Effects of Decision Training on Decision Making and Performance in Young Tennis Players: An Applied Research

Luis García-González, Alberto Moreno, Alexander Gil, M. Perla Moreno & Fernando Del Villar

a University of Zaragoza
b University of Extremadura
c Catholic University Saint Anthony of Murcia

Accepted author version posted online: 28 Apr 2014. Published online: 08 Aug 2014.


To link to this article: http://dx.doi.org/10.1080/10413200.2014.917441

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the “Content”) contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms &
Effects of Decision Training on Decision Making and Performance in Young Tennis Players: An Applied Research

Luis García-González
University of Zaragoza

Alberto Moreno
University of Extremadura

Alexander Gil
Catholic University Saint Anthony of Murcia

M. Perla Moreno and Fernando Del Villar
University of Extremadura

This study examined the effectiveness of a 10-week decision training program on decision making and performance in tennis. Decision training was based on the analysis combining tactical questioning and video feedback about players own actions. A quasi-experimental design with intermediate tennis players (control group, n = 6; experimental group, n = 5) was developed over 18 weeks, divided into 3 phases: preintervention, postintervention, and retention. A total of 13,383 game play actions were analyzed to test differences. Experimental group improves significantly decision making and performance and maintained improvements during the retention phase. Video feedback combined with questioning is recommended to achieve sport expertise.

One of the most complex processes within sport expertise is decision making (García-González, Araújo, Carvalho, & Del Villar, 2011; Williams, Ford, Eccles, & Ward, 2011). Within an expert performance approach, cognitive psychology shows the influence of cognitive elements on sport expertise, such that the level of expertise may depend on the internal mental representations and cognitive processes that occur between the interpretation of a stimulus and the choice of an action. Thus, the field of sport is highly relevant to study decision making (Hodges, Starkes, & MacMahon, 2006; Johnson, 2006; Moran, 2012; Williams &
Ericsson, 2005), and open sports, like tennis, are constrained by decision making (Greháigne, Godbout, & Bouthier, 2001).

The relationship between cognitive variables and execution or performance variables has been studied in tennis (e.g., Del Villar, García-González, Iglesias, Moreno, & Cervelló, 2007; McPherson, 1999; McPherson & Thomas, 1989; Nielsen & McPherson, 2001). Findings show that players with a higher level of expertise develop a larger number of successful decisions and more effective executions, and, thus, reach a higher performance level. A strong relationship between cognitive expertise and performance level is contemplated, which has a decisive influence on decision making during the game and on performance. This relationship between cognitive and execution skills has also been found in basketball (French & Thomas, 1987; Iglesias, Moreno, Santos-Rosa, Cervelló, & Del Villar, 2005), volleyball (Araújo, Alfonso, & Mesquita, 2011; A. Moreno, Moreno, García, Iglesias, & Del Villar, 2006), and baseball (McPherson, 1993).

The expert performance approach developed by Ericsson and Smith (1991) applies three stages to the study of expertise. The first and second stages (i.e., capturing expert performance and establishing mechanisms that underlie expert performance) have been highly studied in the field of sport and have just been set out here. But, the third stage, related to examining the acquisition of identified characteristics of expertise (e.g., using training interventions), is needed to explain how to acquire expertise, because there are fewer studies in this area (Lorains, Ball, & MacMahon, 2013).

There are some activities that have been identified, such as those that contribute more directly to performance improvement; for example, video training or individual feedback (Baker, Côté, & Abernethy, 2003; Deakin & Cobley, 2003). More specifically related to the improvement of decision making and execution skills in tennis, we have found different training intervention approaches (Carvalho, Araújo, García-González, & Iglesias, 2011; Raab, 2007). One of the main conclusions reached is the need to use representative tasks that include essential aspects characterizing the game situations (Ward et al., 2008). Moreover, to assess the effectiveness of an intervention, in situ conditions must be used, where athletes are required to perform real sporting actions, because the effects of expertise are more apparent under these conditions (Travassos et al., 2013).

The decision training model (DTM) developed by Vickers (2003, 2007) explains the construction of tactical experiences, favoring the development of tactical knowledge and cognitive skills, including the training of cognitive skills involved in decision making. To do so, different tools are used, such as video feedback or questioning (Vickers, 2007). These decision training tools are considered as explicit learning procedures and can obtain improvements for highly complex situations (Raab, 2003; Raab & Johnson, 2007).

