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Variability and specificity training programs: Differences in backhand stroke of amateur tennis players
Programas de entrenamiento en variabilidad y especificidad: Diferencias en el golpe de revés de tenistas amateurs

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Abstract. The objective of the present work was to analyze the effect of two training programs based on variability and specificity, on the accuracy of the backhand stroke in tennis. Thirteen amateur tennis players participated in the study, who were distributed into three practice conditions: i) variability (n=4), ii) specificity (n=5), and iii) habitual practice (n=4). The players completed a total of 12 training sessions divided into 2 sessions per week lasting 90 minutes each. Each of the players and practice conditions were subjected to a series of tests, which were conducted at 3 different times: pre-test, post-test, and retention test (re-test), the latter after two weeks without practice. The data obtained, after an intra-subject analysis, showed different results according to tennis player, with greater improvements observed in the players who practiced with specificity and in their habitual manner. As for the variability in the results from the three practice conditions, lower values of accuracy were observed on the transverse axis (width) of the court, with respect to the longitudinal axis (length). Considering the results, the amateur tennis player coaches should apply low variability loads to achieve improvements on the performance of the backhand stroke. it would be interesting to determine the practice load that the training tasks entail in each tennis player, in this way the proposed tasks could be individually adapted to each athlete, providing an adequate stimulus to improve the accuracy of the tennis players.
Keywords: Practice, accuracy, learning, performance, tennis.

Resumen. El objetivo del presente trabajo fue analizar el efecto de dos programas de entrenamiento basados en la variabilidad y especificidad, sobre la precisión del golpe de revés en tenis. En el estudio participaron trece tenistas aficionados, que se distribuyeron en tres condiciones de práctica: i) variabilidad (n = 4), ii) especificidad (n = 5) y iii) práctica habitual (n = 4). Los jugadores completaron un total de 12 sesiones de entrenamiento divididas en 2 sesiones por semana de 90 minutos cada una. Cada uno de los jugadores y condiciones de práctica fueron sometidos a una serie de pruebas, las cuales se realizaron en 3 momentos diferentes: pre-test, post-test y test de retención (re-test), este último tras dos semanas sin práctica. Los datos obtenidos para el análisis intra-sujeto arrojaron resultados diferentes según el tenista, observándose mayores mejoras en los jugadores que practicaban con especificidad y en su forma habitual. En cuanto a la variabilidad en los resultados de las tres condiciones de práctica, se observaron valores menores de precisión en el eje transversal (ancho) de la cancha, con respecto al eje longitudinal (largo). Teniendo en cuenta los resultados, los entrenadores de tenistas deberían aplicar en jugadores aficionados cargas de baja variabilidad para lograr mejoras en el rendimiento del golpe de revés. Asimismo, sería interesante determinar la carga de práctica que suponen las tareas de entrenamiento en cada tenista, de este modo se podrían adaptar individualmente las tareas propuestas a cada deportista proporcionando un estímulo adecuado para mejorar la precisión de los tenistas.
Keywords: Práctica, precisión, aprendizaje, rendimiento, tenis.

Introduction

During the training and learning of tennis, the reproduction of technical models have traditionally been used, with the continuous repetition of different strokes (Alfonso-Asencio and Menayo, 2019; Unierzyski and Crespo, 2016). Nevertheless, more modern approaches have introduced concepts that are part of game analysis, beginning with tenets linked to complex dynamic systems (Alfonso-Asencio and Menayo, 2019; Crespo, 2009; García-González et al., 2011; Hernández-Davó et al., 2014a,b; Menayo and Fuentes, 2011; Urbán et al., 2012). Also, when playing tennis, other individual and contextual variables are found that provoke variations in the stroke conditions, such as: the surface of the court, the opponent's stroke, or weather conditions, among others (Mendes et al., 2013).

Under the perspective of complex dynamic systems, variable practice, in which the execution conditions are modified, could affect learning, especially in open tasks (Davids et al., 2003; Douvis, 2005), as in the case of tennis strokes (Crespo, 2009; Sahan et al., 2018). In this sense, the variability induced could be a stimulus that leads to improvements in performance (Bernacki et al., 2015; Dhawale et al., 2017; García-Herrero et al., 2011; Menayo et al., 2010). However, for inexperienced athletes, the benefits of variability when practicing are not strongly evident in throwing and hitting skills (Alfonso-Asencio and Menayo, 2019; Hernández-Davó et al., 2014a,b; Taheri et al., 2017). With this considered, and the fact that during tennis practice the most common strokes are forehand, followed by backhand and service for both professional

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players and Juniors (Green et al., 1995; Kovalchik and Reid, 2017), it is not strange that a certain need and curiosity has arisen to study the effect of variable practice on these strokes. As observed in the current literature, many research works have analyzed variable practice in the forehand stroke (Bernacki et al., 2015; Green et al., 1995; Sahan et al., 2018) and service (Alfonso-Asencio and Menayo, 2019; Hernández-Davó et al., 2014a,b; Urbán et al., 2012), while for the backhand stroke, the available evidence is lacking. Specifically, it was observed that variable practice partially improved the speed in the backhand shots Alfonso-Asencio et al., 2021).

