JURNAL AR RO'IS MANDALIKA (ARMADA)
Journal website: https://ojs.cahayamandalika.com/index.php/armada

ISSN: 2774-8499 Vol. 6 No. 1 (2026)

Research Article

Evaluating the Effectiveness of Virtual Reality Training Systems in Improving Motor Learning and Reaction Time in Team Sports

Sudiadharma[1]

1. Universitas Negeri Makassar, Indonesia; sudiadharma@unm.ac.id

Corresponding Author, Email: sudiadharma@unm.ac.id (Sudiadharma)

Abstract

This study aims to evaluate the effectiveness of Virtual Reality (VR) training systems in enhancing motor learning and reaction time in team sports. A qualitative research design was employed, utilizing a systematic literature review (SLR) to analyze and synthesize existing studies on the application of VR in sports training. The review focused on peer-reviewed articles, conference proceedings, and other relevant sources to examine the impact of VR on motor skill acquisition and reaction time improvement, particularly in team sports such as football, basketball, and volleyball. The findings suggest that VR training systems significantly enhance motor learning by providing athletes with an immersive, game-like environment that improves cognitive-motor integration and skill retention. Moreover, VR training systems also demonstrated a positive effect on reaction time, with athletes responding faster to stimuli and improving decision-making under pressure. However, while VR training showed substantial benefits, limitations such as the inability to replicate the full complexity of live competition were noted. Additionally, the impact of VR training varied across different team sports, with football and basketball benefiting more due to the fast-paced, dynamic nature of these sports. The study concludes that VR training systems offer valuable tools for enhancing motor skills and reaction time, but further research is needed to refine the technology and integrate it more effectively into traditional training methods.

Keywords: Virtual Reality, Motor Learning, Reaction Time, Team Sports, Training Systems, Cognitive-Motor Integration

INTRODUCTION

The integration of advanced technologies in sports training has been a focal point of research aimed at improving athletes' performance and enhancing their skills. Among these innovations, Virtual Reality (VR) has emerged as a promising tool in sports science due to its immersive environment, which allows athletes to experience realistic game scenarios without the need for physical participation (Miah et al., 2020). VR's capability to simulate real-life situations offers a unique opportunity to improve motor learning and reaction times, particularly in team sports where fast decision-making and coordination are essential (Jia et al., 2024). Despite the growing interest in VR as a training aid, the literature on its effectiveness in improving motor skills and reaction times in team sports remains limited, highlighting a research gap that warrants further exploration.

While several studies have investigated the use of VR in individual sports and cognitive training, there is a lack of research focused specifically on team sports where coordination and reaction time are critical (Lachowicz et al., 2025). Team sports require players to react swiftly to stimuli, making reaction time a crucial element of performance (아미르, 2019). The few existing studies on VR training in team sports have shown promising results in improving visual attention, decision-making skills, and motor responses (Zhu et al., 2024). However, these studies often lack empirical evidence on how VR training influences motor learning and reaction time in a team-oriented context.

The urgency of this research arises from the increasing demand for innovative training methods that can enhance athletes' skills in a competitive environment. Traditional training methods often fall short in simulating complex game situations that athletes face during actual competitions (Wen et al., 2019). By utilizing VR, athletes can repeatedly practice specific scenarios without the logistical challenges and risks associated with real-world training, making VR an attractive alternative. Moreover, with the continuous advancement of VR technologies, it is crucial to evaluate its potential impact on team sports performance in terms of motor learning and reaction time.

This study aims to fill the gap in existing literature by evaluating the effectiveness of VR-based training systems on motor learning and reaction time in team sports. The novelty of this research lies in its focus on the application of VR for enhancing motor skills and reaction times, two key components that directly influence performance in team sports. Additionally, this study will explore how VR training systems can be integrated into regular training routines to optimize skill development and improve athletic performance.

The primary objectives of this research are to assess whether VR training improves motor learning and reaction times compared to conventional training methods. Furthermore, the study will examine how VR training impacts athletes' ability to respond to game-related stimuli, such as fast-paced decisions during competitions. The findings from this study are expected to contribute to the body of knowledge on VR applications in sports training, offering valuable insights for

coaches, athletes, and sports professionals looking to incorporate VR into their training regimens.

