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ORIGINAL ARTICLE

Enhancing Tennis Performance through Visual Training: The Efficacy of Dynamic Vision Exercises

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ABSTRACT

Background. This research examined the impact of visual training on tennis skill levels. Tennis demands high visual capabilities from athletes, requiring them to maintain focus throughout the entire game to secure winning points and ensure victory. The significant impact of visual training on enhancing tennis performance has not been thoroughly investigated. **Objectives.** The purpose of this study is to investigate the impact of an 8-week visual training on tennis performance and to identify the correlation between the effects of visual training and Tennis Performance. **Methods.** Participants (n=50) engaged in dynamic vision exercises using The Sensory Station Training Application and practiced tennis hitting while wearing dynamic vision training devices. The training program aimed to enhance participants' visual skills in real tennis scenarios. The increase of visual training is an effective method to improve tennis skill levels. **Results.** After eight weeks of visual training, the experimental group's ITN average score increased by 40.80 points, indicating a significant improvement. The findings showed that there was no significant improvement in static visual acuity, including visual clarity (Cohen's d=0.05) and perception span (Cohen's d=0.08). However, notable improvements were observed in dynamic visual acuity, specifically in hand-eye coordination (Cohen's d=1.26), reaction time (Cohen's d=1.71), and GO/NO GO (Cohen's d=3.11). **Conclusion.** These studies provide compelling evidence supporting the idea that visual training can enhance tennis performance.

KEYWORDS: ***Dynamic Vision Exercises, Tennis Skills Levels, Training, Visual Training.***

INTRODUCTION

Visual training was first initiated in France by Javal and Manuel (1). Since then, the field of ophthalmology has seen continuous development and diversification of visual training methods across generations of practitioners. It is now widely applied in various fields, including sports education, driving skills, professional skills, academic learning, and performing arts. Visual training has sparked significant interest among researchers and coaches as a widely discussed and applied method in various sports disciplines. The concept of sports vision may vary among different scholars. Sports vision is a specific visual ability that differs from other visual functions. This ability is crucial for athletes to process and perform at their best. Athletes must gather a considerable amount of visual information quickly. Evidence shows that visual skills vary between athletes and non-athletes, and impact athletic performance (2, 3). Research on sports vision is still in its early stages, but it is widely recognized as a critical component of athletic performance (4, 5). In sports, vision is vital in providing athletes with crucial information on where, when, and what to do. Without the ability to quickly and accurately process visual information, even the strongest,

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fastest, and most technically skilled athlete may not reach their full potential. Dynamic visual skill is mainly involved in catching or interceptive actions of ball sports, whereas strategic sports use different visual skills (peripheral and spatial vision) due to the sport-specific requirements (6).

Sports vision is a specific visual ability that differs from other visual functions. Sports Vision is defined as the brain's ability to receive and provide feedback on the messages transmitted by the eyes. Sports vision involves the use of the visual senses to acquire information about the playing field (7). The brain processes this information and generates instructions for the body to execute specific actions (8).

Appelbaum & Erickson (2018) defined sports vision as the brain's ability to receive and provide feedback on the messages transmitted by the eyes. Sports vision involves the use of the visual senses to acquire information about the playing field. The brain processes this information and generates instructions for the body to execute specific actions (9). Sports vision training can improve balance and increase the fixation of Inline Hockey Players (10). Visual training has emerged as a promising technique to improve the visual skills of tennis players. By engaging in repetitive eye exercises prescribed by sports optometrists, tennis players can enhance their basic visual functions, such as visual acuity, depth perception, and peripheral vision. These visual skills are crucial in tennis, as they directly impact the athlete's ability to accurately track the ball, anticipate its movement, and make split-second decisions on how to respond. The study by Şenol, Deniz, et al. compared the visual reaction times (VRT) and auditory reaction times (ART) of individuals with different somatotypes, including athletes and sedentary individuals. The findings indicated that regular training and participation in sports were associated with reduced VRT and ART (11).

The significance of sports vision differs from one sport to another. Tennis, a popular sport worldwide, has athletes and enthusiasts constantly aiming for better performance. In tennis, the ball moves swiftly in various directions during gameplay. Athletes must rapidly assess the trajectory and landing spot of the ball with accuracy. Any approach that can enhance an athlete's visual system will ultimately improve their ability. To improve their technical abilities and excel in competitive sports, athletes constantly look for ways to enhance their skill sets. Athlete's visual strategy in the game is related to eye dynamics, not to head movements (12). In the case of tennis, a dynamic sport with rapidly changing ball speeds and directions, players must be able to make quick and accurate judgments about the trajectory and landing position of the ball. Enhancing visual perception is crucial as it directly impacts an athlete's ability to execute precise movements swiftly. Afshar, Azam, Jaleh Baqerli, et al. conducted a study to assess the impact of visual training on the shooting skills of female soccer players. They utilized Raven and Gibor's vision exercises as their research tools and administered a two-week visual training program to the participants. The results indicated that the sports-specific visual exercises led to an enhancement in the players' shooting skills. Consequently, any technique or method that can optimize an athlete's visual system's functioning will undoubtedly improve accuracy and speed in executing skilled maneuvers.

