Original Investigation
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Perception Training Approach for Elite Badminton Players Using Visual Obstacle

Entrenamiento enfocado en la percepción para jugadores de bádminton de élite mediante obstáculos visuales

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Abstract

Badminton is a fast-paced sport that requires not only physical fitness but also strong mental skills like anticipation and quick decision-making. This study introduces a new training method called "One-Way Mirror Perceptual Training", which uses a one-way mirror to block players' view of their opponent, forcing them to rely on their perception and reaction skills instead of visual cues. Twenty male badminton players aged 13-25 were divided into two groups: an experimental group that received the special training for six weeks and a control group that continued with regular practice. The training focused on improving agility, reaction time, coordination, and accuracy. Performance was measured before and after the training using tests like the Four Corner Run Test (FCRT) and agility drills. The experimental group showed significant improvement, with faster reaction times, better movement, and higher performance scores, while the control group had little change. These results suggest that the One-Way Mirror Perceptual Training helps players improve their mental and physical skills, making them more prepared for high-level competition. This study highlights the importance of including perceptual training in badminton and suggests that similar methods could be useful in other fast-paced sports.

Keywords: *Badminton, perceptual training, one-way mirror, anticipation, visual obstacle, sports performance.*

Resumen

El bádminton es un deporte de ritmo rápido que requiere no solo de una buena condición física, sino también de habilidades mentales sólidas, como la anticipación y la rapidez en la toma de decisiones. Este estudio introduce un nuevo método de entrenamiento denominado «Entrenamiento perceptivo con espejo unidireccional», el cual utiliza un espejo unidireccional para bloquear la visión de los jugadores de su oponente para así obligarlos a confiar en sus habilidades de percepción y reacción en lugar de en las referencias visuales. Veinte jugadores hombres de bádminton de entre 13 y 25 años fueron divididos en dos grupos: un grupo experimental que recibió el entrenamiento especial durante seis semanas y un grupo de control que continuó con la práctica habitual. El entrenamiento se centró en mejorar la agilidad, el tiempo de reacción, la coordinación y la precisión. El rendimiento se midió antes y después del entrenamiento mediante pruebas como el Four Corner Run Test (FCRT) y ejercicios de agilidad. El grupo experimental mostró una mejora significativa con tiempos de reacción más rápidos, mejores movimientos y puntuaciones de rendimiento más altas, mientras que el grupo de control apenas experimentó cambios. Estos resultados sugieren que el entrenamiento perceptivo con espejo unidireccional ayuda a los jugadores a mejorar sus habilidades mentales y físicas, y los prepara mejor para la competición de alto nivel. Este estudio destaca la importancia de incluir el entrenamiento perceptivo en el bádminton y sugiere que métodos similares podrían ser útiles en otros deportes de ritmo rápido.

Palabras clave: *bádminton, entrenamiento perceptivo, espejo unidireccional, anticipación, obstáculo visual, rendimiento deportivo.*

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INTRODUCTION

Badminton is widely recognized as one of the most unique and fast-paced racket sports in the world, characterized by its high speed and demanding nature (Kamruddin & Mannan, 2019; Kumar et al., 2023). While physical fitness is a fundamental aspect of success in badminton, it is not the sole determinant. Success in this sport also requires a significant degree of mental agility and strategic thinking (Green & Bavelier, 2008). Players must possess the ability to anticipate the opponent's next move and accurately place the shuttle in response (Kızılet et al., 2024). This mental aspect of the game is as crucial as physical fitness, making it essential for players to cultivate a well-rounded skill set. (Hagemann et al., 2006)

In badminton, players are required to master multi-dimensional competencies, where perceptual abilities are just as important as physical ones (Caserta et al., 2007). To enhance these perceptual skills, players need to develop unconventional perception and anticipation abilities. This goes beyond traditional physical training, requiring specialized brain stimulation and cognitive exercises that are particularly relevant in racket sports (Cece et al., 2020). These perceptual competencies enable players to process visual information quickly, make rapid decisions, and respond effectively during gameplay.

