Cognitive task performance causes impaired soccer-passing skill

El desempeño de tareas cognitivas provoca un deterioro en la habilidad de pase en el fútbol

Authors

Pavol Horička [1]
Jaromír Šimonek [1]
Bianka Bodnárová [1]
Ľubomír Paška [1]

[1] Constantine the Philosopher University in Nitra (Slovakia)

Corresponding author:
Jaromír Šimonek
jsimonek@ukf.sk

Received: 14-10-25
Accepted: 26-11-25

How to cite in APA

Horička, P., Šimonek, J., Bodnárová, B., & Paška, Ľ. (2026). Cognitive task performance causes impaired soccer-passing skill. *Retos, 75*, 596-606. https://doi.org/10.47197/retos.v75.117878

Abstract

Introduction: The negative effect of mental fatigue on sports performance is moderated by factors like training status and age. Trained athletes typically exhibit greater tolerance to mental fatigue but its effect on the sport-specific performance is relatively under-researched.
Objective: This study aims to investigate the effect of induced mental fatigue on the accuracy and speed of soccer passing in soccer players.
Methods: 19 male university soccer players participated in a field study to identify the effect of two sessions of cognitive loading on the accuracy and speed of passing. The players performed the main protocol of three bouts of the Loughborough soccer passing test (LSPT) tasks and two bouts of 15´ STROOP tasks.
Results: Prolonged fatigue induced by solving mental tasks negatively impacted the speed of passing performance. The accuracy in passing decreased with the reduced time of performance.
Discussion: Growing physical and mental fatigue showed a cumulative effect on the performance of passes. Correlation analysis revealed a potential relationship between the observed variables of passing test and total time with moderate effect.
Conclusion: The findings validate the hypothesis that prolonged fatigue owing to mental tasks has a negative effect on the quality of passing skill in soccer players. These findings are crucial for designing training programs that consider the consequences of both physical and mental fatigue.

Keywords

Cognitive skills; Loughborough Soccer Passing Test (LSPT); mental fatigue; Stroop test; university players.

Resumen

Introducción: El efecto negativo de la fatiga mental en el rendimiento deportivo se ve moderado por factores como el nivel de entrenamiento y la edad. Los atletas entrenados suelen mostrar una mayor tolerancia a la fatiga mental, pero su efecto en el rendimiento deportivo específico ha sido poco investigado.
Objetivo: Este estudio busca investigar el efecto de la fatiga mental inducida en la precisión y la velocidad de los pases en futbolistas.
Métodos: Diecinueve futbolistas universitarios participaron en un estudio de campo para identificar el efecto de dos sesiones de carga cognitiva en la precisión y la velocidad de los pases. Los jugadores realizaron el protocolo principal de tres rondas de tareas del Loughborough Soccer Passing Test (LSPT) y dos rondas de tareas STROOP de 15 minutos.
Resultados: La fatiga prolongada inducida por la resolución de tareas mentales afectó negativamente la velocidad de los pases. La precisión en los pases disminuyó con la reducción del tiempo de ejecución.
Discusión: El aumento de la fatiga física y mental mostró un efecto acumulativo en el rendimiento de los pases. El análisis de correlación reveló una posible relación entre las variables observadas en la prueba de pases y el tiempo total, con un efecto moderado. Conclusión: Los hallazgos validan la hipótesis de que la fatiga prolongada debida a tareas mentales tiene un efecto negativo en la calidad del pase en futbolistas. Estos hallazgos son cruciales para diseñar programas de entrenamiento que consideren las consecuencias de la fatiga física y mental.

Palabras clave

Fatiga mental; habilidades cognitivas; jugadores universitarios; Test de pase de fútbol de Loughborough; Test de Stroop.

Introduction

Soccer is a team sport that involves the participation of two teams of players whose aim is to score a goal and defeat the opponent in line with the rules of play. Successful soccer players incorporate several qualities such as physical, technical, cognitive (executive functions such as visual scanning, focused attention, selective attention, sustained attention, cognitive flexibility, visual memory and others), and emotional ones (Bompa and Buzzichelli, 2018). However, physical exercise can acutely affect cognitive performance, especially executive functions such as selective attention and inhibitory control (Fuentes-Barría, 2025). Recent years have seen an increased interest in cognitive processes in sport (Walton et al., 2018; Skala and Zemková, 2022; Coutinho et al., 2018). Physical tasks involving prolonged effort regulation or motor skills, both fundamental to invasive sports and games, are impaired by prior cognitive exertion (Brown et al., 2020). A decrease in skills performance quality towards the end of a match could be due to the combined effect of an increased perception of effort, and impairments in motor control and decision-making skills (Smith et al., 2016; Smith et al., 2018). Prolonged periods of cognitively demanding activity induce mental fatigue, which is defined as a psychobiological state that may arise during or after a prolonged cognitive activity. It is usually characterized by feelings of tiredness or even exhaustion, lack of energy, and a decreased commitment and increased aversion to continue the current activity (Boksem and Tops, 2008).

