Differences between expert and novice players in execution time and decision-making in technical-tactical actions in football (passing and driving) performed under laboratory conditions
Diferencias entre jugadores expertos y noveles en el tiempo de ejecución y toma de decisiones en acciones técnico-tácticas en fútbol (pase y conducción) realizadas en condiciones de laboratorio

*Guillermo Andrés Calle-Jaramillo, **Enoc Valentin Gonzalez-Palacio, **Andrés Rojas Jaramillo, *Jose Antonio Gonzalez-Jurado
* Universidad Pablo de Olavide (España), **Universidad de Antioquia (Colombia)

Abstract. The objective of this research was to analyze the differences between expert and novice players regarding execution time (ET) and decision-making (DMA) in technical-tactical actions in football performed under laboratory conditions. Methodology: quantitative, comparative, analytical, and cross-sectional study. Four groups of players were simultaneously evaluated, divided into experts (two groups: Envigado FC, n = 16 and Leones FC, n = 12) and novices (two groups: Formantioquia, n = 14 and Unal, n = 13). Results: from a Student-t analysis, statistically significant differences were found between experts and novices in all variables. (DMA, ET, and Total Index: TI) (P < 0, 05); however, in the variable DMA, the effect size (0.37) and statistical power (0.26) show that the expert group has a higher level of performance compared to the novice group. Nevertheless, the opposite happens with the other variables, where the effect size and statistical power are 1.76 and 1.00 for ET and 1.1428571 and 0.99 for TI, which show that the expert group has a higher level of performance than the novice group. Likewise, using ANOVA (Analysis of variance) and Post hoc tests, there were no statistically significant differences between the two groups of experts and between the two groups of novices in any of the variables (DMA, ET, TI). However, Leones FC showed no difference in any of the variables with the two novice groups. Conclusion: there are differences in the level of performance between experts and novices in the TI and ET variables, but not in DMA if we take into account statistical significance, effect size, and statistical power. However, Leones FC showed no differences with the novices or with the expert Envigado FC, indicating that Leones FC can be assumed as an expert team similar to Envigado FC; however, its average values in ET and TI do not place it statistically above the two novices.
Keywords: psychomotor performance, cognition, soccer, stroop test, elite.

Resumen. El objetivo de esta investigación fue analizar las diferencias entre jugadores expertos y noveles en cuanto al tiempo de ejecución (ET) y toma de decisiones (DMA) en acciones técnico-tácticas en fútbol realizadas en condiciones de laboratorio. Metodología: estudio cuantitativo, comparativo, analítico y transversal. Se evaluaron simultáneamente cuatro grupos de jugadores, divididos en expertos (dos grupos: Envigado FC, n = 16 y Leones FC, n = 12) y novatos (dos grupos: Formantioquia, n = 14 y Unal, n = 13). Resultados: a partir del análisis t de Student se encontraron diferencias estadísticamente significativas entre expertos y novatos en todas las variables. (DMA, ET e Índice Total: TI) (P < 0, 05); sin embargo, en la variable DMA, el tamaño del efecto (0,37) y el poder estadístico (0,26) muestran que el grupo de expertos tiene un mayor nivel de desempeño en comparación con el grupo de novatos. Sin embargo, ocurre lo contrario con el resto de variables, donde el tamaño del efecto y el poder estadístico son 1,76 y 1,00 para ET y 1,1428571 y 0,99 para TI, lo que muestra que el grupo de expertos tiene un mayor nivel de desempeño que el grupo de novatos. Asimismo, mediante ANOVA (Análisis de varianza) y pruebas Post hoc no hubo diferencias estadísticamente significativas entre los dos grupos de expertos y entre los dos grupos de novatos en ninguna de las variables (DMA, ET, TI). Sin embargo, Leones FC no mostró diferencias en ninguna de las variables con los dos grupos de novatos. Conclusión: existen diferencias en el nivel de desempeño entre expertos y novatos en las variables TI y ET, pero no en DMA si tomamos en cuenta la significación estadística, el tamaño del efecto y el poder estadístico. Sin embargo, Leones FC no mostró diferencias con los novatos ni con el experto Envigado FC, lo que indica que Leones FC puede asumirse como un equipo experto similar al Envigado FC; sin embargo, sus valores promedio en ET y TI no lo ubican estadísticamente por encima de los dos novatos.
Palabras clave: desempeño psicomotor, cognición, fútbol, test de stroop, élite.

Introduction

The medial temporal lobe and cortical association areas are the structures responsible for the explicit learning of spatiotemporal events (episodic memory and spatial memory). The learning of these events goes through several phases, where different cortical structures, through the phenomena of synaptic plasticity, are responsible for the consolidation and storage of the acquired information. For example, novel information travels down the cortico-hippocampal descending route (prefrontal association areas and parietal - occipital - temporal cortex > parahippocampal cortex and perirhinal cortex > entorhinal cortex > hippocampus) to be stored as short-term memory in the hippocampus, and subsequently, through a reverse process (hippocampus > entorhinal cortex > parahippocampal cortex and perirhinal cortex > parietal − occipital - temporal cortex and prefrontal association areas), this information migrates from the temporal lobe to the other areas of the cerebral cortex to consolidate as long-term memory (Buffalo et al., 2006; Loubon and Franco, 2010; Redolar, 2014). Likewise, the posterior hippocampus, after receiving novel information from the anterior hippocampus, memorizes information related to the location of objects in space that serve as a guide for spatial navigation (spatial memory) (Maguire et al., 2000).