Video has been used as a learning strategy in some sport areas (see Ives, Straub, & Shelley, 2002, for a review). More specifically, video feedback is a useful tool to develop cognitive expertise, decision-making skills, and performance (Hodges, Chua, & Franks, 2003; Raab, Masters, & Maxwell, 2005; Rhea, Mathes, & Hardin, 1997; Vickers, 2003, 2007; Vickers, Reeves, Chambers, & Martell, 2004). However, the use of this tool is not very widespread among trainers for tactical and decision-making training (Vickers et al., 2004). To improve the benefits of this tool, it must be used and interpreted with the help of an expert or supervisor, because events happen quickly and a lot of information is available. Thus, with the help of a supervisor or an expert, attention can be directed toward specific cues in order to achieve greater effectiveness during video feedback. Questioning is a tool to do this (Vickers, 2007; Vickers, Livingston, Umeris, & Holden, 1999).

Questioning is a useful tool to develop decision training, and it is often used with other instructional tools (Chambers & Vickers, 2006, in swimming). In any case, questioning has
proved to be useful for application in sport training, and it has been assessed by trainers as one of the most effective tools for decision training (Vickers et al., 2004). It provokes improvements in execution skills, in decision-making skills, and tactical skills in open sports (Vickers, 2007). The main purpose of questioning is to ask the athlete a series of questions that explore a critical way of developing technical and tactical skills at a high level. Therefore, this is a process where trainers do not tell players what to do in the form of a direct instruction and feedback, but rather they ask athletes questions for them to understand the tasks, the skills, or the decisions being trained (Vickers, 2007).

The DTM developed by Vickers (2007) proposes a combination of different tools to construct tactical experiences, favoring the development of cognitive skills. To this end, and based on the aforementioned reasons, our decision training program will combine video feedback and questioning geared toward tactics in tennis. Moreover, combining the two decision training tools generates an increase in cognitive effort and makes it easier for the athletes to understand the tactical requirements of their sport (Vickers et al., 2004).

A combination of both tools has not been tested in tennis and their effectiveness on decision making and performance has not been assessed, either. Thus, the purpose of our study was to assess the effect of a decision training program, using a combination of video feedback and questioning tools, on decision-making skills and performance in tennis players. Our initial hypothesis is that tactical decision training, via a combination of video feedback and questioning would produce a significant improvement in decision-making skills and performance in young tennis players.

METHOD

Participants

Eleven male players took part, who were divided into two groups: control (n = 6) and experimental (n = 5). One player, who initially took part in the experimental group composed of six players, was removed because of an injury undergone during the study.

To ensure that players in both groups were exposed to the same training process and to control different contaminating variables, all participating players belonged to the same club, belonged to the same training group, shared the same trainer, and trained for 4 hr a week. All athletes belonged to the U-14 category and had the same classification according to the International Tennis Federation. Using the international tennis number, they were rated at Level 5 (intermediate).

The characteristics corresponding to each group, such as age, playing years, and competition years in tennis, are included in Table 1. Players were assigned to the experimental or to the

\begin{table}
\centering
\caption{Characteristics of Participants in Every Group}
\begin{tabular}{lcc}
\hline
 & Control group$^a$ & Experimental group$^b$
 & $M$ & $SD$ & $M$ & $SD$
\hline
Age & 12.83 & 0.75 & 13.00 & 0.71 \\
Tennis playing years & 6.50 & 1.05 & 6.80 & 0.83 \\
Tennis competition years & 3.67 & 0.52 & 3.60 & 0.54 \\
\hline
\end{tabular}
\end{table}

$^a_{n = 6}$. $^b_{n = 5}$. 
control group in agreement with the values obtained in the study variables (i.e., decision making and execution skills) during the preintervention phase (four matches), prior to the application of the decision training program. To ensure group homogeneity, variance homogeneity tests performed using the Levene test showed that both groups were equivalent in the decision-making skills variable (Levene’s statistic = 1.096, \( p = .322 \)) and in the execution skills variable (Levene’s statistic = 1.487, \( p = .254 \)) before the decision training program was started with the experimental group.

