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Visualization Skills in Elite Junior Tennis Players

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ABSTRACT

The purpose of the study. The aim of the research is to examine the relevance of visualization skills in elite junior tennis players.
Materials and methods. Twenty-six junior tennis players, boys and girls (Mage = 13.88), of which eight players ranked 1st or 2nd in the national rankings in Romania (having, also, very good results at European level) took part in the study. The Sport Imagery Ability Questionnaire (SIAQ) was used to assess tennis players' imagery ability.
Results. The Kruskal-Wallis H test and the Dwass-Steel-Critchlow-Fligner pairwise comparison test were used. Elite tennis players have significantly better Goal imagery abilities (p = 0.042) and Affect imagery abilities (p = 0.006), compared to athletes ranked between 7th and 15th in the national ranking. Also, using the Mann-Whitney (U) test gender-related differences in terms of visualization skills were explored.
Conclusions. Tennis players ranked 1st and 2nd in the national ranking can easily imagine the emotions and excitement associated with performing, observing themselves (mentally) more easily winning a medal or a competition. Even if no significant gender-specific differences were found, female athletes reported slightly greater ease in visualizing skills and strategies/game plans, compared to male junior tennis players.

Keywords: mental imagery; tennis; affect imagery ability; goal imagery ability; mental rehearsal.

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INTRODUCTION

Tennis is an individual sports game that requires speed of reaction and movement, the ability to make quick decisions, physical and mental endurance, precision (a deviation of only a few degrees of the tennis racket's inclination resulting in the ball being sent into the net or off the court), perfect coordination and synchronization of movements (Stănescu, 2018). The continuous evolution of tennis encompasses technique and tactics (Crespo & Reid, 2007). Modern tennis emphasizes physical and mental fortitude, the continuous refinement of tennis equipment, such as racquets and strings, also playing a crucial role in shaping the game (Elliott et al., 2017). Professional tennis players now make use of a wider range of strategies, fitness routines, and methods, the psychological aspects of tennis being as vital as the physical and technical. Mental toughness, concentration, and emotional control are crucial for success at the highest levels in tennis, and not only (Yudho & Nugroho, 2021; Zhang et al., 2023).

Visualization represents an effective way to improve tennis players' performances. Mental practice is (generally) based on motor imagery, and refers to the cognitive rehearsal of a physical activity (Saimpont et al., 2013). Prior research indicates that combining imagery with physical practice yields more substantial benefits in learning intricate motor tasks, while imagery alone can assist learners in sustaining initial skill proficiency (Post et al., 2015). Visualization, involving the creation or recreation of sensory experiences in the mind, entails accessing altered states of consciousness, inducing modifications in biochemistry and brainwave patterns, thereby empowering individuals to expedite healing and augment performance capabilities (Predoiu et al., 2020). Athletes harness visualization to mentally rehearse skills, strategize game plans, and cultivate a heightened sense of self-efficacy (Majlesi, 2021). Recent meta-analytic findings and experimental studies confirm that structured imagery interventions produce significant gains in serve performance and reduce pre-competitive anxiety in junior tennis players (Liu et al., 2025; Noel, 1980).

Athletes use mental imagery to improve their overall performance (Jacobs & Wright, 2016). Motor imagery relies on

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accessing a central representation that the brain uses for both physical preparation and execution (Holmes & Collins, 2001). The effectiveness of mental imagery in sports has garnered considerable attention, with studies demonstrating its positive impact on performance enhancement (Zandi & Heris, 2020). An investigation into the use of imagery among young athletes revealed that a significant proportion of participants, drawn from a United Kingdom sports academy, actively employ imagery as part of their training regimens (Parker & Lovell, 2009). Mental imagery has been shown to improve performance in visuomotor tasks (Salehi et al., 2021), while improving, also, the eudaimonic well-being of athletes (Kouali et al., 2020). Mental imagery improved the performance of young soccer players (Sariati et al., 2021), young schoolchildren playing table tennis (Zhang et al., 1992), or in senior basketball players (Meyers & Schleser, 1980).

Imagery functions as a mental training tool, enabling athletes to mentally simulate actions, a skill that develops with age, mirroring adult-level proficiency by around the age of ten (Souto et al., 2020). Imagery can affect the strength of actual muscles - while brief periods of motor imagery training may improve strength, more research is needed with larger populations (Saumur & Perry, 2018). When compared to merely relying on physical practice, combining visualization and physical practice demonstrates superior outcomes in children's motor learning (Takazono & Teixeira, 2018).