Several studies have shown detrimental effects of fatigue specific to soccer performance (Smith et al., 2018). It is likely that the exhaustion of players after the soccer match is the cumulative effect of the physical and mental fatigue experienced by them during the match. Team sports place significant cognitive demands on athletes as they are required to maintain concentration over prolonged periods and make fast and accurate decisions based on the retrieval and processing of information from a dynamic environment (Nédélec, M. et al., 2012). The review by Yáñez-Sepúlveda et al. (2025) revealed that players with greater experience and higher competitive levels tend to manage psychological demands more effectively than less experienced peers. Fatigue during matches can manifest itself as a significant decline in motor skills, and passing and shooting accuracy and speed, which are likely to negatively impact the quality of skills as well as the decision-making speed (Sinkovic et al., 2022). Soccer has specific cognitive requirements such as sustained attention for the sport-specific decision-making, which relies on the extended visual search behavior from a dynamic environment and the information processing system of the brain (Vaeyens et al., 2007; Walsh, 2014). This explains why the accumulation of cognitive fatigue causes the deterioration of the decision-making ability of soccer players (Afonso et al., 2012).

Fatigue can be measured through objective methods (heart frequency and blood lactate concentration measurement), and subjective methods, such as assessment of load sensation using questionnaires and diaries (Novačič, 2018). Assessing fatigue in the soccer field is a relatively easy and straightforward process as its effects are generally seen in reduced velocity and precision of passing, and incorrect tactical decisions.

The negative effects of mental fatigue appear to be moderated by different factors, such as training status or age. Evidence suggests that there is a greater tolerance to mental fatigue in trained adult athletes (Martin et al., 2016), as well as younger children (Filipas et al., 2021). However, the effect of mental fatigue on sport-specific performance of university soccer players is an under-researched area.

The aim of this study is to investigate the effect of induced mental fatigue on the accuracy and speed of soccer passing in university students playing soccer in sub-elite and elite teams across Slovakia. We hypothesize that fatigue induced by bouts of 15 and 30 minutes of mentally demanding activity significantly reduces accuracy and speed of soccer passing.

Method

Participants

A total of 19 male experienced soccer players attending university and playing 1st to 8th Slovak leagues, participated in this study (Table 1). The study included physically active players in good health, who trained at least three times per week, and who routinely competed in national leagues and university tournaments. Those who had experienced any injury within the last six months of the study that might influence sports performance were excluded. The subject matter and aim of the research were first explained to all the players. Subsequently, they provided written informed consents for participating in the study. They were requested not to participate in any mental (computer work or playing games on mobile) or physical activities on the morning before the test to avoid the impact of mental or physical fatigue on testing results. The course of testing was explained in detail. The study was conducted in accordance with the amended 1964 Helsinki Declaration (WMA, 2025) and approved by University Ethic Committee (registration number: UKF-2020/1355-1:191013).

Table 1. Demographic Characteristics of Participants

Variables	Mean	SD
Age (year)	21.2	± 1.68
Height (cm)	178.9	± 5.64
Weight (kg)	73.35	± 8.92
Sport age (year)	13.0	± 3.40

Note: SD = Standard Deviation

Procedure

The experimental protocol was divided into three parts (familiarization, mentally fatiguing task, and passing test). All parts were organized in a single day under the leadership of two administrative people, both experts on testing procedures. All testing procedures were conducted in a university gym with floor area of 375 sq. m (25x15m) and under standard conditions. Prior to the session, participants were instructed to sleep at least seven hours, refrain from vigorous physical training or mental exertion, and avoid drinking alcohol. Participants performed the tests individually in the presence of the testing experts between 8:00 and 12:00 a.m. on the designated day.

Design

This study is a randomized controlled trial aimed at assessing the effects of two sessions of cognitive loading on accuracy and speed of passing. Prior to the tests, players started with 15 minutes of jogging and stretching warm-up. During the experimental session, they performed the main protocol of three bouts of Loughborough soccer passing test (LSPT) tasks and two bouts of 15´ STROOP tasks, each followed by the declaration of Rate of Perceived Exertion (RPE) values based on the CR-10 scale (Figure 1).