Different sports researchers have seen the need to study the relationship that exists between decision making and specific performance in different sports modalities, such as volleyball and football (Suárez et al. 2016, Da Costa et al. 2023), which has led some authors to look for a way to validate instruments for the evaluation of decision making (Otero-Saborido et al. 2012, Calle-Jaramillo et al. 2023), Several studies show that expert players are better than novice players because they had better physical and technical-tactical performance (Reilly et al, 2000; Vaeyens et al., 2006). In this way, neither physical factors nor physiological characteristics are sensitive enough to differentiate professional footballers from semi-professional footballers (Meylan et al., 2010), so it is necessary to have a more comprehensive view when analyzing football performance (Reilly et al., 2000; Vaeyens et al., 2008).

Regarding the direction of the attentional focus, the novice athlete will focus on attending to his movements (Wulf, 2013), and consequently, the attention to external elements related to the game will be reduced. The automation of movements in the expert athlete will allow directing attention to the external foci (Kal et al., 2013), registering with a single visual fixation more information than the novices (Ripoll, 1991). Experts perform deliberate and non-random searches based on acquired information (Bard and Fleury, 1981), where experience allows them to recognize relevant indices to predict the action (Abernethy, 1987; Howarth et al., 1984; Nettleton, 1986; Goulet et al., 1989; Abernethy, 1991). In other words, they not only identify the most relevant prescripts of the game, but also have possible solutions stored in memory (Wickens et al., 2015).

Veteran and more experienced athletes have a greater number of practice hours (Baker et al., 2003; Farrow and Reid, 2012; Ward and Williams, 2003), which consequently results in better response selection and enhanced DMA (Maxwell et al., 2000; Raab, 2003). Thus, DMA, which is defined as action choice (Bruce et al., 2012), is an important skill that discriminates performance between novices and experts (Lorains et al., 2013; Woods, 2016). Indeed, players who perform many short-duration fixations tend to have faster response times in DMA (Da Silva Leite Cardoso et al., 2021). However, the ability to recognize postural features from peripheral vision enables good DMA in sport, which requires a mature visual system and sufficient attentional capacity resulting from prolonged task-specific practice (Klatt and Smeeton, 2022).

In summary, working memory based on long-term memory makes expert players acquire an elaborate memory system that allows them to consolidate and evoke the information related to the task (Roca et al., 2021) to evaluate and plan the current course of action in the future (Ericsson, 2018) to create different alternatives prior choosing a particular option (Ward, 2013). This flexibility to consider various tactical options during the execution of an action is characteristic of creative behavior (Runco, 2014).

Efficiency in the use of cognitive functions in sports is one of the factors that differentiate expert athletes from novices. (Ballester et al., 2015). Thus, players considered elite can obtain better results in neuropsychological tests that evaluate variables such as attention, inhibitory control, or cognitive flexibility than amateur players or sedentary subjects (Ballester et al., 2015; Huijgen et al., 2015; Verburgh et al., 2016).

Cognitive functions are fundamental for high sports performance due to the relationship they have with tactical behavior (García et al., 2011; Lex et al., 2015). Several studies have found that elite soccer players, compared to amateurs, score better on different cognitive tests (Huijgen et al., 2015; Verburgh et al., 2016). Likewise, video-based perceptual and cognitive skills assessment has been a complementary tool in talent selection processes (O'Connor et al., 2016).

This work not only evaluates the correct DMA but also evaluates the time it takes to choose and execute an action, which increases according to the complexity of the stimulus. It is considered that expert players, concerning novices, have a shorter decisional time since they can mitigate conflicts, disturbances, and interferences typical of the paradigms used (Calle-Jaramillo et al., 2023).

Consequently, and using the Stroop Task Football Test (STFT) (Calle-Jaramillo et al., 2023), the objective of this research was to analyze the differences between expert and novice players in terms of ET and DMA in technical-tactical actions in football performed under laboratory conditions. We hypothesize that there will be statistically significant differences between expert and novice players in the test variables (DMA, ET, and TI).

Materials and methods

Design

This was a quantitative, analytical comparative, and cross-sectional study (Manterola and Otzen, 2014). Four groups of football players divided between experts (two groups: Envigado FC, n = 16 and Leones FC, n = 12) and novices (two groups: Formantioquia, n = 14 and Universidad Nacional, n = 13),

Regarding the playing positions according to the level of performance, the group of experts (n=28) presents the following proportions: centerbacks (10.7%), wingbacks (21.4%), defensive midfielders (10). .7%), mixed midfielders (25.0%) and forwards (32.1%); In the group of novices (n=27) the distribution was as follows: centerbacks (11.1%), wingbacks (18.5%), defensive midfielders (11.1%), mixed midfielders (29.6%) and forwards (29.6%), the above indicates that the two groups are very similar, in fact, the contingency coefficient ($p > 0.05$) does not report an association between the level of performance and the playing positions.

were evaluated at the same time by the STFT to analyze the differences in TI, DMA and ET (Calle-Jaramillo et al., 2023).

Variables

Independent variables: DMA and ET; dependent variable: TI.