Before starting this study, participants and their parents were informed, and they signed an informed consent as required by the Helsinki Declaration (2008) and the local ethics committee.

**Design**

A quasi-experimental design was carried out with two groups: control group and experimental group. Each player played a total of 18 tennis matches, which were used to develop three research phases: (a) preintervention phase comprising four matches, thus, permitting the establishment of the initial level of dependent variables; (b) postintervention phase comprising 10 matches to determine the effect of intervention on dependent variables; and (c) retention phase comprising four matches to establish the consolidation effect on the dependent variables, after the intervention ended (Barlow & Hersen, 1984).

**Variables**

Dependent variables of this study were decision-making skills and execution skills. Decision-making skills in tennis are defined as the adaptation of the selected shot to the specific conditions of the game situation, based on an observation instrument (Nielsen & McPherson, 2001). These were measured by the percentage of successful decisions over the total number of decisions made. Execution skills are defined as the performance, outcome, or consequence provoked by the selected shot (Nielsen & McPherson, 2001), and they were measured by the percentage of successful execution actions. All actions following the serve were included in the analysis of these variables.

A total of 13,353 actions were analyzed for the 18 matches in all players (67.59, \( SD = 21.75 \) actions per player and per match). Decision making and execution were analyzed for each action. All aspects related to the reliability of the observation made have been included in a specific subsection next.

**Decision Training Program**

The intervention on the experimental group involved a 10-session decision training program based on video feedback and questioning. The duration of the program was based on previous studies that had demonstrated the effectiveness in similar interventions that lasted for 10 sessions (Iglesias et al., 2005; A. Moreno, Del Villar, García-González, Gil, & Moreno, 2011). This intervention is based on Vickers’s DTM (Vickers, 2007). Video feedback and questioning are used as tools to develop decision training. This decision training program was carried out in addition to the usual training of athletes belonging to the experimental group. The trainer was not informed about the study objectives or about the tactical and decision-making aspects that were going to be studied in each one of the program sessions. This decision training program, as just implied, is based on representativeness of game context, and its effect is assessed by real sporting actions under in situ conditions (i.e., real game play tennis matches).
The main task is to perform an analysis of the decisions made during a match, viewing right and wrong own decisions in different real game actions. The intervention program comprises the analysis of six actions (i.e., three successful decisions and three unsuccessful decisions) after every match. The actions analyzed during each session were selected by an expert, applying the Nielsen and McPherson (2001) instrument to assess if the decisions were successful or unsuccessful. The reliability obtained was high (Cohen $\kappa > .81$) ensuring a correct action selection for subsequent analysis.

The experimental group, by viewing their actions, should identify the main reasons why they took a decision at a given moment. The aim of the supervisor’s participation in the video feedback and questioning sessions was to guide the analysis of the game situation through open questioning, but he did not intervene directly or give answers to the proposed questions.

The specific characteristics of the decision training program in every intervention session were (a) supervision of six actions by video feedback and questioning, which were presented at random in every session, to prevent players from knowing if the action to be supervised was right or wrong; (b) analysis of these six actions, lasting for about 45 min; and (c) individual analysis of every selected action, by means of video editing that showed the point played. The video showed the development of the entire point, and the expert pointed out which action was to be analyzed.

These six actions to be analyzed composed a full intervention session, in line with the structure of previous research that has applied this methodology in other sports (A. Moreno et al., 2011; M. P. Moreno, Moreno, Ureña, Iglesias, & Del Villar, 2008). Every action was supervised according to the structure set out in Figure 1.

**Instruments**

To assess the decision-making skills and execution skills of tennis players, the Nielsen and McPherson (2001) observation instrument was used. This had already been used for other studies, applied to tennis players with different expertise (Del Villar et al., 2007; McPherson & French, 1991; Nielsen & McPherson, 2001). The game play section of this instrument, which assesses all shots made after serve, was used.

This is a useful instrument to assess differences in expertise, complying with the recommendations of Travassos et al. (2013) about the need to perform sporting actions under in situ conditions to assess the effect of expertise.