In tennis, visualization has been used successfully by great champions, for example Chris Evert (world No. 1 in women's singles) stating that before matches she rehearses in her mind what is going to happen on the court, and what will be the reaction in certain situations, imagining herself sending the ball long, powerful and attacking the net on any weaker shot of the opponent (Wu et al., 2023). In tennis, visualization can be used to improve concentration, anxiety, motivation, confidence, to control dysfunctional emotions, to instill game tactics and technical procedures, to eliminate technical errors and inappropriate reactions, or to maintain automaticity during recovery periods (Meier et al., 2020). Visualization can be used before and after practice, before and after the match, before serve, return, or in the break between games (Mathers, 2016). Depending on the orientation, visualization can be future-oriented (athletes visualize successful motor actions) or past-oriented (e.g., game analysis) (M. Hacker & E. Mann, 2022). Also, visualization can be: external (the tennis player sees himself/herself from outside the body) or internal (the athlete sees through his/her own eyes, feels the emotions, and the tension in the muscles); in slow-motion, at the intensity and timing of the competition or at a fast pace; positive (the athlete visualizes correct and successful moves) or negative (see, for example, Stănescu, 2023; Predoiu, 2016).

The effectiveness of visualization and mental rehearsal is contingent upon several factors, including the athlete's skill level, the specificity of the imagery, and the consistency of practice. The efficacy of visualization techniques can vary depending on individual differences in imagery ability, motivation, and cognitive processing styles. It seems that tennis players who directed their attention toward motivational self-talk (more exactly, when movement visualization was combined with self-talk) exhibited enhanced performance in precision motor tasks (Robin et al., 2022). Also, visualization "assisted by neurofeedback, as a method of augmentation of internal feedback" reduced the time needed to correct shots in tennis (Tosti et al., 2024).

The perceived pressure during mental imagery scenarios influences both affective and cognitive processes (Hernández, 2022), but through mental practice tennis players can achieve desensitization, reducing the subjective significance of various situations. The ability to visualize successful outcomes, such as executing a precise serve or hitting a winning shot, can foster a positive mindset, which is crucial for performing under pressure (Holmes & Collins, 2001). Athletes should have the ability to stop and study the mental images anytime during visualization - as when a video analysis of the tennis game is performed (Stănescu, 2018), paying particular attention to angles, bio-mechanical aspects, analytical but, also, global observation (Fadare et al., 2022).

Moreover, visualization can aid in adapting to varying playing conditions and opponents, as tennis players can mentally develop strategies to overcome specific challenges (Fadare et al., 2022). The PETTLEP imagery model has shown potential in improving precision skill levels when combined with physical practice (Hashmi et al., 2020). In PETTLEP imagery, athletes should focus on physical, environment, task, timing, learning, emotion, and perspective aspects (Wright et al., 2014). PETTLEP imagery training (combined with service-specific training) improved serve in junior tennis players (Cherappurath et al., 2020)). Not least, imagery training for tennis players should include body analysis, racquets movements and conditions similar to the tournaments (Robin et al., 2022).

Purpose

The aim of the present research is to investigate the relevance of visualization skills in elite junior tennis players.

Hypothesis

H_1: The investigation of visualization ability reveals significant differences between elite tennis players (ranked 1st and 2nd in the national rankings) and other junior tennis players with very good national results.

H_2: There are gender-related differences in terms of visualization skills in the case of tennis players having national sports performances.

MATERIALS AND METHODS

Participants

The study involved 26 tennis players aged between 12 and 16 years, playing at U12, U14 or U16 categories (MAGE = 13.88), of which 8 players ranked 1st or 2nd in the national rankings in Romania (G1), 8 juniors ranked between 3rd and 6th (G2), and 10 tennis players ranked between 7th and 15th (G3). The distribution of participants in the three groups is as follows (a balanced gender and age distribution can be observed):

Table 1. Detailed Distribution of Athletes by Group, Mean Age, Gender, and National Ranking

Group	n	Mage (years)	Gender Distribution	National Ranking Details	Additional Notes
G1	8	14.25	4 Male, 4 Female	- 1st place: 5 players (3M, 2F) - 2nd place: 3 players (1M, 2F)	Some of the athletes ranked 1st in Romania also achieved outstanding results in