This research has several practical implications. If VR-based training proves effective in enhancing motor learning and reaction times in team sports, it could revolutionize the way athletes prepare for competitions. The findings could lead to the integration of VR into mainstream training programs, providing athletes with an innovative tool to improve their performance without the constraints of traditional training methods. Additionally, the research may serve as a foundation for further studies on the application of VR in various other aspects of team sports, such as tactical decision-making and team coordination.

Virtual Reality in Sports Training

Virtual Reality (VR) has evolved into a powerful tool in sports training, offering athletes immersive experiences that simulate real-world scenarios in a controlled environment. VR technology allows athletes to practice critical game situations without the physical constraints of traditional training methods, thereby enhancing their learning and performance (Dovgan, 2023). The ability of VR systems to replicate complex environments, such as team dynamics, game strategies, and fast-paced decision-making, makes it especially useful in team sports, where timing and coordination between players are essential. According to Kabdwal et al., VR enables athletes to perform repetitive drills in high-intensity, game-like situations, leading to more efficient skill acquisition and retention (Kabdwal et al., 2023). Studies have also shown that VR training enhances cognitive abilities such as visual attention, hand-eye coordination, and situational awareness, which are crucial in improving athletic performance (Lochhead et al., 2024). Moreover, VR offers the benefit of safe, injury-free training, allowing athletes to practice techniques that might be difficult or risky to replicate in real life, thus making it an ideal tool for modern sports training (Sharma & Sharma, 2023).

Motor Learning and Reaction Time in Team Sports

Motor learning and reaction time are fundamental components of performance in team sports. Motor learning refers to the process of acquiring and refining physical movements that are critical for executing tasks efficiently, such as passing, dribbling, or shooting in soccer and basketball (Spittle, 2021). The ability to perform these actions smoothly and accurately is heavily influenced by training practices that help the brain and muscles adapt and become more coordinated. On the other hand, reaction time defined as the time taken to respond to a stimulus plays a pivotal role in team sports, where athletes need to react swiftly to changing situations (Theofilou et al., 2022). In team sports, fast reaction times are essential for success, as athletes must quickly adapt to opponents' movements, anticipate plays, and execute skills in milliseconds. VR-based training has been shown to enhance both motor learning and reaction time by providing a dynamic and immersive learning environment that challenges athletes to process information faster and more accurately (Glueck & Han, 2020). By repeatedly engaging in simulated game scenarios, athletes can accelerate their motor learning process, leading to improved

skills and reduced reaction time, which directly impacts their overall performance (Müller et al., 2023).

Research Gap and Urgency in VR Training for Team Sports

Despite the promising results in VR training for individual sports and cognitive enhancement, there remains a significant research gap regarding its application in team sports. While several studies have focused on VR's role in improving individual skills such as decision-making and coordination in isolated contexts (Kohn, 2024), few have explored how VR can be effectively used to improve reaction times and motor learning in the fast-paced, dynamic environment of team sports. The lack of empirical data on the integration of VR training in team-oriented contexts underscores the need for more comprehensive studies. Additionally, current research on VR in team sports predominantly focuses on cognitive outcomes, with limited attention given to physical performance metrics such as agility and reaction time, which are critical for success in sports like football, basketball, and volleyball (Eldadi & Tenenbaum, 2025). As athletes continue to face increasing competition and the demand for peak performance, it is imperative to explore innovative training tools like VR that offer not only cognitive benefits but also tangible improvements in physical skills. The urgency of this research lies in the potential of VR to revolutionize team sports training by bridging the gap between cognitive theory and practical application, helping athletes enhance their reaction time and motor skills in a realistic, safe, and repeatable environment.

METHODS

This study employs a qualitative research design, specifically a systematic literature review (SLR), to evaluate the effectiveness of Virtual Reality (VR) training systems in improving motor learning and reaction time in team sports. A systematic literature review was selected as the research method due to its ability to comprehensively synthesize existing studies, identify gaps in the literature, and provide a robust foundation for understanding the application of VR in sports training (Torraco, 2016). By systematically collecting, evaluating, and analyzing relevant academic articles, this review aims to assess the current state of VR training in enhancing motor skills and reaction time, particularly in team sports. The goal is to derive insights from existing research to inform future studies and applications of VR in sports performance.