In a typical badminton match, a player's ability to react effectively to their opponent's movements is crucial (Sivamani et al., 2022). For instance, when Player A executes a jump to smash the shuttlecock near the front service line, Player B instinctively anticipates the attack and prepares to defend, often reacting with a sense of urgency or even fear. However, if Player A unexpectedly performs a drop shot instead of a smash, Player B may struggle to respond quickly, leading to a potential loss of the point.

This dynamic changes significantly when a visual obstacle, such as a one-way mirror screen, is introduced. In this scenario, Player B cannot see Player A's movements, which forces them to rely solely on their perceptual and anticipatory skills rather than visual cues. Without the ability to see Player A's actions, Player B may feel less intimidated or anxious, allowing them to focus more on responding to the shuttle's trajectory rather than the opponent's presence. Consequently, Player B might be better prepared for a drop shot, despite the absence of visual information about Player A's movements.

Developing these advanced perceptual skills often involves a range of training methods designed to enhance Global Motion Perception (GMP). Such methods include long-term ball training, sports vision training, stroboscopic training, and visual reaction exercises. Additionally, tools like the Bassin anticipation timer and inertial measurement units (IMU) play a significant role in refining these skills (Russo & Ottoboni, 2019; Kızılet et al, 2024). These techniques are essential for improving vision, reaction time, perception, anticipation, and decision-making across various sports, with a specific focus on enhancing the cognitive aspects of athletic performance.

In the present study, introduce an innovative approach known as visual obstacle one-way mirror screen perceptual training for badminton players. This method is designed to elevate players' perceptual cognitive skills, particularly in the areas of anticipation and rapid decision-making. By utilizing this training, players can better understand and predict their opponent's actions, enabling them to respond swiftly and effectively in competitive scenarios. This approach aims to sharpen a player's ability to counteract the opponent's strategies, thus enhancing their overall performance on the court. (Appelbaum & Erickson, 2018; Broadbent et al., 2015; Russo & Ottoboni, 2019; Farrow, 2013). This can lead to better performance in tournaments and, ultimately, to success at the elite level.

METHOD

Participants

A total of 20 male badminton players were selected for this study. Among these participants, 10 players were randomly assigned to the experimental group, while the remaining 10 players constituted the control group. All participants were from the state of Haryana, India, with an age range between 13 - 25 years. All participants were state-level elite players, training for an average of 15 hours per week in badminton-specific training. Each participant had a minimum of 3-5 years of experience in competitive badminton.

Procedure

In this study, a specialized training setup was employed to assess and enhance the perceptual and cognitive skills of badminton players. The setup involved the use of a one-way mirror screen strategically placed at the midpoint of the badminton court. This screen created a unique visual barrier between the server (feeder) and the receiver (participant). The one-way mirror allowed the server, who could be one of up to five coaches, to have a clear view of the participant's court side and movements, while the participant was unable to see the server's side of the court. This setup was crucial for isolating the participant's perceptual skills, forcing them to rely on anticipation and reaction rather than visual cues from the server. Participants in the experimental group underwent one-way mirror screen training for 3 hours per week.

Variables and Training

The experimental group underwent 42 days of One-Way Mirror Screen training, while the control group did not participate in this specific training. Instead, the control group continued with their regular gameplay practice, which was considered a limitation in assessing the impact of the training. During the training sessions, the feeder served the shuttle to various designated positions on the participant's side of the court, which were randomly numbered as 1, 2, 3, or 4. The participant's task was to return the shuttle to a specific target area predetermined by the coach. This target area remained consistent throughout the session, ensuring that the participant focused on precision and accuracy in their returns. The number of successful returns to the designated target area was recorded as a scoring metric figure 1 shows perceptional training platform. Additionally, the time taken by the participant to complete each return and complete cycle was carefully noted, providing a measure of the participant's reaction time and decision-making speed. The variables assessed in this study included agility, reaction time, anticipation, neuromuscular coordination, eye-hand coordination, speed play, and accuracy. Agility was assessed using the T-test, reaction time with a reaction timer, anticipation with anticipation drills, neuromuscular coordination with coordination exercises, eye-hand coordination using hand-eye coordination tasks, speed play with sprint tests, and accuracy with target hitting drills.

