Computers in Human Behavior xxx (xxxx) 107030

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Analyzing the changes in the psychological profile of professional League of Legends players during competition

Adrián Mateo-Orcajada [a], Lucía Abenza-Cano [a,*], Raquel Vaquero-Cristóbal [a]

[a] Faculty of Sport, Catholic University San Antonio of Murcia, Murcia, Spain

ARTICLE INFO

Keywords:
Competitive environment
Esports
Performance
Psychology

ABSTRACT

The objectives of the research were to analyze the differences in the pre- and post-game mood of players as a function of the outcome; to establish the differences in anxiety and self-confidence as a function of the outcome, the opponent's ranking and the outcome of the previous game; and to determine the relationship between performance variables and post-game mood of professional LOL players. The participants were the players of the starting League of Legends team of UCAM esports. Data collection was carried out during eighteen games belonging to the spring split of SuperLiga Orange. POMS and CSAI-2 questionnaire, and Polar H10 HR sensors were the instrument used to obtain information about the players during the matches. The statistical analysis was carried out using the SPSS statistical package (v.25.0) and a value of $p < 0.05$ was established to determine significant differences. The results show significant differences in all mood states when comparing pre and post values when the game was lost ($p < 0.05$), and in anger ($p = 0.04$) and fatigue ($p < 0.001$) when the game was won. In addition, significant differences were found in post-game values of depression ($p < 0.001$), anger ($p < 0.001$), vigor ($p < 0.001$), and confusion ($p < 0.001$), as a function of whether one won or lost.

1. Introduction

Esports are defined as an area of sports activities in which people develop and train mental and physical skills through the use of information and communication technologies (Wagner, 2006). These have become a worldwide mass phenomenon in which the popularity of video games and the desire of spectators to watch professional competitions have increased as the internet and new technologies have expanded (Jenny et al., 2018). Competition takes on special relevance in the field of esports, as it does in traditional sports, making comparisons between the two common in the scientific literature (Jonasson & Thiborg, 2010; Pizzo et al., 2018; Thiel & John, 2018).

League of Legends (LOL) is the most widely played multiplayer online battle arena (MOBA) in the world, and most of the scientific research that has tried to explain the relationship between psychological variables and performance has been carried out on it (Bálint et al., 2021; Brühlmann et al., 2020; Himmelstein et al., 2017; Matuszewski et al., 2020; bib_Mora_Cantallops_and_Sicilia_2019MoraCantallops & Sicilia, 2019). Among the most determinant psychological variables are motivation, anger, personality, mental toughness or the interaction between players.

Motivation is a fundamental element for esports performance, as intrinsically motivated and self-determined players report positive and enjoyable play experiences, while those with extrinsic motivation associate play with negative and stressful situations, being potentially detrimental to psychological well-being (Brühlmann et al., 2020). Among the most salient elements of LOL that increase professional players' motivation are satisfaction from teamwork, competition, and mastery of complex game interactions (Johnson et al., 2015, pp. 2265–2274).

LOL games, like those of other esports, are divided into distinct phases during the course of the game (Ferrari, 2013), with demanding and varied psychological and attentional demands. Mental toughness takes on special relevance in the different phases of play, as it is related to perceived control and stress management, with players with higher levels of mental toughness opting for coping options focused on problem solving rather than problem avoidance (Poulus et al., 2020).

On the other hand, emotions prior to match participation could influence performance, with pleasant emotions with high tendencies of approach being the ones that could influence to a greater extent, compared to the unpleasant ones of anger and sadness (Behnke et al., 2020). Nevertheless, anger plays a determining role alongside personality in esports performance. It is still unknown whether each esports shapes a different anger expression and personality, or it is the anger expression

* Corresponding author. Catholic University San Antonio of Murcia, Campus de los Jerónimos, Guadalupe, 30107, Murcia, Spain.
E-mail addresses: amateo5@ucam.edu (A. Mateo-Orcajada), labenza@ucam.edu (L. Abenza-Cano), rvaquero@ucam.edu (R. Vaquero-Cristóbal).

https://doi.org/10.1016/j.chb.2021.107030
Received 30 July 2021; Received in revised form 17 September 2021; Accepted 23 September 2021
0747-5632/

and personality that predisposes to practice a certain esports (Bálint et al., 2021).