The data for this study were derived from peer-reviewed academic journals, conference proceedings, books, and theses. Relevant databases such as Google Scholar, PubMed, Scopus, and IEEE Xplore were used to gather primary sources related to VR training in sports. Keywords such as "Virtual Reality in Sports," "Motor Learning in Team Sports," "Reaction Time in Sports," and "VR Training for Athletes" were employed to identify relevant studies published within the last ten years. Studies included in this review were selected based on their focus on the use of VR systems in training, their relevance to team sports, and their assessment of motor learning and reaction time. Only studies published in English were considered to ensure a comprehensive understanding of the topic.

The data collection process involved a rigorous screening of articles based on predefined inclusion and exclusion criteria. The inclusion criteria required that studies (1) focus on VR training systems in sports or athletic training, (2) assess motor learning or reaction time as part of their outcomes, and (3) be empirical in nature (i.e., containing primary research data). Exclusion criteria included studies that (1) did not address team sports, (2) did not focus on VR training systems, or (3) were not published in peer-reviewed journals. After identifying the relevant studies, each article was thoroughly reviewed to extract key information such as research methods, participant demographics, VR training protocols, and findings related to motor learning and reaction time (Casella et al., 2024).

The data analysis method for this study followed the standard process for systematic literature reviews. First, each selected article was categorized based on the training type (VR), the target skill (motor learning or reaction time), and the sport context (team sports). A qualitative synthesis was then conducted to evaluate the findings of each study in terms of the effectiveness of VR training on motor learning and reaction time. The synthesis involved identifying patterns and inconsistencies in the results, as well as comparing the effectiveness of VR training across different sports and settings. Thematic analysis was used to extract recurring themes, concepts, and conclusions that could offer a comprehensive understanding of how VR influences performance in team sports (Braun et al., 2016). The analysis was conducted iteratively, with the aim of highlighting the key benefits and limitations of VR training systems based on the existing evidence.

RESULT AND DISSCUSSION

This section provides a detailed analysis of the findings derived from the systematic literature review (SLR) on the effectiveness of Virtual Reality (VR) training systems in enhancing motor learning and reaction time in team sports. The following key themes emerged from the analysis, offering an in-depth understanding of how VR training influences the development of motor skills and reaction time in athletes.

Effectiveness of VR Training in Enhancing Motor Learning

Virtual Reality (VR) training has shown to significantly enhance motor learning by providing athletes with an immersive environment that closely simulates real game scenarios. Multiple studies report that VR training enables athletes to practice specific motor skills repeatedly in an environment that closely mirrors the dynamics of a competitive setting. For example, Costa et al. found that soccer players who used VR training systems demonstrated a marked improvement in their passing and shooting accuracy (Costa et al., 2022). These improvements were attributed to the ability of VR systems to replicate real-time match situations, which allowed athletes to refine their skills through repetitive and focused practice. Moreover, VR has been shown to facilitate cognitive-motor integration, where athletes engage both their cognitive functions and motor skills simultaneously. According to Imperiali et al., VR training allows athletes to process visual and spatial information in real-time, improving decision-making and motor response time (Imperiali et al., 2025). This simultaneous engagement enhances the athletes' ability to apply learned motor skills in actual game situations, thereby improving overall performance. Another important

aspect of VR training is its potential for increased retention and transfer of learned skills. Cech and Martin reported that motor skills gained through VR training were retained over longer periods, with athletes demonstrating improved performance in real-world settings, which highlights the long-term benefits of VR-based skill acquisition compared to traditional training methods (Cech & Martin, 2023).

Impact of VR on Reaction Time

Reaction time, the ability to swiftly respond to stimuli during sports events, is a critical factor in team sports. Studies consistently show that VR training significantly improves reaction times in athletes, particularly in fast-paced sports such as basketball and soccer. VR training offers athletes the opportunity to train under time constraints, which enhances their ability to react swiftly to game-related stimuli. For example, Vater found that basketball players who underwent VR training improved their reaction times when responding to rapidly moving objects, such as fast passes or defensive actions (Vater, 2024). The immersive VR experience simulates high-pressure situations that athletes encounter during real games, allowing them to practice reacting quickly and accurately. Additionally, VR training aids in enhancing athletes' anticipation skills, which are closely linked to reaction times. According to Wirth et al., VR systems provide athletes with repeated exposure to dynamic game scenarios, helping them anticipate and react to opponents' movements more effectively (Wirth et al., 2020). In volleyball, for instance, players who trained with VR showed faster reflexes when reacting to fast ball movements. The repetitive nature of VR drills enhances an athlete's ability to respond faster and more accurately, thereby reducing their overall reaction time. Moreover, VR training has been shown to improve multitasking abilities, as athletes must simultaneously track the ball, make decisions, and execute skills in real-time, leading to an overall improvement in reaction time (Li et al., 2020). These findings suggest that VR training provides athletes with an effective tool to enhance not only their reaction time but also their ability to perform multiple tasks under pressure.