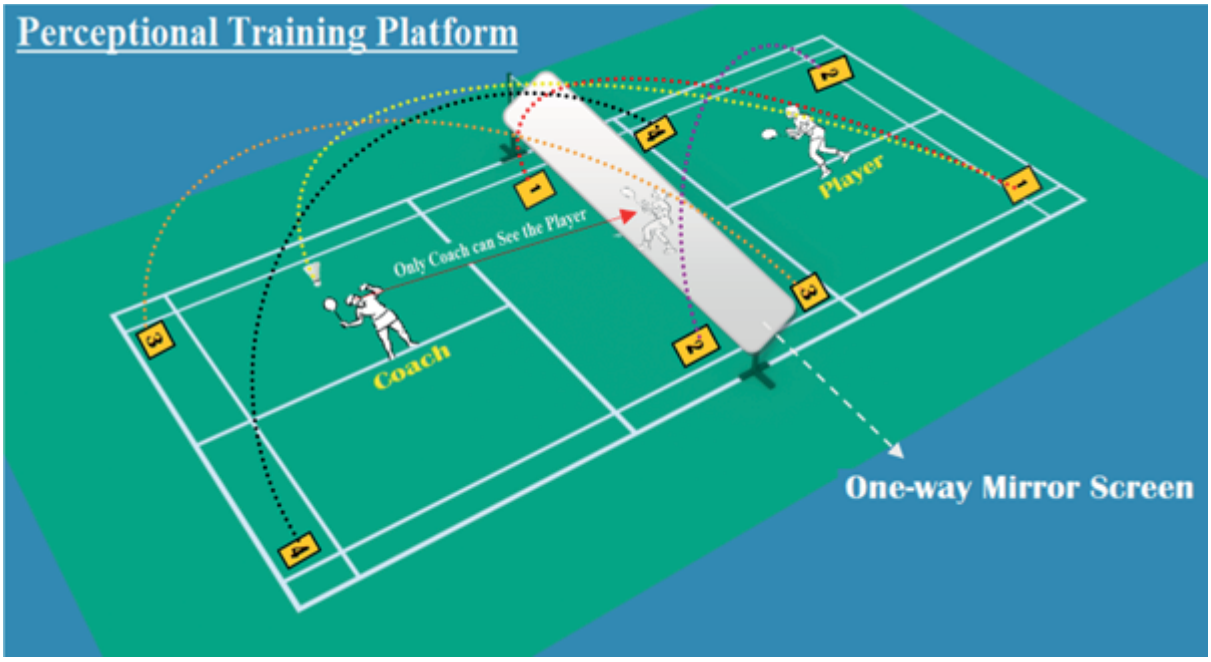

Figure 1. The Visual Obstacle tool as a "One-way Mirror Screen" in the perceptual training platform used for during training and assessment.

The Perceptual Training Approach incorporated in this study involved an X-shaped four-corner training pattern. This pattern required the participant to cover multiple areas of the court, enhancing their agility and spatial awareness while also improving their ability to anticipate the shuttle's trajectory. The combination of these elements aimed to sharpen the player's cognitive processing and quick decision-making under conditions that simulated the unpredictability of real match scenarios.

The effectiveness of the training program was rigorously evaluated by comparing the players' performance before and after the intervention. Pre-training and post-training assessments, consisting of the best of 3 trials, were conducted, and the best timing from these trials was calculated for this study, with particular attention paid to improvements in the accuracy of shuttle returns, the speed of decision-making, and overall court coverage. Further assessment of the training impact on the off-court test was conducted using an agility T-test. The data collected provided valuable insights into the impact of the One-Way Mirror Perceptual Training on the participants' ability to anticipate and respond to game situations, ultimately contributing to enhanced performance on the badminton court.

