Serving up self-efficacy: how modern training methods empower elite junior tennis players
Generando autoeficacia: como los modernos métodos de entrenamiento pueden empoderar a tenistas junior de élite

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Abstract

Introduction: Mastering the game of tennis requires a combination of complex technical, tactical, physical, and mental skills. Tennis training has evolved to support elite junior players' comprehensive development. While traditional training focuses on isolated technical drills, modern methods integrate tactical and gameplay elements.
Objective: This single-case ABCA design study compared the effects of two 4-week training methods - traditional isolated drills and modern integrated gameplay on self-efficacy, tactical awareness, and technical proficiency in elite junior players selected from a high-performance international tennis academy.
Methodology: Three international male junior players, aged 15-17 and ranked within the top 100 in the world, were observed during the pre-intervention, intervention, and follow-up stages, totaling 113 observations. Training methods were delivered 4 times per week by the same professional certified coach with more than 10 years of experience in the ITF and ATP Tours, each tailored to individual player's needs. Self-efficacy questionnaires were administered before and after each session, and player interviews provided qualitative insights into their technical and tactical improvement. Results: Both methods significantly increased self-efficacy when well-structured and individualized. However, the modern method led to greater tactical and technical improvements in gameplay and self-perception, while traditional drills enhanced stroke consistency.
Discussion: The findings suggest that integrating technical, tactical, physical, and mental training facilitates adaptation to tennis' dynamic contexts, and personalized approaches to maximizing strengths are ideal for junior development.
Conclusion: A balanced approach seems ideal, with modern methodology appearing more beneficial for self-efficacy, and traditional training still has value for specific technical skills.

Keywords

Coaching; performance; psychology; racket sports; skill acquisition.

Resumen

Introducción: Dominar el tenis requiere una combinación de habilidades técnicas, tácticas, físicas y mentales complejas. El entrenamiento de tenis ha evolucionado para apoyar el desarrollo de los tenistas juveniles de élite. Mientras que el entrenamiento tradicional se centra en ejercicios técnicos aislados, los métodos modernos integran elementos tácticos y de juego.
Objetivo: El estudio de diseño de caso único ABCA comparó dos métodos de entrenamiento durante 4 semanas: tradicional y moderno, sobre la autoeficacia, la táctica y la competencia técnica en jugadores juveniles de élite de una academia de tenis de alto rendimiento.
Metodología: Tres jugadores juveniles internacionales masculinos, de 15 a 17 años y clasificados entre los 100 mejores del mundo, fueron observados durante las etapas de pre-intervención, intervención y seguimiento, totalizando 113 observaciones. El entrenamiento se realizó 4 veces por semana por el mismo entrenador profesional certificado con más de 10 años de experiencia en ITF y ATP, cada uno adaptado a las necesidades de los jugadores. Se administraron cuestionarios de autoeficacia antes y tras cada sesión, y las entrevistas proporcionaron información cualitativa sobre su mejora técnica y táctica.
Resultados: Ambos métodos aumentaron significativamente la autoeficacia cuando estaban bien estructurados e individualizados. Sin embargo, el método moderno condujo a mayores mejoras tácticas y técnicas en el juego y la autopercepción, mientras que los ejercicios tradicionales mejoraron la consistencia de los golpes.
Discusión: Los hallazgos sugieren que integrar el entrenamiento técnico, táctico, físico y mental facilita la adaptación a los contextos dinámicos del tenis, y los enfoques personalizados para maximizar las fortalezas son ideales para el desarrollo juvenil.
Conclusión: Un enfoque equilibrado es ideal, con la metodología moderna beneficiando más la autoeficacia, y el entrenamiento tradicional tiene valor para habilidades técnicas específicas.

Palabras clave

Entrenamiento.; rendimiento; psicología; deportes de raqueta; adquisición de habilidades.

Introduction

Tennis play is characterized by considerably high technical and tactical requirements due to the remarkable complexity of the motor patterns needed to produce the different strokes and the demand for continuous decision-making. In this context, skill acquisition is a key component of the game (Colomar et al., 2020).

Studies have analyzed a wide array of topics due to the nature of the subject, including the effects of different types of practice, block or random, on players' learning and have emphasized the importance of using one or another type of practice depending on the needs of each player (Menayo et al., 2010). Within the types of practice, the influence on players of the use of various degrees of contextual interference (understood as the interference that is experienced when practicing multiple skills, or variations of a skill) during training sessions has also been analyzed (Reid et al., 2006), and it has been concluded that training sessions using these methods that included increased contextual interference due to higher variability (i.e., constant change) between skills are beneficial for transferring those skills to competition (Buszard et al., 2017). When using modern representative drill designs of strokes (gestures that mimic real match challenges) to explore skills that can be transferred to competition, studies concluded that, if transfer to competition is to be maximized, the practice should occur as closely as possible to actual match conditions (Krause et al., 2019a).

This broad approach has also focused on exploring the benefits of performing traditional analytical exercises related to the improvement of baseline (Carvalho et al., 2015) or service acquisition, concluding that performing only the ball toss as a method of improving the serve may be less useful when trying to improve aspects related to the distal parts of the upper limb (Reid et al., 2015). Both methods have been found to facilitate improvements if the session was well structured, but the modern one showed better results in the retention tests, as explained by the influence of this method on the cognitive facet of skill acquisition (Budi et al., 2020).

Notably, these advancements in skill acquisition also have direct implications on psychological factors crucial to performance, such as self-efficacy, a specific form of self-confidence that has been understood as the subjective belief in one's own ability to organize and execute the actions necessary to achieve certain accomplishments (French et al., 2014). Specifically in tennis, different studies have found variables that positively affect self-efficacy, as it is the case of motivational self-talk which is positive for performance improvement (Hatzigeorgiadis et al., 2008). Motivational or instructional goal setting (Brinkman et al., 2020), as well as performance achievement, modelling, and verbal persuasion (Grylls et al., 2021). Likewise, self-esteem has been shown to have a favorable effect on self-efficacy (Lane et al., 2002).