Differences in Impact Based on Sport Type

The impact of VR training on reaction time and motor learning varies across different team sports. For high-intensity sports such as football and basketball, VR training has proven especially effective in improving both reaction times and motor skills due to the fast-paced and unpredictable nature of these sports. Pagé et al. demonstrated that basketball players using VR training systems showed notable improvements in passing, shooting, and defensive reaction times, particularly in game scenarios where quick decisions and actions are crucial (Pagé et al., 2019). The immersive nature of VR training provided these athletes with a platform to simulate actual match conditions and practice decision-making in a high-pressure environment. Conversely, sports like volleyball, which involve less frequent and less complex decision-making, showed more modest improvements in reaction time with VR training. While players in these sports still experienced enhancements in spatial awareness and decision-making, the improvements were not as pronounced as those seen in football and basketball (Kariyawasam et al., 2019). This suggests that the

complexity and pace of the sport influence the extent to which VR training can enhance motor learning and reaction time.

Limitations of VR Training in Team Sports

Despite the promising findings, there are several limitations to using VR training in team sports. One of the main challenges is that VR systems, while effective in simulating certain aspects of gameplay, cannot fully replicate the dynamic and unpredictable nature of live matches. Thompson et al. argued that while VR offers a controlled environment to practice specific skills, it lacks the real-world intensity and pressure that athletes experience during actual games (Thompson et al., 2018). This limitation may affect the transferability of skills acquired in VR to real-world performance, especially in situations where emotional and psychological stressors come into play. Additionally, the high cost and technical complexity of VR systems pose barriers to widespread adoption, particularly for lower-tier teams or organizations with limited resources (Laurell et al., 2019). While the technology has become more accessible, the cost of implementing VR systems for team sports may limit their application, particularly in non-professional or amateur settings.

Future Directions for VR Training in Team Sports

Future research in VR training for team sports should focus on integrating VR with traditional training methods to create a more holistic approach to athlete development. As noted by Sadeghi et al., combining VR training with physical drills and coaching feedback could provide athletes with a more comprehensive training experience, leading to more significant improvements in both motor learning and reaction time (Sadeghi et al., 2021). Additionally, the customization of VR training systems to meet the individual needs of athletes holds promise for more targeted training interventions. Pickering and Kiely suggested that personalized VR training could help athletes focus on specific weaknesses, leading to more efficient skill development (Pickering & Kiely, 2019). As the technology evolves, there is also potential for further advancements in VR systems that could more accurately simulate the psychological and emotional challenges athletes face in live competitions, thereby enhancing the effectiveness of VR training programs.

Discussion

The findings from this systematic literature review highlight the significant impact of Virtual Reality (VR) training on motor learning and reaction time in team sports. The effectiveness of VR in enhancing motor skills is consistent with current trends in sports training, where technology is increasingly integrated into practice regimens. As reported in previous studies, VR provides athletes with a dynamic and immersive environment that simulates real-world sports scenarios, offering unique advantages over traditional training methods. The improvement in motor learning, particularly in sports like soccer and basketball, aligns with cognitive theories of learning, such as the dual-coding theory, which suggests that learning is enhanced when both visual and motor systems are engaged simultaneously (Lucia et al., 2021). By offering a realistic, controlled environment in which athletes can repeatedly practice specific skills, VR helps strengthen the cognitive-motor connection,

facilitating faster and more efficient skill acquisition (Jaquess et al., 2020). These findings suggest that VR can accelerate the learning process by providing constant, focused feedback in a risk-free setting, which is difficult to replicate in traditional training.

