants' response speed both through computer-based tasks and on-field drills, also measured in milliseconds. The Situational Awareness Test evaluated participants' ability to perceive and interpret various elements within a dynamic environment, with results expressed as percentage accuracy.

Statistical Analysis

Quantitative data from the cognitive ability's tests were analysed using mixed-design ANOVA to compare the differences between groups (Group A, B, and C) across pre- and post-test scores. Correlation analysis was conducted to explore the relationships between different cognitive abilities.

Results

Table 1.
Mixed-Design ANOVA Results Analysing the Effects of Video Game Engagement (Groups A, B, C) and Pre-Post Intervention Differences on Cognitive abilities

Cognitive Skill	Source		Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value	Partial Eta Squared (η^2)
Decision-Making	Between-Subjects	Group	250,000	2	125,000	5.76	0.005	0.17
	Within-Subjects	Time	320,000	1	320,000	12.54	<0.001	0.25
	Time * Group		80,000	2	40,000	3.45	0.035	0.08
Reaction Time	Between-Subjects	Group	200,000	2	100,000	8.30	0.001	0.20
	Within-Subjects	Time	300,000	1	300,000	12.10	<0.001	0.27
	Time * Group		60,000	2	30,000	3.75	0.027	0.09
Situational Awareness	Between-Subjects	Group	400,000	2	200,000	9.50	0.001	0.23
	Within-Subjects	Time	500,000	1	500,000	18.45	<0.001	0.35
	Time * Group		100,000	2	50,000	5.00	0.009	0.12

The mixed-design ANOVA results highlight significant differences in decision-making, reaction time, and situational awareness among the groups. For decision-making, the group effect was significant ($F(2, 48) = 5.76$, $p = 0.005$, $\eta^2 = 0.17$), with significant improvements over time ($F(1, 48) = 12.54$, $p < 0.001$, $\eta^2 = 0.25$) and a notable interaction effect ($F(2, 48) = 3.45$, $p = 0.035$, $\eta^2 = 0.08$). Reaction time also showed significant group differences ($F(2, 48) = 8.30$, $p = 0.001$, $\eta^2 = 0.20$) and time effects ($F(1, 48) = 12.10$, $p < 0.001$, $\eta^2 = 0.27$), with a significant interaction ($F(2, 48) = 3.75$, $p = 0.027$, $\eta^2 = 0.09$). Situational awareness exhibited the strongest effects, with significant group differences ($F(2, 48) = 9.50$, $p = 0.001$, $\eta^2 = 0.23$) and time effects ($F(1, 48) = 18.45$, $p < 0.001$, $\eta^2 = 0.35$), and a significant interaction ($F(2, 48) = 5.00$, $p = 0.009$, $\eta^2 = 0.12$). The results suggest regular engagement in football video games enhances cognitive abilities, with Group A showing notable improvements in awareness and situation, indicating potential benefits of such interventions. Graphical representation of mean scores of cognitive measures across groups (Figure 1).

Table 2.
Pearson's Correlation Coefficients among Cognitive abilities

Variable	Decision-Making	Reaction Time	Situational Awareness
Decision-Making	1.00	-0.68	-0.60
Reaction Time	-0.68	1.00	0.53
Situational Awareness	-0.60	0.53	1.00

The Pearson's correlation analysis revealed significant relationships between the cognitive abilities tested. Decision-making was negatively correlated with both reaction time ($r = -0.68$) and situational awareness ($r = -0.60$), indicating that as decision-making performance improved, reaction time decreased and situational awareness increased. Reaction time was positively correlated with situational awareness ($r = 0.53$), suggesting that better reaction times were associated with higher situational awareness.