Other variable key to skill acquisition is the use of scaled down equipment (i.e., increasing the size of the racket head), which promotes children's enjoyment of the sport and increases their perceived self-efficacy (Giménez-Egido et al., 2023). In this context, the ITF's "Play and Stay" campaign, which was based on the adaptation of different aspects of the game to make it easier for children to play, such as the net, ball playing surface, and a more game-related teaching style, appear as another tool for developing high self-efficacy (Gimenez-Egido et al., 2020).

Despite the considerable progress made in understanding both skill acquisition and self-efficacy in tennis, several gaps can be identified in the literature. While studies have highlighted the benefits of increased contextual interference, representative drill designs, and scaled-down equipment for enhancing skill transfer and self-efficacy, there is a lack of direct comparisons between traditional isolated drills and modern integrated gameplay methods. Few studies have simultaneously analyzed the impact of training methods on both technical and tactical improvements and psychological outcomes like self-efficacy. Moreover, existing findings often stem from amateur players, leaving elite-level training methods underexplored.

Therefore, to address this gap and provide a more comprehensive understanding of training effectiveness for elite tennis players, this study aims to determine which type of training method—traditional isolated drills or modern integrated gameplay—elicits the most significant improvements in technical and tactical skills while also enhancing players' self-efficacy.

The research hypotheses were the following: firstly, it was expected that the technical aspects of performance would improve significantly during the sessions that employed a traditional method, and that this significant improvement would gradually disappear as the weeks progressed (Budi et al., 2020). Secondly, the use of a modern teaching method, which emphasized a more representative learning approach, was hypothesized to lead to greater tactical improvement and that an improvement in the technique of the strokes involved in these game situations would also be observed as training continued (Krause et al., 2019b). Finally, regarding self-efficacy, it was hypothesized that modern training methods would improve the players' self-efficacy to a greater extent than traditional methods, as modern approaches more closely resemble actual game situations.

Method

Participants

This study selected participants who met the following criteria: a) Gender: Male; b) Age: Juniors (up to 18 years old); c) Playing experience: Minimum 10 years; d) Ranking: International top 100; d) Environment: International high-level tennis Academy; e) Availability: For the two 4 -week training interventions; f) Involvement: Full-time players; g) Injury: Free at the time of the study. The study involved 3 elite male junior tennis players of international level with a mean age of 16.33 years (±1.52 years).

The players had an average tennis experience of 12.33 years (± 4.2 years). At the time of the research, all players were taking part in ITF World Junior Circuit events, the most prestigious international junior tennis tour, and had a world ranking of 878 on average (±711.99). In previous years, one of them had been the Spanish U14 champion, and another one was the Spanish U12 champion. All of them were full-time tennis players as they trained in one of the best international tennis academies worldwide, with an average training load of 30 hours of training per week (±3.5). They also played an average of 85 official national and international rankings competitive matches per year (±16.33). All players were purposely selected for this study due to their background among the players who practiced at a high-performance international tennis academy. None of them had suffered any injury during the study and in the previous six months. This selection ensured that the players were accustomed to high-level, individualized coaching and capable of completing the study's rigorous training schedule. The study was conducted following the appropriate criteria from the Helsinki Declaration and received ethical approval from the Ethics Research Committee of the University of Valencia (Spain) with number 2023-FIS-3056077. Training methods were delivered 4 times per week by the same professional certified male tennis coach with more than 10 years of experience in the ITF and ATP Tours, with each method tailored to individual player needs.

Design

The present study has a single-case ABCA design, so participants took part in all experimental situations, with the first A corresponding to the pre-intervention situation, B to intervention 1, C to intervention 2, and the second A to the follow-up (Chrysidis et al., 2020). In our case, the players were assessed for self-efficacy (SE) on several occasions in each phase of the study.

Once the process was completed, semi-structured interviews were conducted with the players to find out their opinions about the process carried out. Therefore, this was a mixed study as it used both quantitative and qualitative methodologies (Chrysidis et al., 2020).

Therefore, this is a quasi-experimental study with controlled intervention as it involves comparing the effects of two specific training methods (traditional isolated drills vs. modern integrated gameplay) on elite junior tennis players. It also has a non-random assignment of the sample as the players were purposefully selected from an international tennis academy. It is a repeated measures study as it observes players during pre-intervention, intervention, and follow-up stages, to measure changes over time. Furthermore, it is a small sample size composed by three international male junior players.

Procedure

All three players took part in training sessions structured under the same methods and underwent the same conditions in each of the weeks of the study. The training sessions carried out during the interventions were grouped into two categories, according to the methods used: traditional or modern. Sessions using traditional methods were based on drills and exercises that met some of the following characteristics (Krause et al., 2018):

- Blocked practice, including drills based on the repetition of the same skill with little contextual interference.

- Practice drills including little or no decision-making by the player.

- Analytical practice, including drills based on skill decomposition, or global practice focusing the attention on a specific aspect of the skill.

- Practices without competition-specific information.

Sessions using modern methodology were based on exercises that met some of the following characteristics (Krause et al., 2018):

- Drills and exercises which included competition-like practice contexts.

- Practice including active decision-making by the player.

- Practice including contextual interference.

- Randomized practice.

Table 1 shows two examples of exercises, one with the traditional teaching method and the other with the modern method, which were used during the interventions, according to the exercise classification system adopted by Penalva et al. (2021).

Table 1. Examples of exercises used with traditional and modern methods.