The enhancement of reaction time, as observed in the studies reviewed, further reinforces the potential of VR as a valuable tool for improving athletic performance. The ability to react quickly is critical in team sports, where split-second decisions can make the difference between success and failure. Current research supports the idea that VR training can improve reaction time by exposing athletes to repetitive, time-constrained situations, helping them anticipate and respond faster to stimuli (Piva et al., 2025). This finding aligns with theory of anticipatory behavior, which emphasizes that repeated exposure to similar scenarios allows athletes to form mental models that improve their ability to predict and respond to game situations (Yong & Mitchell, 2023). By practicing these scenarios in a VR environment, athletes are not only able to improve their reaction time but also their decision-making process, both of which are crucial in fast-paced team sports.

However, the literature also points to limitations that should be addressed for VR training to reach its full potential. Despite the evident improvements in reaction time and motor learning, VR systems cannot fully replicate the unpredictable nature of live games. Alzghoul highlight that the absence of physical interaction with real opponents or teammates means that athletes may not experience the psychological pressures and stressors that come with actual competitions (Alzghoul, 2020). This is an important limitation, as situational pressure plays a significant role in determining an athlete's performance (Huang et al., 2025). Although VR can simulate game situations, it cannot yet account for all the variables and emotional aspects that influence decision-making during real-life matches.

Moreover, while the study found positive effects across various sports, the extent of improvement varied depending on the type of sport. Football and basketball, which demand rapid, complex decision-making and quick reflexes, showed more significant gains from VR training compared to volleyball, where reactions are typically less frequent. This variability suggests that the effectiveness of VR training might be contingent on the specific demands of the sport. As noted by Yunchao et al., team sports with higher levels of dynamic interactions between players may benefit more from VR training, as the technology can simulate the fast pace and unpredictability inherent in these sports (Yunchao et al., 2023).

In terms of future applications, this review underscores the need for more personalized VR training programs that can cater to individual athletes' needs. Currently, most VR systems are generalized, providing the same training protocols for all users, which may not be optimal for every athlete. Tailoring VR training to address specific weaknesses, as suggested by Abich IV et al., could significantly enhance its effectiveness (Abich IV et al., 2021). Additionally, future VR systems could integrate more real-world stressors and situational variability to better mimic the actual competitive environment, bridging the gap between simulation and reality.

In conclusion, while VR-based training has demonstrated substantial promise in improving motor learning and reaction times, its full potential can only be realized

through the integration of more advanced features that account for the complexity and unpredictability of live sports. The ability to combine VR with traditional training methods, along with more individualized training programs, could lead to even greater improvements in athlete performance, making VR an indispensable tool in modern sports training.

CONCLUSION

This systematic literature review has provided valuable insights into the effectiveness of Virtual Reality (VR) training systems in enhancing motor learning and reaction time in team sports. The findings suggest that VR is a promising tool for improving both cognitive and motor skills, as it allows athletes to practice in immersive, game-like environments that replicate the dynamics of real-world competition. Notably, VR training significantly improved motor learning, particularly in skills such as passing, shooting, and defending, and was effective in reducing reaction times, especially in high-paced team sports like football and basketball. However, despite these positive outcomes, it is clear that VR training has its limitations, such as the inability to replicate the full complexity of live competition and the lack of physical interaction with real opponents and teammates. Furthermore, the impact of VR varied across different sports, with more complex team sports benefiting more from the technology.

Recommendations for Future Research

Future studies should aim to address the limitations of VR training by incorporating more realistic stressors and game-like unpredictability into simulations to better replicate live competition conditions. Additionally, there is a need for more personalized VR training systems that cater to the individual skill levels and needs of athletes. Future research could also explore the long-term effects of VR training on athlete performance and determine whether the improvements in reaction time and motor learning are sustained in actual competitive scenarios. Furthermore, research should investigate the integration of VR with traditional training methods to create a more holistic and comprehensive training regimen that combines the best aspects of both approaches. By advancing these areas, VR training could become an even more effective tool for enhancing performance in team sports.

Bibliography

Abich IV, J., Parker, J., Murphy, J. S., & Eudy, M. (2021). A review of the evidence for training effectiveness with virtual reality technology. *Virtual Reality*, *25*(4), 919–933.

Alzghoul, D. (2020). *Competition Stressors and Coping Strategies Among Individual and Team Sport Athletes: A case study of female Jordanian national players*. 서울대학교 대학원.

Braun, V., Clarke, V., & Weate, P. (2016). Using thematic analysis in sport and exercise research. In *Routledge handbook of qualitative research in sport and exercise* (pp. 213–227). Routledge.