Several studies involving baseball, table tennis, and other sports revealed that excellent dynamic vision was important in a variety of ball sports and fast-reacting competitive sports, particularly open-ended, multiplayer, and confrontational sports. For example, Huang (13) discovered that visual scene training greatly improved rookie tennis players' visual search abilities, cognitive functions, and specialized sports skills. In previous research, it has been demonstrated that video training can enhance the throwing speed of novice baseball players and improve their ability to predict and assess the trajectory of baseball (14). Additionally, the implementation of dynamic vision training is advantageous in enhancing athlete performance. Moreover, intervention training focused on sports vision was conducted with softball athletes, leading to a relative improvement in their target capture ability and execution of softball actions (15, 16). Previous research has extensively investigated the potential of visual training to enhance athlete performance. Nevertheless, there is a notable scarcity of research within the domain of tennis sports education concerning the influence of visual training on athletes' technical proficiency and competitive capabilities.

MATERIALS AND METHODS

Methodology. This research aims to investigate the impact of visual training on tennis sports education. Experimental research by organizing an experimental group and a control group, each undergoing different training methods, as shown in Table 3, which is the tennis skill training schedule. Data recorded for both groups evaluate the effects of visual training on improving tennis players' technical proficiency, reaction speed, and performance in matches. Through this research, new perspectives and methods for sports teaching, thereby providing a scientific basis for more significant advances and achievements for athletes at the level of skills. The results of several research scholars (12, 17) confirm that visual training improves the effectiveness of tennis sports teachings and accurately improves the skill levels of tennis. Individuals who underwent visual training showed a higher degree of improvement in tennis skill levels compared to those who did not receive any training.

Participants. The research involved two groups of students from the National Chinese University College of Sports, specializing in Tennis Education. Initially, 75 specialized students underwent a basic vision test, and those with short-sightedness or difficulty seeing distant objects were excluded. Ultimately, 60 students with naked eyesight greater than 1.0 were selected for the research A simple random sampling method was employed to select 60 student subjects. The numbers 1 to 47 were assigned to the 60 students, and each number was written on a label. These labels were then mixed thoroughly, and 50 labels were randomly drawn without replacement. The students corresponding to the numbers on these 50 labels formed the final sample. The selected students were divided into two groups: the control group, consisting of the first 25 samples, and the experimental group, consisting of the next 25 samples. Before starting the experiment, the height and weight data of the subjects were measured by the height and weight meter, and the measurement verified that the BMI of the students was in the normal range.

The premise of visual training is normal vision. Before the experiment, an E-chart was used to verify the subjects' normal vision. According to Table 1, the participants' background information comprises 25 students from both the experimental and control groups. The average age of the students in the experimental group was 20.47±0.68, and the average age in the control group was 20.54±0.45. The average height of the experimental group was 173.75±5.59, and the average height of the control group was 174.34±576. Body Mass Index (BMI) is a value calculated by dividing a person's weight by the square of their height. It primarily reflects the overall body weight and is used as an indicator to assess the individual's overall nutritional status Yajnik and Yudkin (17). The average BMI of the student in the experimental group was 18.25±1.15, and that of the control group was 17.85±1.85. Therefore, 50 students who participated in the experimental research had normal naked-eye vision, were in good physical condition, and could engage in moderate physical exercise activities. All participants in this research volunteered to participate, everyone signed the experimental notice and can withdraw at any time.

Table 1. Basic Information of 50 Sample

	Age	Height (CM)	Weight (KG)	BMI (W/H^2)	Vision
Experimental Group	20.47±0.68	173.75±5.59	55.39±7.18	18.25±1.15	1.0
Control Group	20.54±0.45	174.34±5.76	54.87±9.15	17.85±1.85	1.0

Measures. Prior to starting the visual training, a visual ability test was administered to 50 participants. During this test, the participants' current levels of visual abilities were evaluated, and the resulting data were recorded and stored to gather the raw scores of their existing visual abilities. To facilitate the visual skills exercises, the participants engaged with the Sensory Station Training Application. There were 9 system test items (as depicted in Figure 1 and Table 3): The utilization of this well-structured application ensured a comprehensive and systematic approach to evaluating and enhancing the participants' visual capabilities. Firstly, visual clarity pertains to the ability of the eyes to see objects clearly, serving as the foundation for any visual task. Contrast sensitivity marks the initiation of the visual process and holds vital importance in recognizing objects and faces. Near-far quickness evaluates the capacity of individuals to swiftly adjust their focus, essential for tasks involving motion, spatial judgment, and timely decision-making. Perception span denotes the breadth of the visual field, enabling the efficient gathering of diverse visual information for quick and accurate processing. Target capture assesses how rapidly one can identify and focus on the most pertinent visual data among available information. Multiple Object Tracking allows individuals to track and navigate a target, crucial for collision avoidance when dealing with multiple moving objects. Reaction time denotes the speed at which individuals respond to visual stimuli, a critical aspect of various activities requiring swift decision-making. Eye-hand coordination measures the ability to synchronize eye movement with hand movement, determining the accuracy of executing actions after receiving visual information and brain instructions. In the GO/NO GO test, participants are required to swiftly touch "Go" targets before they disappear while avoiding "No-Go" targets, assessing quick decision-making and rapid response skills.