Method	Game situation	Target	General content	Special content	Method	No. player x court	Player interaction	Conditions / Limitations
Traditional	Serve	Learning	Technique	Slice serve	Player only	2	None	Zone
Modern	Baseline	Application	Tactics	Neutral groundstrokes	Points	2	Opposition	Score

Before the two interventions, a pre-intervention week was scheduled in which 16 measurements of the players' SE (completed before and after each practice session, except in the morning post-training and the afternoon pre-training) were performed in 9 training sessions and 1 simulated match. During this week there was no direct intervention on the objectives to be addressed in the intervention weeks. SE was measured before and after each tennis activity, as suggested by Hepler and Chase (2008) whether it was practice or official competition matches. In tennis it is possible to play two matches on the same day, hence up to 3 questionnaires per day.

The pre-intervention week was followed by two one-week interventions. Intervention 1 used a modern training method, as described above, to improve the baseline game situation and a traditional method, with the aforementioned characteristics, to improve the serve. Intervention 1 lasted one week in which the players practiced 6 days and played 1 match on Saturday as a control, with their SE being measured 16 times.

Intervention 2 used a modern method to improve the net play game situation and a traditional method to work on passing the net player game situation. It lasted one week in which the players practiced 6 days, in a total of 10 sessions, and played 2 matches, with their SE being measured 16 times.

Next, SE measurements were obtained from the players during their participation in an official tournament. When they finished their participation in the tournament, measurements were taken of the training matches, during a follow-up week. In this week, no direct intervention was made on the objectives that had been addressed in the two intervention weeks.

During the last week of the intervention, as it was an official tournament, once they had lost before the final, they had a day off after their last tournament match. The rest of the days of that week players

practiced with no direct intervention in any objective that could interfere with the study. This process is shown in Figure 1.

Figure 1. Flow diagram of the experimental process.
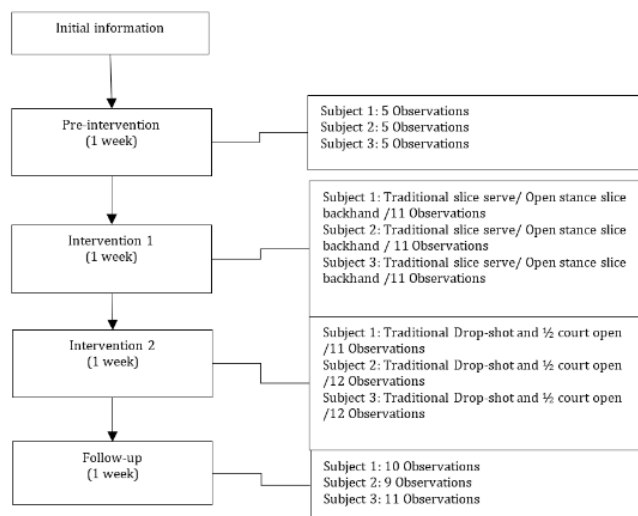
Measurement of self-efficacy

The self-efficacy survey was conducted following the suggestion to control the competencies that affect performance (Lane et al., 2002). Eight questions with four sub-questions for each of them, four on the tactical and four on the technical aspects, were used. Of these four questions, one dealt with the baseline game, one with the mid-court game, one with the net game, and one with the serve and return game situations, thus addressing the different game situations that occur in tennis. In these questions, players were asked to rate their self-efficacy using a 6-point Likert scale according to their expectations of themselves, with 1 being never and 6 always, similar to Sindall et al. (2020). The variables measured were baseline game tactics, mid-court game tactics, serve and return, and net play game tactics, and as per the technical aspects, baseline game, mid-court game, serve and return, and net play technique. These measures represented the degree of self-efficacy perceived by the players. Content validation was performed by consulting experts in sports psychology and tennis coaching to ensure that items accurately reflected the targeted dimensions of self-efficacy within tennis gameplay contexts.

 Interviews

Semi-structured interviews were conducted to gather relevant information about the players' opinions on different aspects related to the process (Harwood & Knight, 2009; Vernon et al., 2018). The aim was to provide players with an individual and personal space in a calm environment, where they could share their thoughts about different aspects and provide the details they felt were important to them. The questions were approached sequentially, but players were given no time restrictions to provide their answers. The questions asked are shown in Table 2. They were adapted from a tennis-specific questionnaire conducted to gather the view of professional players on the return of serve (Vernon et al., 2018; Chrysidis et al., 2020). The qualitative data were analyzed using systematic coding techniques, and a triangulation process between researchers was conducted to enhance reliability and minimize potential biases.

The interviews were conducted using the Microsoft Teams application, given the ease of connecting, recording, and exporting transcripts. These interviews were analyzed with the Qcoder for R package.

Table 2. Questions asked to the players in the individual interviews.

Question 1	Which area do you consider more important to work on to improve your performance as a player, technique, or tactics? Why? Do you think it influences your self-confidence and/or self-assurance?
Question 2	Which area have you worked on more during your sporting career in training, technique, or tactics? Can you give an approximate percentage?
Question 3	What type of exercises do you consider most important to improve your performance as a player (basket, rally, etc.), Why? Do you think the type of drill influence your self-confidence and/or self-assurance?
Question 4	What type of exercises have you done most during your sporting career in training (baskets, rallies)? Can you give an approximate percentage?
Question 5	Do you think you can improve your technique more by using a particular type of exercise and technical variety?
Question 6	Do you think you can improve tactics more by using a particular type of exercise, and tactical variety?
Question 7	Which game situation(s) do you consider most important in your game (serve, return, baseline game, approach and passing game)?
Question 8	Which game situation(s) have you worked on the most during your training sessions (serve, return, baseline game, approach and passing game)? Can you give an approximate percentage?