Interaction between players during LOL games is essential for the proper functioning of the team (Mora Cantallops & Sicilia, 2018a, 2019), mainly in the professional environment. Professional players consider esports as a job, characterized by competitiveness and demand, while the recreational nature of the practice predominates in casual players (Ma et al., 2013, pp. 615–621). The differences in the objectives pursued with the practice of esports between professional and amateur players lead to a different level of development of the skills involved (Ding et al., 2018; Leis & Lautenbach, 2020; Matuszewski et al., 2020). Thus, the ability to concentrate, pay attention and follow multiple objects is higher in professional players than in amateurs (Ding et al., 2018), although the latter tend to be less extroverted and pleasant, and more open to experiences (Matuszewski et al., 2020).

Differences between professional and amateur players seem to be present in certain variables (Ding et al., 2018; Matuszewski et al., 2020), but research on professional players of the MOBA genre is limited (Mora Cantallops and Sicilia, 2018b) , and the changes produced in the mood, anxiety and self-confidence of players during competitive games have not been previously studied. Given the importance of results for professional players, research is needed to determine the influence that psychological state can have on performance in this group. For this reason, the objectives of the present research were to analyze the differences in the pre- and post-game mood of players as a function of the outcome; to establish the differences in cognitive and somatic anxiety and self-confidence as a function of the outcome of the game, the ranking of the opponent and the outcome of the previous game; and to determine the relationship between performance variables and post-game mood of professional LOL players.

Based on the results obtained in other sports modalities (Lochbaum et al., 2021; Samełko et al., 2018, 2020), it is hypothesized that the mood of LOL players will be modified as a function of the outcome of the game, the ranking of the opposing team and the outcome of the previous game, and that there will be a relationship between performance variables and post-game mood.

2. Materials and methods

2.1. Design

The study design was descriptive and longitudinal. The STROBE statement (Vandenbroucke et al., 2014) was followed for the development of the manuscript. The study participants signed the informed consent form prior to data collection, and were informed of the objectives of the study, as well as the processing of the data and the confidentiality of their treatment.

2.2. Participants

The five players of the starting LOL team of UCAM esports club were registered during the eighteen games belonging to the Spring Split of the 2019/2020 season of SuperLiga Orange. The players participated voluntarily, being the sample selection non-probabilistic by convenience. Inclusion criteria were a) being male; and b) being a starting player of UCAM esports club. A total of 90 records belonging to the eighteen professional competitive LOL games were obtained.

2.3. Procedure

In the hour before the start of each game, prior to warm-up and specific instructions from the coach for the match, the players completed the POMS and CSAI-2 questionnaire individually. The "Profile of Mood States" (POMS) questionnaire (McNair et al., 1971) in its 58-item version, previously validated in Spanish (Andrade Fernández et al., 2002) and English (Albrecht & Ewing, 1989), with an internal factor consistency ranging from 0.76 to 0.91, allowed information to be obtained on the mood states of the players. This questionnaire has a Likert scale from 0 (not at all) to 4 (very much) for its completion. The 58 items are divided into six dimensions: tension-anxiety, depression-melancholy, anger-hostility, vigor-activity, fatigue-inertia, and confusion-disorientation. Tension includes adjectives describing increases in skeletal muscle tension; depression represents depressed moods accompanied by feelings of personal inadequacy; anger includes moods of antipathy toward others; vigor represents high energy; fatigue shows low energy level; and confusion is characterized by adjectives related to disorder (Balaguer et al., 1993). The "tension" dimension is composed of nine items, with a maximum score of 36 and a minimum of 0. The "depression" dimension includes fifteen items, with a maximum score of 60 and a minimum of 0. The "anger" dimension is composed of twelve items, with a maximum score of 48 and a minimum of 0. The "vigor" dimension contains eight items, with a maximum score of 32 and a minimum score of 0. The "fatigue" and "confusion" dimensions have seven items each, the maximum score being 28 and the minimum 0. Items 19 (relaxed) and 48 (efficient), belonging to the "tension" and "confusion" dimensions, respectively, are summed inversely to the total value of the dimension (4 = 0; 3 = 1; 2 = 2; 1 = 3; 0 = 4). With the value obtained in each dimension, percentiles were calculated, following the scale for men by Balaguer et al. (1993).

The "Competitive State Anxiety Inventory – 2" (CSAI-2) (Martens et al., 1990), previously validated in English (Cox et al., 2003) and Spanish (Jaenes et al., 1999), has three dimensions of nine items each: cognitive anxiety, somatic anxiety and self-confidence. The reliability of the instrument ranges between 0.77 and 0.82 in the three dimensions. Cognitive anxiety refers to the mental component of anxiety, caused by negative expectations of success or negative self-evaluation (Martens et al., 1990); somatic anxiety is related to the physiological components that result in states of nervousness and restlessness, among others (Jaenes & Caracuel, 2005); and self-confidence refers to the subject's perception of being able to successfully face the competition (Bandura, 1977). For its completion, it includes a Likert scale from 1 (not at all) to 4 (very much), with 9 being the minimum value and 36 the maximum value for each dimension.