To compare the differences between the two groups of data, Cohen's d was chosen in this research. The formula for effect size (Cohen's d) is as follows:

Cohen's d=(M1-M2)/SD,

M1 and M2 represent the meaning of the two sample groups, and SD was the average of the standard deviations of the two sample groups.

Table 3 illustrates the statistical analysis of diverse visual abilities within the experimental and control groups. The calculation of effect sizes for each test, employing Cohen's d formula, provided insights into the distinctions between the data sets of both groups. The effect sizes observed for all nine visual ability tests in the two groups were consistently below 0.8, indicating relatively modest differences in the data sets for each group. Hence, the findings showed that there was a similarity in the levels of visual abilities between the experimental and control groups before the commencement of visual training.

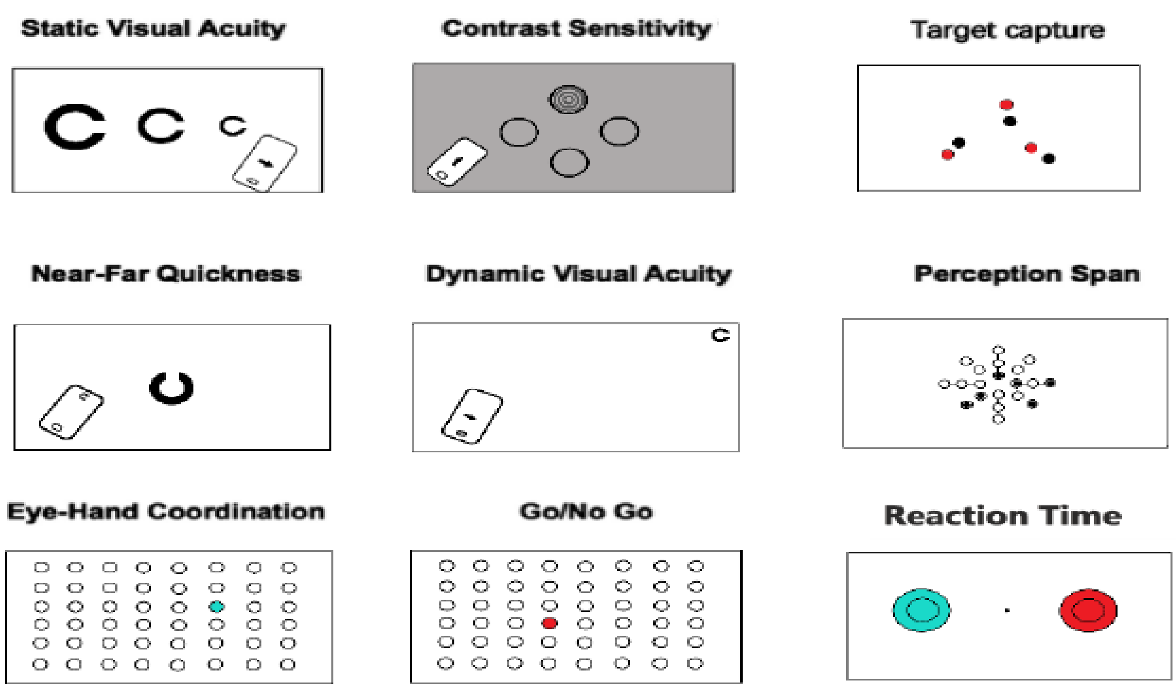

Figure 1. Assessment Items in the present study.

Procedures. Both the experimental and control groups engaged in an eight-week training program focusing on basic tennis skills. The training sessions were conducted at the Chinese University Tennis Course and encompassed various tennis skill exercises, including Forehand baseline stroke (FBS), Backhand Baseline Stroke (BBS), Forehand volleyball (FV), Backhand volley (BV), Mid-PS, Forecourt pressure shot (Fore PS), First serve (FS), Second serve (SS), and other techniques. The index method test results are displayed in Table 2.