On the other hand, the existing scientific research on the effects of variability on the tennis strokes provide disparate results in terms of speed and accuracy (Alfonso-Asencio and Menayo, 2019; Buszard et al., 2017; 2020; Douvis, 2005; Hernández-Davó et al., 2014a,b; Menayo and Fuentes, 2011; Menayo et al., 2010; Sahan et al., 2018), which is an indication of the evident need to continue research on this subject. A possible explanation of this is perhaps that the conditions of execution imply a different practice load for each athlete (Alfonso-Asencio and Menayo, 2019; Moreno and Ordoño, 2015), so that practice load should be individually adjusted to each athlete in order to achieve an adequate stimulation that led to improvements in performance (Moreno and Ordoño, 2015). More specifically, an insufficient load would not create a disruption that could produce changes in learning. On the contrary, excessively high practice loads could result in maladjustments and a loss of performance (Moreno and Ordoño, 2015). Also, the same task could produce different levels of practice loads in each learner, and it could even produce different practice loads for a single athlete as a function of the season or the level of performance. Thus, the design of better training programs should consider all, and every aspect described above, with the magnitude of load practice or variability load that is adapted to the characteristics of the athlete, being vitally important (Moreno and Ordoño, 2015).

As for the throwing or hitting skills, accuracy is a determining variable for performance (Caballero et al., 2012; García et al., 2015; García-Herrero et al., 2016; Ranganathan et al., 2010; Rein et al., 2010; Reynoso et al., 2013). In this sense, diverse studies indicate that it is also a determining factor in tennis (González-Hernández et al., 2017; Haake et al., 2000; Menayo et al., 2008; 2012; Urbán et al., 2012).

Thus, many studies have analyzed the effects of induced variability training on accuracy, with different results provided (Caballero et al., 2012; García-Herrero et al., 2016; Hernández-Davó et la., 2014a,b). More specifically, García-Herrero et al. (2016) in their study on the effect of variability training on the accuracy of the seven-meter throw in handball, found that the application of greater levels of variability led to an adaptation, expressed as higher accuracy values as those observed after a period of intervention with specificity training. However, Caballero et al. (2012) found that high quantities of variability during practice were associated with worse results on accuracy than low levels of variability in the seven-meter throw in handball. These same authors also showed that the intermediate loads obtained the greatest benefits in this type of throw. Along the same line, García-Herrero et al. (2016) found that the hit accuracy in soccer improved after the application of variable practice. Also, Rein et al. (2010) obtained similar results, finding that both specificity and variability training improved the performance of the free throw of basketball players. Nevertheless, in the work by Hernández-Davó et al. (2014a) on basketball shooting, the results of the analysis of the accuracy in different situations of variability and specificity training showed that specificity training increased the accuracy of the shot, while variability training decreased it.

Lastly, if we specifically focus on hitting a tennis ball, especially during service, Hernández-Davó et al. (2014b) found that the type of training had an influence on accuracy. In this research study, the group that practiced in induced variability conditions showed significant improvements in accuracy, while the group who practiced in conditions of consistency improved their accuracy, but not significantly. Along the same line, Douvis (2005) analyzed the effects of variable practice on learning the forehand stroke in tennis, with children and adolescents. The results found in this work showed that the adolescents performed the strokes with a greater accuracy as compared to the children. Also, the variable practice resulted in a better performance as compared to specificity training.

Given the above, the objective of the study was to analyze the effect of the application of induced variability and specificity training on the backhand stroke performed by amateur tennis players. Accordingly, the starting hypothesis is that the accuracy in the backhand stroke will increase in the players who practiced using the induced variability technique. As for the variability in the results, it will be reduced in the tennis players who practiced in conditions of variability.

Materials and Methods

Design and Participants

In the study, a descriptive and cross-sectional design was utilized, with a non-probabilistic sampling method. The sample was selected through quota sampling (Sierra, 1998). A total of 13 amateur and junior tennis players participated in the study. The players were divided into three different practice conditions: induced variability (n=4), specificity (n=5), and habitual practice (n=4). The mean age of the players was 11.85 ± 1.57, with an average tennis playing experience of 4.46 ± 2.22 years. The mean height and weight of the participants were 147.62 ± 9.13 cm and 43.62 ± 6.48 kg, respectively. The players were all right-handed and belonged to the Tennis Club of the province of Alicante (Spain). All the tennis players participated voluntarily and had prior knowledge about the study. As they were not adults, their parents or legal tutors provided their consent for their participation. The research study followed the principles established by the Declaration of Helsinki (2013) and was approved by the Ethics Committee from the Catholic University of Murcia (Code: CE051701).

Measurements and instruments

To quantify the level of learning of the backhand stroke, accuracy was considered (Alfonso-Asencio and Menayo, 2019). Accuracy was measured through the calculation of radial error (RE) (Equation1) (Van den Tillar and Ettema, 2003) and variable error (VE) (Equation 2) (Menayo et al., 2010) obtained from every backhand. The RE measures the distance from the place in the court where the ball bounced to the point of maximum accuracy, located in the intersection between the baseline and the sidelines (**Figure 1**), while VE indicates the variability obtained by the subject with respect to the mean of the strokes, which is equivalent to the standard deviation of the mean of the absolute constant error of the participant. This is an error measurement that is very sensitive to the learning process (Rose and Christina, 2005; Schmidt and Lee, 2005).

To measure RE, the distance between the ball's bounce on the court to the point of maximum accuracy, located at the intersection between the baseline and sidelines, was measured (**Figure 1**, Equation 1).

$$RE = \sqrt{(x - x')^2 + (y - y')^2}$$

Legend: x and y = the longitudinal and transversal location of the ball's bounce on the court; x′ and y′ are the points of maximum accuracy (intersection between the baseline and the sidelines).

The VE was measured by calculating the dispersion of the ball's bounce in the court with respect to the point of maximum accuracy, which was located at the intersection between the baseline and the sidelines. Equation 2 was used to calculate VE.

$$VE = \sqrt{\sum \frac{(Xi - T)^2}{n} - CE^2}$$

Legend: Xi= location of the ball's bounce on the court; T= location of the point of maximum accuracy; n= number of tries; CE=constant error which indicates the direction towards which the error is produced

To record the ball's bounce, a Casio EXILIM High EX-ZR1000 camera was utilized. The video camera recorded the ball's bounce on the court at 240Hz, for its posterior digitalization and transformation into real coordinates through the use of the Kinovea 0.8.27® software. To do this, first of all, with the program, a perspective grid is created, Next, the perspective grid is adjusted to the vertices of the target marked on the tennis court and the dimensions or the target are calibrated with a margin of error less than or equal to 1 ± cm. After that, the ball bounces of each of the executions during the tests were recorded, placing markers at the point where the ball bounced (Figure 5.11.), to finally export the markers to a spreadsheet for further statistical analysis.