Subsequent to completing the questionnaires and before the warm-up, Polar H10 HR sensors with a Pro strap (Polar Electro, Kempele, Finland) were placed on the thoracic area of the players to measure heart rate at 2-s intervals (Gilgen-Ammann et al., 2019). Prior to sensor placement, the skin of the participants was cleaned, and the electrodes of the pro strap were moistened to facilitate recording. The heart rate of the Polar H10 HR sensors of all players was recorded using the Polar Club software. The recording started when the players entered the game (minute 00:00) and ended when the nexus of one of the teams was destroyed. Once one of the nexuses was destroyed, the Polar H10 sensors were removed, and the players immediately completed the POMS questionnaire again.

The analysis of LOL performance variables was carried out using the spectator viewing platform available within the video game (Riot Games, California, United States). Individual performance variables (K/D/A) and collective performance variables (gold, neutral targets, towers and kills/deaths) were recorded for each of the games played.

2.4. Statistical analysis

The normality of the data was analyzed using the Kolmogorov-Smirnov test. All variables included showed a normal distribution, using parametric tests for the analysis. Descriptive analysis of psychological and performance variables was performed. The T-student test for related samples was used to establish differences in pre- and post-game mood states. The T-student test for independent samples was used to

analyze the differences in mood states, anxiety, and self-confidence according to the final result of the game, the classification of the opposing team and the result of the last game played. Cohen's d was used to calculate the effect size in these cases, being small when d < 0.2; moderate when d < 0.8; and large when d > 0.8 (Cohen, 1988). Pearson's correlation coefficient was carried out to determine the relationship between post-match mood states and the performance variables of the match played. For the variables that were statistically significant in the Pearson correlation, a linear regression analysis was performed to predict the performance variables that could be more influential on the players' moods. A simple model was used in which the interaction between the variables was not considered, being the prediction equation obtained followed the structure y = b0 + b1x, with "y" being the independent variable, "x" the dependent variable and b0-1 the constant parameters. A value of p < 0.05 was used to determine significant differences. Statistical analysis was performed using the SPSS statistical package (v.25.0; SPSS Inc., IL).

Table 1
Characteristics of esports players.

	Variable	Results (M ± SD)
Age	Players' age (years)	20,20 ± 1,92
	Years of competitive experience	3,20 ± 0,84
Moods	Tension PRE (Score)	6,60 ± 6,45
	Tension POST (Score)	6,92 ± 6,33
	Depression PRE (Score)	2,73 ± 4,99
	Depression POST (Score)	7,59 ± 10,78
	Anger PRE (Score)	4,33 ± 6,10
	Anger POST (Score)	7,06 ± 9,20
	Vigor PRE (Score)	18,06 ± 5,92
	Vigor POST (Score)	14,91 ± 8,27
	Fatigue PRE (Score)	3,23 ± 4,80
	Fatigue POST (Score)	5,16 ± 5,54
	Confusion PRE (Score)	3,42 ± 4,05
	Confusion POST (Score)	5,24 ± 5,26
CSAI-2	Cognitive anxiety (Score)	15,59 ± 7,05
	Somatic anxiety (Score)	7,98 ± 4,71
	Self-confidence (Score)	27,34 ± 4,68
Performance in game	Team kills (Score)	11,44 ± 4,73
	Team deaths (Score)	10,11 ± 6,01
	K/D/A (Score)	6,38 ± 5,28
	Towers destroyed by the team (Score)	7,83 ± 3,66
	Towers destroyed by the opposing team (Score)	5,39 ± 2,64
	Team gold (thousands*)	62,42 ± 9,69
	Opposing team gold (thousands*)	61,10 ± 11,70
	Team objectives achieved (Score)	3,56 ± 1,84
	Opposing team objectives achieved (Score)	2,83 ± 1,72
	Average heart rate (b.p.m)	114,84 ± 16,46
	Maximum heart rate (b.p.m)	147,16 ± 18,34

K/D/A: kills/death/assist. The value is calculated adding the individual values of kills and assist and dividing by the death value; B.p.m: beats per minute.

3. Results

Table 1 shows the characteristics of the sample with respect to age, mood, anxiety, self-confidence, and sports performance.