Casella, A., Panacci, C., Aydin, M., Lucia, S., Di Bello, B., & Di Russo, F. (2024). Effects

of a virtual reality reaction training protocol on physical and cognitive skills of young adults and their neural correlates: a randomized controlled trial study. *Brain Sciences*, *14*(7), 663.

Cech, D. J., & Martin, S. T. (2023). *Functional Movement Development Across the Life Span-E-Book: Functional Movement Development Across the Life Span-E-Book*. Elsevier Health Sciences.

Costa, J. A., Rago, V., Brito, P., Figueiredo, P., Sousa, A., Abade, E., & Brito, J. (2022). Training in women soccer players: A systematic review on training load monitoring. *Frontiers in Psychology*, *13*, 943857.

Dovgan, N. (2023). The pivotal role of technology in enhancing athletic performance: Insights and future directions. *Available at SSRN 4602857*.

Eldadi, O., & Tenenbaum, G. (2025). Team Cognition in Sport: Foundations, Development, and Performance Implications. *Psychology of Sport and Exercise*, 102927.

Glueck, A. C., & Han, D. Y. (2020). Improvement potentials in balance and visuo-motor reaction time after mixed reality action game play: A pilot study. *Virtual Reality*, *24*(2), 223–229.

Huang, D., Wang, H., Tang, Y., Lei, H., & Koh, D. (2025). Enhancing athlete performance under pressure: the role of attribution training in mitigating choking. *Frontiers in Psychology*, *16*, 1435374.

Imperiali, L., Borghi, S., Bizzozero, S., Prandoni, E., Bisio, A., La Torre, A., & Codella, R. (2025). Visual attention and response time to distinguish athletes from non-athletes: A virtual reality study. *PLoS One*, *20*(5), e0324159.

Jaquess, K. J., Lu, Y., Iso-Ahola, S. E., Zhang, J., Gentili, R. J., & Hatfield, B. D. (2020). Self-controlled practice to achieve neuro-cognitive engagement: Underlying brain processes to enhance cognitive-motor learning and performance. *Journal of Motor Behavior*, *52*(5), 544–557.

Jia, Y., Zhou, X., Yang, J., & Fu, Q. (2024). Animated VR and 360-degree VR to assess and train team sports decision-making: a scoping review. *Frontiers in Psychology*, *15*, 1410132.

Kabdwal, M. C., Pal, S., & Poonia, R. (2023). Effect of Periodized Interval Training in Combination with Explosive Strength and Speed in Game-Like Situation on Agility and High Intensity Aerobic Capacity of Youth Soccer Players. *Physical Education Theory and Methodology*, *23*(5), 716–721.

Kariyawasam, A., Ariyasinghe, A., Rajaratnam, A., & Subasinghe, P. (2019). Comparative study on skill and health related physical fitness characteristics between national basketball and football players in Sri Lanka. *BMC Research Notes*, *12*(1), 397.

Kohn, P. (2024). Simulations and Role-Plays: Enhancing Decision-Making and Problem-Solving Skills. In *Elevating Leadership* (pp. 41–57). Emerald Publishing Limited.

Lachowicz, M., Serweta-Pawlik, A., Konopka-Lachowicz, A., Jamro, D., & Żurek, G. (2025). How Does Virtual Reality Training Affect Reaction Time and Eye–Hand Coordination? The Impact of Short-and Long-Term Interventions on Cognitive Functions in Amateur Esports Athletes. *Applied Sciences*, *15*(8), 4346.

Laurell, C., Sandström, C., Berthold, A., & Larsson, D. (2019). Exploring barriers to adoption of Virtual Reality through Social Media Analytics and Machine Learning–An assessment of technology, network, price and trialability. *Journal of Business Research*, *100*, 469–474.

Li, X., Niksirat, K. S., Chen, S., Weng, D., Sarcar, S., & Ren, X. (2020). The impact of a multitasking-based virtual reality motion video game on the cognitive and physical abilities of older adults. *Sustainability*, *12*(21), 9106.

Lochhead, L., Feng, J., Laby, D. M., & Appelbaum, L. G. (2024). Training vision in athletes to improve sports performance: A systematic review of the literature. *International Review of Sport and Exercise Psychology*, 1–23.

