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ORIGINAL RESEARCH

The effects of coach encouragement on the physical and technical test performances of young tennis players

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Abstract

This study investigates the effects of coach encouragement (CE) on the physical and technical performance of young tennis players. Twenty nationally ranked male tennis players (age: 13.6 ± 0.3 years, height: 160.9 ± 7.9 cm, body mass: 52.5 ± 7.6 kg,) participated in the present study. The physical and technical tests were conducted both with and without CE, using a randomized crossover design. Participants attended two sessions for performance assessments, undergoing a series of tests, including the hit and turn tennis test (HTTT), international tennis number test (ITN), counter-movement jump (CMJ) test, 20-m sprint tests, and the T-drill agility test. A paired t-test results demonstrated significant improvements in VO2max, CMJ height, 20-m sprint times, T-drill agility, and ITN scores under CE conditions compared to tests conducted without CE ($p < 0.05$). These findings suggest that CE positively influences physical and technical performances. Moreover, the effects of CE were more pronounced in long-duration exercises (HTTT and ITN), highlighting the crucial role of motivational support from coaches in the development of young athletes.

Introduction

Tennis is characterized by a series of intermittent high-intensity actions, encompassing a wide range of movements such as running at varying speeds, changing direction, pivoting, hitting strokes, sliding, and upper body maneuvers (Fernandez et al., 2006; Kilit et al., 2018). These diverse movements engage both anaerobic and aerobic energy systems. Due to these complex metabolic demands, tennis is predominantly viewed as an anaerobic sport, interspersed with aerobic pauses between rallies, which can extend over long match durations. This intermittent nature permits players to recover between bouts of intense activity (Fernandez et al., 2006; Fernandez-Fernandez et al., 2009; Kilit et al., 2018).

Studies show that young tennis players typically maintain an average heart rate of about 150-160 beats per minute (Hoppe et al., 2014; Kilit & Arslan, 2017). In simulated tennis match conditions, these players generally cover distances ranging from 2 to 4 kilometers, with high-intensity activities, constituting approximately 10-25% of the total distance covered. Such high-intensity activities place significant demands on players' endurance and speed capacities (Hoppe et al., 2014; Kilit et al., 2018; Pereira et al., 2015). Additional match characteristics include an average rally duration of around 8 seconds, an effective playing time of approximately 20-25%, and resting periods between rallies averaging 18 seconds (Fernandez-Fernandez et al., 2009; Kilit et al., 2018). Recognizing these physical and technical requirements is crucial for sports scientists and coaches, as it allows them to develop game-based training drills and accurately increase the intensity of simulated tennis match in young players.

Game-based tennis training drills are specifically designed to replicate the actual movements and patterns observed during matches, thereby improving players' performance by simulating tennis match conditions (Reid et al., 2008; Reid et al., 2013). Combining technical and physical training within these drills has proven to be highly effective, as it concurrently enhances physical conditioning, technical abilities, and tactical insight (Kilit & Arslan, 2019; Reid et al., 2013). This comprehensive approach not only boosts training efficiency but also helps players adapt better to match situations. Additionally, these popular drills are generally more engaging and enjoyful for young players

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compared to off-court training methods, fostering a positive training environment (Kilit et al., 2019). Enhancing player motivation is crucial for their long-term development and retention in the sport. Numerous studies have confirmed the effectiveness of on-court drills, showing significant improvements in game-based technical skills that directly translate to tennis match performance (Kilit et al., 2019; Reid et al., 2008; Reid et al., 2013).

Consequently, game-based or running-based training methods better prepare players for actual match conditions (Fernandez-Fernandez et al., 2009; Kilit et al., 2018). During these training interventions, coach encouragement (CE) has been identified as a key element in training and exercise motivation, especially for young athletes (Kilit et al., 2019). The support and encouragement from coaches play a critical role in enhancing players' performance and motivation. Motivation is critical during physical activities to incentivize people's behaviors, desires, and demands throughout sports. Positive feedback, such as CE, can be effectively used as a stimulus for intrinsic motivation (Hammami et al., 2023; Selmi et al., 2023; Soylu et al., 2023a, 2023b). For example, Rampinini et al. (2007) demonstrated that psychophysiological responses were significantly increased during exercises with CE compared to those performed without it. These findings indicate that exercises performed with CE increase physical responses. Moreover, the positive effects of CE on heart rate, rating of perceived exertion, and enjoyment levels have been documented among young soccer players during game-based training sessions. Other studies have shown significant positive effects of CE on the physical and technical skill performance, motivation, and enjoyment of young athletes (Hammami et al., 2023; Kilit et al., 2019; Sahli et al., 2022; Sahli et al., 2023).