In every action, the instrument evaluates decision-making skills as either successful decisions (Value 1) or unsuccessful decisions (Value 0), by means of criteria that assess the player’s intention (i.e., offensive or defensive) according to the opponent’s position, player’s position, ball trajectory, and the intention of putting pressure on the opponent (e.g., trying to displace the opponent, keeping him on the baseline, playing to his weak side, etc.) or defending (e.g., recovering position after a forceful shot by the opponent).

For execution skills, it establishes four levels according to the performance of the shot and its effect/outcome on the opponent (i.e., Value 3, displacing and putting pressure on the opponent; Value 2, no pressure on the opponent; Value 1, forced error; Value 0, unforced error).

Decision-making skills were assessed by means of the percentage of successful decisions (Value 1) made during the match. Successful decision making (Value 1) refers to the tennis player’s capacity to make appropriate decisions under specific conditions (i.e., tending to put pressure on the opponent, forcing him to move, playing to his weak side, or remaining behind the baseline; Del Villar et al., 2007; Nielsen & McPherson, 2001). Execution skills were assessed by means of the percentage of successful actions (Value 3) achieved in every match.
### STEP 1 - WATCHING selected images:

1.1. Watching the full point and the selected action to be analyzed.
1.2. Waiting moment to favor stimulated recall.
1.3. Watching the same action again and contextualization of that point (scoreboard).

**Observations:** The expert completes information with data such as game order in which the point is framed (e.g., fifth game of the match) and scoreboard at the start of the point (e.g., winning 3-1, 40-30).

### STEP 2 – SELF-ANALYSIS and player’s reflection:

2.1. Explanation and valuation of the analyzed point. Global analysis of his action and initial analysis of the decision made.

### STEP 3 – COMBINED ANALYSIS player-expert:

**Sequential analysis of the causes and reasons for the decision through questioning**

<table>
<thead>
<tr>
<th>3.1. Analysis of the decision context</th>
<th>Scoreboard, opponent’s placement, player’s placement, ball placement and direction, shot executed by the opponent, etc. These context conditions were analyzed as constraints to decision-making and related to tactics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2. Valuation of possible solutions</td>
<td>Type of shot (forehand, backhand), effect shot (flat, topspin, backspin or slice), direction (down the line, cross-court, to the center), depth (short, medium, long), height (high, medium or low trajectory) and shot power that might be selected. Valuation of the best resources of every shot characteristic taking into account the decision context.</td>
</tr>
<tr>
<td>3.3. Analysis of the selected response</td>
<td>Type of shot (forehand, backhand), effect shot (flat, topspin, backspin or slice), direction (down the line, cross-court, to the center), depth (short, medium, long), height (high, medium or low trajectory) and shot power selected. Analysis of the selected shot characteristics taking into account the decision context.</td>
</tr>
<tr>
<td>3.4. Analysis of the execution of the decision</td>
<td>Analysis of the result of the selected action. Differentiation between decision and execution. The player has to differentiate between tactical intention and execution outcome.</td>
</tr>
<tr>
<td>3.5. Analysis of the result of the decision</td>
<td>Main consequences on the opponent and on the player. In a successful decision, players have to identify some good consequences (e.g., displacement of the opponent, entire space to send the next shot, etc.). In an unsuccessful decision, players have to identify some bad consequences (e.g., their displacement, loss of initiative, etc.).</td>
</tr>
<tr>
<td>3.6. Global analysis of the action.</td>
<td>Comparison with the analysis done in Step 2. Reinforcement of decision-making or proposal of alternatives (only when analyzing an error). If the decision-making analyzed was successful, the player has to reinforce why the decision made was successful decision. If the decision-making analyzed was unsuccessful, the player has to search for the best alternative after analyzing context and possible solutions, and justify why this is the best.</td>
</tr>
</tbody>
</table>

**Figure 1. Sequence for the analysis of every game action.**
Successful execution (Value 3) is defined as a forcing shot that usually displaces the opponent (e.g., playing to the opponent’s weak side) and places pressure on the opponent, forcing a weak return (Nielsen & McPherson, 2001).