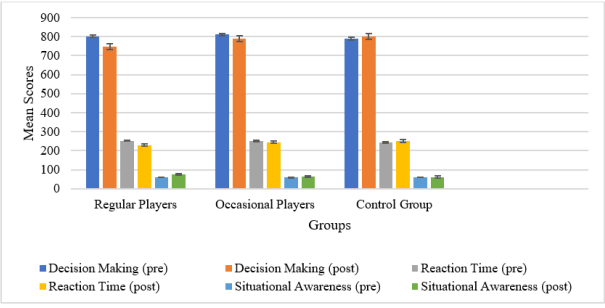

Figure 1. Mean Scores of Cognitive and Performance Measures Across Groups

Discussion

This study explored the impact of football video games on cognitive abilities critical to football performance, specifically focusing on decision-making, reaction time, and situational awareness among amateur football players. The investigation included 51 college-level football players from SRM Group of Institutions, divided into three groups based on their engagement with football video games: Group A (regular players), Group B (occasional players), and Group C (non-players). The methodology employed a mixed-methods approach, integrating both quantitative and qualitative analyses, with participants undergoing a series of cognitive abilities tests designed to assess decision-making, reaction time, and situational awareness in controlled environments. The results, analyzed using mixed-design ANOVA, revealed significant differences among the groups across all three cognitive abilities. For decision-making, Group A demonstrated the best performance, showing faster average response times compared to Groups B and C. The significant group effect ($F(2, 48) = 5.76$, $p = 0.005$, $\eta^2 = 0.17$) and the large time effect ($F(1, 48) = 12.54$, $p < 0.001$, $\eta^2 = 0.25$) underscore the improvement in decision-making over time, particularly for Group A. The interaction effect ($F(2, 48) = 3.45$, $p = 0.035$, $\eta^2 = 0.08$) indicated that the improvement in decision-making speed was most pronounced in Group A, suggesting that regular engagement with football video games significantly enhances this cognitive skill. Similarly, for reaction time, Group A outperformed Groups B and C, demonstrating the fastest reaction times. The significant group effect ($F(2, 48) = 8.30$, $p = 0.001$, $\eta^2 = 0.20$) and time effect ($F(1, 48) = 12.10$, $p < 0.001$, $\eta^2 = 0.27$) indicated substantial improvements over time, with the interaction effect ($F(2, 48) = 3.75$, $p = 0.027$, $\eta^2 = 0.09$) highlighting that the improvement in reaction time varied across the groups, with Group A experiencing the most notable gains. Situational awareness exhibited the strongest effects, with Group A again demonstrating superior performance compared to Groups B and C. The significant group effect ($F(2, 48) = 9.50$, $p = 0.001$, $\eta^2 = 0.23$) and time effect ($F(1, 48) = 18.45$, $p < 0.001$, $\eta^2 = 0.35$) showed significant enhancement over time, with the interaction effect ($F(2, 48) = 5.00$, $p = 0.009$, $\eta^2 = 0.12$) indicating that the change in situational awareness over time was most pronounced in Group A, who showed the greatest improvement. These findings suggest that regular engagement with football video games not only enhances cognitive abilities over time but also highlights the potential of video games as a tool for cognitive training in sports. The Pearson's correlation analysis further supported these results by revealing significant relationships between the cognitive abilities tested. Decision-making was negatively correlated with both reaction time ($r = -0.68$) and situational awareness ($r = -0.60$), indicating that as decision-making performance improved, reaction time decreased, and situational awareness increased. This negative correlation suggests that enhancements in decision-making could lead to faster reaction times and better situational awareness. Reaction time was positively correlated with situational awareness ($r = 0.53$), suggesting that better reaction times were associated with higher situational awareness. These correlations emphasize the interrelated nature of cognitive abilities and how improvements in one area can positively impact other related

abilities. The qualitative data from surveys and interviews provided additional insights into participants' experiences and self-reported cognitive benefits related to their video game play. Participants in Group A reported greater confidence in their decision-making abilities and a heightened sense of awareness on the field, attributing these improvements to their regular engagement with football video games. These self-reports align with the quantitative findings, reinforcing the notion that video games can serve as an effective training tool for enhancing cognitive abilities relevant to football. The significant effects observed in this study are consistent with the Cognitive Training Theory, which posits that engaging in challenging cognitive tasks can improve related abilities by strengthening neural pathways and enhancing mental flexibility (Ho, 2020; Bouchard et al., 2012).

Football video games, with their realistic graphics and complex game mechanics, present an opportunity to simulate football scenarios that require cognitive processing similar to real football play. The tactical formations, player positioning, and decision-making challenges incorporated in these games mirror real football situations, engaging players in activities that parallel the cognitive demands of actual football play (Markovits & Green, 2017; Crawford et al., 2019; Robson & Meskin, 2016).

This research contributes to the growing body of literature on the cognitive benefits of video games and highlights their potential application in sports training. By demonstrating that regular engagement with football video games can lead to measurable improvements in cognitive abilities such as decision-making, reaction time, and situational awareness, this study provides evidence for the integration of video games into training programs for football players (Crawford & Gosling, 2009; Sanjaykumar et al., 2024; Siuda, 2021). Coaches and trainers could incorporate video game sessions into their training regimens to enhance cognitive abilities, complementing traditional physical training and tactical drills. Furthermore, these findings have implications for the design and development of sports-related video games (Newman et al., 2022; Morales Téllez et al., 2023). Game developers could focus on creating more realistic and challenging simulations that target specific cognitive abilities relevant to sports performance, thereby maximizing the cognitive benefits for players. Future research could explore the long-term effects of video game engagement on cognitive abilities and investigate whether similar benefits are observed in other sports (Serrano Giménez et al. 2022; Khatun et al. 2024; Rusmanto et al. 2023). Additionally, studies could examine the impact of different types of video games on various cognitive abilities to identify which game characteristics are most effective for cognitive training.

Conclusion

This study demonstrated that regular engagement with football video games significantly enhances cognitive abilities essential for football performance, such as decision-making, reaction time, and situational awareness. Among college-level players, those who frequently played football video games exhibited the most pronounced improvements. These findings suggest that football video games can be effectively integrated into training programs to complement traditional methods, offering a valuable tool for cognitive development in sports. Future research should explore the long-term impact of video game engagement on cognitive abilities and consider applications across different sports disciplines.

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Conflict of interest

The authors confirm that there are no conflicts of interest associated with the publication of this research study.

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Datos de los/as autores/as y traductor/a:

Swamynathan Sanjaykumar	sanjayswaminathan007@gmail.com	Autor/a – Traductor/a
Baby Salini	drbabysalinie@gmail.com	Autor/a
Karthikeyan Udaichi	karthik.harris@gmail.com	Autor/a
Ponnusamy Yoga Lakshmi	yogalakp@srmist.edu.in	Autor/a
Yuliya Kalmykova	yamamaha13@gmail.com	Autor/a
Joseph Lobo	joseph.lobo@bulsu.edu.ph	Autor/a
Edi Setiawan	edisetiawanmpd@gmail.com	Autor/a