The variable DMA was obtained from the sum of the successful attempts (a maximum of 64: 32 types of action (TA) and 32 directions of movement (DM) corresponding to 32 trials. The variable ET is expressed in decimal minutes and is calculated by dividing the seconds the test lasts by 60 seconds. For example, 1 minute and 10 seconds equals 70 seconds, so 70 seconds equals 1.16 minutes. if the test lasted 50 seconds, then 50 seconds equals 0.83 minutes. ET corresponds to the total duration of the test, which is 32 trials. The TI is the ratio between DMA and ET (Calle-Jaramillo et al., 2023).

Participants

To determine the sample size, the "A priori: computer requires sample size," one-way Anova function of the G-power 3.1.9.7 program was used based on the following parameters: effect size 0.50; probability $\alpha < 0.05$; statistical power (1-b=0.80) and four groups; the calculation established a minimum sample of 48 players; finally, it was possible to evaluate 55 subjects; 28 expert male football players of the U-20 category belonging to the minor divisions of two professional football clubs: Envigado F C (n=16) and Leones FC (n=12). Likewise, 27 novice male football players belonging to two football teams (Formantioquia, n=14 and Unal, n=13) that do not belong to the minor divisions of any professional team and that, due to their hours, training quality, and weekly competition, were classified as novices. The characteristics of the sample (mean ± SD) were the following: experts, age (18.6 ± 0.82 years), height (178.56 ± 4.35 cm), weight (68.58 ± 4.47 kg); novices age (19.4 ± 1.79 years), height (174.80 ± 4.60 cm), weight (72.32 ± 5.14 kg).

Procedure

The Stroop Task Football Test (STFT) assesses the DMA and ET through technical-tactical actions (passing and driving) in laboratory conditions (Calle-Jaramillo et al., 2023).

The test was performed in competition season at the same time of the day for all participants 48 hours after a demanding training session. Before the assessment, participants performed a warm-up based on typical football actions. They also performed six practice attempts at low intensity to familiarize themselves with the test.

Environmental characteristics

The test was conducted between 8:00 a.m. and 10:00 a.m. at a temperature between 18 and 25 degrees Celsius on football fields featuring synthetic turf. An official FIFA Golty® ball was utilized during the test.

Inclusion criteria

Signing the informed consent form, attending the tests, and having attended and participated in all scheduled training sessions over the last month.

Exclusion criteria

Having consumed caffeine or any other stimulant substance on that day, diagnosis of any psychiatric or neurological problem, and physical injury or discomfort at the time of testing.

A total of 73 players participated in the study (see Figure 1), of which 10 players did not meet the inclusion criteria and 8 players were excluded due to injuries or physical discomfort at the time of the test. Finally, data from 55 players were included in the analysis.

Ethical considerations

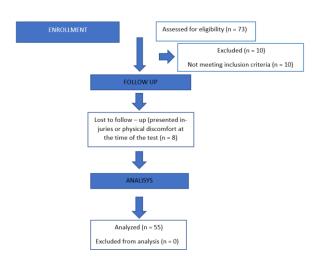We refer to the ethical provisions of the Declaration of Helsinki.

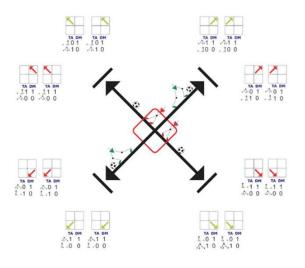Figure 1. Flowchart: inclusion/exclusion criteria to obtain the sample.

Figure 2. Qualifying Stroop Task Football Test (STFT). Evaluation of trials with their respective stimuli and responses.

Test design to evaluate the groups

The Stroop Task Football Test (STFT) was used to assess ET and DMA of expert and novice players. The test consists of 32 stimuli emitted by a screen (16 stimuli with red arrows and 16 stimuli with green arrows), where the red arrows correspond passing and the green arrows correspond

to handle. The arrows may or may not match the quadrant (congruent vs. incongruent trials). The participant must respond to the direction of the arrow and not to the location of the same, as well as to the color of the arrow. This allows that for each stimulus two responses are qualified (type of action and direction of movement), for a total of 64 possible hits. The number of correct answers is divided by the time the ET test lasts, and the result is TI, a value that indicates the cognitive motor performance of the footballer in the test (Calle-Jaramillo et al., 2023) (see figure 2).

Stimuli response   stimuli response

Finally, the STFT data (Calle-Jaramillo et al., 2023) (see figure 3) were exported to an Excel spreadsheet and subsequently analyzed in IBM SPSS version 29 software.

Results

To begin the description of the results, we proceeded to evaluate the normality of the variables (DMA, ET and TI) according to the performance level factor (experts and novices) from the Shapiro – Wilk test. The results indicated that DMA, both in experts and in novices, presented non-normal distribution ($p>0.05$), so non-parametric statistics were used to compare and describe them; in the case of the variables ET and TI in both groups, the distributions were normal, therefore, they are compared and described with parametric statistics (Table 1). Similarly, in the case of these last two variables, the homoscedasticity assumption was verified using Fischer's statistic, and in both cases equal variances were assumed ($F=0.205$ and $F=2.340$; $p>0.05$).

Table 1.
Distribution of variables to compare.