Filming and observation conditions proposed by Nielsen and McPherson (2001) were taken into account in order to apply the observation instrument. To record and observe the real game play, a digital video camera was used (Sony HDR-XR155 with Sony VCL-HGA07 wide angle lens) placed at the back of the tennis courts at a distance of 7 m (22.96 ft) from the baseline and at a height of 2 m (6.56 ft), with the aim of obtaining a filming angle that clearly captured both sides of the court.

**Observation Reliability**

Inter- and intraobserver reliability was tested to correctly observe all the matches of every player. Seven observers were selected due to the high volume of action to be analyzed (i.e., a total of 13,353 actions). Observers were external to the study, tennis experts, and with experience in systematic observation processes. All of them had degrees in sport science and a master’s course in observational analysis. Ten training sessions were held with observers in order to for all of them to attain the necessary inter- and intraobserver reliability level, both in the decision-making variable and the execution variable. The actions selected to train observers and to assess the reliability of the observation process were actions from the actual study, which included recordings of all the phases, on a proportional basis.

Cohen’s Kappa statistic was calculated for intraobserver reliability, because in this statistic, concordance on a random basis is excluded. Values achieved were higher than .84 for decision-making skills, and higher than .88 for execution skills, in all observers. Values greater than .75 establish very good/almost complete concordance (Fleiss, Levin, & Paik, 2003).

The intraclass correlation coefficient (ICC) was used for interobserver reliability. This gives us the levels of concordance and systematic error of some observers in respect of others when there are more than two observers at the same time (Hartmann, 1977; Losada & Arnau, 2000; Shrout & Fleiss, 1979). The ICC values were greater than .81 in the decision-making variable and greater than .85 in the execution variable. With ICC values greater than .75, reliability is considered as excellent (Prieto, Lamarca, & Casado, 1998). That is why the observers were prepared for coding game actions.

**Procedures**

Eighteen matches were played by each tennis player. These matches were divided into three experimental phases. First, a preintervention phase lasting for four matches, where the initial level of the individuals was assessed and the values to establish the study groups were achieved. Second, a postintervention phase lasting for 10 matches, when the decision training program was developed, with 10 video feedback and questioning sessions for every player in the experimental group. These sessions were held after every match. Finally, a retention phase, which comprised the last four matches, when the decision training program was no longer applied, and whose purpose was to evaluate the degree of retention in decision-making and execution skills, in participants from the experimental group. Decision-making skills and execution skills variables were assessed in the 18 matches played, in all players of this study.

To ensure continuous competition, a league system was used for the initial 12 (finally 11) participants to compete together. This competition structure ensured that opponents had a similar level (i.e., all players were rated at Level 5 in the international tennis number classification), controlling opponent skill level, preventing the level of expertise from being able to affect the decision-making and execution skills variables. This structure also permitted a
video feedback and questioning session using own images for every athlete in the experimental
group every week, over 10 consecutive weeks.

Matches were played on Sundays, and each intervention session was held during the
following 24 hr, before the athlete carried out the first weekly training. The on-court trainer
was not informed of the specific objectives to avoid having an influence on this process. In
the experimental group, athletes dedicated about 45 min to the decision training program
in each session. In the control group, the same amount of time was spent viewing actions
with the same characteristics. The control group also viewed six actions (i.e., three successful
decisions and three unsuccessful decisions, similar to Step 1 in Figure 1), but without decision
training emphasis. After the tennis players in the control group had seen the action for the
first time, they also received information about contextualization of that point (i.e., only game
order and scoreboard, similar to step one in Figure 1), but there was no kind of tactical or
decision-making information.

Statistical Analysis
The IBM SPSS Statistics v.19.0 program was used for data analysis. Results were obtained
by parametric statistics because the values were achieved by means of the Shapiro-Wilks test
for samples with fewer than 30 individuals, indicating data normality. A $3 \times 2$ mixed analysis
of variance was performed (Test-Time $\times$ Group). Within the repeated measure factor (test-
time as within-subjects factor) the three phases of the study were used (i.e., preintervention,
postintervention, and retention). Moreover, both experimental and control groups were in-
cluded for the group factor (between-subjects factor). Analysis of differences was performed
by means of multivariate contrasts, which are reported in this type of analysis. In addition, the
estimation of the effect size was included by means of partial squared eta ($\eta^2$) to improve
the assessment of the differences found, because it eliminates the influence of the sample size.
Statistical power ($SP = 1-\beta$) was calculated to test for the probability of a type II error.

