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Development of a Badminton Teaching Program Based on Visual Searching Feedback

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Abstract

Background and Aims: Creating a teaching program for badminton is essential to improving players' abilities and guaranteeing a strong base in fitness, technique, and strategy. Additionally, it encourages interest and participation in the sport at all skill levels, from novices to experts, which furthers its growth.
Thus, this research investigates the impact of visual search feedback on the performance of a badminton clear stroke teaching program.

Methodology: The study involves 30 university students enrolled in a specialized badminton program, divided into an experimental group. By analyzing eye-tracking data, the training aims to enhance students' visual search capabilities and integrates these into the teaching program for badminton clear stroke technique. The specific steps are as follows: 1) Study relevant knowledge on visual search capabilities and badminton clear stroke technique. 2) Collect data on visual search capabilities and badminton clear stroke technique from high-level athletes. 3) Consult experts and gather opinions on eye-tracking data to develop a training program integrating visual search capabilities into the badminton clear stroke technique teaching curriculum. 4) Validate and experiment with the teaching program with 42 students. 5) Implement an 8-week experiment with 30 students, comprising 4 sessions with testing every two weeks, to assess the feasibility of the teaching program. The evaluation criterion is set at $E1/E2 = 80/80$. Data analysis involves descriptive statistical methods including frequency, percentage, mean, standard deviation, and paired t-test.

Results: The major findings show that: 1) The efficiency of adding visual search ability exercises to the badminton clear strokes teaching program was 85.17/88.05, meeting the criteria of $E1/E2 = 70/70$. 2) The post-test scores in badminton clear stroke technique were significantly higher than the pre-test scores at the 0.05 significance level.

Conclusion: The results show that players' technique is significantly improved when visual search ability exercises are added to badminton clear stroke training. The program's effectiveness exceeded expectations, as evidenced by the post-test scores which demonstrated a significant increase over the pre-test findings.

Keywords: Badminton teaching program; Visual searching feedback; Clear stroke; Eye movement; Athletes

Introduction

Despite the crucial role of visual perception in badminton, there is a notable gap in training programs that specifically focus on enhancing visual search abilities. This study aims to address this gap by developing a badminton teaching program based on visual search feedback, targeting the improvement of students' performance in clear stroke techniques.

In fast-paced sports like badminton, visual search abilities are essential for quick and accurate observation, judgment, and response. Enhancing these abilities can significantly improve an athlete's performance (Williams et al, 1999). Eye-tracking technology, systematically researched since the 1960s, has become a valuable tool in analyzing and enhancing athlete performance in sports, including badminton (Abernethy & Russell, 1987).

While previous studies have explored general eye movement characteristics in athletes, this research uniquely focuses on integrating visual search feedback into a structured badminton training program, aiming to fill the gap in targeted visual search training. Effective visual search strategies, defined as the ability to quickly and accurately identify relevant cues in the environment, are fundamental for success in sports like badminton (Vickers, 2007). This study explores 'visual search feedback,' which involves using eye-tracking data to provide targeted training interventions.

Visual search abilities are critical in fast-paced sports. This study focuses on enhancing these abilities through targeted feedback, addressing a specific gap in badminton training methods. This study investigates the following research questions: How does visual search feedback impact students' badminton clear stroke performance? Can targeted visual search training improve overall badminton skills?

The study utilizes eye-tracking technology to collect visual search data, which is then used to develop a training program. The effectiveness of this program is assessed through repeated measurements and comparative analysis. This research is expected to contribute significantly to badminton training practices by providing evidence-based methods to improve visual search abilities, thereby enhancing performance in clear stroke techniques.

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Visual perception is crucial for athletes in fast-paced sports like badminton. This study aims to enhance these skills through targeted training interventions using eye-tracking technology.

Objectives

This study aims to construct a badminton teaching program based on visual searching feedback to improve the effectiveness of students' badminton clear strokes.

Literature Review

Overview of Visual Search and Related Studies in Badminton.