The differences in the pre- and post-game mood states of the players according to the outcome of the game are shown in Table 2. The differences are significant in all pre-post mood states when losing the game (p < 0.05), while when winning there are only differences in anger (p = 0.040) and fatigue (p < 0.001). The effect size is moderate to large in all variables showing significant differences, except in the anger variable where the effect size is small.

The results of the students' t-test for independent samples for mood, anxiety and self-confidence are in Tables 3 and 4. The differences are significant in depression (p < 0.001), anger (p < 0.001), vigor (p < 0.001) and confusion (p < 0.001) post-match, with higher values for anger, depression, and confusion after losing, and higher values for vigor after winning, with a large effect size. No significant differences were found in pre- or post-match moods according to the opponent's classification, and only pre-match depression showed significant differences (p = 0.027) when considering the result of the last match played, with a moderate effect size. Regarding anxiety and self-confidence, the first row of Table 4 shows the differences in victory and defeat as a function of pre-game cognitive and somatic anxiety, and self-confidence. The second and third rows show the differences in cognitive, somatic anxiety and self-confidence as a function of the previous result and the opponent's rating. The first row is how anxiety influences performance, and the second row is how previous performance influences anxiety. In this respect, competitive anxiety and self-confidence did not show significant differences when considering the result of the game played, the opponent's classification or the result of the previous game.

Pearson's correlation analysis between post-match mood states and in-game performance variables is shown in Table 5. The variables tension and fatigue correlate negatively with minimum and maximum heart rate; depression and anger correlate with all the variables included in the analysis, except with the gold achieved by the opposing team; vigor correlates with all the variables included, except with gold in favor of the team and heart rate; and confusion correlates with

Table 2
Differences in pre-and post-game moods.

Mood	M ± DS		95% IC		t	p	d
	Pre	Post					
Victory (n = 55)							
Tension	6,44 ± 6,06	5,89 ± 6,08	−0,462	1553	1086	0,282	0,09
Depression	2,13 ± 4,08	2,38 ± 4,97	−0,976	0467	−0,708	0482	0,05
Anger	4,05 ± 6,03	3,58 ± 5,83	0,023	0923	2106	0,040*	0,08
Vigor	18,44 ± 5,32	19,13 ± 6,68	−1817	0,436	−1230	0,224	0,11
Fatigue	3,16 ± 4,65	4,76 ± 5,35	−2498	−0,702	−3574	0,001*	0,32
Confusion	3,09 ± 3,66	3,4 ± 3,98	−0,738	0120	−1446	0,154	0,08
Defeat (n = 35)							
Tension	6,86 ± 7,12	8,54 ± 6,46	−3114	−0,258	−2399	0,022*	0,25
Depression	3,69 ± 6,11	15,77 ± 12,34	−15,152	−9020	−8011	<0,001**	1,24
Anger	4,77 ± 6,26	12,51 ± 10,83	−10,371	−5114	−5987	<0,001**	0,88
Vigor	17,46 ± 6,81	8,29 ± 5,88	7443	10,900	10,782	<0,001**	1,44
Fatigue	3,34 ± 5,10	5,77 ± 5,85	−3440	−1417	−4881	<0,001**	0,44
Confusion	3,94 ± 4,60	8,14 ± 5,75	−5174	−3226	−8759	<0,001**	0,81

*p < 0.05; **p < 0.001.

Table 3
Differences in moods according to game win and loss.