RESULTS

Decision-Making Skills
Results showed an interaction effect between test-time and group factors and a large effect
size in decision-making skills, $\Lambda = .285$, $F(2, 8) = 10.052$, $p = .007$, $\eta^2 = .715$, $SP = .916$.

In the within-group analysis, multivariate contrasts show no significant differences in the
control group (Table 2) between the three measurements carried out, $\Lambda = .587$, $F(2, 8) =
2.819$, $p = .118$, $\eta^2 = .413$, $SP = .403$. In contrast, there were significant differences with a
large effect size in the experimental group between the different measurements carried out in
this study, $\Lambda = .241$, $F(2, 8) = 12.563$, $p = .003$, $\eta^2 = .759$, $SP = .963$. Pairwise comparisons
(Table 2) showed how the percentage of successful decisions in the experimental group in-
creases significantly after the intervention (i.e., significant differences between preintervention
and postintervention phases). This significant increase is maintained in the retention phase
(i.e., significant differences between preintervention and retention phase).

Execution Skills
Execution skills results showed an interaction effect between test-time and group factors
and a large effect size, $\Lambda = .443$, $F(2, 8) = 5.028$, $p = .039$, $\eta^2 = .557$, $SP = .643$.

In the within-group analysis, multivariate contrasts showed that there were no signifi-
cant differences in the control group (Table 3) between the three measurements, $\Lambda = .938,$
### Table 2
Descriptive Statistics and Pairwise Comparison of Decision-Making Skills for Intragroup Analysis

<table>
<thead>
<tr>
<th>Group</th>
<th>Test-time</th>
<th>M</th>
<th>SD</th>
<th>(A) Decision-making skills</th>
<th>Test-time</th>
<th>M</th>
<th>SD</th>
<th>(B) Decision-making skills</th>
<th>M diff. (A - B)</th>
<th>Typical error</th>
<th>p</th>
<th>Differences 95% CI [LL, UL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>PRE</td>
<td>58.65</td>
<td>2.46</td>
<td>POST</td>
<td>59.90</td>
<td>5.94</td>
<td>1.253</td>
<td>-1.503</td>
<td>1.000</td>
<td></td>
<td></td>
<td>[-5.66, 3.15]</td>
</tr>
<tr>
<td></td>
<td>PRE</td>
<td>58.65</td>
<td>2.46</td>
<td>RET</td>
<td>54.95</td>
<td>4.69</td>
<td>3.697</td>
<td>1.547</td>
<td>.122</td>
<td></td>
<td></td>
<td>[-.84, 8.23]</td>
</tr>
<tr>
<td></td>
<td>POST</td>
<td>59.90</td>
<td>5.94</td>
<td>RET</td>
<td>54.95</td>
<td>4.69</td>
<td>4.950</td>
<td>2.174</td>
<td>.146</td>
<td></td>
<td></td>
<td>[-1.48, 11.32]</td>
</tr>
<tr>
<td>Experimental</td>
<td>PRE</td>
<td>55.54</td>
<td>4.31</td>
<td>POST</td>
<td>62.42</td>
<td>5.09</td>
<td>6.878</td>
<td>1.646</td>
<td>.007</td>
<td></td>
<td></td>
<td>[-11.71, -2.05]</td>
</tr>
<tr>
<td></td>
<td>PRE</td>
<td>55.54</td>
<td>4.31</td>
<td>RET</td>
<td>61.00</td>
<td>5.29</td>
<td>5.459</td>
<td>1.695</td>
<td>.031</td>
<td></td>
<td></td>
<td>[.49, 10.43]</td>
</tr>
<tr>
<td></td>
<td>POST</td>
<td>62.42</td>
<td>5.09</td>
<td>RET</td>
<td>61.00</td>
<td>5.29</td>
<td>1.419</td>
<td>2.382</td>
<td>1.000</td>
<td></td>
<td></td>
<td>[-8.41, 5.57]</td>
</tr>
</tbody>
</table>

*Note.* Values are percentages. PRE = preintervention phase; POST = postintervention phase; RET = retention phase; CI = confidence interval; LL = lower limit; UL = upper limit.