					European competitions
G2	8	13.38	6 Male, 2 Female	- 3rd place: 2 players (1M, 1F) - 4th place: 2 players (2F) - 5th place: 1 player (1M) - 6th place: 3 players (3M)	–
G3	10	14.00	6 Male, 4 Female	- 7th place: 2 players (1M, 1F) - 8th place: 2 players (1M, 1F) - 9th place: 1 player (1F) - 11th place: 1 player (1F) - 13th place: 2 players (1M, 1F) - 15th place: 2 players (2M)	–

Test and Measurement Procedures

To assess tennis players' imagery ability the Sport Imagery Ability Questionnaire (SIAQ) was used, developed by Sarah E Williams and Jennifer Cumming (Williams & Cumming, 2011). We mention that written permission was obtained from the authors to translate and use the questionnaire for research purposes. The SIAQ was translated into Romanian through retroversion, a procedure used in previous studies (Predoiu et al., 2024; Piotrowski et al., 2021). SIAQ has 15 items and five separate subscales (there are three items for each subscale): Skill imagery ability, Strategy imagery ability, Goal imagery ability, Affect imagery ability and Mastery imagery ability. Junior tennis players were asked to image each item and to mention how easy they are able to image each scenario. Athletes marked their answers on a 7-point Likert type scale: 1 = "Very hard to image", 2 = "Hard to imagine", 3 = "Somewhat hard to imagine", 4 = "Neutral (not easy or hard)", 5 = "Somewhat easy to imagine", 6 = "Easy to imagine", 7 = "Very easy to image". Instructions: "For each item, bring the image to your mind with your eyes CLOSED. Then rate how easy it is for you to form this image" (Williams & Cumming, 2014). For example, if a tennis player finds imaging himself/herself staying positive after a setback Hard to imagine, he/she will select 2.

Item examples: "Refining a particular skill" (Skill imagery ability), "Making up new plans/strategies in my head" (Strategy imagery ability), "Being interviewed as a champion" (Goal imagery ability), "The excitement associated with performing" (Affect imagery ability), "Staying positive after a setback" (Mastery imagery ability). To obtain the final score for each subscale, the result (sum of answers for each scale) is divided by 3.

Procedure

The study was conducted during the year 2024. The questionnaire in this research was administered online via google forms (Google LLC, Mountain View, CA, United States). Informed consent was obtained from the parents of the athletes participating in this study, participants had the opportunity to withdraw from the research at any time, data were treated confidentially and anonymity was ensured. The current study was approved by the local ethics committee of the National University of Physical Education and Sport, Bucharest, authorization number assigned is 376/SG.

Statistical Analysis.

Statistical analysis was performed using Jamovi. The Kruskal-Wallis (H) test and the Dwass-Steel-Critchlow-Fligner (DSCF) test were used to verify the differences between the investigated groups of tennis players. Also, the Mann-Whitney (U) test was used to check the gender-related differences in terms of athletes' imagery abilities.

RESULTS

Using the Kruskal-Wallis non-parametric test the differences between the three groups of tennis players (G1, G2 and G3) were examined, in terms of: Skill imagery ability, Strategy imagery ability, Goal imagery ability, Affect imagery ability and Mastery imagery ability (Table 2).

Table 2. Visualization skills – differences between groups

Visualization Skill	χ^2	df	p	ε^2
Skill imagery ability	0.237	2	0.888	0.009
Strategy imagery ability	1.586	2	0.452	0.063
Goal imagery ability	5.192	2	0.075	0.207
Affect imagery ability	10.229	2	0.006	0.409

Note. $\varepsilon^2 > 0.14$ = strong effect size (López-Martín & Ardura, 2023)

Significant differences were found for Affect imagery ability (p = 0.006) between investigated tennis players, a very strong difference between groups being observed ($\varepsilon^2 = 0.40$). To verify the differences between groups (analyzed two by two), the Dwass-Steel-Critchlow-Fligner (DSCF) pairwise comparison test was used. Only the significant results are presented below (Table 2 and Table 3).