Figure 1. Design of the Experimental Protocol

Cognitive Loading

To induce mental fatigue, players performed two 15-minute-long mobile device Stroop color-word tasks (Smith, et al. 2016). The Stroop test has been widely used in sport science research settings in different invasive sports (soccer, handball, basketball, volleyball, tennis) (Coutinho, et al., 2018; Blecharz et al., 2022; Fortes et al., 2019) to assess inhibitory control and selective attention, both considered as components of cognitive function. Players were asked to perform tasks according to instructions shown on a mobile screen. The test consists of two versions: the first version of the Stroop test requires the user to click on the palette the color that a given word names immediately after being shown this word. In the first stage of the experiment, the participant is shown names of colors written in black font, and in the second stage, the names of the colors are written in fonts of different colors. In the second version of the Stroop test, the participant will need to click on the button with the name of the color that he/she sees. In the first turn, multi-colored rectangles will be shown on the screen, and the task is to click on the name of the ink color of the rectangle shown. In the second round of the experiment, participants will need to select the button with the name of the ink color of the words shown on the screen. The test result is calculated from the difference between the average response time in the first and second stages of the experiment for the selected version of the Stroop test. Participants could choose to pick from the two versions of the test.

Shooting Skill Performance

The LSPT was employed (Lyons et al., 2006; Ali et al., 2007) as a valid and reliable objective assessment of soccer-specific technical performance with respect to passing. Having familiarized themselves with the technical aspects of the test, participants performed three trials of the LSPT with 16 consecutive passes towards four different colored targets according to the protocol by Smith et. al (2016) (Figure 2). These three trials were separated by two bouts of 15´ STROOP tests. The measures for the LSPT included time to complete 16 passes (original time), penalty time (number of errors), bonus time (1 second deduction, if the ball hit the 10-cm strip in the middle of the target), and performance time (original time + penalty time - bonus time - number of seconds under 43 s). Penalty time was calculated based on the following criteria:

+5 s for completely missing the bench or passing to the wrong bench

+3 s for missing the target area (0.6 x 0.3 m)

+3 s for handling the ball

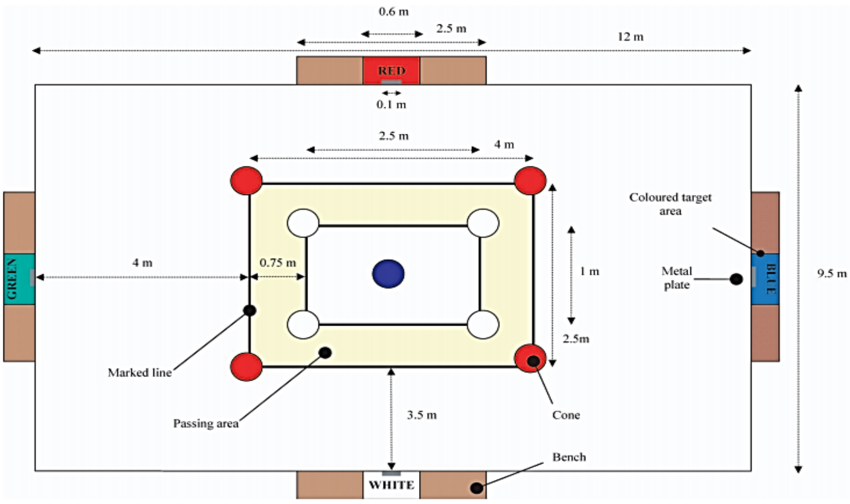
+2 s for passing the ball from outside of the passing area

+2 s if the ball touched any cone

+1 s for every second taken over the allocated 43 s to complete the test

-1 s for each pass that hit the 10-cm strip in the middle of the target (bonus time)

Figure 2. Schematic Representation of the LSPT



Subjective Perceptions

Participants recorded their subjective sensation of mental fatigue (RPE) at various points during the testing period using CR-10 scale (Williams, 2017). RPE I was collected upon the conclusion of LSPT I and STROOP1, RPE II at the end of LSPT II and STROOP2, and RPE III after LSPT III. The participants were required to circle a number which corresponded to their rating. As Robertson and Noble (1997) point out, RPE can be understood as the subjective intensity of effort, strain, discomfort and/or fatigue experienced during physical exercise. RPE levels during exertion are linked to physiological and psycho-cognitive changes and can therefore be used to determine the intensity of a particular physical task.

Data Analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 20.0 version (Chicago, USA). The normality of continuous variables was assessed using the Shapiro-Wilk test, which found the variables to be not normally distributed. Therefore, non-parametric tests were used for the remainder of the analysis. The Friedman test of dependent variables was used to confirm that the variables of time and mental fatigue were different between RPE I, II, and III in our study group of football players (Table 2). Paired comparison of variables was carried out using the post-hoc Durbin-Conover test. To prove the differences between variables, Kendall's W was employed. The sample effect was determined by effect size coefficient (95% level). Spearman correlation analysis was used to prove the relationships between performance of players in passes (LSPT), the time of execution (TT), and the subjective sensation mental fatigue of players (RPE). All correlation coefficients were assessed following Schober et al. (2018) (0,00 – 0,10 = negligible correlation; 0,10 – 0,39 = weak correlation; 0,40 – 0,69 = moderate correlation; 0,70 – 0,89 = strong correlation; 0,90 – 1,00 = very strong correlation).