Data analysis

The data were analyzed using the Non-Overlap of All Pairs (NAP) technique. NAP is a non-parametric methodology used to assess dominance between experimental phases, making it suitable for studies that do not require strict assumptions of normality or linearity in the data. This technique is particularly useful because it does not account for data trends, allowing its application to various types and distributions of data, including dichotomous data.

Moreover, NAP demonstrates significant statistical efficiency, achieving between 91% and 94% of the efficiency observed in linear regression models when data fit well. In multimodal datasets with pronounced biases, its efficiency can even exceed 100%, highlighting its robustness under heterogeneous distribution conditions. This method is equivalent to calculating the empirical area under the curve (AUC) in a Receiver Operating Characteristic (ROC) analysis and can also be derived from the Mann-Whitney U test, further underscoring its utility for group comparisons without assuming normality.

Table 3. Conventional values for interpreting effect size indices PND, PEM, and NAP in single-case designs.

Index	Values	Interpretation	Reference
PND	< 50% 50% - 69% 70% - 89%	Ineffective treatment Questionable effectiveness Fairly effective treatment	Scruggs y Mastropieri (1998)
PEM	> 90% < 70% 70% - 89%	Highly effective treatment Questionable or ineffective treatment Moderately effective treatment	Ma (2006)
NAP	90% - 100% 0% - 65% 66% - 92% 93% - 100%	Highly effective effect Weak effect Medium effect Large effect	Parker y Vannest (2009)

Note. PND = Percentage of Non-Overlapping Data; PEM = Percentage of Data Exceeding the Median; NAP = Non-Overlap of All Pairs.

The main advantages of NAP include its simplicity, the ability to visually reflect non-overlap, and its statistical power. In many cases, NAP proves to be a more effective solution compared to mean or median difference tests between phases. According to Parker and Vannest (2009), NAP is particularly useful in single-case research due to these characteristics.

For data analysis, the NAP calculator from the web-based application hosted on singlecaseresearch.org was used, available at the following domain: https://singlecaseresearch.org/calculators/nap/.

Results

Quantitative analysis of self-efficacy

Table 3 shows the means and standard deviations of SE measures in each phase: pre-intervention, post-intervention 1, post-intervention 2, and follow-up. The values of overall SE after intervention 1, where players worked on the slice serve using a traditional method and on the slice backhand using a modern method were significantly higher than those of the pre-intervention in subjects 1 ($p<0.05$), 2 ($p<0.05$)

and 3 (p<0.05). Similarly, the overall SE of the baseline game increased in subjects 1 (p<0.05), 2 (p<0.05) and 3 (p<0.05). This was also the case for the serve SE in players 1 (p<0.05) and 2 (p<0.05). The technical SE also improved significantly in subjects 1(p<0.05), 2(p<0.05) and 3(p<0.05). As per the SE Baseline Tactical, significant differences were found in subjects 1(p<0.05) and 2(p<0.05). Baseline technique SE also increased significantly in subjects 2 (p<0.05) and 3(p<0.05).

Regarding the results of intervention 2, which included a baseline game, forehand and backhand drop shot with a traditional method, and the volley using a modern method, significant improvements in SE concerning the pre-intervention measure in the serve were shown in subjects 1 (p<0.05), 2 (p<0.05) and 3 (p<0.05). Between intervention 1 and intervention 1, significant differences were only found in the SE of the serve in subject 2 (p<0.05).

As per intervention 2, which included baseline game work in closed situations and mid-court and net game using an open method, significant improvements were observed in the SE in the serve in subjects 1 (p<0.05), 2 (p<0.05) and 3 (p<0.05) compared to the pre-intervention measures. Between intervention 1 and intervention 2, significant differences were only found in the SE of the serve in subject 2 (p<0.05).

Table 4. Measures of self-efficacy and significant differences.

Area	Game Situation	Subject	Pre-intervention		Intervention A		Intervention B		Follow-up	
			N	M(Dt)sig	N	M(Dt) sig	N	M(Dt)sig	N	M(Dt)sig
General	Baseline	1		4.35*†		4.73*		4.65†		4.225
		2		3.8*†		4.833*		4.688†		4.45
		3		5.025*$†		5.583*		5.458†		5.75 $
	Net	1		4.575*		5.042*		4.917		4.6
		2		3.525*†$		4.542*		4.563†		4.4$
		3		5.1*†$		5.542*		5.542†		5.875$
	Serve	1		4.325*†		4.75*		4.77 †		4.6
		2		4.275 *†$		4.958 *#		5.479 †#		5.275 $
		3		5.325 †$		5.479		5.563 †		6$
	Tactics	1		4.5*		5.042*		4.844		4.536
		2		4.263*†$		5.021*		5.323†		5.075$
		3		5.65$		5.615		5.583		5.825$
	Technique	1		4.238*		4.583*		4.542		4.325
		2		3.538*$†		4.458*		4.302†		3.975$
		3		4.563*$†		5.396*		5.458†		5.675$
	Mean	1		4.225*		4.73*		4.48		4.3
		2		4*†		4.625*		4.52†		3.975
		3		4.975*†$		5.417*		5.521†		5.7$
Tactics	Baseline	1		4.445*		4.96*		4.88		4.4
		2		4.2*$†		5.16*		5.29†		5.2$
		3		5.6		5.79		5.5		5.9
	Serve & Return	1		4.5*		5.125*		4.83		4.65
		2		4.8†		5#		5.458†#		5.1
		3		4.9*†$		5.5*		5.625†		5.75$
	Net game	1		4.8		5.17		5		4.75
		2		3.8$†		4.875		5.29†		4.95$
		3		5.65$		5.66		5.58		5.95$
	Mid-court	1		4.2*		4.91*		4.66		4.35
		2		4.25$†		5.04		5.25†		5.05$
		3		5.45		5.5		5.625		5.7
Technique	Baseline	1		4.25		4.5		4.42		4.05
		2		3.4*†		4.5*		4.08†		3.7
		3		4.45*$		5.375*		5.417		5.6$
	Serve & Return	1		4.1†		4.375		4.71†		4.55
		2		3.75*†$		4.916*		5.5†		5.45$
		3		4.75*†$		5.46*		5.5†		5.6$
	Net game	1		4.35*†		4.92*		4.83†		4.45
		2		3.25*$		4.21*		3.83		3.85$
		3		4.55*†$		5.42*		5.5†		5.8$
	Mid-court	1		4.25*		4.54*		4.21		4.25
		2		3.75*		4.20*		3.79		2.9
		3		4.5*†$		5.33*		5.42†		5.7$