The video camera was placed on a tripod 1 meter from the singles line and 4.5 meters from the baseline. Also, to control the speed, accuracy, effect and throw frequency of the tennis balls used on the test, a ball-throwing «Spinshot Pro®» machine was utilized. The ball-throwing machine was placed on the baseline, 2 meters from the singles line (Figure 1). Before the tests, a pilot test was conducted to calibrate and verify the correct functioning of the machine and the placement of the instruments. As for calibration, the following configuration was utilized: flat spin, a speed of 6, throwing frequency of 2, and without oscillation.

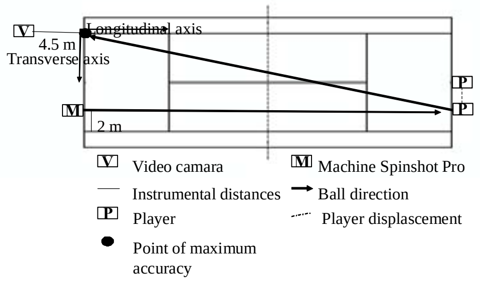

Figure 1. Experimental set-up. Placement of the instruments and hitting area

Procedure

In first place, the magnitude of the variability load of each of the hitting series of the players who practiced with induced variability was determined (Alfonso-Asencio and Menayo, 2019). For this, a prior test was conducted which consisted on performing 8 series of 10 backhand strokes, in which the hitting conditions were modified, with 1 minute of recovery between each of the series (Figure 2).

To determine the variability-modified hitting series, the hitting conditions were modified, utilizing different materials and implements (Buszard et al., 2017; Menayo and Fuentes, 2011; Sanz and Moreno, 2013). In both research studies, the variability proposals were based on the application of conditioning factors to the equipment, such as the use of different rackets and the manipulation of the ball. Taking these into account, the variable practice series were: i) normal execution, ii) hitting of orange balls (-50% of pressure, 46 gr), iii) hitting with a padel racket (370 gr, with a 38 mm profile and drop shape) iv) hitting of green balls (-25% of pressure,49 gr), v) hitting with tennis racket and open stance, vi) hitting of red balls (-75% of pressure, 44 gr), vii) normal execution, trying to achieve accuracy, and viii) hitting with the non-dominant hand (the left hand uses the same grip as the backhand, but removes the dominant hand).

(Alfonso-Asencio and Menayo, 2019; Alfonso-Asencio et al., 2021). Lastly, to calculate the variability load, a performance of 100% was assigned to an execution that did not vary from the habitual execution. Afterwards, the percentage was calculated of the practice load of the different series, for each of the tennis players as a function of the performance achieved in terms of accuracy. This was done in 10% intervals, depending if the series increased or reduced the backhand stroke performances in terms of accuracy with respect to the non-variable series (Alfonso-Asencio and Menayo, 2019).

In second place, before the application of the different training programs, a pre-test was performed. As related to the training programs, all the tennis players performed 2 weekly training sessions for a total of 6 weeks. Each session lasted 90 minutes. At the end of the training programs, a post-test was conducted, and lastly, a retention test (re-test) after two weeks without practicing the backhand stroke (Figure 2).

The tennis balls during the training sessions, were thrown by a qualified and trained tennis coach using his racket and from the opposite court side (Rodríguez-Cayetano et al., 2022). After the warm up, the players performed 8 series of 10 shots, modifying the hitting conditions depending of training conditions. The players who did not practice in a specific or variable manner performed 8 randomized series of 10 hits to the baseline, alternating forehands and backhands, in the same conditions before the start of the study. With respect to those who practiced with specificity, they completed 8 series of 10 topspin backhand hits without modifying the habitual pattern of execution. As for those who practiced with induced variability, they performed 8 series of 10 hits in which the hitting conditions were modified. In each session, the order of the series was electronically randomized as a function of the variability load for each tennis player (https://www.randomiser.org). Once the backhand shots were executed, the rest of the included exercises in the sessions performed by the three training conditions were the same. Likewise, in the rest of the training session, the players could not hit backhand

As for the experimental setting, the tests completed during the research study followed the same guidelines and characteristics. In first place, the instruments were placed and calibrated. Then, the tennis players were welcomed, who were called in an interval of 15 minutes. The players, with the help of a study collaborator, performed a general warm-up which lasted 5 minutes, and a specific warm-up which lasted 10 minutes. Finally, each tennis player completed the test, which consisted on hitting the ball in 6 series of 6 backhand strokes with 20 seconds of recovery between each series. The backhand executions that hit the net were not considered for the analysis of the results. The number of hits per series was determined starting with the mean number of hits per point of professional players, which is established as a cut-off point of 5 for men, and 4.8 for women (Kovalchik and Reid, 2017). For his part Yusoff

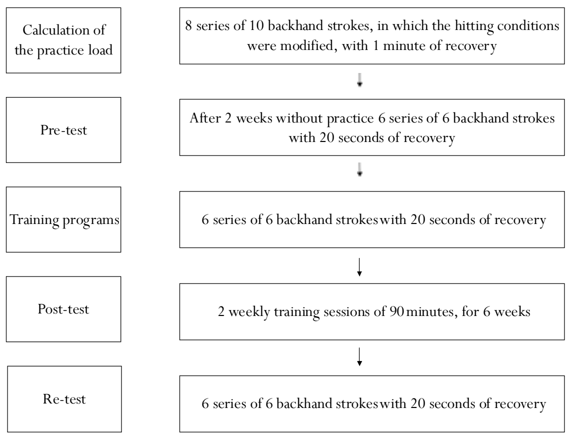

Figure 2. Procedure followed during the investigation

and Krasilshchikov (2021) indicated that in junior male players the number of hits per point was 6.14. Therefore, to determine the number of hits per series, the considerations of these studies were followed.