Variables	Group	Shapiro-Wilk		
		Statistics	GI	P
DMA	Experts	,831	28	,000
	Novice	,845	27	,001
ET (dec. min.)	Experts	,976	28	,758
	Novice	,939	27	,114
TI	Experts	,991	28	,995
	Novice	,965	27	,479

Differences between experts and novices

The analysis showed statistically significant differences between experts and novices in all variables (DMA, ET and TI). In the variable DMA despite the significant difference (UMW=227.5; $p<0.05$), the effect size was small ($d=0.37$) and statistical power on the other hand, denotes that assuming this difference as relevant has an error potential of 74% (1-=0.26), well above the statistically allowed

value (b=0.80); Therefore, there is no statistically relevant evidence to determine the difference between the two groups, thus, they are assumed to be equal (see Table 2).

Table 2.
Statistics for decision making (DMA) variables.

Variables	Md	IR	UMW	P	d	1-□
DMA Experts (n=28)	61,0	6,0	227,5	0,011	0,37	0,26
DMA Novice (n=27)	59,0	6,0				

Note: DMA: Decision – Making; Md: Median; IR: Interquartile Range.

In the case of the variables ET and TI, the differences were presented in a very significant way ($p<0.01$), where the effect size and the statistical p is 1.76 and 1.00 for ET and 1.14 and 0.99 for TI, which shows that the differences between the groups are substantial and the probability of committing a type 2 error is practically nil, in both variables, the results were in favor of the group of expert players, who presented a better ET (M=1.15; SD=0.13) and better TI (M=52.70; SD=8.58) than novice players (M=1.31; SD=0.14 and M=44.39; SD=6.16) (see Table 3).

Table 3.
Statistics for execution time (ET) and total index (TI) variables

Variables	Mean SD	IC95		T	p Value	d	1-□
ET (min-dec.) Experts (n=28)	1,15 0,13	- 0,2239	- 0,0772	4,116	0,01	1,76	1,00
ET (min-dec.) Novice (n=27)	1,31 0,14						
TI Experts (n=28)	52,70 8,58	4,2590	12,3660	4,113	0,01	1,14	0,99
TI Novice (n=27)	44,39 6,16						
df=53							

Note: ET: Execution Time; TI: Total Index; SD: Standard Deviation; LL: Lower Limit; UL: Upper Limit.

Compare the four groups

After the analysis between experts and novices, we proceeded to compare the four teams evaluated (two experts and two novices), for which the normality was first verified (Shapiro-Wilk), and, subsequently, homoscedasticity (Levene's statistic). The results showed that two of the four variables referred to DMA presented a non-normal distribution; therefore, the Kruskal-Wallis's test was used. On the other hand, for the variables ET and TI in the four groups or teams presented normal distribution ($p>0.05$). Hence, they were compared with an ANOVA (see Table 4).

Since not all variables for comparison related to DMA followed a normal distribution, the Kruskal Wallis's Test (KW) was used for contrast. The medians of the two expert teams (Md = 61.0 and 61.5) appear above the two novice teams (M = 59.0 and 58.0); however, these differences were not statistically significant ($p>0.05$). Therefore, groups are assumed to be equal in DMA (see table 5).

Subsequently, the variable ET (decimal minute) was analyzed; once the assumption of homoscedasticity between the variances was fulfilled (Levene = 1.81 0; $p>0.05$), a one-way ANOVA was used, finding statistically significant

differences between the groups evaluated (F = 6.933; gl = 3; p <0.01); that is, at least one of the groups is different from the others. For example, between the two expert teams (Envigado and Leones), there are no statistically significant differences (p>0.05); however, one expert team (Envigado) presented better ET compared to the two novice teams. (p<0.05), nonetheless, the other expert team (Leones) does not present statistically significant differences with respect to the two novice teams (p>0.05), but between the two novice teams, the TE is statistically similar (p>0.05) (see Tables 6 and 7).

Table 4.
Anova to compare the four groups.

	Teams	Shapiro-Wilk		
		Statistical	gl	Sig.
DMA	Envigado	,812	16	,004
	Leones	,870	12	,065
	Unal	,944	13	,511
	Formantioquia	,828	14	,011
ET dec. min.	Envigado	,975	16	,916
	Leones	,915	12	,244
	Unal	,929	13	,335
	Formantioquia	,899	14	,111
TI	Envigado	,981	16	,973
	Leones	,959	12	,775
	Unal	,942	13	,477
	Formantioquia	,903	14	,124

Table 5.
Kruskal Wallis Test.

	Rangos				
	Teams	N	Md	RI	p
DMA	Envigado	16	61,0	5,0	0,82
	Leones	12	61,5	7,0	
	Unal	13	59,0	4,0	
	Formantioquia	14	58,0	7,0	

n=55
DMA: Decision – Making; Md: Median; IR: Interquartile Range.

Table 6.
Means for each group in the variable ET.

Group	N	Mean	SD	CI$_{95\%}$	
				LL	UL
Envigado	16	1,110417	,1352467	1,038349	1,182485
Leones	12	1,214167	,1012161	1,149857	1,278476
Unal	13	1,370513	,2399994	1,225483	1,515543
Formantioquia	14	1,126429	,1200389	1,207120	1,345737
Total	55	1,236788	,1816443	1,187683	1,285893

Execution Time (ET); SD: Standard Deviation; LL: Lower Limit; UL: Upper Limit.