*Significant differences (p<0,05) between Pre and Intervention 1; † Significant differences (p<0,05) between Pre and Intervention 2; # Significant differences (p<0.05) between 1 and 2; and $ Significant differences (p<0.05) between pre-intervention and follow-up.

Finally, as it can be seen in Table 4, between pre-intervention and follow-up SE measures, higher follow-up scores were found on the following measures of overall SE: 1) SE of baseline game in subject 1 ($p<0.05$); 2) SE of net game in subjects 2 and 3 ($p<0.05$); 3) SE of serve in subjects 2 and 3($p<0.05$); 4) SE of tactics in subjects 2 and 3 ($p<0.05$); 5) SE of technique in subjects 2 and 3 ($p<0.05$); 6) SE of tactics in subject 3 ($p<0.05$). There were also differences in the SE of tactics in the following variables: 1) SE of baseline tactics in subject 2 ($p<0.05$); 2) SE of net tactics in subjects 2 and 3 ($p<0.05$); and 3) SE of mid-court tactics in subject 2 ($p<0.05$). Finally, significant differences were also found in measures of SE of technique: 1) SE of baseline technique in subject 3 ($p<0.05$); and 2) SE of mid-court technique in subject 3 ($p<0.05$).

Scores of subjects 1, 2, and 3 on self-efficacy, tactics, and technique are shown in Figures 2, 3, and 4.