Table 2. Testing Index and Methods

Test index	Test method
Visual clarity	The participants held a mobile device while standing 3 meters away from a tablet computer for the test. On the tablet computer, a black Landolt ring appears with a random missing section at the top, bottom, left, or right, presented in a random sequence on a white background according to predefined acuity requirements. The participants are required to identify the direction of the missing section and swipe the mobile device in the corresponding direction.
Contrast sensitivity	The participants stand 3 meters away from a tablet computer while holding a mobile device. On the screen, four black circular shapes are displayed, with one of them containing concentric circles of varying shades. The participants are required to identify the circular shape with the concentric circles and swipe the mobile device in the corresponding direction.
Target capture	The participants stand 3 meters away from the large screen while holding a mobile device. Randomly, a Landolt ring will suddenly appear in one of the four corners of the large screen. The participants are required to judge the gap direction of the Landolt ring and swipe the mobile device in the corresponding direction on the mobile device's screen.
Near-far quickness	The participants stand 3 meters away from a tablet computer while holding a mobile device positioned 40cm from their eyes. During the test, Landolt rings alternately appear on the tablet computer and the mobile device screen. After determining the direction of the gap in the ring displayed on the tablet screen, the participants immediately swipe the mobile device in the corresponding direction and quickly identify the gap direction in the ring on the mobile device screen. They repeat this sequence, switching focus between the distant and near screens within the 30s.
Multiple object tracking	The participants are positioned 60cm away from the tablet computer. On the screen, multiple sets of balls are displayed, each consisting of two black balls, with one of them briefly turning red and then returning to black. Subsequently, the balls in each set start rotating randomly in both clockwise and counterclockwise directions for several rounds before coming to a stop. The participants are required to identify the ball in each set that initially turned red.
Perception span	The participants stand 60cm away from the tablet computer, with their eyes aligned horizontally with the center of the screen. During the test, a certain number of circles appear on the screen. Initially, the circles form a pattern radiating outward from the center. Some of these circles have a central black dot that appears in a very brief period. After the black dot disappears, the participants need to identify the circle where the black dot appeared and click on it.
Eye-hand coordination	The participants stand 60cm away from the large screen. Randomly, 96 circular rings are displayed in 8 columns on the screen. At the start of the test, a random point appears within one of the circular rings, and the participants must quickly and accurately click on this point. Once the point is touched, another point appears at a random location. The goal is to click on as many points as possible within a specified time. The higher the number of correct clicks, the higher the test score.
GO/NO GO	The participants stand 60cm away from the large screen. On the screen, 96 circular shapes are displayed in 8 columns, each designed to mimic eye-hand coordination. Within these circular shapes, green or red dots appear pseudo-randomly. When a green dot appears, the participants need to quickly tap it, and when a red dot appears, they must refrain from tapping it.
Reaction time	The participants stand 60cm away from the tablet, with their eye level aligned with the center of the screen. At the start of the test, two circular shapes appear on the screen. Using their index fingers on both hands, they lightly touch the center of each circle. Once their fingers are correctly aligned with the centers, the circular shapes change color to green. Subsequently, the two circular shapes randomly turn red, and the corresponding index fingers must be swiftly lifted and then pressed down again. The faster this action is performed, the higher the score.

Table 3. Visual Ability Level of Participants

	Experimental Group	Control Group	Cohen's d
Visual clarity	17.18±1.32	18.22±1.54	-0.68
Contrast sensitivity	30.07±1.16	29.78±1.02	0.29
Near-far quickness	19.33±3.14	20.46±2.98	-0.37
Perception span	58.94±4.87	59.59±6.12	0.11
Target capture	20.94±1.28	21.19±0.76	0.22
Multiple object tracking	70.82±2.25	69.83±3.87	0.31
Reaction time	14.18±3.61	15.22±2.65	0.29
Eye-hand coordination	50.80±4.87	49.81±4.75	0.21
GO/NO GO	29.28±4.91	30.87±5.27	0.32

The tennis basic skills exercises were carried out three times a week, with each session lasting for 90 minutes. To ensure the participant's safety and well-being, warming-up and relaxation activities were incorporated at the beginning and end of each training session to prevent unnecessary physical injuries. The detailed training schedule is provided in Table 4.

Table 4 outlines the schedule of skills exercises to be carried out by all participants in the research The exercises have been designed to incorporate a diverse range of techniques, providing athletes with comprehensive practice opportunities for each skill. Notably, the experimental group was required to wear dynamic vision glasses (Model 2MJ03SE-868, also known as the Primary Dong Dynamic Vision Trainer). The purpose of using these glasses was twofold: first, to heighten the difficulty level for the experimental group in receiving visual information, and second, to reduce the frequency of interruptions in the dynamic visual trainer blocking the picture surface. As a result, the path to the ball becomes more inconsistent, necessitating the experimental group of students to focus their attention entirely on gathering visual information. Subsequently, they must transmit this information to the brain and execute the corresponding action while practicing their tennis skills.