	Mood	Victory (n = 55)	Defeat (n = 35)	95% IC		F	p	d
		M ± DS	M ± DS					
PRE	Tension	6,44 ± 6,06	6,86 ± 7,12	−3209	2367	1855	0,765	0,06
	Depression	2,13 ± 4,08	3,69 ± 6,11	−3691	0,574	4910	0,150	0,30
	Anger	4,05 ± 6,03	4,77 ± 6,26	−3346	1913	0,560	0589	0,12
	Vigor	18,44 ± 5,32	17,46 ± 6,81	−1571	3530	3345	0,448	0,16
	Fatigue	3,16 ± 4,65	3,34 ± 5,10	−2254	1895	0,447	0864	0,04
	Confusion	3,09 ± 3,66	3,94 ± 4,60	−2593	0,889	1899	0,333	0,20
POST	Tension	5,89 ± 6,08	8,54 ± 6,46	−5328	0,025	0775	0,052	0,42
	Depression	2,38 ± 4,97	15,77 ± 12,34	−17,086	−9693	50,538	<0,001**	1,42
	Anger	3,58 ± 5,83	12,51 ± 10,83	−12,428	−5437	22,003	<0,001**	1,03
	Vigor	19,13 ± 6,67	8,29 ± 5,88	8103	13,58	0,424	<0,001**	1,72
	Fatigue	4,76 ± 5,35	5,77 ± 5,85	−3392	1377	0,508	0403	0,18
	Confusion	3,4 ± 3,98	8,14 ± 5,75	−6781	−2705	10,923	<0,001**	0,96
	Mood	Previous result: Victory (n = 50) M ± DS	Previous result: Defeat (n = 35) M ± DS	95% IC		F	p	d
PRE	Tension	5,90 ± 5,85	6,89 ± 6,94	−3756	1784	1230	0,481	0,15
	Depression	1,54 ± 2,97	3,94 ± 6,66	−4521	−0,285	20,035	0,027*	0,47
	Anger	3,44 ± 4,77	5,29 ± 7,70	−4536	0,845	5898	0,176	0,29
	Vigor	18,46 ± 5,46	17,06 ± 6,63	−1212	4018	2833	0,289	0,23
	Fatigue	2,72 ± 4,18	3,80 ± 5,75	−3221	1061	2274	0,319	0,21
	Confusion	2,84 ± 3,41	4,00 ± 4,78	−2926	0,606	3851	0,195	0,12
POST	Tension	6,06 ± 6,09	7,66 ± 6,56	−4352	1158	0,485	0252	0,25
	Depression	5,46 ± 8,82	8,37 ± 11,45	−7285	1462	4062	0,189	0,28
	Anger	5,50 ± 7,59	7,94 ± 10,42	−6327	1441	5223	0,214	0,27
	Vigor	15,96 ± 8,10	14,06 ± 8,65	−1749	5555	0,449	0303	0,2
	Fatigue	4,24 ± 4,91	5,80 ± 6,08	−3934	0,814	2706	0,195	0,28
	Confusion	4,12 ± 4,60	6,11 ± 5,56	−4191	0,203	2097	0,075	0,39

*p < 0.05; **p < 0.001.

Table 4
Cognitive, somatic and self-confidence anxiety score as a function of the outcome of the game, the position of the opposing team and the outcome of the previous game.

		Victory (n = 55)	Defeat (n = 35)	F	95% IC		p	d
Result of this game	Cognitive anxiety	15,38 ± 7,00	15,91 ± 7,21	0,135	−3576	2511	0,729	0,07
	Somatic anxiety	7,80 ± 4,72	8,26 ± 4,76	0,412	−2491	1577	0,656	0,10
	Self-confidence	27,75 ± 4,20	26,71 ± 5,34	1474	−0,978	3040	0,311	0,22
		Higher ranking (n = 35)	Lower ranking (n = 50)					
Rival's ranking	Cognitive anxiety	15,09 ± 7,03	15,22 ± 6,97	0,002	−3201	2932	0,931	0,02
	Somatic anxiety	7,91 ± 4,82	7,66 ± 4,51	0,150	−1778	2287	0,804	0,05
	Self-confidence	27,66 ± 4,52	27,26 ± 4,81	0,529	−1661	2455	0,702	0,09
		Victory (n = 50)	Defeat (n = 40)					
Result of the previous game	Cognitive anxiety	14,90 ± 7,04	15,54 ± 6,91	0,053	−3706	2420	0,677	0,09
	Somatic anxiety	7,66 ± 4,57	7,91 ± 4,74	0,084	−2287	1778	0,804	0,05
	Self-confidence	27,84 ± 4,34	26,83 ± 5,11	0,046	−1037	3059	0,329	0,21

all the variables included, except with gold in favor of the team and against the team.

Table 6 shows the results of the linear regression analysis for post-match mood states. One explanatory model was found for tension, vigor, and fatigue, two models for anger and confusion, and three models for depression. Prediction equations were determined for these models: Tension/Anxiety = 27.982 - (0.183 x Mean HR); Depression/Melancholy = 55.117 - (0.784 x Towers in favor of the team) - (0.259 x Max HR) - (0.516 x K/D/A); Anger/Hostility = 44.917 - (0.210 x FC Max) - (0.894 x Towers in favor of the team); Vigor = 23.452 - (1.585 x Towers against the team); Fatigue = 20.439 - (0.133 x FC Mean); and Confusion = 28.684 - (0.173 x FC Mean) - (0.453 x Towers in favor of the team).