Figure 2. Scores of subjects 1, 2, and 3 on self-efficacy in each of the performance dimensions in the different phases of the study. Brackets indicate significant differences (<0.05). In intervention 1 players worked on the serve using a traditional method and on the slice backhand using a modern method. In intervention 2 players worked on the drop shot with a traditional method and on the mid-court game with a modern method.
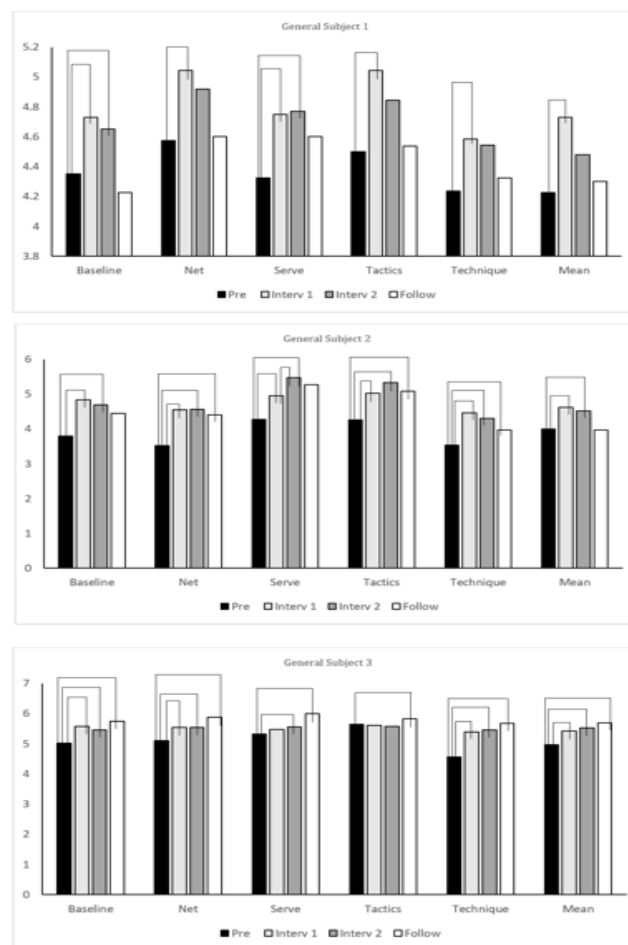
Figure 3. Scores of subjects 1, 2, and 3 on tactic-specific self-efficacy for each of the game situations in the different phases of the study. Brackets indicate significant differences (<0.05). In intervention 1 players worked on the serve using a traditional method and on the slice backhand using a modern method. In intervention 2 players worked on the drop shot with a traditional method and on the mid-court game with a modern method.
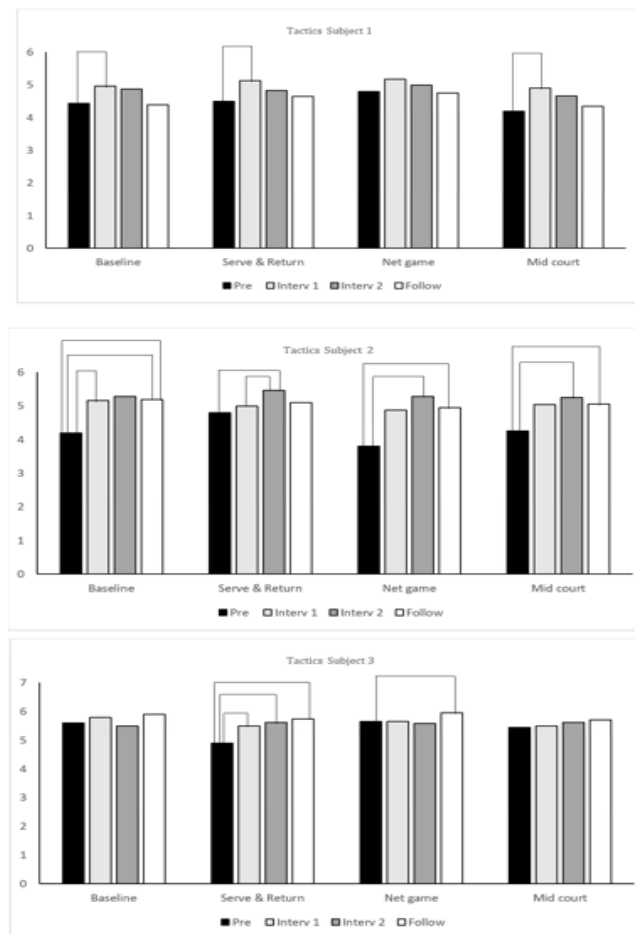
Figure 4. Scores of subjects 1, 2, and 3 on technique-specific self-efficacy for each of the game situations in the different phases of the study. Brackets indicate significant differences (<0.05). In intervention 1 players worked on the serve using a traditional method and on the slice backhand using a modern method. While in intervention 2 players worked on the drop shot with a traditional method and on the mid-court game with a modern method.
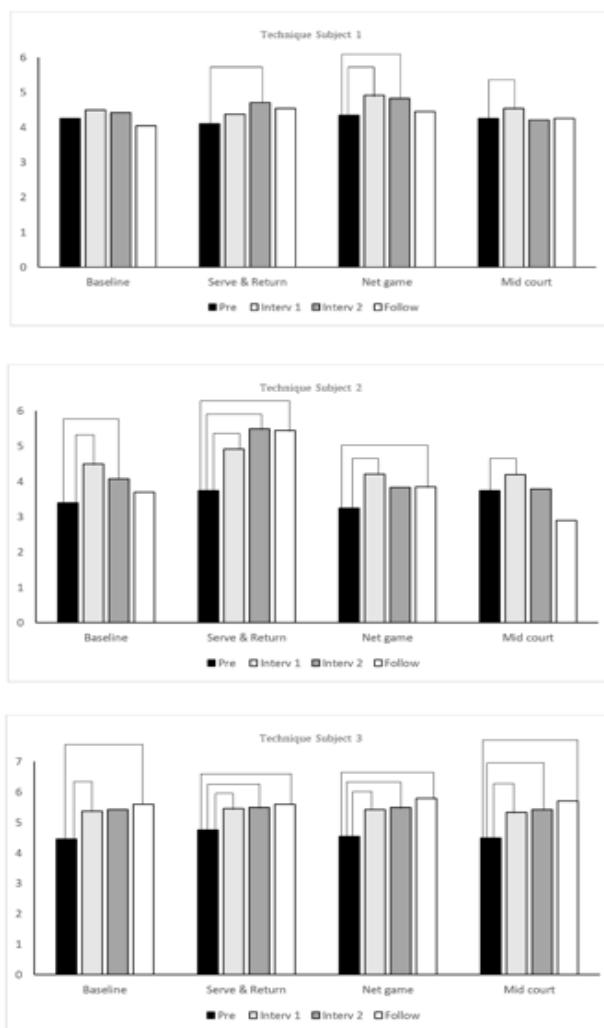
Qualitative analysis

Analysis was conducted through interview transcripts (Table 5). This was conducted following several systematic steps consisting of reading, scanning, and coding following Bingham (2023). The qualitative analysis generated 8 themes, all in line with the questions asked to the players. Firstly, all players agreed that tactics were the most relevant aspect for them. They indicated that the technical aspects had considerable importance in a sport like tennis, but they stated that "making good decisions is what affects the development of the game" (player 1). This was understood as something that gave them confidence in their game. However, contrary to these views, two of the players claimed to have trained more technique than tactics "70% technique and 30% tactics" (player 1), "55% tactics and 45% technique" (player 2), while the only player who claimed to have trained more the tactical component of the game was number 3: "60% tactics and 40% technique", because he said: "I have always had a good [technical] base" (player 3).

Table 5. Interview transcripts.

	Subject 1	Subject 2	Subject 3
1. Which area do you consider more important to work on to improve your performance as a player, technique, or tactics? Why? do you think it influences your self-confidence and/or self-assurance?	Tactics: "Everyone can be very good technically, but it's how you put it all together on the court and how you use all your weapons that really makes the difference. It influences my SC, because in the end	Tactics: "Although technique is important to be able to apply what you talk about with your coach; I feel much better when I work on tactical aspects".	Tactics: "Sometimes I rush, I lose my temper, and I want to finish the point very quickly, I finish the point more directly than I should, and now I'm working on building the point a bit more".