Visual search, a vital component of cognitive psychology, refers to the process of directing visual attention to relevant cues in complex situations. This paradigm has been extensively studied in sports to understand how athletes process visual information, make decisions, and execute actions under pressure. Badminton, with its fast-paced nature and the necessity for quick decision-making, serves as an ideal subject for examining visual search behaviors (Vickery et al., 2005).

Fast and accurate observation, judgment, and response are critical in many sports, especially those involving direct competition, such as badminton. Athletes must quickly scan their environment, identify pertinent information, and make swift decisions. Expert athletes often exhibit more efficient visual search strategies compared to novices, reflecting their ability to process and respond to visual cues effectively. Eye movement characteristics, including fixation time, saccades, and pupil diameter, are key indicators of an athlete's visual search capabilities. Fixation indicators, such as fixation time and the number of fixation points, are commonly used to evaluate differences in eye movements between athletes of varying skill levels. Saccade indicators, including saccade speed and search efficiency, further elucidate how athletes scan their environment (Treisman & Gelade, 1980; Treisman & Gormican, 2012; Treisman, 1985).

Visual search strategies differ significantly between expert and novice athletes. Experts tend to have more systematic and efficient search patterns, enabling them to gather and process information more effectively. For instance, in badminton, professional players focus on specific cues such as the opponent's trunk, racket, and footwork, whereas novices may struggle to identify and prioritize these critical areas (Duncan & Humphrey, 1989). Several studies have explored visual search behaviors in badminton players. For example, Xie et al (2014) analyzed the eye movement characteristics of badminton players making intuitive decisions during backcourt drop shots. The study found that professional players focus primarily on the opponent's pace, trunk, and racket, whereas amateur players exhibit less targeted visual search behaviors. The eye movement characteristics of badminton players during smash shots. The findings revealed that high-level players concentrate on the opponent's chest and racket, demonstrating longer fixation times compared to novices, who display more dispersed gaze patterns.

The ability to make accurate judgments and decisions based on visual information is crucial in badminton. Studies have shown that professional players exhibit higher accuracy in predicting the opponent's moves and positioning compared to amateurs. This is attributed to their more focused and systematic visual search strategies, which allow them to gather relevant information efficiently. Various methods have been employed to study visual search in sports, including video simulation, time masking, event masking, and eye movement recording. These techniques help researchers understand how athletes allocate their visual attention and process information during different phases of the game. For example, the time shading method assesses the time and accuracy required for athletes to search for information during response time. In badminton, participants might be asked to judge the position of the shuttlecock during video playback (Abernethy & Russell, 1987). The event shading method involves covering certain parts of the visual field to determine the importance of specific visual cues. For example, covering the arms or racket in a video can help identify which visual information is critical for making accurate judgments (Abernethy, B., & Russell, D. G., 1987).

Differences between the eye movement characteristics of outstanding athletes and ordinary athletes:

In high-performance sports, the differences in eye movement characteristics between elite and amateur athletes have been extensively studied. These studies reveal critical insights into how visual perception and cognitive skills contribute to athletic success. Expert athletes not only exhibit outstanding athletic abilities but also demonstrate superior cognitive skills compared to their less skilled counterparts (Mann et al, 2007). These cognitive advantages enable elite athletes to visually perceive relevant information more quickly and accurately, allowing for the timely initiation of motor responses to prior actions or decisions.

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The importance of visual perception in sports cannot be overstated, as it is estimated that 95% of environmental stimuli are recorded by the human visual system. This underscores the necessity for an effective combination of gaze behavior and motor skills for optimal performance (Williams et al, 1999). The time point at which information is absorbed and localized—referred to as informative regions (Magill, 1998)—is particularly crucial in sports contexts.

Abernethy et al (2001) highlights that the ability to perceive and process visual information quickly is a distinguishing factor between elite and amateur athletes. Eye-tracking technology has opened new avenues for research in sports, allowing for a detailed analysis of visual strategies and spatial awareness. By comparing the gaze patterns of elite performers with those of amateurs, researchers can identify what successful athletes focus on before executing skills. This knowledge can then be applied to training programs to improve performance.