4. Discussion

The first objective of the present investigation was to analyze the differences in the pre- and post-game mood of players as a function of the final outcome and the previous result. The results obtained showed higher values of depression, anger and post-game confusion when the game was lost, and of vigor when the game was won. These results follow the line of previous studies carried out in sports such as field hockey, where significant differences in mood states were observed between winning and losing teams (Ismail et al., 2017), in soccer, where a decrease in vigor and an increase in tension and depression were observed in defeats (Casanova et al., 2016), and in volleyball, where a decrease in stress and an increase in depression and fatigue were found (De La Vega-Marcos et al., 2014).

Pre-match mood states do not seem to be related to subsequent performance, in contrast to previous research (Brandt et al., 2016; Totterdell, 1999), since no significant differences in pre-match mood states were found when comparing winning and losing games. Only pre-game depression was shown to be significantly higher when the outcome of the last game played was a loss. This could be due to the fact that the format of the competition forces players to play consecutive games, with less than 24 h of rest between some matches, so that psychological wear and tear and influence could remain, as indicated by De Lima Pinto et al. (2018) in their study with basketball players in

Table 5
Correlational analysis of mood states and performance variables.

	Tension POST	Depression POST	Anger POST	Vigor POST	Fatigue POST	Confusion POST
Team kills	−0,173	−0,416**	−0,340**	0,334**	−0,096	−0,267*
Team deaths	0,158	0360**	0,292*	−0,436**	0,172	0289*
K/D/A	−0,125	−0,405**	−0,283*	0,425**	−0,075	−0,231*
Towers destroyed by the team	−0,168	−0,455**	−0,380**	0,488**	−0,078	−0,346**
Towers destroyed by the opposing team	0,144	0395**	0,337**	−0,506**	0,114	0310*
Team gold	−0,094	−0,264**	−0,227*	0,115	0026	−0,163
Opposing team gold	0,061	0140	0,109	−0,305*	0,139	0133
Team objectives achieved	−0,098	−0,356**	−0,304*	0,315*	−0,053	−0,254*
Opposing team objectives achieved	0,101	0332**	0,299*	−0,436**	0,139	0266*
Average heart rate	−0,477**	−0,434**	−0,429**	0,107	−0,395**	−0,560**
Maximum heart rate	−0,389**	−0,445**	−0,439**	0,079	−0,312**	−0,517**

*p < 0.05; **p < 0.001.

Table 6
Linear regression analysis for the mood states of esports players based on performance in game.

Analysis	R2	P	Independent Variables Included	Standardized Coefficients (B)	p
Tension					
Model 1	0,227	<0,001	Average Heart Rate	−0,477	<0,001
Depression					
Model 1	0,207	<0,001	Towers destroyed by the team	−0,455	<0,001
Model 2	0,383	<0,001	Towers destroyed by the team	−0,431	<0,001
			Maximum heart rate	−0,419	<0,001
Model 3	0,419	<0,001	Towers destroyed by the team	−0,266	0016
			Maximum heart rate	−0,440	<0,001
			K/D/A	−0,253	0022
Anger					
Model 1	0,193	<0,001	Maximum heart rate	−0,439	<0,001
Model 2	0,319	<0,001	Maximum heart rate	−0,418	<0,001
			Towers destroyed by the team	−0,356	<0,001
Vigor					
Model 1	0,256	<0,001	Towers destroyed by the opposing team	−0,506	<0,001
Fatigue					
Model 1	0,156	<0,001	Average Heart Rate	−0,395	<0,001
Confusion					
Model 1	0,314	<0,001	Average Heart Rate	−0,560	<0,001
Model 2	0,413	<0,001	Average Heart Rate	−0,542	<0,001
			Towers destroyed by the team	−0,315	<0,001

K/D/A: kills/death/assist. The value is calculated adding the individual values of kills and assist and dividing by the death value.

which they found a partial influence of successive games on psychological state. Such demands could favor the appearance of chronic psychological fatigue, which is a risk factor for developing burnout (Reynaga-Estrada et al., 2017), behaviorally affecting the players' performance and lack of adherence, and contributing cognitively and physiologically to the devaluation of sports practice and physical exhaustion (García-Jarillo et al., 2020).

The second objective was to establish the differences in cognitive and somatic anxiety and self-confidence as a function of the outcome of the game, the ranking of the opponent and the outcome of the previous game. Nor were differences observed in competitive anxiety and pre-match self-confidence between matches that ended in victory and those that ended in defeat, so that these variables do not seem to influence performance. Although competitive anxiety has been commonly associated with performance in a negative way, previous scientific literature has not clarified the relationship between the two variables, as shown by the systematic review conducted by Núñez Prats & Garcia Mas (2017).