RESULTS

The paired t-test analysis reveals significant differences in the performance of the experimental and control groups. For the experimental group, the mean agility score improved from 11.14 seconds (pre-test) to 10.11 seconds (post-test), with a mean difference of

1.03 seconds. The t ratio of 10.88, which is more than the table value of 2.26 at a 0.05 significance level, and a p-value of 1.75 (below 0.05) indicate a statistically significant improvement due to the training. The control group showed a small change in mean agility scores, from 11.13 seconds (pre-test) to 11.12 seconds (post-test), with a mean difference of only 0.009 seconds. The t ratio of 1.71, which is below the table value, and a p-value of 0.12 (above 0.05) suggest no significant change in performance. Figure 2 shows the performance of the experimental and control groups for agility.

Table 1.
Paired t-test for Experimental and control group (Agility T-Test)

Groups	Test	Mean	N	Std. Dev	SEM	DM	t ratio
Experimental	Agility Pre-test	11.14	10	0.55	0.17	1.03	10.88*
	Agility Post-test	10.11	10	0.49	0.15		
Control	Agility Pre-test	11.13	10	0.56	0.17	0.09	1.71
	Agility Post-test	11.12	10	0.56	0.18		

Note: Significance level at 0.05

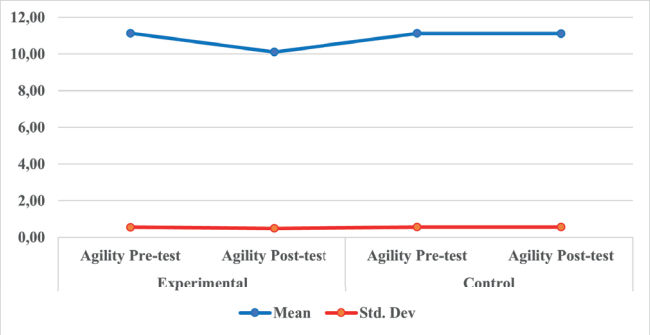

Figure 2. Performance of the experimental and control groups for agility

Table 2.
Four Corner Run Test (FCRT)

Groups	Test	Mean	N	Std. Dev	SEM	Mean Difference	t ratio
Experimental	FCRT Pre-test	10.968	10	0.690	0.218	1.224	6.968*
	FCRT Post-test	9.744	10	0.673	0.213		
Control	FCRT Pre-test	10.917	10	0.643	0.203	0.071	1.578
	FCRT Post-test	10.846	10	0.647	0.204		

Note: Significance level at 0.05

In the Four Corner Run Test (FCRT), the experimental group showed a significant improvement between the pre-test and post-test, with the mean score decreasing from 10.968 to 9.744. The calculated t ratio of 6.968 is significantly higher than the table value of 2.262 at a 0.05 significance level with 9 degrees of freedom, indicating statistical significance ($p < 0.05$). The control group showed a small change, with pre-test and post-test means of 10.917 and 10.846, respectively. The t ratio for the control group was 1.578, which is below the table value of 2.262, suggesting that the difference is not statistically significant ($p > 0.05$). These results highlights that the training significantly improved the experimental group's FCRT, while in the control group, there were no significant changes. Figure 3 shows performance of the four-corner run test (FCRT) timing.

Table 3.
Performance Score (PS)

Groups	Test	Mean	N	Std. Dev	SEM	Mean Difference	t ratio
Experimental	PS Pre-test	94	10	11.734	3.711	15	6.708*
	PS Post-test	109	10	7.378	2.333		
Control	PS Pre-test	93	10	8.234	2.604	2	0.802
	PS Post-test	91	10	7.378	2.333		

Significance level at 0.05

In the Performance Score (PS) test, the experimental group showed a significant performance improvement, with the mean score increasing from 94 in the pre-test to 109 in the post-test. This significant improvement, reflected by a mean difference of 15 and a t ratio of 6.708, is more than the table value of 2.262 at a 0.05 significance level with 9 degrees of freedom, indicating statistical significance ($p < 0.05$). The control group showed a slight decline in scores, with pre-test and post-test means of 93 and 91, respectively. The mean difference of 2 and a t ratio of 0.802 are below the table value of 2.262, suggesting that the observed change is not statistically significant ($p > 0.05$). These results highlight that the training significantly improved the experimental group's performance scores, while in the control group, there were no significant changes. Figure 4 shows performance score (PS) for 4 corners.