Table 7.
Post-hoc test, ET variable.

(I) Teams	(J) Teams	Mean difference (I-J)	Sig.	CI 95%	
				LL	UL
Envigado	Leones	-,1037500	,544	-,268887	,061387
	Unal	-,2600962*	,000	-,421563	-,098629
	Formantioquia	-,1660119*	,035	-,324265	-,007759
Leones	Envigado	,1037500	,544	-,061387	,268887
	Unal	-,1563462	,099	-,329457	,016764
	Formantioquia	-,0622619	1,000	-,232379	,107855
Unal	Envigado	,2600962*	,000	,098629	,421563
	Leones	,1563462	,099	-,016764	,329457
	Formantioquia	,0940842	,763	-,072472	,260641
Formantioquia	Envigado	,1660119*	,035	,007759	,324265
	Leones	,0622619	1,000	-,107855	,232379
	Unal	-,0940842	,763	-,260641	,072472

LL: Lower Limit; UL: Upper Limit.

Finally, in the TI variable, and once the homoscedasticity assumption was met (Levene=0.965; p>0.005), a one-way ANOVA was used, finding statistically significant differences between the groups (F=6.257; gl=3); at least one of the teams is different from the others. That is, between the two expert teams (Envigado and Leones), there were no statistically significant differences (p>0.05); however, one expert team (Envigado) presented better TI than the two novice teams (p<0.05); nevertheless, the other expert team (Leones) cannot be assumed as different from the two novices (p>0.05), but between the two novice teams TI is statistically similar (p>0.05) (see table 8 and 9).

Table 8.
Media for each group in the TI variable

Group	N	Mean	SD	CI$_{95\%}$	
				LL	UL
Envigado	16	54,6080	9,86982	49,3487	59,8672
Leones	12	50,1625	5,95854	46.3767	53,9484
Unal	13	43,6622	7,97154	38,8451	48,4794
Formantioquia	14	44.5947	6,23044	40,9973	48,1920
Total	55	48,5020	8,88902	46,0990	50,9051

SD: Standard Deviation; LL: Lower Limit; UL: Upper Limit.

Table 9.
Pos-hoc test, TI variable

(I) Team	(J) Team	Mean difference (I-J)	Sig.	CI 95%	
				LL	UL
Envigado	Leones	4,44543	,857	-3,7525	12,6433
	Unal	10,94575*	,003	2,9301	18,9614
	Formantioquia	10,01332*	,006	2,1572	17,8695
Leones	Envigado	-4,44543	,857	-12,6433	3,7525
	Unal	6,50032	,257	-2,0934	15,0940
	Formantioquia	5,56789	,457	-2,8772	14,0130
Unal	Envigado	-10,94575*	,003	-18,9614	-2,9301
	Leones	-6,50032	,257	-15,0940	2,0934
	Formantioquia	-,93243	1,000	-9,2008	7,3359
Formantioquia	Envigado	-10,01332*	,006	-17,8695	-2,1572
	Leones	-5,56789	,457	-14,0130	2,8772
	Unal	,93243	1,000	-7,3359	9,2008

LL: Lower Limit; UL: Upper Limit.

Discussion

The objective of this research was to analyze the differences between expert and novice players concerning ET and DMA in technical-tactical actions in football performed under laboratory conditions, using the Stroop Task Football Test (STFT) (Calle-Jaramillo et al., 2023) in young football players at the same time.

The studies reviewed for talent identification in soccer use different tests to comprehensively assess the capabilities related to physical and tactical technical behavior (Reilly et al., 2000; Vaeyens et al., 2006; Meylan et al., 2010). Within tactical behavior, cognitive behavior is evaluated, and more specifically, decision making, although indirectly, since it is assumed that the development of other cognitive functions improves the choice of behaviors to follow. That is, attention, perception, navigation, memory, inhibitory control, and cognitive flexibility are functions that support decision-making, and their study allows us to conclude that cognitive behavior related to technical-tactical behavior is directly proportional to the performance of each cognitive function.

For example, it has been shown that peripheral vision allows the recognition of postural features (Klatt and Smeeton, 2022) and that the improvement of attentional levels is expressed in the number of attentional foci, in the delay time to capture information from each attentional focus and the place in space tracked, is related to success in decision-making (Wulf, 2013; Kal et al., 2013; Ripoll, 1991; Bard and Fleury, 1981; Da Silva Leite Cardoso et al., 2021). Likewise, the amount of information stored in long-term memory and used in perception and anticipation is also related to good decision-making (Abernethy, 1987; Howarth et al., 1984; Nettleton, 1986; Goulet et al., 1989; Abernethy, 1991). Similarly, experience and consolidated and evoked information used as working memory show a direct relationship with the correct choice of stored options (Wickens et al., 2015; Baker et al., 2003; Farrow and Reid, 2012; Ward and Williams, 2003, Maxwell et al., 2000; Raab, 2003; Roca et al., 2021). In addition, other executive functions, such as cognitive flexibility, enable several alternatives when executing an action (Runco, 2014), allowing decision-making to be a creative behavior (Roca et al., 2021; Ward, 2013), since the soccer player can change one option for another at the last moment if the dynamic environment demands it.