*a*Bonferroni adjust for multiple comparisons.
Table 3
Descriptive Statistics and Pairwise Comparison of Execution Skills for Intragroup Analysis

<table>
<thead>
<tr>
<th>Group</th>
<th>Test-time</th>
<th>(A) Execution skills</th>
<th>(B) Execution skills</th>
<th>M diff. (A - B)</th>
<th>p</th>
<th>Typical error</th>
<th>Differences 95% CI [LL, UL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>PRE</td>
<td>22.58 4.39</td>
<td>POST</td>
<td>23.18 4.39</td>
<td>0.599</td>
<td>1.282</td>
<td>[−4.36, 3.16]</td>
</tr>
<tr>
<td></td>
<td>PRE</td>
<td>22.58 5.89</td>
<td>RET</td>
<td>23.37 7.23</td>
<td>0.787</td>
<td>1.097</td>
<td>[−4.07, 2.52]</td>
</tr>
<tr>
<td></td>
<td>POST</td>
<td>23.18 4.39</td>
<td>RET</td>
<td>23.37 7.23</td>
<td>0.188</td>
<td>1.445</td>
<td>[−4.43, 4.05]</td>
</tr>
<tr>
<td>Experimental</td>
<td>PRE</td>
<td>21.72 2.71</td>
<td>POST</td>
<td>28.20 2.64</td>
<td>6.475</td>
<td>1.405</td>
<td>[−10.60, −2.35]</td>
</tr>
<tr>
<td></td>
<td>PRE</td>
<td>21.72 2.71</td>
<td>RET</td>
<td>25.95 3.93</td>
<td>4.226</td>
<td>1.202</td>
<td>[−7.75, −0.70]</td>
</tr>
<tr>
<td></td>
<td>POST</td>
<td>28.20 2.64</td>
<td>RET</td>
<td>25.95 3.93</td>
<td>2.250</td>
<td>1.583</td>
<td>[−2.39, 6.89]</td>
</tr>
</tbody>
</table>

Note. Values are percentages. PRE = preintervention phase; POST = postintervention phase; RET = retention phase; CI = confidence interval; LL = lower limit; UL = upper limit.

*Bonferroni adjust for multiple comparisons.
However, there were significant differences between the different measurements of the experimental group with a large effect size, \( \Lambda = .251, F(2, 8) = 11.919, p = .004; \eta_p^2 = .749, SP = .954 \). Pairwise comparisons showed a significant increase in the experimental group in execution skills between the preintervention phase and postintervention phase. This significant increase is maintained in the retention phase (i.e., comparing preintervention phase and retention phase).

**DISCUSSION**

The aim of this study was to assess the effect of a decision training program, based on video feedback and questioning, on decision-making skills and performance in tennis players. We hypothesized that the tactical decision training program, using a combination of video feedback and questioning, would produce a significant improvement in decision-making skills and performance in young tennis players. With respect to decision-making skills, experimental group findings show how decision training with video feedback and questioning is effective in improving decision-making skills. On the other hand, the control group did not experience a significant change in decision-making skills. These results show that decision training, based on video feedback and questioning, helps to improve decision-making in young tennis players. This represents an important fact because the decision-making component is really relevant in open sports such as tennis (Grehaigne et al., 2001).

Likewise, players in the experimental group improved at decision-making level enabling them to increase their expertise to a level where a larger number of successful decisions are expected in order to force the opponent (Del Villar et al., 2007; McPherson, 1999; McPherson & Thomas, 1989; Nielsen & McPherson, 2001). These improvements in decision-making skills show a higher decision-making quality because the use of specific strategies or tactics enables them to take better decisions and make strategically better selections. All of this implies selecting the most suitable shot for the game situation or developing responses that make it difficult for the opponent to play his or her own game. These improvements in decision-making capacity are expressed by a selection of tactically better and superior shots, which imply a better decision about which shot to select (type of shot and effect), knowing where to direct the shot, and the depth and power to be used (McPherson, 1999, 2000; Nielsen & McPherson, 2001).