	making good decisions is what really affects the development of the game".		
2. Which area have you practised more on during your sporting career in training, technique, or tactics? Can you give an approximate percentage?	Technique: 70% technical and 30% tactical	Technique: 55% technical, 45% tactical	Tactical 60% Technical 40%, "Because technically I've always had a good base".
3. What kind of exercises do you consider most important to improve your performance as a player (baskets, rallies, etc.)? Why? do you think it influences your self-confidence and/or self-assurance?	Baskets for technique and live ball / rallies / points for tactics. "I think that for technique I practised more with baskets, and for tactics I used more rallies. When working on technique you can make mistakes, and by using baskets it doesn't affect anyone".	"Live ball exercises, rallies, it's what I need, and it makes me feel better, it's what benefits me the most." Baskets for technique and live ball drills for tactics.	Rallies: "High tempo one-on-one. Although I also work with baskets to improve certain aspects in my game".
4. What type of exercises have you done most during your sporting career in training (baskets, rallies)? Could you give an approximate percentage?	60% rallies and 40% baskets, "I've practised using more rallies throughout my life, although the last year I practised a lot with baskets because I was injured".	60% baskets and 40% rallies "I think baskets because it is also what you start doing when you are young. In the end it is a progression, when you reach a certain age, it changes, and you do more rallies".	"I think I practised using more rallies." Mostly rallies.
5. Do you think you improve your technique more by using a particular type of exercise? What about technical variety?	Baskets. Because you can practice movements on all directions "front, back, sides... it is a progression".	"Baskets for the technique".	Baskets, "which go in progression, first very static to get the technique right and when I mechanise with more movement or more variability then, I progress on to the rallies".
6. Do you think you improve your tactics more by using a particular type of exercise? What about tactical variety?	Yes, with the live ball exercises with changes of direction "i.e., 3 cross court and 1 down the line, and then again, exercises similar to real match situations".	"Above all, live ball exercises, real situations, and points".	Live ball exercises "with changes of direction, speed, height...".
7. Which game situation(s) do you consider most important in your game (serve, return, baseline game, mid-court and passing game)?	Serve and return, "especially serve +1".	Serve and ground game, "the volley is less important, although I should use it more. For me the serve + 1".	Serve and groundstrokes "Serve +1, as I like to start by dominating the point".
8. Which game situation/s you have worked on the most during your tennis career in training (serve, return, baseline game, mid-court and passing game)? Can you provide an approximate percentage?	40% serve and return, 60% others "I have trained quite a lot the serve because I have grown up on hard courts since my childhood and the points are faster 2, 3, 4 strokes. I also train a lot the baseline game because it is the base of the game".	20% serve and return, 70% baseline game, and 10% net game situation.	"I've worked more on my baseline game".

Discussion

This research focused on the improvements in players' self-efficacy using different interventions based on traditional and modern methods. The findings obtained showed higher values of self-efficacy after both interventions 1 and 2, which can be considered positive interventions for improvement. This improvement was accentuated due to the importance the coaches gave to fostering the players' confidence since the player's belief in their abilities is directly related to self-efficacy (Hepler & Chase, 2008).

In tennis, there is a lack of studies on this topic, and the previously existing literature has analyzed 10U (Gimenez-Egido et al., 2020), and school or university players (Zetou et al., 2014). Caputi (2018) stated that training through deliberate practice was more beneficial than traditional training based on repetitions, as was the case with the first intervention in this study, in which through a modern method, greater self-efficacy was observed in the baseline game, in all its aspects, both in the general and in the tactical and technical ones, as the three players greater benefits in the tactical part, by the fact of raising game situations with greater decision making. However, with the serve, which was worked on using a traditional method, no significant differences were observed in either the technical or tactical aspects, and only in the general part.

The significant differences observed in the general part of both technique and tactics can be explained due to the work conducted using the modern method, given that significant differences were observed in the rest of the sections, while in those referring to the serve, these differences were not appreciated.

As per intervention 2, significant differences were observed in the values of the general part of the net game follow-up in subjects 2 and 3. There is also a significant improvement in the tactical part of the net game and, in addition, subject 3 experienced a notable improvement in his self-efficacy in the technique of the net game. These results were observed to be prolonged in time during the follow-up phase, because this type of open methods which includes greater contextual interference interventions than the traditional ones, facilitates retention to a greater extent (Buszard et al., 2017).

Finally, intervention 2 was characterized as being purely pre-competitive, with the inclusion of a considerable number of game situations (Krause et al., 2019a). Hence, it is likely that the improvements in aspects related to the serve, which are multiple in the follow-up phase, were due to the large number of game situations that started with this stroke. The same would apply to the general tactical part, where subjects 2 and 3 showed a significant improvement. When relating these results with those of the qualitative part, where all the players highlighted the importance of the tactical aspects, it is understandable that the modern method, in which more representative game situations were used was understood by the players in the same way, which provoked such evident effects.

Considering the findings from our study, the integration of modern methods—emphasizing representative game situations and higher contextual interference—seems to offer some advantages over the use of traditional isolated and repetitive drills, particularly in fostering improvements in strategical and tactical awareness and self-efficacy. These results are aligned with previous research, which has demonstrated that training protocols incorporating increased variability and real-match conditions lead to better skill transfer and retention (Buszard et al., 2017; Krause et al., 2019a). The significant improvements in the tactical aspects of performance observed with modern methods echo findings from studies that highlight the value of open skill practice, where players are exposed to representative practices including dynamic, and decision-rich environments that closely mirror competition (Caputi, 2018). Furthermore, the enhancement in self-efficacy following the modern methodology intervention is consistent with the cognitive benefits identified in other research, which underscores how contextualized, realistic practice boosts players' confidence (Budi et al., 2020). The traditional method, while beneficial mainly for technical improvement, showed more limited effects on the players' ability to adapt to the tactical demands of a match. This suggests that while traditional methods can provide solid foundational skills, they may not be as effective in developing the cognitive and adaptive skills required for high-performance competitive tennis, where adaptation, decision-making and tactical execution under pressure are crucial.

Practical applications

The findings of this study have practical applications for coaches, coach education courses, and players. From the coaches' perspective, it highlights the benefits of integrating modern training methods that combine technical, tactical, physical, and mental elements in elite junior tennis training. Coaches working with high-performance players should consider moving beyond traditional, isolated drills and instead incorporate gameplay-based scenarios that challenge players in dynamic, match-like conditions. This approach has been shown to improve not only tactical awareness and technical proficiency but also self-efficacy, which is critical for players' confidence during competitive play (Cordellat & Valenciano, 2022). A balanced training plan that adapts to individual needs and integrates both traditional and modern methodologies is ideal, helping players strengthen their consistency in technical strokes while also developing the broader skills necessary to excel in the complexities of the game.