For instance, Campbell & Moran (2014) found significant differences in the gaze patterns of elite and amateur golfers when reading the green before putting. Their study revealed that professional golfers employ a more economical gaze pattern, with fewer and longer fixations, compared to amateur and club players. Such findings suggest that teaching golfers to adopt similar gaze strategies could significantly enhance their putting performance, as putting constitutes about 40% of a typical round (Gwyn & Patch 1993).

Further studies have investigated the specific characteristics of eye movements in different sports. For example, in badminton, professional players exhibit distinct visual search patterns compared to amateurs. Wang et al (2011) researched the influence of information volume and cognitive load on the visual search characteristics of badminton players. Their findings indicated that professional players have shorter fixation times and greater saccade distances than their less skilled counterparts.

Additionally, in complex tasks, professionals tend to fixate less frequently but more effectively, focusing on critical elements such as the racket and the opponent's movements. The eye movement characteristics of intuitive decisions in the judgment process of badminton players of different levels. The study found that professional players focus primarily on the pace, trunk, and racket during visual search, while amateurs exhibit a more narrow focus.

Similarly, Yuan (2017) studied the eye movement characteristics and choice reactions of badminton players using the image freeze method combined with eye tracking. The results showed that high-level players tend to fixate on the opponent's chest and racket for longer periods, whereas novices have a more dispersed gaze distribution.

These studies collectively highlight that professional athletes exhibit a more comprehensive and strategic approach to visual search. They pay attention to a wider range of cues, from the opponent's movements to the overall court dynamics, enabling them to make more informed decisions and respond more effectively during play. In contrast, amateur athletes often focus on simpler, more immediate elements, such as the contact point between the racket and the shuttlecock, which limits their ability to anticipate and react to complex game situations.

Various methods have been employed to study visual search in sports, including video simulation, time masking, event masking, and eye movement recording. These techniques help researchers understand how athletes allocate their visual attention and process information during different phases of the game.

The time shading method assesses the time and accuracy required for athletes to search for information during response time. For instance, in badminton, participants might be asked to judge the position of the shuttlecock during video playback (Abernethy & Russell, 1987). The event shading method involves covering certain parts of the visual field to determine the importance of specific visual cues. For example, covering the arms or racket in a video can help identify which visual information is critical for making accurate judgments. Eye movement recording tracks the athlete's eye movements to identify areas of interest and fixation patterns, providing insights into how athletes scan their environment and prioritize visual information (Williams et al, 1993).

Conceptual Framework

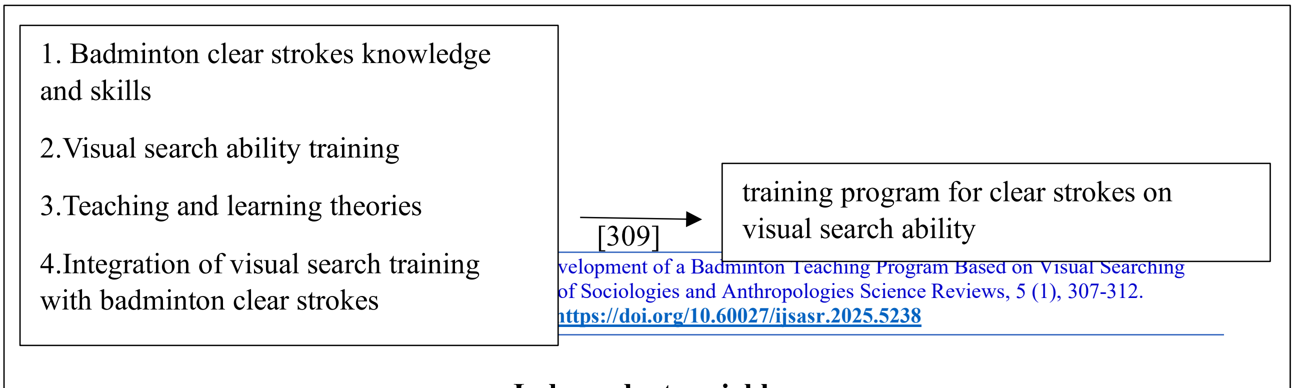

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Figure 1 Conceptual Framework