Results

Descriptive data are presented as means and standard deviations (SD) and normality of distribution as Shapiro-Wilk´s w and p. The performance score consists of two variables: the time taken to complete the LSPT and the total time (TT) with accrued penalty time and bonus time. RPE values showed the level of perceived fatigue in post-LSPT I, post-LSPT II and post-LSPT III (Table 2).

Table 2. Descriptive Statistics

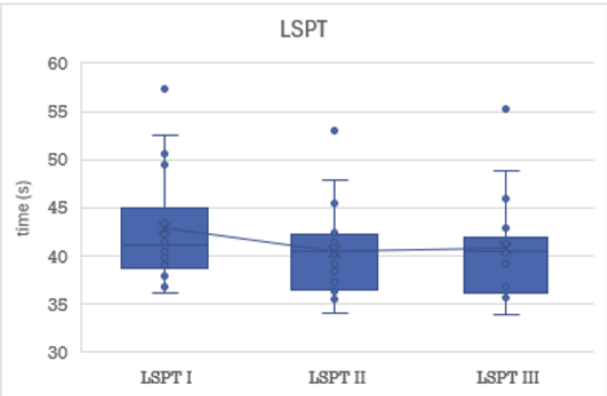
	Descriptives								
	LSPT I	LSPT II	LSPT III	TT I	TT II	TT III	RPE I	RPE II	RPE III
N	18	18	18	18	18	18	18	18	18
Mean	42.9	40.6	40.7	50.1	52.4	55.2	1.44	2.33	3.56
Median	41.1	40.4	40.4	47.4	50.0	53.7	1.00	2.00	4.00
Mode	36.1[a]	34.1[a]	35.6	34.3[a]	32.6[a]	35.8[a]	1.00	2.00	4.00
SD	5.91	4.72	5.23	11.0	12.2	14.2	0.705	1.03	1.10
Min	36.1	34.1	34.0	34.3	32.6	35.8	0	0	2
Max	57.4	53.0	55.2	73.6	93.0	95.2	3	4	6
Shapiro-Wilk W	0.869	0.918	0.886	0.901	0.797	0.917	0.838	0.914	0.866
Shapiro-Wilk p	0.017	0.128	0.033	0.060	0.001	0.117	0.006	0.100	0.015

[a] More than one mode exists, only the first is reported

Figures 3 and 4 depict the shift in the variables and the distribution of successfully passed test values of LSPT across the three rounds of tests. The first measurement followed the warm-up, the second after the RPE I, and third following the RPE II. The following results were recorded: LSPT I (x = 42.9 ± 5.91), LSPT II (x = 40.6 ± 4.72), and LSPT III (x = 40.7 ± 5.23).

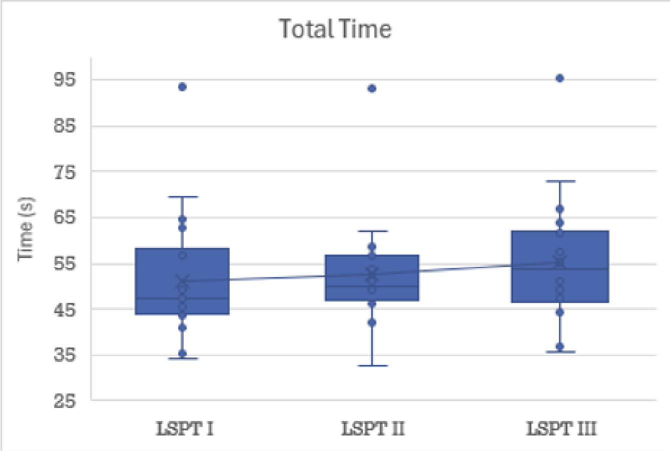
The mental activities undertaken caused different dynamics of changes in the LSPT indicators (Mean LSPT I = 42.9 s; II = 40.6 s; III = 40.7 s) (Figure 3) and TT (Mean Total Time I = 50.1 s; II = 52.4 s; III = 55.2 s; fig. 4), as well as slight stagnation of time between LSPT II and III. (0.1 s).

Figure 3. Distribution of the LSPT Values



The TT scores were calculated after adding penalty times and subtracting bonus times from the time measured (Figure 4). The comparison shows increasing values of TT from TT I (x = 50.1 ± 22.5; SD = 11.00), through TT II (x = 52.4; 6 ± 40.6; SD = 12.2) to TT III (x = 55.2 ± 40.0; SD = 14.2).