Regarding the ranking of the opposing team, there were no significant differences when considering the psychological variables included in the research. This could be due to the fact that in LOL each game starts with specific conditions that differ from the rest, since the champions, the game strategy, the game side, among other relevant aspects, change. Therefore, it is a practice with highly variable conditions in which the ranking of the opposing team seems to show reduced importance. Future research could try to clarify which are the most determinant elements in LOL, since it would have enormous practical implications, as far as specific preparation of players for the competition is concerned.

Based on the results obtained, which respond to the first and second objectives set out, the hypothesis that the mood of LOL players will change depending on the outcome of the game, the ranking of the opposing team and the result of the previous game can be partially approved, since the result of the game played seems to be the only element to be taken into account in the changes in mood states.

The third objective was to determine the relationship between performance variables and post-game mood of professional LOL players. In this regard, heart rate and performance actions that were favorable to the team, such as tower destruction, kills or achievement of objectives, showed a positive correlation with vigor and a negative correlation with the rest of the mood states. In contrast, heart rate and performance actions favorable to the opposing team showed negative correlation with vigor and positive correlation with the rest of the mood states. This profile is similar to the iceberg profile (Morgan, 1980), understood as the state in which precompetitive vigor is elevated, compared to the rest of the factors, favoring subsequent performance. In this case, the possibility is raised that this relationship occurs inversely, so that it is the positive actions that occur during the game that could favor high post-competitive vigor, suggesting that games with numerous successful situations will show a post-competitive profile with higher vigor values. Morgan's mental health model could be related to this proposal (Morgan, 1978, 1980), since it postulates that successful athletes have better mental health than unsuccessful athletes and the general population, showing a psychological profile with more positive mental health characteristics.

Thus, the second part of the hypothesis, that performance variables and post-game mood states are related, can be confirmed. Heart rate and tower destruction seem to be the variables with the highest predictive capacity for post-game mood states. This could be due to the fact that towers are one of the priority targets in LOL, since their destruction allows pressure to be generated in that area of the map, making it easier to obtain other targets, and to the fact that heart rate is related to changes in mood states during sports practice (McGowan et al., 1996). In addition, previous research has shown that victory produces emotional changes that are not present during defeat (Bardel et al., 2010; Del Bosque et al., 2020; Doron & Gaudreau, 2014), such as greater perceived control, greater perceived competence, or changes in the dimen-

sions depression, hostility or vigor, which could be a factor to be taken into account to explain the changes in post-game mood states.

This research constitutes a first approach to the analysis of the mental state of professional LOL players and which also allows professionals in the field of e-sports to consider mental state, as well as its variations respect the final result of the game, as a key element for performance.

Considering the results of the present research, the approach to the psychological preparation of professional esports players should focus on providing resources to players to control their moods during the game, especially with respect to the control of the state of depression, anger, vigour and confusion, as these are the ones that show the strongest relationship with the specific actions of performance in the game. However, the state of anxiety and self-confidence seem to be more stable during the game, so that psychological strategies in these aspects should not necessarily be focused exclusively on playing time.

As for the limitations of the study, it should be noted that the sample of professional players is small, although the number of games analyzed is acceptable. The variables included in the research are some of the most relevant to performance, but they are not the only ones that can influence performance. In addition, the analyses performed are simple in nature and consider the variables independently, without assessing the relationship between them. Likewise, further studies would be convenient in future research to complement the information obtained from the questionnaires by means of interviews, since more valid and reliable data could be obtained on the psychological state of the players and their relationship with the rest of the variables; it would be interesting to use devices such as the Diadem EC or the Eye Tracker - Tobii Pro X2-60, used in previous research (Escolano et al., 2011; Krupinski, 2019), as it would be possible to monitor changes in players' emotions depending on what is happening at a certain moment in the game. In addition, differences in pre- and post-competitive mood states could be investigated as a function of playing position and competitive experience. Besides, further work is required to include more data as for example the importance that the player attaches to the match because of its possible influence on moods or other aspects such as obtaining scholarships and prizes depending on the outcome of the competition. By including these variables, more complex models could be designed in which the interaction between variables is assessed. Other future studies could increase the number of teams/players analyzed, or to design longitudinal research to find out if a psychological intervention with the players changes the relationships found in the present research.

5. Conclusions

It can be concluded that there are differences in mood states before and after the match when the match is won, with a significant decrease in anger and a significant increase in fatigue. Differences were also showed in all mood states when the match is lost, with a significant decrease in all the mood states except vigor. However, there were no significant differences in somatic anxiety, cognitive anxiety, or self-confidence when considering the outcome of the game, the opponent's ranking, or the outcome of the previous game. Furthermore, there is a relationship between performance variables (deaths, kills, towers, gold, and targets) and post-game mood states. Therefore, the results obtained indicate the events occurring during the game, as well as the final outcome of the game, significant influence the mood of the players.