Table 3. Pairwise comparisons (DSCF) – Goal imagery ability

Group 1	Group 2	W	p
1–2 National ranking	3–6 National ranking	-1.995	0.336
1–2 National ranking	7–15 National ranking	-3.414	0.042
3–6 National ranking	7–15 National ranking	-0.317	0.973

Table 4. Pairwise comparisons (DSCF) – Affect imagery ability

Group 1	Group 2	W	p

1–2 National ranking	3–6 National ranking	-3.180	0.064
1–2 National ranking	7–15 National ranking	-4.320	0.006
3–6 National ranking	7–15 National ranking	-1.170	0.687

Junior tennis players ranked 1st and 2nd in Romania (regardless of gender) have significantly better imagery abilities: Goal imagery abilities ($p = 0.042$, $M = 6.71$, $SD = 0.33$) and Affect imagery abilities ($p = 0.006$, $M = 6.41$, $SD = 0.79$), compared to athletes ranked between 7th and 15th in the national ranking ($M = 5.60$, $SD = 1.30$, respectively $M = 5.46$, $SD = 0.55$). The null hypothesis is rejected (H1). Descriptive statistics are presented in Table 5.

Table 5. Descriptive statistics – tennis players' visualization skills

Statistic	National ranking	Skill IA	Strategy IA	Goal IA	Affect IA	Mastery IA
Mean	1–2	5.71	5.79	6.71	6.41	5.87
	3–6	5.71	5.16	5.79	5.67	4.85
	7–15	5.53	5.73	5.60	5.46	5.23
Median	1–2	6.17	6.00	6.83	6.50	6.33
	3–6	5.50	5.33	6.16	6.00	4.67
	7–15	5.66	5.67	5.83	5.50	5.17
SD	1–2	1.23	1.05	0.33	0.50	0.99
	3–6	1.03	1.11	1.22	0.80	0.96
	7–15	1.10	0.93	1.30	0.55	1.37

Note. IA = imagery ability.

DISCUSSION

The integration of visualization and mental rehearsal into tennis training regimens represents a promising avenue for athletes seeking to enhance their performance, optimize their mental game, and gain a competitive edge. Mental imagery engages neural pathways similar to those activated during actual physical execution, thereby refining motor skills, improving decision-making, and fostering a sense of preparedness (Corrado et al., 2025; Majlesi, 2021)). However, the effectiveness of imagery interventions is contingent upon the vividness and controllability of the images created (Ji et al., 2015), therefore, not all athletes enjoy the benefits of visualization sessions to the same extent.

Mental rehearsal involves the systematic and repetitive practice of a skill or sequence of movements in the mind's eye (Predoiu et al., 2020). In tennis, where split-second decisions and precise movements are paramount, visualization offer athletes a valuable tool for optimizing their performance. Guided imagery employs, also, emotions and a spectrum of bodily senses (Skeens, 2017). Therefore, the integration of visualization into tennis training can yield multifaceted benefits. By mentally rehearsing serves, volleys, forehands or match strategies, athletes can fine-tune their motor programs, enhance their anticipation skills and develop a deeper understanding of the game's nuances.

Our study findings revealed that junior tennis players ranked 1st and 2nd in the national ranking have significantly better Goal imagery abilities and Affect imagery abilities, compared to athletes ranked between 7th and 15th in Romania. In other words, for elite athletes is significantly more easy to imagine themselves winning a competition or a medal, being interviewed after a tennis match (Goal imagery ability), and, also, is significantly more easy to imagine the positive emotions they feel during the match, the excitement associated with performing, and the anticipation (and excitement) associated with a tennis competition (Affect imagery ability). Even if the difference was not statistically significant (p-value was relatively close to the 0.05 threshold), tennis players ranked 1st and 2nd registered higher values for Affect imagery ability compared, also, to athletes ranked between 3rd and 6th.

Data analysis showed, also, that elite athletes obtained the highest scores for skill imagery ability (e.g., visualizing the improvement of a particular/specific skill), strategy imagery ability (e.g., visualizing alternative plans/strategies), and mastery imagery ability (e.g., visualizing remaining confident in a difficult situation), but the differences were not statistically significant. However, in performance sports, any small advantage can make the difference during the competition, especially when athletes are at a relatively close technical level. Therefore, athletes and specialists should pay more attention to developing visualization skills, more exactly to developing (with priority) Goal and Affect imagery abilities, aspects that are likely to differentiate between tennis players. As researchers stated (and in accordance with PETTLEP system), emotions "should be associated with performance and incorporated into visualization from an inner perspective" (Predoiu et al., 2020), the positive emotions felt during visualization and the excitement associated with playing tennis (mentally) being essential. Athletes need to be guided to "step into" the feeling during visualization techniques, when imagining a future desired outcome (for example), or a previous performance (Noel, 1980). Regarding Goal imagery ability (e.g., imagining winning a competition or a medal), Williams and Cumming emphasized that positively predicted athletes' confidence, "which in sequence positively predicted challenge appraisal and negatively predicted threat appraisal tendency" (Williams & Cumming, 2012). Literature highlights, also, that easily imagining the proposed goals, skills and game strategies "predicted athlete observational learning use", very important for athletes' personal and professional development (Kwon et al., 2022; Wu et al., 2023). Therefore, training tennis players' imaginative skills and maximizing the effects of visualization sessions should be a priority for athletes, coaches and sports psychologists.