Statistical Analysis

The Shapiro-Wilk homogeneity test was applied to verify the normal distribution of the control, weight, and height variables. As for the data analysis, it should be indicated that inter-group inferential statistics were not applied due to the reduced sample size, the individualized application of the variability loads, and given that each athlete individually adapted to the proposed practice loads (Moreno and Ordoño, 2015).

Therefore, we utilized the technique proposed by Jacobson and Truax (1991), this statistics technique is based on determining the existence of significant changes in the dependent variable by first calculating the cut-off score «C», which is defined as the value at which we move from no effect to effect. Afterwards, the reliability of the change must be determined through the Reliable Change Index (RCI). For this, we take into account the standard error of the difference between the results from each test (sdif), which depends on Cronbach's á. Cronbach's á estimates the reliability of the tests (Cronbach, 1951), and oscillates between 0 and 1. Based on what was presented by George and Mallery (2003), the following recommendations were followed to evaluate the Cronbach's á values: a) an alpha coefficient >0.9 is excellent; b) an alpha coefficient >0.8 is good; c) alpha coefficient >0.7 is acceptable; d) alpha coefficient >0.6 is questionable; e) alpha coefficient >0.5 is poor; f) alpha coefficient <0.5 is unacceptable. The formula utilized to calculate the index of reliability of the change is shown in Equation 3.

$$RCI=\frac{X2-X1}{Sdif}$$

$$(Sdif=\sqrt{2\times\left(\sigma grupo\times\sqrt{(1-\alpha\ Cronbach)}\right)^2}$$

Legend: x_2= results of the player in a test; x_1= score in a previous test.

The standard error of the difference between two tests (sdif) describes the amplitude of the distribution of the change scores that would be expected if no real change occurred, so that an RCI greater than 1.96 would be little probable ($p<0.05$) without a real change. For this, a change in the result of the tennis players must be higher than the RCI value of 1.96 to ensure that the changes are not simply due to measuring error or chance (Equation 4).

$$RCI>1.96\rightarrow\frac{X2-X1}{Sdif}>1.96\rightarrow X2-X1>Sdif\times 1.96$$

In third place, the effectiveness of the training achieved by each of the tennis players was detailed and presented as a percentage. More specifically: 0.00% if the players did not improve when comparing between the tests; 16.67% if the players obtained the same result in two tests, with a decrease in improvement in the rest; 33.33% if the players showed improvement in one of the tests; 50.00% if the players improved in one of the tests and obtained the same results in two tests when comparing between them; 66.67% if the players improved in two of the tests after their comparison; 100.00% if an improvement was observed in the post-test with respect to the pre-test and re-test with respect to the pre-test and post-test. A training program was considered to improve performance if the effectiveness was e» 66.67 (Alfonso-Asencio et al., 2021).

Results

According to the data presented below, the greatest improvements in performance in terms of accuracy were found in the players who practiced in their habitual conditions and in the specificity training, while minor improvements were observed in the accuracy of the players who practiced with variability.

Table 1 shows the accuracy results of the backhand stroke obtained by each tennis player as a function of the practice conditions in pre-test, post-test, and re-test. In general terms, it can be observed that the tennis players from the three different practice conditions tended to slightly increase the accuracy of the backhand stroke after finishing the practice period, although this trend seemed to decrease in the re-test in the players who practiced with variability. As for the variability of the hit results, a greater dispersion was observed in the longitudinal axis, as well as a dispersion reduction trend after the training programs in all the training conditions, with a loss of performance after a period without practice. The results according to type of training are described below, starting with the habitual training condition and ending with the training conditions in variability.

Considering the analysis of Non-Overlap of All Pairs (NAP) (Parker and Vannest, 2009) data, the habitual training of Player 1 showed an effectiveness of 100.00% in accuracy (RE), while the improvement was only significant in the accuracy obtained in the re-test with

Table 1.
RE and EV results for each player in the pre-test, post-test, and re-test, expressed in cm

Practice	Player	RE_Pre-test	RE_Post-test	RE_Re-test	VE_Pre-test		VE_Post-test		VE_Re-test	
		M ±SD	M ±SD	M ±SD	X	Y	X	Y	X	Y
Habitual	1	587.54 ± 327.58	534.70 ± 364.51	498.18 ± 219.82	216.51	322.76	291.27	310.18	247.88	258.94
	2	769.89 ± 259.75	590.53 ± 305.02	571.58 ± 242.87	298.32	330.16	209.77	347.22	211.55	300.93
	3	585.58 ± 243.46	516.29 ± 218.23	534.40 ± 216.46	181.10	299.69	207.25	262.48	164.21	280.77
	4	464.18 ± 285.07	567.19 ± 262.96	506.55 ± 132.54	177.45	267.81	205.49	259.60	197.59	244.34
Specificity	5	505.11 ± 258.59	470.36 ± 284.79	429.65 ± 237.71	202.89	288.27	217.74	296.17	209.31	249.96
	6	368.65 ± 170.09	366.58 ± 199.54	520.66 ± 244.53	195.54	210.29	139.29	229.55	202.14	273.69
	7	459.64 ± 215.52	453.50 ± 261.39	369.07 ± 218.63	159.81	262.99	154.78	296.38	149.06	231.61
	8	385.13 ± 176.27	395.29 ± 259.04	391.34 ± 200.04	174.24	242.05	171.08	241.11	159.90	247.51
	9	532.33 ± 208.41	436.53 ± 191.87	415.38 ± 268.57	198.95	242.50	154.98	238.47	148.67	300.45
Variability	10	571.13 ± 279.27	438.12 ± 277.21	636.33 ± 286.21	259.80	292.25	208.47	275.20	249.02	321.74
	11	540.39 ± 273.71	455.91 ± 275.24	506.92 ± 260.93	235.42	308.84	238.83	261.39	202.39	285.78
	12	500.27 ± 465.90	454.46 ± 235.44	492.82 ± 214.24	368.15	283.73	167.18	252.38	189.91	244.72
	13	596.08 ± 199.15	534.39 ± 291.85	381.95 ± 239.58	145.84	269.20	180.57	304.86	121.77	282.63