CE is an external motivation that improves behavior, physical engagement, and the desire to practice (Hammami et al., 2023). Other research has highlighted the effects of CE on improving aerobic and anaerobic fitness. While extensive research has focused on the impact of CE in team sports like soccer (Hammami et al., 2023; Sahli et al., 2023; Selmi et al., 2023; Soylu et al., 2023a, 2023b), there is a lack of studies exploring its effects on the performance of tennis players (Kilit et al., 2019). The limited research on the effects of CE in individual sports like tennis underscores the importance of this study.

Thus, the main purpose of the study is to investigate the effects of CE on the physical and technical test performance of young tennis players. Specifically, the study seeks to determine which training model is more effective in enhancing tennis training performance. Based on previous findings suggesting improvements in physical and technical responses with CE, it is hypothesized that CE will positively impact both physical and technical responses in young tennis players. It is anticipated that training with CE will positively influence the performance of young tennis players.

Methods

Participants

Twenty nationally ranked male young tennis players volunteered for this study (age: 13.6 ± 0.3 years, height: 160.9 ± 7.9 cm, body mass: 52.5 ± 7.6 kg, maturity offset: −0.3 ± 0.3 years, peak height velocity: 13.9 ± 0.3 years). All were right-handed players with a training workload of more than three units per week and at least two years of experience in training and competition. At the time of the study, the players were not involved in any training or matches. The inclusion criteria were: (i) regularly playing tennis, including participation in competitive matches for at least six months. Participants were excluded if they had (i) acute injuries or (ii) failed to attend tennis training sessions or matches. Prior to testing, all players and parents were informed of the research procedures, requirements, benefits, and risks, and provided written informed consent. The study was approved by the local university's research ethics committee (E-40272023-804.99-401116, 01-36) and conducted in accordance with the Declaration of Helsinki. No participants were injured or withdrew during the study.

Procedures

This study employed a within-subject design over a pre-season training period, involving a single group of twenty participants who underwent both with CE (CE_{with}) and without CE ($CE_{without}$) physical and technical tests at two different times, with a one-week interval. Initially, anthropometric measurements were taken. All tennis players refrained from any other training or matches during this period. They performed a series of randomized physical tests (Hit and Turn Tennis Test (HTTT), counter-movement jump (CMJ) test, 20-m sprint tests, and the T-drill agility test) and technical tests (International Tennis Number test (ITN)), both CE_{with} and $CE_{without}$. To minimize fatigue effects, each testing session was separated by at least 48 hours. Each session began with a standardized 20-minutes warm-up: a 10-minute warm-up for the physical tests and a 10-minute warm-up for the technical tests, including low-intensity running, stretching, brief sub-maximal sprints, and tennis-specific movements. Participants were randomly assigned to perform the both physical and technical tests under either the CE_{with} or $CE_{without}$ conditions. One week later, they were re-randomized to ensure balanced exposure to both conditions. During the tests with CE, consists of communication strategies that classify coaches' verbal behaviors as reactive and spontaneous, including general technical instructions or technical corrections (e.g., correction of technical execution) (Smith et al., 1977), the coach provided standardized verbal CE every 5 seconds, such as "quick," "good shot," "get back in position quickly," and "turn quickly" (Kilit et al., 2019). In contrast, no feedback was provided during the tests without CE. Similar encouragement interventions are frequently preferred to perform the maximum effort for players (Hammami et al., 2023; Sahli et al., 2022). All testing sessions were conducted on indoor hard courts at the same time each day, between 17:00 and 19:00, to control for variables like fluctuations in energy levels or environmental conditions.

Measures

Anthropometrics and maturity offset

Body mass (kg) was measured using a bioelectric impedance analyzer (BC-418, Tanita, Tokyo). Participants' sitting and standing heights (cm) were measured using a stadiometer (Holtain Ltd., UK). Maturity was assessed as described by Mirwald et al. (2002), by calculating the maturity offset, which indicates the years before or after peak height velocity (PHV). The maturity offset value was then subtracted from the players' chronological age to estimate PHV.

The Hit and Turn Tennis Test

The Hit and Turn Tennis Test (HTT) is an acoustically controlled, progressive fitness test for tennis players, performed by one or more players (Ferrauti et al., 2011). It involves forehand and backhand stroke simulations. At the start of each level, the player stands in the middle of the baseline with their racket facing forward. Upon hearing a signal, the player runs to the designated corner, simulates a shot, and returns to the middle using side or crossover steps while facing the net. The test ends when players fail to reach the corners in time or can no longer perform the movements. The final completed level indicates tennis-specific endurance capacity, measuring maximum oxygen uptake and peak velocity. After the test, estimated VO_{2max} for under-14 boys was calculated using the formula (Ferrauti et al., 2011): $VO_{2max} = 30.0 + 1.66 \times$ (player's final level in HTT).