Table 4. Schedule of Skills Exercises

Week	Day	Training
Week 1	Monday 2 pm-3:30 pm	FBS+BBS, FS
	Wednesday 4 pm-5:30 pm	Mid-PS+ Fore PS, SS
	Friday 4 pm-5:30 pm	FV+BV, SS, Footwork training
Week 2	Monday 2 pm-3:30 pm	Mid-PS+ Fore PS, FS
	Wednesday 4 pm-5:30 pm	FV+BV, SS
	Friday 4 pm-5:30 pm	FBS+BBS, FS, Footwork training
Week 3	Monday 2 pm-3:30 pm	FBS+BBS, FS
	Wednesday 4 pm-5:30 pm	Mid-PS+ Fore PS, SS
	Friday 4 pm-5:30 pm	FV+BV, SS
Week 4	Monday 2 pm-3:30 pm	Mid-PS+ Fore PS, FS
	Wednesday 4 pm-5:30 pm	FV+BV, SS
	Friday 4 pm-5:30 pm	FBS+BBS, FS
Week 5	Monday 2 pm-3:30 pm	FBS+BBS, FS, Footwork training
	Wednesday 4 pm-5:30 pm	Mid-PS+ Fore PS, SS
	Friday 4 pm-5:30 pm	FV+BV, SS
Week 6	Monday 2 pm-3:30 pm	Mid-PS+ Fore PS, FS, Footwork training
	Wednesday 4 pm-5:30 pm	FV+BV, SS
	Friday 4 pm-5:30 pm	FBS+BBS, FS
Week 7	Monday 2 pm-3:30 pm	FBS+BBS, FS
	Wednesday 4 pm-5:30 pm	Mid-PS+ Fore PS, SS
	Friday 4 pm-5:30 pm	FV+BV, SS
Week 8	Monday 2 pm-3:30 pm	Mid-PS+ Fore PS, FS
	Wednesday 4 pm-5:30 pm	FV+BV, SS, Footwork training
	Friday 4 pm-5:30 pm	FBS+BBS, FS

As illustrated in Figure 2, a Feeder (F) was stationed in the field, handing the ball to the opposing Player (P) and conducting skills exercises according to the predetermined schedule. The primary objective of this exercise was to ensure that all participants engaged in tennis skills exercises with an equal amount of practice and intensity.

The experimental team, in addition to wearing dynamic vision glasses during tennis ball practice, also engaged in auxiliary visual skills exercises utilizing the ZF-Test Attention Capacity Test. Following the specialized tennis training, participants moved to the indoor classroom at the tennis court for attention span training, with each session lasting 90 seconds per person and was conducted in two consecutive sessions.

The ZF-test was utilized as a focus range measurement method and device in this research. It involved placing multiple LED light keys on a test panel, arranged in a composition matrix (as shown in Figure 3). Testers initiated the test by pressing the start button to initiate the timing. During the test, when an LED light on the test board was illuminated, another LED light immediately lit up simultaneously. If a tester failed to press the illuminated light within the predetermined interval time, this instance was not recorded in the score, and the light switched to another LED light. This process continued until the timing was completed. Finally, the test score was displayed and recorded for subsequent analysis.

The purpose of this exercise was to enhance the stability, concentration, and flexibility of visual attention. Testers were required to concentrate their attention on specific targets and quickly switch their focus to other targets, to improve their perception and responsiveness to the surrounding environment.

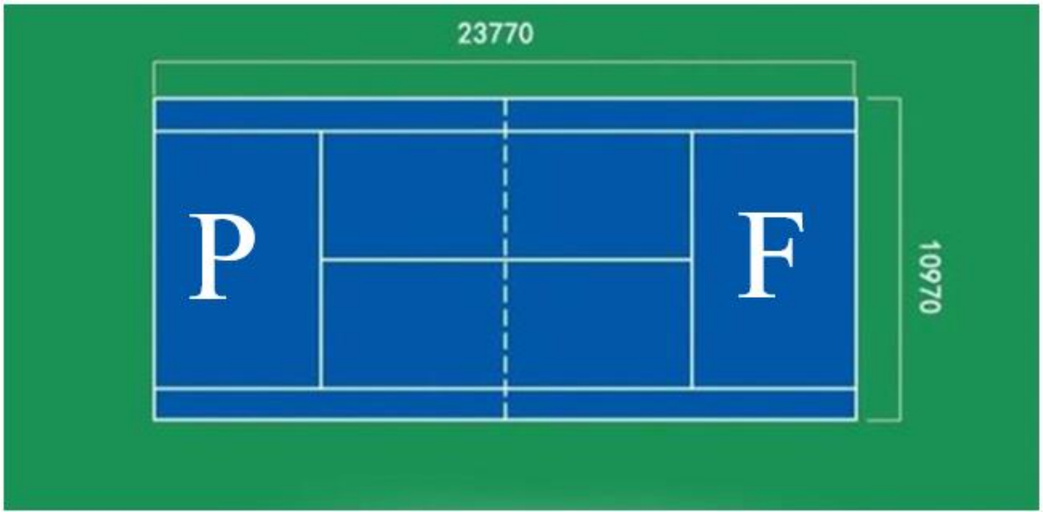

Figure 2. Position of Feeder and Player.