Figure 4. Distribution of TT Values



1. LSPT

The Friedman test revealed statistically significant differences (p = 0.030) between the pre-test and sub-tests in LSPT. The Kendall's W with the coefficient of concordance was w = 0.194, showing a small effect. Post-hoc Durbin–Conover pairwise comparison revealed the following between-measurement differences: LSPT I – LSPT II (p = 0.053), LSPT I – LSPT III (p = 0.048) and LSPT II – LSPT III (p = 0.586), implying the presence of a significant difference between the first and the last test values at the 5% level of significance. The other differences were not statistically significant at the 5% level (Tables 3 and 4).

Table 3. LSPT – Significance of Differences Table 4 Post-hoc Test

Friedman			
χ^2	df	Asymp. Sig	Kendall's W[a]
4.33	2	0.030*	0.194

a - Kendall's Coefficient of Concordance

Table 4.

Pairwise Comparisons (Durbin-Conover)				
			Statistic	p
LSPTI	-	LSPTII	1.938[b]	0.053
LSPTI	-	LSPTIII	1.982[b]	0.048*
LSPTII	-	LSPTIII	0.544[b]	0.586

b - homogeneous group

2. TT

An identical procedure was undertaken with the variables of TT to test for differences between them in the pre-test and sub-tests. No statistically significant difference was found in TT values (p = 0.115). The Kendall's W with the coefficient of concordance was w = 0.022, showing a small effect (Table 5). Separate post-hoc paired comparison revealed the following between-measurement differences: TT I – TT II (p = 0.557), TT I – TT III (p = 0.036), and TT II – TT III (p = 0.306) (Table 6), indicating only one significant difference at the 5% level, i.e. between the first and the last performance times. The remaining values were not statistically significant at the 5% level of significance.

Table 5. Friedman Test

Friedman			
χ^2	df	Asymp. Sig	Kendall's W[a]
4.33	2	0.115	0.022*

a - Kendall's Coefficient of Concordance

Table 6. TT Post-hoc Test

Pairwise Comparisons (Durbin-Conover)				
			Statistic	p
TT I	-	TT II	0.588[b]	0.557
TT I	-	TT III	1.111[b]	0.036*
TT II	-	TT III	1.023[b]	0.306

b - homogeneous group

3 RPE

The final procedure was performed using the variables of subjective sensation of mental fatigue (RPE). The Friedman test was performed to examine the differences between the variables (RPE I, II, and III). It revealed statistically significant differences at the 1% level of significance for all pairwise comparisons. The Kendall's W with the coefficient of concordance was 0.777, indicating a strong effect (Tables 7 and 8). The Durbin–Conover pairwise comparison showed the following differences: RPE I – RPE II (p <0.003), RPE I – RPE III (p <0.000), and RPE II – RPE III (p <0.001).

Table 7. Friedman Test

Friedman			
χ^2	Df	P	Kendall's W[a]
28.0	2	<0.001	0.777

a - Kendall's Coefficient of Concordance

Table 8. RPE Post-hoc Test

Pairwise Comparisons (Durbin-Conover)				
			Statistic	p
RPE I	-	RPE II	2.961[b]	<0.003**
RPE I	-	RPE III	3.559[b]	<0.000**
RPE II	-	RPE III	3.493[b]	<0.001**

b - homogeneous group

The correlation analysis (Table 9) revealed a potential relationship between the observed variables. The following values were registered: LPST I and TT I (r = 0.674; p = 0.001) with a moderate correlation coefficient effect and statistical significance (p <0.01), which represents a close relationship between the skills of players and the TT with all possible penalties. While we found the statistically significant relationships also between TT I and LSPT II, and TT I and LSPT III, these could be either spurious or coincidental, as they have no sound logical explanation. The relationship between the TT II and LSPT II (r = 0.503; p = 0.018) had a correlation coefficient at a moderate level, and statistical significance at the 5% level. This relationship is important as it indicates a close association between the skills of players and TT II with all possible penalties. The strongest relationship was between the LSPT III and TT III (r = 0.780; p <0.01), with a high correlation coefficient and statistically significant value at the 1% level of significance. This shows a close link between the skills of players and TT III with all possible time penalties.

The relationship between LSPT I and LSPT II showed a close connection between the skills of players without any penalties in different trials (r = 0.560; p = 0.009). Despite a moderate correlation coefficient, the statistical significance was at the 1% level. The relationship between LSPT I and LSPT III, likewise, showed a moderate correlation coefficient (r = 0.407; p = 0.047), but at the 5% level of significance. This indicates that the first trial of passing had a bearing on the second and the third passing test results. Finally, the relationship between RPE II and RPE III showed a strong correlation at the 1% level of significance (r = 0.728; p <0.001).