Legend: X= transversal axis-width of the court;Y= longitudinal axis-length of the court; M=mean; SD=standard deviation.

respect to that obtained in the pre-test (RCI= 3.48 > 1.96; *p* <0.05). As for player 2, an effectiveness in accuracy of 100.00% was shown overall. Nevertheless, the improvement was only significant in the accuracy obtained in the re-test as compared with that obtained in the pre-test (RCI = 7.73 > 1.96; *p* <0.05). As for player 3, an effectiveness of 66.67% in accuracy was observed overall, while the improvement was only significant in the accuracy obtained in the re-test with respect to that obtained initially in the pre-test (RCI = 2.00 > 1.96; *p* <0.05). As for player 4, an effectiveness of 33.33% was observed globally. More specifically, the improvement was significant in the accuracy obtained in the re-test as compared to that obtained in the post-test (RCI = 2.36 > 1.96; *p* <0.05) (Table 2).

As for the VE results of the players, an increase in the dispersion was observed in the transversal axis, as well as a reduction in the longitudinal axis in the habitual practice of Player 1. However, the reduction in dispersion was only significant when comparing the re-test and pre-test in the longitudinal axis (RCI = 2.99 > 1.96; *p* <0.05). As for Player 2, a reduction in the dispersion was observed globally in the transversal and longitudinal axes. The reduction in dispersion was significant in the transversal axis when comparing re-test and pre-test (RCI = 2.87 > 1.96; *p* <0.05). As for Player 3, a global reduction in the dispersion was observed in the transversal and longitudinal axes as well. However, the reduction in dispersion was not significant when the tests were compared with each other. As for Player 4, an increase in the dispersion was observed in the transversal axis, along with a reduction in the longitudinal axis. The reduction in dispersion was not significant when comparing the tests (Table 2).

As for the players who trained with specificity, and considering the NAP analysis, the specificity training program performed by Player 1 showed an effectiveness of 100% in accuracy globally, while the change in the accuracy obtained was not significant when comparing the tests. For Player 2, an effectiveness of 33.33% was globally observed in accuracy, although the improvement was not significant when comparing the tests performed. Player 3 showed an effectiveness of 100% globally. The improvement in accuracy in the post-test was significant with respect to that obtained in the pre-test (RCI=2.01>1.96; *p* <0.05) and as compared to the post-test (RCI = 2.55 > 1.96; *p* <0.05). As for Player 4, a global effectiveness of 33.33% was observed. However, the accuracy gained was not significant when comparing the tests between themselves. Lastly, for player 5, a 100% effectiveness in accuracy was globally observed, while the improvement was only significant in the accuracy obtained in the re-test as compared to that obtained initially in the pre-test (RCI = 2.60 > 1.96; *p* <0.05) (Table 3).

As for the dispersion in the backhand strokes recorded and considering the NAP analysis of the specificity training of Player 1, a reduction in the post-test was observed with respect to the pre-test. As for Player 2, an increase in the dispersion was observed in the transversal axis. However, a reduction was also observed in the post-test with respect to the pre-test, with this reduction being significant (RCI = 3.49 > 1.96; *p* <0.05). Nevertheless, an increase in dispersion was observed in the longitudinal axis. As for Player 3, the dispersion was globally reduced in the transversal and longitudinal axes. Player 4 obtained a dispersion reduction in the

Table 2.
Calculation of the cut-off point and reliable change index (RCI) of the accuracy and dispersion of the hits expressed in cm, of the habitual practice players.

	RE						VE X-axis					VEY-axis				
	C		RCI 1.96			EFC	C		RCI 1.96			C		RCI 1.96		
Player 1	M	Sdif	Post-Pre	Re-Post	Re-Pre		M	Sdif	Post-Pre	Ret-Post	Ret-Pre	M	Sdif	Post-Pre	Ret-Post	Ret-Pre
Pre-test	587.54	97.63	0.54	1.42	3.48*		216.51	48.95	1.53	1.19	1.04	322.76	24.13	0.52	1.42	2.99*
Post-test	534.70	25.65				100%	291.27	36.54				310.18	36.05			
Re-test	498.18	25.65					247.88	30.20				258.94	21.35			
Player 2																
Pre-test	769.89	97.63	1.84	0.74	7.73*		216.51	48.95	1.81	0.05	2.87	330.16	24.13	0.71	1.28	1.37
Post-test	590.53	25.65				100%	291.27	36.54				347.22	36.05			
Re-test	571.58	25.65					247.88	30.20				300.93	21.35			
Player 3																
Pre-test	585.58	97.63	0.71	0.71	2.00*		181.10	48.95	0.53	1.18	0.56	299.69	24.13	1.54	0.51	0.89
Post-test	516.29	25.65				66.67%	207.25	36.54				262.48	36.05			
Re-test	534.40	25.65					164.21	30.20				280.77	21.35			
Player 4																
Pre-test	464.18	97.63	1.06	2.36*	1.65		177.45	48.95	0.57	0.22	0.67	267.81	24.13	0.34	0.42	1.10
Post-test	567.19	25.65				33.33%	205.49	36.54				259.60	36.05			
Re-test	506.55	25.65					197.59	30.20				244.34	21.35			