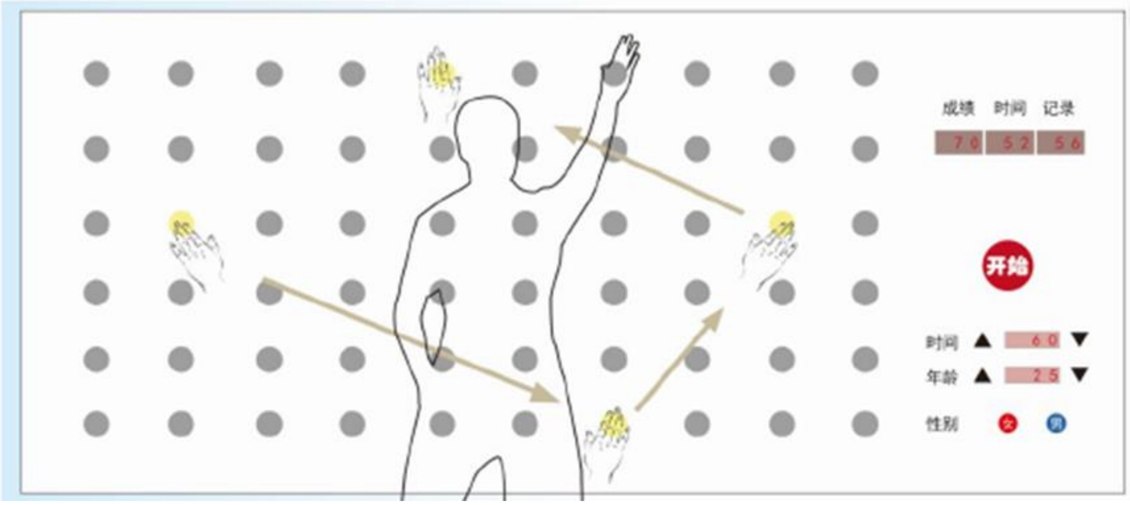

Figure 3. ZF-Test Panel Plot.

Analysis. To assess the students' specialized tennis skills, this research utilized the International Tennis Number (ITN) as a measurement tool and incorporated the collected data into the overall analysis. The normality distribution was confirmed by inspecting Skewness, Kurtosis, Kolmogorov-Smirnov statistics, and Shapiro-Wilk statistics. The International Tennis Number (ITN) was used as a measurement instrument in this research to assess the students' specialized tennis skills, and the obtained data was incorporated into the overall analysis. Skewness, Kurtosis, Kolmogorov-Smirnov, and Shapiro-Wilk statistics were used to confirm the normality of the distribution. The visual ability and ITN scores have Kolmogorov-Smirnov values greater than 0.05. The Z-score for skewness was calculated as 0.078/0.141=0.55, and the Z-score for Kurtosis was 0.262/0.281=0.93.

The skewness and kurtosis values were close to zero, and the Z-scores were within 1.96 standard deviations of the mean. This showed that the data gathered in this research for visual ability scores and ITN scores has a normal distribution.

RESULTS

International Tennis Number (ITN). The purpose of this research was to explore the impact of visual training on tennis sports education. To achieve this, the International Tennis Number (ITN) was used to quantify the level of tennis skills among the participants, and the student skill scores of both the experimental and control groups were statistically summarized.

Table 5 shows that both groups underwent statistical data analysis before and after the experiment. The control group had an average ITN score of 99.28 before training, with a total score of 2482.00 and a range of 21. After training, the control group had an average ITN score of 106.76, with a total score of 2669.00 and a range of 29. The paired-sample t-test for the control group showed a value of -7.067 with a significance level of 0.000. For the experimental group, the average ITN score before training was 98.48, with a total score of 2462.00 and a range of 21. After training, the average ITN score increased to 139.28, with a total score of 3482.00 and a range of 42. The paired sample t-test for the experimental group showed a value of -28.199 with a significance level of 0. 000. After eight weeks of visual training, the experimental group's average score increased by 40.80 points, significantly improved.

Table 5. ITN of 25 samples

Control Group	Pro-test ITN	Post-test ITN	Effect Size	Experimental Group	Pro-test ITN	Post-test ITN	Effect Size
A1	94	97	3	B1	104	139	35
A2	111	120	9	B2	93	129	36
A3	96	104	8	B3	97	135	38
A4	105	112	7	B4	95	135	40
A5	95	100	5	B5	111	166	55
A6	93	103	10	B6	98	130	32
A7	106	101	-5	B7	106	139	33
A8	101	107	6	B8	104	141	37
A9	90	94	4	B9	93	135	42
A10	97	106	9	B10	96	147	51
A11	104	115	11	B11	98	148	50
A12	100	103	3	B12	92	141	49
A13	93	101	8	B13	95	131	36
A14	95	112	7	B14	91	134	43
A15	111	110	-1	B15	98	137	39
A16	98	108	10	B16	102	142	40
A17	95	96	1	B17	110	146	36
A18	92	99	7	B18	95	126	31
A19	108	114	6	B19	94	124	30
A20	102	111	9	B20	97	135	38
A21	106	123	7	B21	93	146	53
A22	90	101	11	B22	90	135	45
A23	103	121	9	B23	99	135	36
A24	100	108	8	B24	108	152	44
A25	97	103	6	B25	103	154	51
Mean	99.28	106.76		**Mean**	98.48	139.28	
Total	2482.00	2669.00		**Total**	2462.00	3482.00	
Range	21	29		**Range**	21	42	

Figure 4 displays a line chart illustrating the changes in tennis skill levels before and after visual learning for both the experimental group and the control group, each consisting of 50 samples.