The 4-corner assessment showed that right-handed players moved more quickly to the right-side corners, both front and back, compared to the left-side corners. The mean time to reach the right-side corners was significantly lower than the time to reach the left-side corners, indicating a potential area for targeted training to balance their movement efficiency across all directions.

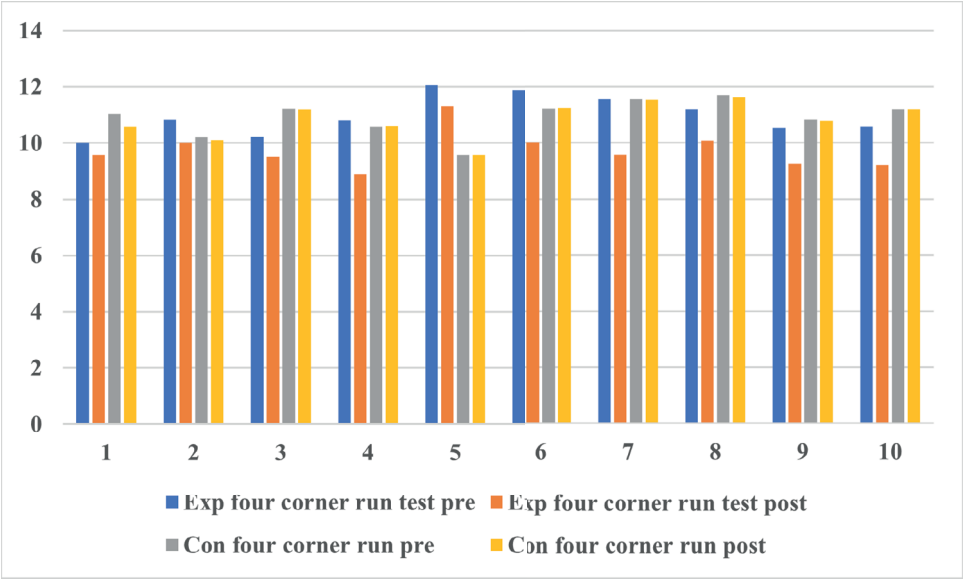

Figure 3. Performance of the Four Corner Run Test (FCRT) timing.

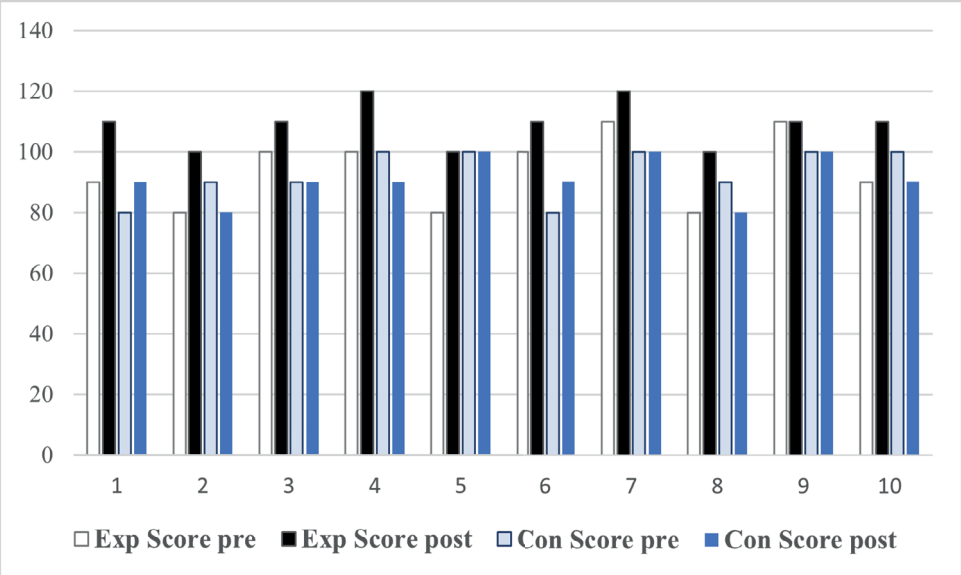

Figure 4. Performance Score (PS) for 4 corners.