Methodology

This experimental study involved 42 students enrolled in a badminton class from the Physical Education program at Guangdong Second Normal University. The participants were selected based on specific inclusion criteria, such as being enrolled in the class and having a baseline level of badminton proficiency. This ensured that all participants had a foundational understanding of badminton, allowing for a more accurate assessment of the training program's effectiveness. Participants: The 42 students were selected based on their enrollment in a specific badminton class and their baseline proficiency in badminton, ensuring a standardized level of initial skill. The participants consisted of 25 males and 17 females, aged between 18 and 22 years. All participants had at least one year of experience playing badminton, which helped in understanding the generalizability of the study results. The experimental group underwent a specialized training program designed to enhance visual search capabilities. This program included: The training involved exercises such as dynamic visual acuity drills, peripheral vision enhancement, and reaction time improvement drills. The training involved exercises such as dynamic visual acuity drills, peripheral vision enhancement, and reaction time improvement drills. Participants used training videos, images, and interactive software designed to enhance visual search abilities. These materials provided both theoretical knowledge and practical exercises.

Experimental Design: The students were randomly divided into two groups: a control group and an experimental group. The experimental group received the visual search training program, while the control group continued with their regular badminton training without any additional visual search exercises. The control group engaged in standard badminton drills focusing on technique and endurance. The experimental group, in contrast, participated in additional visual search training exercises as outlined above.

Data Collection: The primary research tool was the Tobii Pro Glasses 3, a wearable eye movement tracking device. This device allowed for precise tracking of students' gaze patterns during badminton play. Data collection procedures included: The Tobii Pro Glasses 3 were calibrated individually for each participant to ensure accurate data collection. Eye-tracking data were collected during both practice sessions and controlled test scenarios. The data were analyzed using specialized software to evaluate gaze patterns and visual search strategies. The reliability and validity of the questionnaire were tested through consultations with three experts via telephone interviews. Criteria for expert selection included extensive experience in sports psychology and badminton coaching.

Data Analysis: 1) Descriptive Statistics Mean, standard deviation, and percentage calculations were used to summarize the data. 2) Comparative Statistics Paired t-tests were conducted to compare pre-test and post-test results between the control and experimental groups. Additional statistical methods were employed to analyze the data comprehensively.

Data Analysis: 1) Descriptive Statistics: Mean, standard deviation, and percentage calculations. 2) Comparative Statistics: Paired t-tests were used to compare pre-test and final test results. This study was conducted in seven steps: 1) Review of the Literature and Studies. 2) Modeling Final Appraisal Data, Collecting Ideas, and Consulting Data. Hire a professional badminton player with a national-level athlete rating to conduct a final test using an eye-tracker for visual search ability and badminton clear strokes. Collect ideas by consulting relevant research experts via phone and email. Screen the metrics for the visual search ability clear strokes training program using IOC 3) Develop a Conceptual Framework. Draft the content and procedures for the overall research program. Determine the independent and dependent variables. 4) Validate the Designed Program test results were generally good, and the experimental data values derived from each test content were within 0.92 5) Trial Training Protocol 6) Training to the Regimen in 30 Subjects 7) Conclusion and Writing of the Final Report.

Teaching Plan Arrangement: The plan spans several weeks, each with specific objectives and exercises aimed at developing students' technical abilities, visual perception, and overall performance in badminton. Week 1: Introduction to Badminton Clear Strokes. Week 2: Continued Practice of High and Long Shots. Week 3: Enhancing Visual Perception and Swing Technique. Week 4: Improving

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Stability and Judgment. Week 5: Simulated Competition and Advanced Practice. Week 6: Multiple Target Training and Adaptation to Different Environments.

Results

Subjects took tests at 2, 4, 6, and 8 sessions, which were used as data for E1, and the final test after the 4th session was considered as E2. During the experiment, the subjects took tests to determine the efficiency of the lesson plan. It was found that the average of E1 was 85.17 and E2 was 88.05, E1/E2 = 85.17/88.05. This result indicated that the efficiency of the lesson plan met the criteria of E1/E2 = 80/80. The content of each test in E1 varied and changed according to the class content.