Table 9. Correlation Matrix

		RPE I	RPE II	RPE III	TT I	TT II	TT III	LSPT I	LSPT II	LSPT III
RPE I	Spearman's rho	—								
	p-value	—								
RPE II	Spearman's rho	0.361	—							
	p-value	0.070	—							
RPE III	Spearman's rho	0.189	0.728***	—						
	p-value	0.226	<0.001	—						
Total Time I	Spearman's rho	0.204	0.148	0.207	—					
	p-value	0.208	0.279	0.205	—					
Total Time II	Spearman's rho	0.353	0.064	0.111	0.333	—				
	p-value	0.076	0.400	0.330	0.088	—				
Total Time III	Spearman's rho	0.334	0.369	0.303	0.228	0.292	—			
	p-value	0.088	0.066	0.110	0.181	0.119	—			
LSPTI	Spearman's rho	-0.081	-0.283	-0.235	0.674**	0.110	0.092	—		
	p-value	0.625	0.873	0.826	0.001	0.331	0.359	—		
LSPTII	Spearman's rho	0.147	-0.207	0.028	0.529*	0.503*	0.121	0.560**	—	
	p-value	0.280	0.795	0.456	0.013	0.018	0.316	0.009	—	
LSPTIII	Spearman's rho	0.202	0.186	0.036	0.571**	0.273	0.780***	0.407*	0.341	—
	p-value	0.211	0.230	0.443	0.007	0.137	<0.001	0.047	0.083	—

Note. H_a is positive correlation
Note. * p <0.05, ** p <0.01, *** p <0.001

Discussion

The aim of this study is to examine the impact of fatigue represented by two sessions of cognitive loading (15 and 30-minute-long Stroop tests) on the accuracy and speed of passing in university soccer players. We hypothesize that fatigue induced by bouts of 15 and 30 minutes of mentally demanding activity would significantly reduce accuracy and speed of soccer passing. Pairwise comparisons of LSPT I and LSPT II trials, and LSPT II and LSPT III trials do not demonstrate a statistically significant effect of the Stroop test. Contrarily, a trial order effect is manifested with performance time improving with the number of trials. Although the LSPT is demanding on spatial orientation, players adapt to the changing of passing direction. They also react quickly to the changing color commands in the Stroop test. The overall impact of the 30-minute mentally demanding activity can be seen in the statistically significant difference (0.048) between LSPT I and LSPT III. The results thus show that prolonging fatigue induced by solving mental tasks indeed shows a negative effect on the speed of passing performance, a finding aligned with existing study by Lyons et al. (2006) which revealed a significant difference between performance at rest and performance following high-intensity fatigue.

An analysis of the TT between individual trials indicates that with the growing duration of fatigue, the error impact on passing performance increases (TT I – TT III (p = 0.036)) with a small effect. With a reduction in the time of performance, the accuracy of passing decrease. We argue that the technical performance is negatively impacted due to the onset of mental fatigue. The increasing values of standard deviation between the trials suggest growing differences between elite and sub-elite players resulting from fatigue.

Statistical analysis of the subjective sensation of mental fatigue (RPE) between trials I and II, II and III, and I and III reveals statistically significant differences at the level of 1% significance. This implies that gradually increasing physical and mental fatigue has a cumulative effect on the performance of passes. The result of our experimental study is consistent with the evidence from previous study by Filipas et al. (2021) who found out that soccer-specific technical performance was negatively affected by mental fatigue condition in U18 in the LSPT. Smith et al. (2016) reported that mentally fatiguing treatment in moderately trained soccer players increased subjective ratings of mental fatigue (P <0.01), moreover, penalty time significantly increased in the mental fatigue condition (P = 0.015). Mental fatigue also impaired shot speed (P = 0.024) and accuracy (P <0.01), whereas shot sequence time was similar between conditions.

Correlation analysis reveals the potential relationship between the observed variables with moderate to strong effect and statistical significance: LPST I and TT I (r = 0.674; p = 0.001) (p <0.01); LSPT II and

TT II (r = 0.503; p = 0.018) ($p < 0.05$); and LSPT III and TT III (r = 0.780; p = <0.01). These relationships represent the close association between the skills of players and the TT with all possible penalties.

The results of our study complement previous studies on the impact of "match-related" and "practice-related" mental fatigue on the physical and technical performance of players. Mental fatigue negatively impairs sport performance by decreasing the accuracy and efficiency of motor skills, impairing decision-making, and making submaximal endurance activities feel more difficult, although maximal physical efforts are largely unaffected. Athletes who are mentally fatigued may exhibit reduced passing accuracy, slower reaction times, and an increased rate of perceived exertion during exercise. Trainers are recommended to regularly incorporate both mentally and physically demanding exercises into training routines. This parallel loading of "body and mind" would stimulate mental processes in soccer players resulting in better adaptation to the continuously changing match environment. It is possible that younger players might be negatively affected by the mentally demanding activities of their daily school/college routine, and coaches should account for this while designing soccer training programs.