After decision training and when they have improved their expertise, experimental group players make more correct decisions. This improvement is the result of them being able to make decisions based on a larger number of conditions that take place in the game context (e.g., court position, opponent's position, or the scoreboard; MacMahon & McPherson, 2009). They will also interpret tendencies, strengths, and weaknesses in a more sophisticated manner, taking their opponents into account as well as their own specific characteristics (McPherson & Kernodle, 2003, 2007). Furthermore, they will bear in mind the different contextual conditions that may have an influence on shot selection (Garcia-Gonzalez, Moreno, Moreno, Iglesias, & Del Villar, 2012; McPherson, 1999; Nielsen & McPherson, 2001).

With respect to performance or execution skills, a significant increase can be found in the percentage of successful executions in the experimental group, whereas in the control group there are no significant differences. As the performance of the tennis players in the experimental group increases, their execution skills also improve, thus, increasing their expertise, resulting in shot execution that forces their opponents more. Thus, a greater number of successful executions will considerably displace the opponent, placing pressure on him or forcing a weak...
Improvements achieved in execution skills by means of a decision training program reinforce the existent relationship between decision-making skills and execution skills (Del Villar et al., 2007; Hastie, Sinelnikov, & Guarino, 2009; McPherson, 1993, 1999; Nielsen & McPherson, 2001; Vickers et al., 2004). Thus, the improvement produced in decision making may have an indirect effect on the execution quality, making it possible to solve problems better during the game and modifying their decisions more effectively (McPherson, 1993). A decision training program is effective not only with respect to “what” decision making (tactical) but also with respect to “how” decision making (technical; Raab et al., 2005).

The effectiveness of analysis-based intervention programs, using video feedback and questioning, is shown to improve decision making and/or execution skills, as has occurred in other studies that have used these tools in other sports (Chambers & Vickers, 2006; Goudas & Giannoudis, 2008; Iglesias et al., 2005; Moreno et al., 2011; Moreno et al., 2008; Raab et al., 2005). Furthermore, the 10 sessions that make up this type of intervention seem to be effective, as other studies that have applied tactical decision training programs with similar characteristics and similar duration, have also obtained significant improvements (Iglesias et al., 2005; Moreno et al., 2011). Specifically in tennis, we also found that the posterior analysis using video feedback combined with questioning may be an effective tool to make athletes assess certain aspects of performance and consequently, they could get improvements, too (Rhea et al., 1997).

The effectiveness of decision training using video feedback and other tools like questioning is well established (Vickers, 2007). An explanation about its effectiveness could be that decision training using video feedback and questioning is an explicit learning strategy. This explicit learning is an intentional acquisition and it could be focused toward the cues that could be used and the way in which they could be used to get results or to make decisions in sport (Raab, 2003; Raab & Johnson, 2007). Questioning in decision training can also develop cognitive discovery learning based on explicit processes that will allow for successful decisions and executions in open sports (Raab et al., 2005; Raab et al., 2009). However, despite the effectiveness shown by this 10-week decision training program on decision making and performance, the small size of the sample makes us cautious about extrapolating the findings. This type of tactical-decision training program will also have to be replicated at different levels of expertise.

**CONCLUSIONS**

Because of the improvement produced in decision making and execution skills, the idea that it is necessary to develop significant and complementary activities to improve variables related to performance is reinforced (Baker et al., 2003; Davids & Baker, 2007). Specific decision training helps athletes learn how to make decisions under conditions drawn from their own sport activity. In the same way, training focused on decision-making improvement will help athletes anticipate events, pay attention to critical cues, select better responses, and make efficient decisions (Vickers, 2007; Vickers et al., 2004). Decision training has also proved to be effective for athletes in changing environments such as when they perform in competition (Vickers, 2003).

Decision training also contributes to the development of activities that use audiovisual methods to favor the acquisition of cognitive expertise in sport (Williams et al., 2011). It also leads to the need for those activities performed outside the game situation to be able to be
transferred to the decision-making behaviors developed within real situations (Farrow & Raab, 2008).

The inclusion of this kind of specific program to improve tactical and decision-making skills should be present in the different expertise development stages, in such a way that there could be significant improvements on cognitive, behavioral and/or performance variables.

REFERENCES


Losada, J. L., & Arnau, J. (2000). Fiabilidad entre observadores con datos categóricos [Reliability among observers when the data are categorical]. *Psicothema, 12*(S2), 335–339.