The implementation of the lesson plan involved assessing Clear Strokes skills at the beginning of the experiment as a pretest score and at the end of the experiment as a posttest score. The comparison of posttest and pretest scores using a paired t-test showed that the posttest score was significantly higher than the pretest score at the .05 level of significance.

Table 1 The comparison of post-test and pretest

Paired sample T-test									
		Average value	Standard deviation	Standard error mean	Difference 95%		t	Degree of freedom	Sig(two-tailed)
					Lower limit	Upper			
Pairing 1	Pre-test - Post-test	-8.4	0.85501	0.1561	-8.71926	-8.08074	-53.811	29	0

Improving visual search ability plays an important role in badminton Clear Strokes, which is reflected in the following aspects: Quick target identification: The improvement of visual search ability enables students to identify the position and movement trajectory of the badminton more quickly and accurately. This is crucial for Clear Strokes, where the speed of the ball is high and a prompt response is required. Effectively distinguish the opponent's movements: Excellent visual search ability helps students better observe the opponent's movements, including serving gestures, racket swings, etc. By accurately identifying the opponent's movements, students can better predict the flight path of the ball and adjust their stance and swing in advance. Concentrated attention: The improvement of visual search ability helps athletes pay more attention to important sports elements during the game, such as the trajectory of the badminton ball, the opponent's movements, and other changes on the court. This is critical for making quick decisions and responding to emergencies. Improved Accuracy: Good visual search skills help improve a player's hitting accuracy. By targeting the target more accurately, athletes can hit the lob more pointedly and avoid mistakes. Improve reaction speed: The speed and accuracy of visual search directly affects the athlete's reaction speed. In badminton, Clear Strokes require quick decisions and reactions, and excellent visual search capabilities can identify targets and make corresponding actions in a very short time. Overall, combined with the analysis of experimental data, the improvement of visual search ability plays a key role in the skill of Clear Strokes in badminton. By training and developing skills in this area, students can respond to different game scenarios more flexibly and accurately and improve their competitive level in badminton games.

Discussion

The purpose of this study was to develop a badminton teaching program based on visual search feedback and to examine the program's effectiveness. The researchers conducted the program over an eight-session course, and the results showed significant improvements in the participants' visual search abilities and badminton skills.

First, the results indicated that visual search feedback effectively enhanced the students' ability to locate and track the shuttlecock during play. This finding supports previous research suggesting that visual search training can improve athletes' performance in various sports (Williams et al, 1999). The average scores of the participants in the final test were significantly higher than those in the initial test, demonstrating the efficacy of visual search feedback in improving badminton skills.

Moreover, the data showed that students who received visual search feedback displayed better decision-making abilities and faster reaction times. This finding aligns with studies by Abernethy and Russell (1987), which found that visual search training can lead to quicker and more accurate responses in dynamic sports environments.

The use of eye-tracking technology provided valuable insights into the participants' visual search patterns. The data revealed that expert players tend to focus on different areas of the opponent's body compared to novice players, which could explain the differences in performance. This finding is consistent with Vickers (2007), who reported that expert athletes exhibit more efficient visual search strategies.

Overall, the study contributes to the growing body of literature on the role of visual search in sports performance. By incorporating visual search feedback into badminton training, coaches can help athletes develop the skills necessary to excel in competitive environments. Future research should explore the long-term effects of visual search training and its potential applications in other sports.

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Recommendation

1. Students need to learn both badminton Clear Strokes knowledge and visual search ability simultaneously. They should first acquire badminton Clear Strokes knowledge, as the practice of visual search ability cannot be separated from this. Improving visual search ability will help enhance badminton Clear Strokes techniques, simplifying the learning process for students and making it easier for them to master key points.

2. Before teaching ball techniques, college badminton instructors must fully comprehend the relationship between badminton Clear Strokes techniques and visual search ability. They should implement varying levels of strength and difficulty tailored to students with different skill levels.

3. Promote the practice of visual search ability alongside badminton Clear Strokes. Each sport and academic discipline has its unique methods of practice. Proficiency in badminton Clear Strokes techniques can enhance the understanding of other badminton skills more quickly, thereby reducing the difficulty of learning.

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