Limitations and perspectives

Despite the insights provided by this study on the effects of mental fatigue on passing skill in young players, it is important to note that the study and actual game environments are vastly different, and impairments observed in the former may not be applicable in the latter in a linear or straightforward manner. Players undertaking the passing test do not really compete, and therefore the critical emotional aspect of competition is missing. Individual contests cannot replace the team rivalry evident in soccer matches. This is because in ball sports, decisions need to be constantly made about passing the ball especially when the actions of opponents or the location of the ball inhibit the intended actions. These dynamics are very challenging to capture in a controlled study environment. Another limitation of this study is the restricted number of university players included as participants. However, the study design lends itself quite easily to a wider participant base across locations, and future research could experiment on larger sample sizes.

Conclusions

The sport of soccer involves different types of skill – motor, perceptual, and cognitive, all of which function in parallel within the sports environment. It is important to implement a variety of strenuous and demanding exercises to positively challenge the brain and the body to effectively manage the tasks during a match. Since team sports are characterized by dynamic environments, it would be fruitful to complement physical exercises with decision-making tasks under fatigue conditions, thus improving the sports performance of players. A key recommendation is that while mentally demanding tasks could be incorporated into training routines, they should be avoided prior to actual matches as they can induce mental fatigue.

Perceptual-cognitive performance is fundamental for the anticipation and decision-making demands of open-skill sports but may be disrupted by fatigue. Future research should include more sport-specific designs, as well as stressors other than fatigue, such as environmental and psychosocial stressors. New studies could also investigate key executive functions in specific skilled performance to determine the mechanism of effects.

Financing

The study has been undertaken with the support of the scientific grant agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic (MŠVVaŠ SR), and the Slovak Academy of Sciences (SAV): "VEGA 1/0145/25 Impact of Fatigue on Cognitive Performance of Athletes".

References

Afonso, J., Garganta, J., & Mesquita, I. (2012). Decision-making in sports: The role of attention, anticipation and memory. *Revista Brasileira de Cineantropometria & Desempenho Humano*, 14(5), 592-601. https://doi.org/10.5007/ 1980-0037.2012v14n5p592

Ali, A., Williams, C., Hulse, M., Strudwick, A., Reddin, J., & Howarth, L. (2007). Reliability and validity of two tests of soccer skill. *Journal of Sports Sciences,* 25(13), 1461-1470. https://doi.org/10.1080/02640410601150470

Blecharz, J., Wrześniewski, K., Siekańska, M., Ambroży, T., & Spieszny, M. (2022). Cognitive factors in elite handball: Do players' positions determine their cognitive processes? *Journal of Human Kinetics*, *Section IV – Behavioural Sciences in Sport & Sport for the Disabled,* 82, 213-221. https://doi.org/10.2478/hukin-2022-0063

Boksem, M.A.S., & Tops, M. (2008). Mental fatigue: Costs and benefits. *Brain Research Reviews,* 59(1), 125–39. https://doi.org/10.1016/j.brainresrev.2008.07.001

Bompa, T.O., & Buzzichelli, C.A. (2018). *Periodization-6th Edition: Theory and Methodology of Training*. Human Kinetics.

Brown, D.M.Y., Graham, J.D., Innes, K.I., Harris, S., Flemington, A., & Bray, S.R. (2020). Effects of prior cognitive exertion on physical performance: A systematic review and meta-analysis. *Sports Medicine*, 50(3), 497–529. https://doi.org/10.1007/s40279-019-01204-8

Coutinho, D., Goncalves, B., Wong, D.P., Travassos, B., Coutts, A.J., & Sampaio, J. (2018). Exploring the effects of mental and muscular fatigue in soccer players´ performance. *Human Movement Science,* 58, 287-296. https://doi.org/10.1016/j.humov.2018.03.004

Filipas, L., Borghi, S., La Torre, A., & Smith, M.R. (2021). Effects of mental fatigue on soccer-specific performance in young players. *Science and Medicine in Football,* 5(2), 150-157. https://doi.org/10.1080/24733938.2020.1823012

Fortes, L.S., Lima-Junior, D., Nascimento-Júnior, J.R.A., Costa, E.C., Matta, M.O., & Ferreira, M.E.C. (2019). Effect of exposure time to smartphone apps on passing decision-making in male soccer athletes. *Psychology of Sport and Exercise*, 44, 35–41. https://doi.org/10.1016/j.psychsport.2019.05.001