The Sensory Station Training Application. The research quantified the participants' tennis skill levels using the International Tennis Number (ITN). Subsequently, the skill scores of students in both the experimental and control groups were subjected to thorough statistical analysis and summarization.

Table 6 presented the Cohen's d values for different visual abilities, with Visual clarity, Contrast sensitivity, Perception span, and multiple object tracking showed relatively small Cohen's d values, while the remaining four indicators exhibit relatively large Cohen's d values. The assessment of visual abilities encompassed both dynamic visual acuity and static visual acuity. The findings from the training conducted using The Sensory Station Training Application revealed that there was no significant improvement in static visual acuity, including visual clarity (Cohen's d=0.05) and perception span (Cohen's d=0.08). However, notable improvements were observed in dynamic visual acuity, specifically in hand-eye coordination (Cohen's d=1.26), reaction time (Cohen's d=1.71) and GO/NO GO (Cohen's d=3.11).

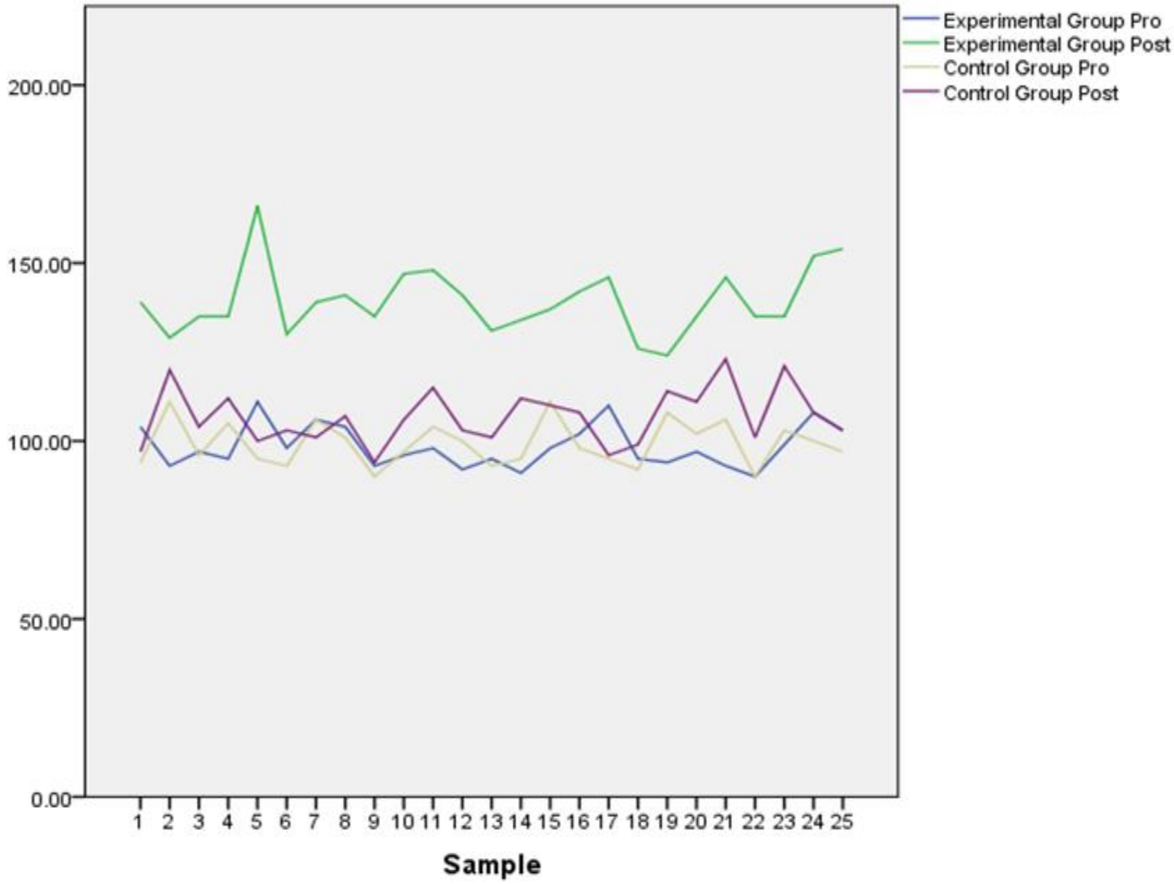

Figure 4. Changes in Tennis Skill Levels.