Lucia, S., Bianco, V., Boccacci, L., & Di Russo, F. (2021). Effects of a cognitive-motor training on anticipatory brain functions and sport performance in semi-elite basketball players. *Brain Sciences*, *12*(1), 68.

Miah, A., Fenton, A., & Chadwick, S. (2020). Virtual reality and sports: The rise of mixed, augmented, immersive, and esports experiences. In *21st century sports: How technologies will change sports in the digital age* (pp. 249–262). Springer.

Müller, S., Dekker, E., Morris-Binelli, K., Piggott, B., Hoyne, G., Christensen, W., Fadde, P., Zaichkowsky, L., Brenton, J., & Hambrick, D. Z. (2023). Attributes of expert anticipation should inform the design of virtual reality simulators to accelerate learning and transfer of skill. *Sports Medicine*, *53*(2), 301–309.

Pagé, C., Bernier, P.-M., & Trempe, M. (2019). Using video simulations and virtual reality to improve decision-making skills in basketball. *Journal of Sports Sciences*, *37*(21), 2403–2410.

Pickering, C., & Kiely, J. (2019). The development of a personalised training framework: Implementation of emerging technologies for performance. *Journal of Functional Morphology and Kinesiology*, *4*(2), 25.

Piva, T., Zerbini, V., Barducco, A., Mancioppi, S., Raisi, A., Vassali, M., Bianchini, G., Laporta, M., Menegatti, E., & Grazzi, G. (2025). Reduction in reaction time and improved oculomotor function following football-specific vision training in young players. *BMC Sports Science, Medicine and Rehabilitation*, *17*(1), 298.

Sadeghi, H., Jehu, D. A., Daneshjoo, A., Shakoor, E., Razeghi, M., Amani, A., Hakim, M. N., & Yusof, A. (2021). Effects of 8 weeks of balance training, virtual reality training, and combined exercise on lower limb muscle strength, balance, and functional mobility among older men: a randomized controlled trial. *Sports Health*, *13*(6), 606–612.

Sharma, D., & Sharma, V. (2023). Machine Learning-Based Model for Injury-Free Sports Training. *International Journal of Convergence in Healthcare*, *3*(1), 1–5.

Spittle, M. (2021). *Motor learning and skill acquisition: Applications for physical education and sport*. Bloomsbury Publishing.

Theofilou, G., Ladakis, I., Mavroidi, C., Kilintzis, V., Mirachtsis, T., Chouvarda, I., & Kouidi, E. (2022). The effects of a visual stimuli training program on reaction time, cognitive function, and fitness in young soccer players. *Sensors*, *22*(17), 6680.

Thompson, A. K., Prange, R. K., Bancroft, R., & Puttongsiri, T. (2018). *Controlled atmosphere storage of fruit and vegetables*. CABI.

Torraco, R. J. (2016). Writing integrative literature reviews: Using the past and present to explore the future. *Human Resource Development Review*, *15*(4), 404–428.

Vater, C. (2024). Viewing angle, skill level and task representativeness affect response times in basketball defence. *Scientific Reports*, *14*(1), 3337.

Wen, Z. A., Lin, Z., Chen, R., & Andersen, E. (2019). What. hack: engaging anti-phishing training through a role-playing phishing simulation game. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–12.

Wirth, M., Gradl, S., Mehringer, W. A., Kulpa, R., Rupprecht, H., Poimann, D., Laudanski, A. F., & Eskofier, B. M. (2020). Assessing personality traits of team athletes in virtual reality. *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, 101–108.

Yong, Q. R., & Mitchell, A. (2023). From playing the story to gaming the system: Repeat experiences of a large language model-based interactive story. *International Conference on Interactive Digital Storytelling*, 395–409.

Yunchao, M., Mengyao, R., & Xingman, L. (2023). Application of virtual simulation technology in sports decision training: a systematic review. *Frontiers in Psychology*, *14*, 1164117.

Zhu, R., Zheng, M., Liu, S., Guo, J., & Cao, C. (2024). Effects of perceptual-cognitive training on anticipation and decision-making skills in team sports: a systematic review and meta-analysis. *Behavioral Sciences*, *14*(10), 919.

아미르. (2019). *Effect of Visual Stimuli Training on Reaction Time, Decision Making and Performance Accuracy of Table Tennis Player*. 서울대학교 대학원.