International Tennis-Number Test

The International Tennis Federation (ITF) uses the ITN ranking system to measure the performance of tennis players at all levels. This objective on-court assessment tool evaluates tennis-specific tasks such as ball control, accuracy, and power. The assessment includes five technical elements: groundstroke depth, groundstroke accuracy, volley depth, serve, and mobility. The test, performed according to ITF guidelines, has a maximum score of 430 points (*The ITF International Tennis Number Testing Guide*, 2004). The ITN was conducted on an indoor hard court to assess the players' technical skills. Each participant's best result was recorded after two attempts. A ball machine (Tennis Tutor Plus, Burbank, CA, USA®) was used to feed balls to the players.

Jump test

Players began by standing with their feet shoulder-width apart and their hands on their hips. It was recommended that they land with straight lower limbs to prevent knee flexion and to land at the same starting location. The Optojump system (Microgate, Bolzano, Italy) a photoelectric cell system, was used to evaluate jump performance. The jump height (cm) was recorded for analysis. Participants completed three attempts for the countermovement jump test (CMJ), with 120-seconds of rest between each attempt. The best trial was used for analysis (Sampaio et al., 2023).

Sprint test

Each athlete performed a 20-m linear sprint test with intervals at 5-m, 10-m, and 20-m. The starting point was 70 cm behind the first pair of photocells (Smartspeed Pro, Fusion Sport, Coopers Plains, Australia) marking the starting line. Participants were instructed to sprint maximally up to the 20-m timing gate. Players performed two trials with a 120-second rest period between trials. The best performance was used for analysis (Sampaio et al., 2023).

T-Drill agility test

The T-drill agility test is designed to assess agility through movements common in tennis training and matches. Players sprinted from a standing position to a cone placed 9.14-m away, shuffled sideways to the left to a cone 4.57-m away, shuffled to the right to a third cone 9.14-m away, shuffled back to the center cone, and then ran back to the starting point (Pauole et al., 2000). Time was measured using a portable wireless photocell system (Smartspeed Pro, Fusion Sport, Coopers Plains, Australia). Participants performed two trials with a 120-second rest period between trials. The best performance was used for analysis.

Statistical Analysis

The normality of the data was confirmed using the Kolmogorov-Smirnov test with Lilliefors correction prior to conducting parametric tests. Differences between the all tests on CE_{with} and $CE_{without}$ were assessed using a paired t-test. Statistical analyses were performed using IBM SPSS Statistics (version 22), with a significance level set at $P < 0.05$. Effect sizes were quantified using Cohen's *d* with the following thresholds: trivial (0.2), small (0.6), moderate (1.2), large (2.0), and very large (>2.0) (Hopkins et al., 2009). The intra-class correlation coefficient (ICC) was employed to determine the test-retest reliability of all tests.

Results

The all test results show that the scores of young tennis players in the CE_{with} were significantly different from their scores in the $CE_{without}$ ($p < 0.05$). Table 1 indicates that CE_{with} induced higher physical and technical performance responses in terms of VO_{2max} (p = 0.000; t = -7.378; 95% CI: -1.508 to -0.842), CMJ (p = 0.000; t = -5.339; 95% CI: -0.835 to -0.365), 5-m sprint (p = 0.000; t = 12.583; 95% CI: 0.010 to 0.015), 10-m sprint (p = 0.000; t = 8.029; 95% CI: 0.024 to 0.041), 20-m sprint (p = 0.000; t = 8.110; 95% CI: 0.055 to 0.094), T-drill agility (p = 0.000; t = 9.491; 95% CI: 0.062 to 0.097), ITN (p = 0.000; t = -10.727; 95% CI: -21.512 to -14.727) compared to $CE_{without}$ (Figure 1).

Table 1

Compares the physical and technical performance of young tennis players under conditions of CE_{with} and $CE_{without}$.

Variables	$CE_{without}$	CE_{with}	% change	Cohen *d* and Rating
VO_{2max} (ml.kg^{-1}.min^{-1})	45.18 ± 1.80*	46.35 ± 1.72	2.58	0.66; Moderate
CMJ (cm)	26.30 ± 2.05*	26.90 ± 2.00	2.28	0.29; Small
5-m sprint (s)	1.16 ± 0.04*	1.15 ± 0.04	0.86	0.25; Small
10-m sprint (s)	2.18 ± 0.09*	2.15 ± 0.10	1.39	0.31; Small
20-m sprint (s)	3.67 ± 0.19*	3.60 ± 0.20	1.94	0.35; Small
T-drill agility (s)	12.71 ± 0.18*	12.63 ± 0.20	0.63	0.42; Small
ITN (a.u.)	209.0 ± 27.74*	227.0 ± 28.11	8.61	0.64; Moderate

VO_{2max}: maximal oxygen consumption; CMJ: countermovement jump test; ITN: international tennis number test.