Thus, the test to evaluate the execution time and decision-making in technical, tactical actions in football (Calle-Jaramillo et al., 2023) requests a high demand for visual skills (saccadic movements and peripheral vision) and several cognitive resources related to sensory information (attention, perception, proprioception, navigation) to make a good decision in the shortest possible time. The attentional foci that it locates are the signals emitted by the computer screen and the objectives (wall) towards which it directs the movements (passing and driving) and the ball. Perception is related to the movement of the ball according to the bounce on the walls, and proprioception allows the player to perceive the location and movement of the body segments while locating the different attentional foci. Likewise, and due to the characteristics of the test, spatial navigation has a high demand since the movements are performed in four directions. Moreover, the player performs concurrent tasks since the onset of cognitive tasks may coincide with the completion of motor tasks.

Not only the processing of sensory information is required by the test since its design is based on paradigms of cognitive neuroscience, it generates conflicts, interferences and disturbances at the time of decision making based on cognitive flexibility and inhibitory control (Calle - Jaramillo et al., 2023).

In other words, the executive functions of the frontal lobe, as well as the other cognitive functions related to sensory information, are also highly demanded, a fact that allows differentiating expert players from novices or professional players from amateurs. It is necessary for future research, to correlate the information obtained in the test with other information related to other cognitive tests, for example, recording information from attentional foci through eye tracking or acquiring information using neuro-psychological tests from questionnaires or other software that emit visual signals from a computer. We considered that a shortcoming of this research was the lack of more information on the cognitive performance of the athlete that would allow us to make more correlations.

Some studies have used as a contrast variable the level of expertise to compare the performance of players. That is, they analyze DMA between professional and non-professional footballers and elite and non-elite footballers (Glavas et al., 2023; Le Moal et al., 2014). In addition, other research related to DMA in footballers has as a comparison factor other variables that also affect cognitive performance, for example, the age of footballers (Farahani et al., 2020; Murr et al., 2021; Klatt and Smeeton, 2022) and the level of creativity (Roca, 2021).

The results of this study indicate that in DMA, professional players tend to have a better score than novices; however, this difference was not statistically significant, a result that differs from that exposed by (Glavas, 2023), where professional players presented better performance in the accuracy variable (Accuracy rates) compared to amateur and recreational players. Regarding the ET variable, the results of this study coincide with the research previously reported (Glavas, 2023), where professional players had a better performance in reaction time in DMA compared to amateur and recreational players. Likewise, the study by Le Moal (2014), which uses the Loughborough Soccer Passing Test, reported better results in ET and DMA in favor of elite players compared to sub-elite and non-elite players, a result very similar to that shown by our study.

Understanding that the reaction time is very significant in sports performance, and that it refers specifically to the time lapse between the appearance of the stimulus and the onset of the motor response (Pérez Tejero et al., 2011), we also consider the decision reaction time or decisional time, which refers to the time it takes DMA derived from the characteristics of the stimulus, which increases the total visual reaction time (Calle-Jaramillo et al., 2023; Bonnet, 1994); That is, the more complex the stimulus, the longer the delay time to perceive the signals, process the information and emit the response.

In this sense, DMA in football must be fast and successful, so it is not enough to have a good performance in one of the two variables. The above is necessary to explain because in this research, there were no statistically significant differences between experts and novices in the DMA variable, but there were statistically significant differences in the ET and TI variables, indicating that for football, we can evaluate cognitive motor performance by measuring the delay time of the decision taken reflected in the chosen response.

Conclusions

There are statistically significant differences between experts and novices in TI and ET but not in DMA. Likewise,

between the two groups of experts and between the two groups of novices, there were no statistically significant differences in any of the variables (DMA, ET, TI). However, Leones FC did not show differences in any of the variables with the two groups of novices, indicating that the performance of the players analyzed from these variables may have intermediate values that allow the non-polarization of the data.

The discrimination between expert and novice players allows construct validity (Carvajal et al., 2011).

References

Abernethy, B. (1987). Anticipation in sport: a review. Physical Education Review, 10(1), 5-16.

Abernethy, B. (1991). Visual search strategies and decision-making in sport. International Journal of Sport Psychology, 22(3-4), 189–210.

Baker, J., Cote, J., & Abernethy, B. (2003). Sport-Specific Practice and the Development of Expert Decision-Making in Team Ball Sports. Journal of Applied Sport Psychology, 15(1), 12-25. https://doi.org/10.1080/10413200305400

Bard, C., & Fleury, M. (1981). Considering eye movement as a predictor of attainment. Vision and sport, 20, 28-41.

Ballester, R., Huertas, F., Yuste, F. J., Llorens, F., & Sanabria, D. (2015). The relationship between regular sports participation and vigilance in male and female adolescents. PloS one, 10(4), https://doi.org/10.1371/journal.pone.0123898

Bonnet, C. (1994). Psicofísica de los tiempos de reacción: teorías y métodos. Revista Latinoamericana de psicología, 26(3), 431-444.

Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. Psychology of Sport and Exercise, 13(2), 152-161. https://doi.org/10.1016/j.psychsport.2011.10.005

Buffalo, E. A., Bellgowan, P. S. F., & Martin, A. (2006). Distinct roles for medial temporal lobe structures in memory for objects and their locations. Learning & Memory (Cold Spring Harbor, N.Y.), 13(5), 638-643. https://doi.org/10.1101/lm.251906

Calle-Jaramillo, G. A., Gonzalez-Palacio, E. V., Perez-Mendez, L. A., Rojas-Jaramillo, A., & Gonzalez-Jurado, J. A. (2023). Design and validation of a test to evaluate the execution time and decision-making in technical-tactical football actions (passing and driving). Behavioral Sciences, 13(2), 101. https://doi.org/10.3390/bs13020101

Carvajal, A., Centeno, C., Watson, R., Martínez, M., & Sanz Rubiales, Á. (2011). ¿Cómo validar un instrumento de medida de la salud? Anales Del Sistema Sanitario de Navarra, 34(1), 63-72. https://doi.org/10.4321/s1137-66272011000100007

Da Costa, I. T., Mezzadri, E., Cardoso, F., & Machado, G. (2023). Speed of decision-making as a key element for professional and academy soccer players' performances. Retos: nuevas tendencias en educación física, deporte y recreación, (50), 1195-1203.

Ericsson, K. A. (2018). Capturing expert thought with protocol analysis: Concurrent verbalizations of thinking during experts' performance on representative task. In K. A. Ericsson, R. R. Hoffman, A. Kozbelt, & A. M. Williams (Eds.), The Cambridge handbook of expertise and expert performance (2nd ed., pp. 192–212). Cambridge, UK: Cambridge University Press.

Farahani, J., Soltani, P., & Rezlescu, C. (2020). Assessing decision-making in elite academy footballers using real-world video clips. Progress in Brain Research, 253, 59-70. https://doi.org/10.1016/bs.pbr.2020.06.015

Farrow, D., & Reid, M. (2012). The contribution of situational probability information to anticipatory skill. Journal of Science and Medicine in Sport, 15(4), 368-373. https://doi.org/10.1016/j.jsams.2011.12.007

García, S., Rodríguez, A., & Garzón, A. (2011). Conceptualización de inteligencia táctica en fútbol: Consideraciones para el desarrollo de un instrumento de evaluación en campo desde las funciones ejecutivas. Cuadernos de psicología del deporte, 11(1), 69-78.

Glavaš, D., Pandžić, M., & Domijan, D. (2023). The role of working memory capacity in soccer tactical decision making at different levels of expertise. Cognitive Research: Principles and Implications, 8(1), 20. https://doi.org/10.1186/s41235-023-00473-2

Goulet, C., Bard, C., & Fleury, M. (1989). Expertise differences in preparing to return a tennis serve: A visual information processing approach. Journal of sport and Exercise Psychology, 11(4), 382-398. https://doi.org/10.1123/jsep.11.4.382

Huijgen, B. C., Leemhuis, S., Kok, N. M., Verburgh, L., Oosterlaan, J., Elferink-Gemser, M. T., & Visscher, C. (2015). Cognitive functions in elite and sub-elite youth soccer players aged 13 to 17 years. PloS one, 10(12), https://doi.org/10.1371/journal.pone.0144580

Kal, E. C., Van der Kamp, J., & Houdijk, H. (2013). External attentional focus enhances movement automatization: A comprehensive test of the constrained action hypothesis. Human movement science, 32(4), 527-539. https://doi.org/10.1016/j.humov.2013.04.001

Klatt, S., & Smeeton, N. J. (2022). Processing visual information in elite junior soccer players: Effects of chronological age and training experience on visual perception, attention, and decision making. European Journal of Sport Science: EJSS: Official Journal of the European College of Sport Science, 22(4), 600-609. https://doi.org/10.1080/17461391.2021.1887366

Le Moal, E., Rué, O., Ajmol, A., Abderrahman, A. B., Hammami, M. A., Ounis, O. B., Kebsi, W., & Zouhal, H. (2014). Validation of the Loughborough Soccer Passing Test in young soccer players. Journal of Strength and Conditioning Research, 28(5), 1418-1426. https://doi.org/10.1519/JSC.0000000000000296

Lex, H., Essig, K., Knoblauch, A., & Schack, T. (2015). Cognitive representations and cognitive processing of team-specific tactics in soccer. PloS one, 10(2), https://doi.org/10.1371/journal.pone.0118219

Lorains, M., Ball, K., & MacMahon, C. (2013). Expertise differences in a video decision-making task: speed influences on performance. Psychology of Sport and Exercise, 14(2), 293–297. https://doi.org/10.1016/j.psychsport.2012.11.004

Loubon, C. O., & Franco, J. C. (2010). Neurofisiología del aprendizaje y la memoria. Plasticidad Neuronal. ARCHIVOS DE MEDICINA, 6(1), 2.

Maguire, E. A., Gadian, D. G., Johnsrude, I. S., Good, C. D., Ashburner, J., Frackowiak, R. S. J., & Frith, C. D. (2000). Navigation-related structural change in the hippocampi of taxi drivers. Proceedings of the National Academy of Sciences, 97(8), 4398. https://doi.org/10.1073/pnas.070039597

Maxwell, J. P., Masters, R. S. W., & Eves, F. F. (2000). From novice to no know-how: A longitudinal study of implicit motor learning. Journal of Sports Sciences, 18(2), 111-120. https://doi.org/10.1080/026404100365180

Manterola, C y Otzen, T. (2014). Estudios observacionales. los diseños utilizados con mayor frecuencia en investigación clínica. Int. J. Morphol., 32(2):634-645.