Table 6. Visual Ability Level of Pre-Post

`	Experimental Group Pre-Test	Experimental Group Post-Test	Cohen's d
Visual clarity	17.18±1.32	17.12±1.92	0.05
Contrast sensitivity	30.07±1.16	30.13±2.06	-0.035
Near-far quickness	19.33±3.14	25.67±3.60	2.03
Perception span	58.94±4.87	59.32±5.05	0.08
Target capture	20.94±1.28	21.16±1.70	0.13
Multiple object tracking	70.82±2.25	72.20±2.85	0.48
Reaction time	14.18±3.61	20.80±4.26	1.71
Eye-hand coordination	50.80±4.87	57.12±5.08	1.26
GO/NO GO	29.28±4.91	44.68±5.15	3.11

DISCUSSION

The objective of this research was to examine the influence of visual training on tennis physical education and its potential to enhance tennis skill levels. Moreover, the researchers sought to introduce a straightforward and practical visual training method into university sports courses. During the 8-week study, the experimental group students underwent visual ability training, resulting in notable improvements in their visual abilities. Additionally, the enhanced tennis skill levels observed in this group provided further evidence of the effectiveness of utilizing the dynamic visual training device.

The visual abilities, including static and dynamic visual acuity showed different levels of improvement after the training. In this research confirmed that when visual training was applied with high-ball speed and high-focus tasks, athletes demonstrated significant improvements in tracking ball trajectories and making precise ball predictions. Before research, several scholars have obtained consistent research results in various sports. Visual training has been shown to significantly enhance athletic performance in a range of sports, such as badminton, baseball, table tennis, and football. Before this research, several studies have been conducted to investigate the effects of visual training on athletic performance across these sports. For instance, Feng (18) examined its impact on badminton players, while Liu et al. (19) and Millard (20) focused on baseball players, and Coetzee and de Waal (21) focused on netball players. Similarly, Shinkai et al. (10) researched table tennis, and Yang et al. (22) investigated its applications in football. Skeet Shooting Athletes have better hand-eye coordination and visual memory than non-athletes (23). Collectively, these studies provide compelling evidence supporting the notion that visual training can yield significant improvements in athletic performance in a diverse range of sports. Although research results demonstrate that visual training can enhance fundamental tennis skills, the specific skills and techniques with the most significant improvement remain unclear.

The continuous advancements in the ability of visual training devices have raised intriguing questions about their potential impact on athletes' physiological structure and subsequent sports performance. As this critical question remains unanswered, it was strongly recommended further research in this field to delve deeper into these aspects. By investigating the effects of visual training on athletes' performance, the research adds to the growing interest in understanding the training method can contribute to improved sports proficiency.

CONCLUSION

The findings of this study will not only provide valuable insight and recommendations for athletes and coaches but will also contribute to the advancement of tennis education and the improvement of athletes' competitiveness in the sport. Furthermore, as technology continues to evolve and visual training devices become increasingly popular, the study highlights the importance of delving deeper into their potential impact on the physiological aspects of athletes. Addressing this gap in the research field will help to better understand the mechanisms by which visual training enhances sports performance, ultimately opening up new possibilities for optimizing sports training and performance in the future.

From a theoretical perspective, this research can be grounded in the framework of perceptual motor skills and neural adaptations. Visual training is thought to improve athletes' perceptual skills, including the perception of movement trajectory, speed, and position, which is crucial for making quick decisions in fast-paced sports such as tennis. Additionally, neuroadaptive theory suggests that consistent training and practice can improve the way the brain processes specific motor tasks, leading to improved athletic performance. By examining how visual training affects perceptual-motor skills and neural adaptations, a fuller understanding of its impact on athletes' competitive abilities can be gained.

In conclusion, this study will not only provide practical advice for athletes and coaches but also provide theoretical support for the development of tennis education. In addition, by thoroughly investigating the physiological effects of visual training, we can reveal its potential mechanisms for optimizing sports training and performance and provide new directions for future sports science research and sports training.

APPLICABLE REMARKS

- The primary aim of this study was to examine the impact of visual training on tennis physical education and skill enhancement, focusing on the introduction of a practical visual training method into university sports courses.
- The experimental group of students who underwent visual ability training during 8 weeks

demonstrated substantial improvements in their visual abilities, including static and dynamic visual acuity.

- The study's results provided evidence that utilizing a dynamic visual training device was effective in enhancing tennis skill levels, particularly when high ball speed and high-focus tasks were employed.
- This research contextualized its findings by referring to prior studies in various sports like badminton, baseball, table tennis, and football, all of which supported the idea that visual training can significantly improve athletic performance.
- The study also acknowledged the need for further investigation to determine which specific skills and techniques benefited the most from this training.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Zhang Die Die, Sheiladevi Sukumaran. Acquisition of data: Sheiladevi Sukumaran. Analysis and interpretation of data: Zhang Die Die. Drafting the manuscript: Zhang Die Die, Sheiladevi Sukumaran. Critical revision of the manuscript for important intellectual content: Sheiladevi Sukumaran. Statistical analysis: Sheiladevi Sukumaran. Administrative, technical, and material support: Zhang Die Die. Study supervision: Sheiladevi Sukumaran.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest that could have inappropriately.

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