** Significant difference from the CE_{with}.*

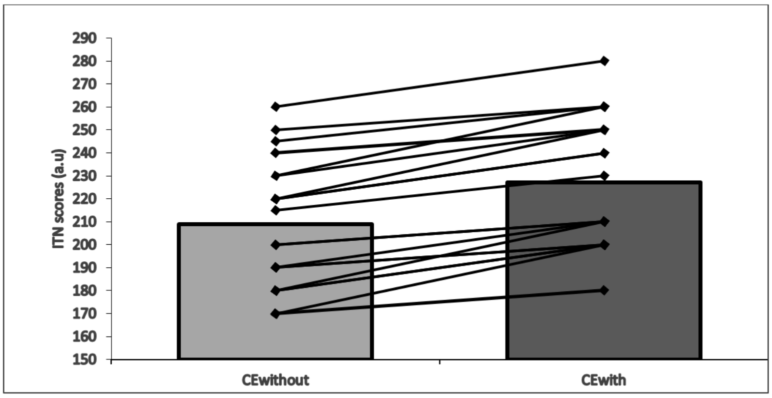

Figure 1. ITN test responses of young tennis players CE_{with} and $CE_{without}$.

Discussion

The results of this study indicate that coach encouragement (CE) significantly enhances both the physical and technical performance of young tennis players. The improvements observed in VO_{2max}, CMJ height, sprint times, T-drill agility, and ITN scores under CE conditions highlight the critical role of motivational support in athlete development. Notably, the effects of CE were more pronounced in long-duration exercises (HTTT and ITN), suggesting that sustained encouragement may be particularly beneficial for endurance and technical skill maintenance. The immediate feedback and motivation provided by coaches during short-duration tests (jumping, sprinting, and agility) also contributed to performance enhancements, though to a lesser extent than in long-duration activities. This suggests that while CE is valuable across various types of physical and technical drills, its impact may vary depending on the nature and duration of the exercise.

Verbal encouragement plays a crucial role in human psychology, influencing both cognitive and emotional processes. Mason et al. (2021) examined the use of autonomy-supportive feedback by coaches and found that while this feedback promotes learning, more controlling or prescriptive feedback may be more effective in enhancing immediate performance. This complexity highlights the nuanced role of encouragement in sports. Additionally, neurological research has shown that brain circuits involved in trial-and-error learning and enhanced feedback are crucial for integrating sensory-perceptual processes with motor execution (Makino et al., 2016). Emotional factors, such as internal reactions and self-awareness, also influence how athletes respond to encouragement, as described by Martin and Pear (2019). Adler's theory of encouragement emphasizes its role in fostering engagement and development, especially through positive social interaction (Preiss & Molina-Ray, 2007). Bandura (1997) highlighted the importance of verbal behavior in shaping athletes' beliefs and performance through positive reinforcement.

One of the limited number of studies on CE in tennis, conducted by Kilit et al. (2019), demonstrated that CE significantly improves psychophysiological and performance responses in young tennis players. Their study found that CE led to enhanced cardiovascular responses, reduced perceived exertion, and improved overall performance during tennis drills. These findings align with the current study's results, reinforcing the idea that motivational support from coaches is critical for optimizing athletic performance. Furthermore, the significant improvements in VO_{2max} and ITN scores observed in this study suggest that CE is particularly effective in enhancing endurance and technical skills, which are crucial for tennis performance. The positive effects of CE on these long-duration activities may be attributed to the sustained motivational support provided by the coach, helping athletes maintain their effort and focus over extended periods. This is consistent with previous findings showing increased physical responses during exercises performed with CE (Rampinini et al., 2007; Sahli et al., 2022; Selmi et al., 2023; Soylu et al., 2023a, 2023b).

Furthermore, CE has been shown to enhance game intensity, technical performance, and psychological responses across various sports, including soccer-specific training (Selmi et al., 2023). This broad applicability demonstrates the potential of CE to improve many aspects of athletic performance. Coaches' use of positive reinforcement, particularly under high-pressure conditions, can significantly influence athletes' ability to concentrate, manage anxiety, and reduce stress, as highlighted by Lai and Smith (2021). Similarly, Corbett et al. (2024) emphasized that coach encouragement boosts athletes' motivation and perseverance by employing supportive language that fosters confidence and resilience in challenging situations.