Not least, the gender-related differences in terms of visualization skills were examined. Even if no significant differences were observed, it is worth mentioning that female junior tennis players reported slightly greater ease in visualizing skills and strategies/game plans, compared to male athletes. Yarayan et al., (2024) mentioned no significant difference between the imagery levels of male athletes (runners were investigated) according to their sports performances. However, female athletes having higher performances showed higher levels of imagery, compared to female athletes having low- and medium-results. Studying elite level

athletes, Parker & Lovell, (2009) underlined that female athletes (Australian Football League players and cricketers) "used imagery significantly more frequently prior to training compared to competition", while in the case of male athletes the findings were opposed (male athletes used imagery more before competing). Nuanced investigations into gender-specific differences in imagery use and its effects on athletic performance are still needed. It is imperative to delve into the potential gender-based variations in imagery preferences, and the resultant impact on athletic outcomes.

In practical terms, acknowledging and addressing gender differences in tennis players' imagery abilities across different skill levels can have profound implications for coaching, training, and psychological interventions.

Limitation and future research directions

The present study is not without limitations. We can think, for example, at the relative small sample size (however, athletes are ranked the highest in the country at U12, U14 or U16 age level, and some of them registered important European performances). Also, the results could be different in another setting (e.g. country), if only boys (or only girls) would be investigated (taking into consideration the sports performances), or the results would be compared with those of tennis players ranked at the bottom of the national rankings. Future research could examine only a specific age category, seniors, while aspects such as tennis players' level of education and personality traits (e.g., conscientiousness, emotional and cognitive autonomy, openness to experiences) can be, also, considered.

Regarding the gender differences in visualization within sports a multifaceted approach is needed, considering both sociocultural factors (e.g., gender stereotypes, sport-specific cultural norms) and cognitive ones, that may contribute to these variations. Cognitive psychology and neuroscience suggests that males and females may exhibit differences in visual processing, cognitive strategies, in small-scale and large-scale spatial abilities (Li et al., 2019), which could subsequently influence their imagery abilities, with males demonstrating better results (while females tend to excel in emotional processing). These cognitive differences could translate into variations in the vividness, accuracy, and emotional content of mental images experienced by athletes. Understanding these cognitive underpinnings is essential for tailoring imagery interventions to suit the specific cognitive profiles of males and females, potentially maximizing the benefits derived from mental imagery (Yoo & Kim, 2014). Further research is needed to determine how these cognitive factors interact with imagery skills and influence athletic performance across different sports and skill levels.

Moreover, the investigation of gender differences in imagery within tennis (and sports, generally) should also consider the methodological nuances and potential biases that may influence research findings. Sample sizes, participant characteristics, and the specific types of imagery tasks employed can all impact the observed results. Addressing these methodological limitations is crucial for ensuring the validity and reliability of research findings and for advancing our understanding of gender differences in imagery within the context of sports performance.

Future studies should strive to employ more representative samples, utilize standardized imagery assessment tools, and consider the influence of contextual factors such as sport type and competitive level, being known that elite athletes consistently differentiate themselves through psychological qualities and mental techniques (Woodcock et al., 2011). Longitudinal studies that track tennis players' imagery use and performance over time can provide, also, valuable insights into the developmental trajectories of imagery skills and the potential impact of gender on these trajectories. Furthermore, incorporating qualitative research methods, such as interviews and focus groups, can offer a deeper understanding of athletes' subjective experiences with imagery.

CONCLUSION

Tennis players ranked 1st and 2nd in the national ranking show significantly greater ease in visualizing goal and affect imagery abilities, compared to athletes ranked between 7th and 15th. Elite junior tennis players can easily imagine the emotions and excitement associated with performing, observing themselves (mentally), at the same time, more easily winning a medal or a competition. Also, female junior tennis players reported slightly greater ease in visualizing game plans and skills, compared to male athletes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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