DISCUSSION

The findings of this study offer valuable insights into the role of perceptual training in enhancing badminton performance. The implementation of the One-Way Mirror Screen as a training tool has shown considerable potential in developing critical skills that are essential for competitive play. This research demonstrates that incorporating visual obstacle training can significantly boost a player's agility (Kızılet et al, 2024), allowing them to move more efficiently and react swiftly to their opponent's actions.

In addition to physical agility, the study reveals that perceptual training markedly improves players' ability to anticipate their opponent's next move. Anticipation is a key element in badminton, where the speed of play demands rapid decision-making (Kızılet et al, 2024). The enhancement of this skill suggests that players who engage in such training may gain a strategic edge, being better prepared to counteract their opponent's strategies (Loffing et al., 2015).

The study also indicates a positive impact on neuromuscular coordination, which is crucial for executing precise movements and maintaining control during high-intensity rallies (Cece et al., 2020). The improvement in this area suggests that the training method used not only benefits perceptual abilities but also translates into more effective physical execution on the court.

Another significant aspect highlighted by the research is the enhancement of visual tracking and eye-hand coordination (Faber et al., 2019; Vickers, 2011). These improvements are fundamental to a player's ability to follow the shuttle's trajectory accurately and respond with precision (Russo & Ottoboni, 2019). The

findings suggest that visual obstacle training could be particularly effective in honing these skills, which are often the difference between success and failure in high-stakes matches. (Williams et al., 2003; Hassan El-Gezawi, 2015).

The study also emphasizes the role of speed and accuracy, two elements that are intrinsically linked in badminton. The improvements observed in these areas further support the notion that perceptual training is an effective approach for developing a comprehensive skill set in players (Russo & Ottoboni, 2019).

The six-week training program utilizing the One-Way Mirror Screen had a significant impact on the performance of the experimental group compared to the control group (Farrow, 2013). Participants who underwent this specialized training demonstrated notable improvements in agility, reaction time, and decision-making, outperforming those who did not receive the intervention (Hopwood et al., 2011)

The One-Way Mirror Screen proved to be an effective tool in challenging and enhancing the players' perceptual and cognitive abilities, leading to superior performance outcomes. The training program also improved the players' ability to anticipate their opponent's moves and react quickly, suggesting that operating with limited visual information sharpened their focus and court awareness (Poliszczuk & Mosakowska, 2009). These findings highlight the potential of the One-Way Mirror Screen as an innovative addition to traditional training regimens, emphasizing the importance of perceptual training in developing the mental (Gobet, 2000) and physical coordination essential for success in badminton.

Overall, this study not only supports the integration of perceptual training into badminton practice but also opens the door for further exploration into how these methods can be applied across different sports (Appelbaum & Erickson, 2018). The promising results suggest that future research should continue to explore innovative training techniques that challenge traditional approaches, thereby contributing to the evolution of sports performance training (Roberts et al., 2019).

CONCLUSION

This research significantly contributes to the understanding of the effectiveness of perceptual training programs in badminton. The introduction of visual obstacle training, specifically using the One-Way Mirror Screen, has demonstrated notable improvements in several key areas of badminton performance. The study highlights that such training enhances agility, reaction time, and anticipation, all critical components for success in a fast-paced sport such as badminton. Additionally, the training positively impacts nerve stimulation and neuromuscular coordination, further refining the players' ability to respond swiftly and accurately during gameplay. The 4-corner assessment shows that right-handed players move to the right-side corners, both front and back, very quickly, but they move slowly and struggle to the left-side corners compared to the right. Hence, the study suggests that future research should more focus on left side as well as all directions of player movement. Moreover, the research underscores the importance of eye-hand coordination, speed play, visual tracking, and accuracy, all of which are crucial for high-level badminton performance. The findings suggest that incorporating perceptual training into regular practice routines can lead to significant advancements in these areas, ultimately improving overall player performance on the court. The positive outcomes observed in this study may serve as a foundation for future research, encouraging the exploration of similar training techniques in other sports and contexts, thereby further advancing the science of athletic performance enhancement.

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