Meylan, C., Cronin, J., Oliver, J. y Hughes, M. (2010). Reviews: Talent identification in soccer: The role of maturity status on physical, physiological and technical characteristics. International Journal of Sports Science and Coaching 5(4), 571–592. https://doi.org/10.1260/1747-9541.5.4.571

Murr, D., Larkin, P., & Höner, O. (2021). Decision-making skills of high-performance youth soccer players: Validating a video-based diagnostic instrument with a soccer-specific motor response. German Journal of Exercise and Sport Research, 51(1), 102-111.

Nettleton, B. (1986). Flexibility of Attention and Elite Athletes' Performance in 'Fast-Ball-Games'. Perceptual and motor skills, 63(2), 991-994. https://doi.org/10.2466/pms.1986.63.2.991

Howarth, C., Walsh, W. D., Abernethy, B., & Snyder, C. (1984). A field examination of anticipation in squash. Australian Journal of Science and Medicine in Sport, 16(3), 6-10.

Otero-Saborido, F. M., González-Jurado, J. A., & Lluch, Á. C. (2012). Validación de instrumentos para la medición del conocimiento declarativo y procedimental y la toma de decisiones en el fútbol escolar. Retos: nuevas tendencias en educación física, deporte y recreación, (22), 65-69.

O'Connor, D., Larkin, P., y Williams A.M. (2016). Talent identification and selection in elite youth football: An Australian context. European Journal of Sport Science, 16(7), 837-844, https://doi.org/10.1080/17461391.2016.1151945

Pérez Tejero, J., Soto Rey, J., & Rojo González, J. J. (2011). Estudio del tiempo de reacción ante estímulos sonoros y visuales. Motricidad: European Journal of Human Movement, 2011(27), 149-162. http://revistamotricidad.es/openjs/index.php?journal=motricidad&page=index

Raab, M. (2003). Decision making in sports: Influence of complexity on implicit and explicit learning. International Journal of Sport and Exercise Psychology, 1(4), 406-433. https://doi.org/10.1080/1612197X.2003.9671728

Reilly, T., Williams, A. M., Nevill, A., y Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. Journal of sports sciences, 18(9), 695-702. https://doi.org/10.1080/02640410050120078

Redolar, D. (2014). Neurociencia cognitiva. Editorial medica panamericana. 1ra, España.

Ripoll, H. (1991). The understanding-acting process in sport: The relationship between the semantic and the sensorimotor visual function. International Journal of Sport Psychology, 22(3-4), 221–243.

Roca, A., Ford, P. R., & Memmert, D. (2021). Perceptual-cognitive processes underlying creative expert performance in soccer. Psychological Research, 85, 1146-1155. https://doi.org/10.1007/s00426-020-01320-5

Runco, M. A. (2014). Creativity—Theories and themes: Research, development, and practice (2nd ed.). Burlington, MA: Elsevier Academic Press.

Suárez, M. C., Rabaz, F. C., Fernández-Echeverría, C., Gil-Arias, A., & Arroyo, M. P. M. (2016). Toma de decisiones y rendimiento en las acciones de juego en voleibol, en sets con diferentes resultados (Decision-making and performance in intermediate and terminal actions in volleyball according to the set result). Retos, 31, 28-33.

Vaeyens, R., Lenoir, M., Williams, A. M., y Philippaerts, R. M. (2008). Talent identification and development programmes in sport. Sports medicine, 38(9), 703-714. https://doi.org/10.2165/00007256-200838090-00001

Vaeyens, R., Malina, R.M., Janssens, M., Van Renterghem, B., Bourgois, J., Vrijens J. y Philippaerts, R.M. (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. British Journal of Sports Medicine. 40, 928 –934. http://dx.doi.org/10.1136/bjsm.2006.029652

Verburgh, L., Scherder, E. J., Van Lange, P. A., & Oosterlaan, J. (2016). Do elite and amateur soccer players outperform non-athletes on neurocognitive functioning? A study among 8-12-year-old children. PloS one, 11(12), https://doi.org/10.1371/journal.pone.0165741

Ward, P., Ericsson, K. A., & Williams, A. M. (2013). Complex perceptual-cognitive expertise in a simulated task environment. Journal of Cognitive Engineering and Decision Making, 7, 231–254.

Ward, P., & Williams, A. M. (2003). Perceptual and Cognitive Skill Development in Soccer: The Multidimensional Nature of Expert Performance. Journal of Sport and Exercise Psychology, 25(1), 93-111. https://doi.org/10.1123/jsep.25.1.93

Wickens, C. D., Hollands, J. G., Banbury, S., & Parasuraman, R. (2015). Engineering psychology and human performance. Psychology Press.

Williams, A.M. y Reilly, T. (2000). Talent identification and development in soccer. Journal of Sports Sciences. Routledge. 18, 657–667. https://doi.org/10.1080/02640410050120041

Woods, C. T., Raynor, A. J., Bruce, L., & McDonald, Z. (2016). Discriminating talent-identified junior Australian football players using a video decision-making task. Journal of Sports Sciences, 34(4), 342–347. https://doi.org/10.1080/02640414.2015.1053512.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104. https://doi.org/10.1080/1750984X.2012.723728.