*Legend: * Significant change p<0.05; C= Cut-off point; X= transversal axis; Y= longitudinal axis; Cronbach's alpha RE= 0.7; Cronbach's alphaVE transversal axis= 0.62; Cronbach's alpha EV longitudinal axis= 0.63; EFC= Effectiveness.*

transversal and longitudinal axes when comparing the tests. Lastly, for Player 5, the accuracy dispersion was reduced in all the tests in the transversal axis, with this reduction being significant when comparing the post-test and the pre-test (RCI = 2.73> 1.96; p <0.05). In the longitudinal axis, the dispersion was only reduced in the post-test when compared to the pre-test, with this reduction not being significant (Table 3).

Table 3.
Calculation of the cut-off point and reliable change index (RCI) of the accuracy and dispersion of the hits expressed in cm, of the specificity practice players.

	RE						VE X axis					VEY axis				
	C		RCI 1.96			EFC	C		RCI 1.96			C		RCI 1.96		
Player 1	M	Sdif	Post-Pre	Re-Post	Re-Pre		M	Sdif	Post-Pre	Re-Post	Re-Pre	M	Sdif	Post-Pre	Re-Post	Re-Pre
Pre-test	505.11	55.77	0.62	1.23	1.68		202.89	16.12	0.65	0.43	0.24	288.27	24.81	0.32	1.62	1.66
Post-test	470.36	33.08				100%	217.74	30.02				296.17	28.46			
Re-test	429.65	45.04					209.31	25.79				249.96	23.10			
Player 2																
Pre-test	368.65	55.77	0.04	4.66	3.37		195.54	16.12	3.49*	2.09	0.26	330.16	24.13	0.78	1.55	2.74
Post-test	366.58	33.08				33.33%	139.29	30.02				347.22	36.05			
Re-test	520,66	45.04					202.14	25.79				300.93	21.35			
Player 3																
Pre-test	459.64	55.77	0.11	2.55*	2.01*		159.81	16.12	1.82	0.62	0.42	299.69	24.13	1.35	2.28	1.36
Post-test	453.50	33.08				100%	130.53	30.02				262.48	36.05			
Re-test	369.07	45.04					149.06	25.79				280.77	21.35			
Player 4																
Pre-test	385.13	55.77	0.18	0.12	0.14		174.24	16.12	0.20	0.37	0.56	267.81	24.13	0.04	0.23	0.24
Post-test	395.29	33.08				33.33%	171.08	30.02				259.60	36.05			
Re-test	391.34	45.04					159.90	25.79				244.34	21.35			
Player 5																
Pre-test	532.33	55.77	1.72	0.64	2.60*		198.95	16.12	2.73*	0.21	1.95	267.81	24.13	0.16	2.18	2.51
Post-test	436.53	33.08				100%	154.98	30.02				259.60	36.05			
Re-test	415.38	45.04					148.67	25.79				244.34	21.35			

*Legend: * Significant change p<0.05; C= Cut-off point; X= transversal axis; Y= longitudinal axis; Cronbach's alpha RE= 0.7; Cronbach's alphaVE transversal axis= 0.62; Cronbach's alpha EV longitudinal axis= 0.63; EFC= Effectiveness.*

As for the players who trained with variability, and considering the NAP analysis, the variability training program followed by Player 1 showed a global effectiveness in accuracy of 33.33%. The improvement was significant in the accuracy obtained in the post-test with respect to that obtained initially in the pre-test (RCI = 4.16> 1.96; p <0.05). For Player 2, an effectiveness of 66.67% was obtained globally for accuracy. More specifically, the improvement was significant in the accuracy obtained in the post-test with respect to that obtained initially in the pre-test (RCI = 2.64> 1.96; p <0.05). For Player 3, a global effectiveness of 66.67% was observed. However, the improvement in the accuracy obtained was not significant when comparing the tests. Lastly, for Player 4, an effectiveness of 100.00% was globally obtained; more specifically, the improvement was significant in the accuracy obtained in the re-test with respect to the pre-test (RCI = 2.65 > 1.96; p <0.05), and as compared to the post-test (RCI = 4.55 > 1.96; p <0.05).

Table 4.
Calculation of the cut-off point and reliable change index (RCI) of the accuracy and dispersion of the hits expressed in cm, of the variability practice players.

	RE						VE X axis					VEY axis				
	C		RCI 1.96 (p <.05)			EFC	C		RCI 1.96 (p <.05)			C		RCI 1.96 (p<.05)		
Player 1	M	Sdif	Post-Pre	Re-Post	Re-Pre		M	Sdif	Post-Pre	Re-Post	Re-Pre	M	Sdif	Post-Pre	Re-Post	Re-Pre
Pre-test	571.13	32.00	4.16*	5.92	0.81	33.33 %	259.80	79.73	1.22	3.13	0.24	292.25	14.25	1.20	2.36	1.09
Post-test	438.12	33.47					162.36	27.70				275.20	19.73			
Re-test	636.33	80.67					249.02	45.83				321.74	27.08			
Player 2																
Pre-test	540.39	32.00	2.64*	1.52	0.41	66.67 %	235.42	79.73	0.04	1.32	0.72	308.84	14.25	3.33*	1.24	0.85
Post-test	455.91	33.47					238.83	27.70				261.39	19.73			
Re-test	506.92	80.67					202.39	45.83				285.78	27.08			
Player 3																
Pre-test	500.27	32.00	1.43	1.15	0.09	66.67 %	368.15	79.73	2.52*	0.82	3.89*	283.73	14.25	2.20*	0.39	1.44
Post-test	454.46	33.47					167.18	27.70				252.38	19.73			
Re-test	492.82	80.67					189.91	45.83				244.72	27.08			
Player 4																
Pre-test	596.08	32.00	1.93	4.55*	2.65*		145.84	79.73	0.44	2.12*	0.53	269.20	14.25	2.50	1.13	0.50
Post-test	534.39	33.47				100%	180.57	27.70				304.86	19.73			
Re-test	381.95	80.67					121.77	45.83				282.63	27.08			