Previous studies have highlighted the importance of CE in various sports contexts, particularly in team sports such as soccer, where it has been shown to improve physiological and perceptual responses, motivation, and enjoyment levels (Hammami et al., 2023; Selmi et al., 2023; Soylu et al., 2023b). In addition to endurance and technical skills, the immediate feedback and motivation provided by coaches during short-duration tests, such as jumping, sprinting, and agility, also contributed to performance enhancements, albeit to a lesser extent. This suggests that while CE is valuable across various types of physical and technical drills, its impact may vary depending on the nature and duration of the exercise. This aligns with the literature indicating that CE can effectively stimulate intrinsic motivation, leading to improved performance outcomes (Hammami et al., 2023; Sahli et al., 2022; Selmi et al., 2017, 2023).

Moreover, further study support these findings by showing that CE can improve game intensity, technical performance, and psychological responses during soccer-specific training (Selmi et al., 2023). Their research highlights the broad applicability of CE across different sports and emphasizes its potential to enhance various facets of athletic performance. By fostering a supportive and motivating environment, coaches can significantly impact their athletes' performance, not only in soccer but also in tennis and other individual sports.

The significant improvements in VO_{2max} observed in this study highlight the effectiveness of CE in enhancing aerobic endurance. VO_{2max} is a critical determinant of cardiovascular fitness and is closely linked to performance in endurance sports like tennis. The sustained encouragement from coaches likely contributed to the athletes' ability to push through physical discomfort and maintain high-intensity efforts for extended periods, leading to improvements in aerobic capacity. This is consistent with previous research showing that CE can enhance endurance performance by increasing motivation and reducing perceived exertion (Engel et al., 2019; Soylu et al., 2023b)

In generally, endurance is a multifaceted attribute influenced by physiological, psychological, and environmental factors. In the context of tennis, endurance not only involves cardiovascular fitness but also the ability to maintain high levels of concentration, technique, and tactical awareness throughout a match. CE can positively impact all these aspects by providing continuous motivational support that helps athletes stay focused, manage fatigue, and maintain their technical and tactical execution over long durations. The improvements in ITN scores observed in this study suggest that CE also enhances technical skills in tennis. Technical skills are critical for success in tennis, as they determine an athlete's ability to execute precise and effective shots. CE likely contributed to these improvements by boosting athletes' confidence and focus during practice sessions, allowing them to refine their techniques and perform at their best. This aligns with previous findings that highlight the role of CE in enhancing technical performance by increasing athletes' motivation and self-efficacy (Hammami et al., 2023; Selmi et al., 2017; Soylu et al., 2023a).

This study has limitations, including a sample composed exclusively of young male tennis players, which restricts the generalizability of the findings to other age groups, genders, and skill levels. Additionally, the specific tests used may not encompass the full range of practices employed by different coaches, potentially limiting the applicability of these results to other training contexts. This study demonstrates the positive impact of CE on the physical and technical performance of young tennis players. Coaches and practitioners should use these results by integrating positive CE into training sessions as an effective motivational tool to optimize and maximize athlete aerobic and anaerobic performance. Therefore, in practical terms, using CE during tennis drills not only enhances physical performance but also improves technical skills, which are critical for tennis match success.

Conclusion

In conclusion, CE plays a significant role in both the short-duration and long-duration physical and technical test performance of young tennis players. The marked improvements observed in endurance and technical skills emphasize the importance of motivational support in athlete development. Therefore, incorporating effective CE methods and motivation strategies into coaching practices can enhance the overall performance levels of young athletes, helping them reach their maximum potential. The evidence presented in this study provides a strong foundation for the practical application of CE in coaching and underscores its value in promoting athletic excellence. Future studies should explore the long-term effects of CE on performance retention, as well as its impact on various age groups, skill levels, and female athletes. Research could also investigate the ideal frequency and intensity of CE, and how it influences real match performance compared to training. Additionally, examining physiological responses to CE may provide insight into its mechanisms of action.

Authors' Contribution

Study Design: BK, EA, YS, BK; Data Collection: BK, EA, YS, BK; Statistical Analysis: EA, YS; Manuscript Preparation: BK, EA, YS, BK; Funds Collection: BK, EA, YS, BK.

Ethical Approval

The study was approved by the Tokat Gaziosmanpasa University of Social and Humanities Research Ethical Committee (13.02.2024), and it was carried out by the Code of Ethics of the World Medical Association, also known as the Declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this study.

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