Fuentes-Barría, H., Alarcón-Rivera, M., & Aguilera-Eguía, R. (2025). Dinámica cardiovagal en una sesión de entrenamiento en bloque comparada con un entrenamiento en circuito: ensayo controlado aleatorizado. *Retos*, 72, 37–49. https://doi.org/10.47197/retos.v72.116904

Lyons, M., Al-Nakeeb, Y., & Nevill, A. (2006). Performance of soccer passing skills under moderate and high intensity localized muscle fatigue. *Journal of Strength & Conditioning Research,* 20, 197-202. https://doi.org/10.1519/00124278-200602000-00032

Martin, K., Staiano, W., Menaspá, P., Hennessey, T., Marcora, S., Keegan, R.,.Thompson, K. G., Martin, D., Halson, S., & Rattray, B. (2016). Superior inhibitory control and resistance to mental fatigue in professional road cyclists. *PLoS One,* 11(7) e0159907. https://doi.org/10.1371/journAL.PONE.0159907

Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2012). Recovery in soccer. *Sports Medicine*, 42(12), 997-1015. https://doi.org/10.1007/bf03262308

Novačič, V. (2018). *Metode Praćenja Trenažnog Opterećenja u Nogometu*. Sveučilište u Zagrebu. Kineziložki Fakultet.

Robertson, R. J., & Noble, B. J. (1997). Perception of Physical Exertion: Methods, Mediators, and Applications. *Exercise and Sport Sciences Reviews*, 25(1), 407-452.

Schober, P., Bossers, S.M., & Schwarte, L.A. (2018). Correlation coefficients: Appropriate use and interpretation. *Anesthesia & Analgesia*, 126(5), 1763-1768. https://doi.org/ 10.1213/ANE.0000000000002864

Sinkovic, F., Foretic., N., & Novak, D. (2022). Reliability, validity and sensitivity of newly developed tennis-specific reactive agility tests. *Sustainability,* 14(20), 13321. https://doi.org/10.3390/su142013321

Skala, F., & Zemková, E. (2022). Effects of acute fatigue on cognitive performance in team sport players: Does it change the way they perform? A scoping review. *Applied Sciences*, 12(3), 1736. https://doi.org/10.3390/app12031736

Smith, M. R., Zeuwts, L., Lenoir, M., Hens, N., De Jong, L. M., & Coutts, A. J. (2016). Mental fatigue impairs soccer-specific decision-making skills. *Journal of Sports Sciences*, 34(14), 1297-1304. https://doi.org/10.1080/02640414. 2016.1156241

Smith, M. R., Thompson, C., Marcora, S. M., Skorski, S., Meyer, T., & Coutts, A. J. (2018). Mental fatigue and soccer: Current knowledge and future directions. *Sports Medicine*, 48(7), 1525-1532. https://doi.org/10.1007/s40279 018-0908-2

Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: An analysis of visual search behaviors. *Journal of Motor Behavior*, 39(5), 395-408. https://doi.org/10.3200/JMBR.39.5.395-408

Walsh, V. (2014). Is sport the brain´s biggest challenge? *Current Biology*, 24(18), R859-R860. https://doi.org/10.1016/j.cub.2014.08.003

Walton, C.C., Keegan, R.J., Martin, M., & Hallock, H. (2018). The Potential role for cognitive training in sport: More research needed. *Frontiers in Psychology*, 9:1121. https://doi.org/10.3389/fpsyg.2018.01121

Williams, N. (2017). The Borg Rating of Perceived Exertion (RPE) scale. *Occupational Medicine*, 67(5): 404–405, https://doi.org/10.1093/occmed/kqx063

World Medical Association (2025). *World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Participants*. *JAMA,* 333(1), 71–74. doi:10.1001/jama.2024.21972

Yáñez-Sepúlveda, R., Olivares-Arancibia, J., Vás-quez-Bonilla, A., Lafourcade, I., Araya-Retamal, A., Giakoni-Rámirez, F., González-Aroca, J., Hinojosa-Torres, C., Cortés-Roco, G., Becerra-Patiño, B., Duclos-Bastías, D., López-Gil, J. F., Clemente-Suá-rez, V. J., Zavala-Crichton, J. P., & Olivares-Aranci-bia, J. (2025). Factores psicológicos en jugadores de pádel: una revisión sistemática. Retos, 68, 466–484. https://doi.org/10.47197/retos.v68.115407

Authors' and translators' details:

Pavol Horička	phoricka@ukf.sk	Author
Jaromír Šimonek	jsimonek@ukf.sk	Author/ Translator
Bianka Bodnárová	bianka.bodnarova@ukf.sk	Author
Ľubomír Paška	lpaska@ukf.sk	Author