*Legend: * Significant change p<0.05; C= Cut-off point; X= transversal axis; Y= longitudinal axis; Cronbach's alpha RE= 0.7; Cronbach's alphaVE transversal axis= 0.62; Cronbach's alpha EV longitudinal axis= 0.63; EFC= Effectiveness.*

As for the dispersion of the backhand strokes according to the NAP analysis, the results for Player 1 showed an overall reduction in the transverse axis, although the improvement was not significant. For Player 2, a general reduction in dispersion was observed in the transversal and longitudinal axes. However, the reduction was only significant when comparing the post-test with the re-test in the longitudinal axis (RCI = 3.33> 1.96; p <0.05). As for Player 3, a reduction in the dispersion was observed in the transversal and longitudinal axes, with it being significant in the transversal axis when comparing the re-test to the pre-test (RCI = 2.52> 1.96; p <0.05), and the longitudinal axis when comparing the re-test and pre-test (RCI = 2.20> 1.96; p <0.05). Lastly, for Player 4, the training reduced the dispersion in the transversal axis, with the improvement being significant when comparing the re-test with the post-test (RCI = 2.12> 1.96; p <0.05), while no significant reductions were observed in the longitudinal axis.

Discussion

The objective of the present work was to analyze the effect of induced variability and specificity training on the accuracy and variability in the results of the backhand strokes performed by amateurs.

The results of the tennis players generally showed that the variability training had a lower effectiveness, especially in the retention of the acquired accuracy. These data coincide with those obtained in studies on the effect of variable practice on throwing and hitting skills (Breslin et al., 2012; García-Herrero et al., 2016; Reynoso et al., 2013). These results are perhaps due to the fact that variability practice requires a greater period of adaptation (Hernández-Davó et al., 2014a, b). In this sense, according to the general adaptation syndrome, an excessive magnitude of load variability or practice load can produce a phase of alarm, which reduces the performance of the players (Moreno and Ordoño, 2009). Similar studies on basketball throwing obtained disparate results, as greater learning was registered in terms of accuracy for constant practice, as compared to variable practice (Breslin et al., 2012). On the other hand, for the volleyball serve, Reynoso et al. (2013) analyzed the effects of the modification of hitting situations, concluding that training in consistency improved accuracy. Along the same line, in basketball throwing studies by Hernández-Davó et al. (2014a) after a period of consistency training, the accuracy results were higher than those recorded on the initial test. However, after a period of variability training, a slight decrease in accuracy was observed, these data coincide with our retention tests.

On the other hand, in a Frisbee throwing task, accuracy improved after the application of random and specific training (Zipp and gentile, 2010). Along this line, similar results were found in handball throwing, as in the study, the control (lack of practice), variability, consistency and mixed practice groups showed a tendency towards improvement after the training provided. These data coincide with the results found in the present work, as 3 out of 4 tennis players who practiced in their habitual manner, 4 out of 5 of the players who trained on specificity, and the 4 players who practiced with induced variability, improved their post-test accuracy. Although in 3 of the 4 players who practiced in variability there were reductions in accuracy in the retention test compared to the post-test. Likewise, in another research study on soccer kicks, both the specificity and the variability training groups improved their accuracy, with the improvement being greater in the group that trained with specificity (García et al., 2015). These data are partially in agreement with those obtained in the present study, as 2 players who trained with variability obtained significant improvements in accuracy when comparing the post-test with the pre-test, while no significant differences were found in the players who trained with their habitual program. Although it should be noted that 3 of the 4 players improved in general.

Considering the age and experience of the players, perhaps the data obtained were produced because the tennis players were amateurs and did not have a fully defined the pattern of execution. In addition, as age increases, there is an improvement in motor skills (Rosa-Guillamón et al., 2020). In this sense, our results are in agreement with those obtained in previous studies, in that the benefits of variability training are not very evident in apprentices and non-experts (Caballero et al., 2012; Douvis, 2005; García-Herrero et la., 2016; Taheri et al., 2017). In this sense, Wulf and Shea (2002) concluded that variability during practice should not be considered in motor learning processes, due to the high loads of variability that are already observed in inexperienced subjects. Along this line, in his study on the forehand drive, Douvis (2005) observed that the groups that utilized variability training had a significant reduction in accuracy as compared to the group that trained on consistency. In this sense, in our work, in a global sense, the percentage of effectiveness was 100% for a player who practiced with induced variability, and for 3 players who practiced with specificity, Observing generally better results in the tennis players who practiced in this way.

However, our results are partially contrary to those found in other tennis studies. More specifically, for the tennis serve, variable training conditions improved accuracy (Hernández-Davó et al., 2014b; Menayo et al., 2012). Likewise, for the forehand stroke, when comparing random variability, blocked variability, specific, and control, the results pointed to the superiority of practice over the lack of practice, variable practice over specific practice, and random variability over blocked variability (Green et al., 1995). Along this line, variable training seemed to increase the skills and accuracy of amateur players to a greater extent as compared to specific practice (Sahan et al., 2018). On the other hand, the forehand stroke in kids, the use of less pressurized balls, and rackets adjusted to the size of the players, seemed to be associated with a greater performance in terms of accuracy (Buszard et al., 2020). These data are contrary to those found in the present study, as variability training with the use of smaller-sized implements and balls with lower pressures resulted in a lower effectiveness in long-term accuracy performance. Perhaps the results obtained by Buszard et al. (2020) were due to the fact that the players practiced in conditions which facilitated their hits.