Coach education programs should adapt their curricula to emphasize the importance of holistic training approaches that combine various dimensions of tennis performance (Pacheco et al., 2024). Integrating modules on how to effectively use modern, gameplay-focused methods alongside traditional drill-based training will prepare coaches to meet the evolving demands of the sport. Additionally, these programs should encourage coaches to assess the self-efficacy of their players regularly, using both quantitative and qualitative tools to ensure that mental development is aligned with physical and technical progress. Understanding how to design training that fosters tactical intelligence, and technical precision will give coaches the skills needed to optimize player development, particularly at the junior elite level.

For players, especially those in elite junior programs, the findings suggest that training regimens incorporating modern, individualized approaches can lead to greater improvements in match performance and self-confidence. By embracing training plans that mirror real-game conditions and encourage

adaptability, players can maximize their growth in tactical awareness and technical execution under pressure.

While the findings provide valuable insights into the benefits of modern, integrated training methods, implementing these methodologies across broader coaching contexts presents several challenges. First, transitioning from traditional drills to gameplay-based training requires a fundamental shift in coaching philosophy, often encountering resistance from coaches accustomed to long-established practices (Vives et al., 2024). This shift necessitates robust education initiatives to equip coaches with the skills to design and implement representative training scenarios that effectively integrate technical, tactical, physical, and mental components. Resource limitations—such as restricted court time, limited access to performance analysis technology, and high coach-to-player ratios—further hinder the widespread adoption of these individualized and complex programs, particularly in grassroots or underfunded environments. Additionally, the increased variability and less structured nature of modern methods may challenge players accustomed to isolated drills, potentially leading to frustration and reduced engagement during the adaptation phase. To address this, coaches should employ gradual integration of modern methodologies alongside traditional drills, providing clear communication on the benefits and ensuring that players remain motivated through progressive goal-setting and tailored feedback. Furthermore, achieving broader adoption will require collaborative efforts among coaching organizations, coach education providers, and stakeholders to develop accessible resources, scalable training models, and funding strategies that support holistic approaches to player development. These efforts will be critical to ensure the adaptability and sustainability of modern training methods across varying levels of play and institutional settings.

Limitations

This study has several limitations that should be acknowledged. First, the sample consisted exclusively of elite junior tennis players ranked within the international top 100, without the inclusion of starter, beginner, intermediate, advanced players, or those from other age groups such as children or adults. While this homogeneity provides valuable insights into this specific population, it limits the generalizability of the findings to broader groups. Second, the small sample size reflects the challenges of accessing players at this level of performance, given their limited availability and highly demanding schedules. Although the study employed a repeated-measures ABCA design with 113 observations to enhance robustness, the findings should be interpreted cautiously when applied to larger or more diverse populations. Third, the absence of a control group makes it difficult to fully attribute the observed changes in self-efficacy to the interventions alone. To address this, participants acted as their own controls, reducing variability and enabling detailed within-subject analyses. Nonetheless, we recommend that future studies incorporate parallel control groups to strengthen causal inferences. Fourth, the reliance on a single professional coach, while ensuring consistency in intervention delivery, may have introduced potential biases due to the coach's individual style, preferences, and interpretation of the methodologies. This limits the external validity of the findings, as outcomes might differ with other coaches or training environments. Fifth, qualitative data collection relied on semi-structured interviews analyzed using tools such as Microsoft Teams and Qcoder. While these tools have provided functional and systematic analyses, they are not the most advanced options available. Future research could benefit from integrating more sophisticated qualitative analysis methods or triangulating data with additional approaches, such as video analysis or participant observation. Finally, the absence of physical, biomechanical, or technical tests to objectively measure improvements in technical and tactical skills represents another limitation. Incorporating such measures in future studies could provide a more comprehensive understanding of the interventions' impact.

Future lines of research

These challenges assist in identifying the future lines of research, which could focus on the analysis of different strokes, the application of these methods in players of different skill levels and ages, the access

to a higher number of players in the sample, and the long-term effects of combining modern and traditional training methods. Furthermore, as there could have been improvements in shot speed, direction, or consistency, future studies could control these variables, to detect whether they affect the improvement in self-efficacy. Future studies could also explore the impact of such training on mental resilience, injury prevention, or the development of specific game strategies, providing valuable insights for the continual improvement of high-performance tennis training.

Furthermore, while the competitive context and decision-making processes are acknowledged in our study, there is significant potential to continue exploring how these factors specifically influence the technical and tactical outcomes. The understanding of how tennis players take decisions under pressure contexts, influenced by multiple crucial variables such as opponent behavior, game dynamics, individual features, and environmental factors, could provide fundamental insights into performance optimization.

Conclusions

Previous studies have stressed the relevance of focusing on one of the basic principles of training, individualization, to maximize the benefits of the practice sessions with junior elite tennis players (Fuelscher et al., 2012). Both training methods used in the study are effective in assisting players in improving the different tennis strokes practiced as well as their self-efficacy. Therefore, coaches should use one or the other method and a combination of both, depending on the specific and individual needs of each player. In this regard, it is crucial to consider many of the variables that affect the periodization and planning of the training of elite players. Among them, coaches and support personnel should consider the training period of the season in which the players are, their previous training experiences, their state of form, their preferences, etc., as these aspects are directly related to their perception of the training methods that will help them to improve their self-efficacy and their tactics and techniques (Krause et al., 2019a).

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