As for the dispersion of the bounces from the backhand strokes, just as with accuracy, the tennis players showed disparate results, coinciding with what was described for the intra-subject variability in basketball throwing (Miller, 2002). Likewise, Mendes et al. (2015) showed that the intra and inter-individual variability of the motor behavior underlined the singular nature of the execution of the serve for each player. These results could be extrapolated to the singular nature of the execution of the backhand stroke by each player, thereby providing an explanation for the different accuracy results obtained for each player. In this sense, the functional role of variability in motor learning depends on the limitations of the tasks and the intrinsic characteristics of the individuals (Caballero et al., 2017). In addition, as has been exposed, the amateur level of the tennis players can produce variability in the executions.

When analyzing the results according to the axes, 9 out 13 tennis players reduced their degree of dispersion in the transversal axis, thereby increasing their performance. More specifically, 2 players who practiced in habitual conditions, 4 who trained in specificity, and 3 tennis player that practiced in induced variability condition. As for the longitudinal axis, 6 out of 13 tennis players reduced their dispersion, 3 who practiced with the usual conditions, 1 tennis player that practice in specificity, and 2 tennis players who practiced in conditions of variability. This indicates that the dispersion of the hits was more reduced in the transversal axis than the longitudinal one. These results could be due to the age of the players, as in order to send the ball to the baseline, more strength is needed. On the other hand, the results partially coincided with those presented by Hernández-Davó et al. (2014a) on the throwing of a basketball. These authors observed that the error-variable improved in the re-tests, while significant differences were not found between tests. Along the same line, in the volleyball serve, neither blocked training nor training based on contextual interference (greater variability), reduced the dispersion of the hits in a significant manner (Reynoso et al., 2013). This was also generally observed in the present study, as significant reductions were only found in 2 players. Also, these reductions occurred in 2 tests and not in both axes. The data obtained suggest that the players individually adapted to the practice loads applied.

To conclude, it should be noted that this study had some limitations that must be taken into account when interpreting the results. The first one refers to the small sample size, this makes it difficult to attribute changes in accuracy to the effect of practice. The results obtained for individual players are very interesting for individualizing training loads. However, they could be extended with an intra-group study and by incorporating the calculation of the effect size, in order to achieve greater representativeness and learn more about the effects of training. In this sense, it would be interesting to carry out the training conditions based on the performance results obtained in a previous test. Second, the study was conducted in a single tennis club. Likewise, the study was conducted with amateur players, and the results could be different with players of different ages or levels. Thus, it would be interesting for future research to analyze variability in practice and its effects on accuracy with other types of players. Likewise, in the future, the effects of longer training programs should be analyzed.

Conclusions

In general terms, three of the four players who practiced in their habitual conditions improved the accuracy of their shots. Specifically, the improvements were significant in player 1, when comparing the re-test with the pre-test; in player 2, when comparing the re-test with the pre-test; in player 3, when comparing the re-test with respect to the pre-test; in player 4, when comparing the re-test with the pre-test. Three of the four players improved accuracy when comparing the post test and the retention test.

For the players who performed specificity training, the accuracy improved in three out of five tennis players. More concretely, the improvement was significant in player 3 when comparing the re-test with the pre-test, and the re-test with respect to the post-test; in player 5, when comparing the re-test with the pre-test. Four of the five players improved accuracy when comparing the post test and the retention test

Lastly, for the players who practiced with induced variability, the accuracy increased in three out of four players. The improvement was significant in player 1 when comparing the post-test and the pre-test although the accuracy of this player was noticeably reduced in the retention test; in player 2 when comparing the post-test with the pre-test ; in player 4, when comparing the re-test with the pre-test, as well as the re-test with the post-test. Only one of the players who practiced under conditions of variability improved his accuracy when comparing the retention test with the post-test.

Considering the results from the training programs, the tennis players generally showed improvements in accuracy, although the improvement in general were greater in the tennis players who practiced in their habitual condition and the tennis player who practiced with specificity. This would partially reject our initial hypothesis.

As for the dispersion of the backhand strokes, the results according to axis showed that for the transversal axis, 9 out of 13 tennis players reduced their dispersion, thereby increasing their performance. More specifically, 2 players who regularly practiced, 4 from who practiced specifically, and 3 trat practice in induced variability. Lastly, for the longitudinal axis, 6 out of 13 tennis players reduced their dispersion: 3 tennis players who practiced regularly, 1 player who trained in specificity and 2 tennis players that practiced in variability. This implies that dispersion was reduced to a greater extent on the transversal axis than on the longitudinal axis.

According to the results obtained, the importance of individually adapting the training load to obtain improvements in the accuracy of the tennis players, was observed. Likewise, for the players in training, in the case that variability is utilized, the training loads should be low. And for dispersion, in amateur players, the depth of the hits should be insisted upon, as a greater dispersion was observed on the longitudinal axis.

On the other hand, considering that speed is another determining variable to achieve performance in tennis. It would be interesting for future research to analyze the different practice conditions on speed in amateur tennis players and expert players.

Finally, the results of this study will allow tennis coaches to plan and design their training sessions to apply training loads that are individualized to each tennis player. In this context, the individual analysis of the data allowed us to determine the evolution of the tennis player's performance more precisely, making possible the individual adjustment of the training programs.

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