Author contribution statement

M-O, A. participated in conceptualization, data curation, formal analysis, investigation, methodology, validation, and writing original draft. V–C, R. participated in conceptualization, data curation, formal analysis, methodology, project administration, supervision, validation, and writing review and editing. A-C, L. participated in conceptualization, data curation, formal analysis, methodology, project administration, supervision, visualization, and writing review and editing.

Funding statement

M-O, A. participation in this research is funding by Seneca Foundation – 21409/FPI/20. Fundación Séneca. Región de Murcia (Spain).

Declaration of competing interest

None.

Acknowledgments

The authors would like to thank the players and coaching staff of the first League of Legends team of UCAM Esports Club for their participation in the research.

References

Albrecht, R. R., & Ewing, S. J. (1989). *Standardizing the administration of the profile of mood states (POMS): Development of alternative word lists. Journal of Personality Assessment, 53* (1), 31–39. https://doi.org/10.1207/s15327752jpa5301_4.

Andrade Fernández, E. M., Fernández, C. A., & Pesqueira, G. S. (2002). *Adaptación al español del cuestionario «Perfil de los Estados de Ánimo» en una muestra de deportistas. Psicothema, 14*(4), 708–713.

Balaguer, I., Fuentes, I., García-Merita, M., Pérez Recio, G., & Meliá, J. L. (1993). *El perfil de los estados de ánimo (POMS). Revista de Psicologia del Deporte, 2*(2). 0039–0052 http://ddd.uab.cat/record/63162.

Bálint, B., Tényi, T., Jeges, S., Bernstein, L., & Békési, Á. (2021). *Aggression expression among League of Legends and Fortnite players - a brief report. Psychiatria Hungarica, 36*(2), 180–186.

Bandura, A. (1977). *Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84*(2), 191–215. https://doi.org/10.1007/978-3-319-75361-4.

Bardel, M. H., Fontayne, P., Colombel, F., & Schiphof, L. (2010). *Effects of match result and social comparison on sport state self-esteem fluctuations. Psychology of Sport and Exercise, 11* (3), 171–176. https://doi.org/10.1016/j.psychsport.2010.01.005.

Behnke, M., Gross, J., & Kaczmarek, L. (2020). *The role of emotions in esports performance. Emotion.* (in press).

Brandt, R., Viana, M., Crocetta, T., & Andrade, A. (2016). *Association between mood states and performance of Brazilian elite sailors: Winners vs non-winners. Cultura. Ciencia y Deporte, 11*(32), 119–125.

Brühlmann, F., Baumgartner, P., Wallner, G., Kriglstein, S., & Mekler, E. D. (2020). *Motivational profiling of league of Legends players. Frontiers in Psychology, 11*(July), 1–18. https://doi.org/10.3389/fpsyg.2020.01307.

Casanova, N., Palmeira-De-Oliveira, A., Pereira, A., Crisóstomo, L., Travassos, B., & Costa, A. M. (2016). *Cortisol, testosterone and mood state variation during an official female football competition. The Journal of Sports Medicine and Physical Fitness, 56*(6), 775–781.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.*

Cox, R. H., Martens, M. P., & Russell, W. D. (2003). *Measuring anxiety in athletics: The revised competitive state anxiety inventory-2. Journal of Sport & Exercise Psychology, 25*(4), 519–533. https://doi.org/10.1123/jsep.25.4.519.

De La Vega-Marcos, R., Ruiz-Barquín, R., Tejero-González, C., & Rivera-Rodriguez, M. (2014). *Relationship between mood states and performance in elite male volleyball. Revista de Psicologia del Deporte, 23*(1), 49–56.

De Lima Pinto, J. C. B., Menezes, T. C. B., Fortes, L. D. S., & Mortatti, A. L. (2018). *Monitoring stress, mood and recovery during successive basketball matches. Journal of Physical Education and Sport, 18*(2), 677–685. https://doi.org/10.7752/jpes.2018.02099.

Del Bosque, R. A., Rodríguez, Ó. G., & Gabilondo, J. A. A. (2020). *Influence of gender and result on the mood of initiated football players. Retos, 38*, 349–354.

Ding, Y., Hu, X., Li, J., Ye, J., Wang, F., & Zhang, D. (2018). *What makes a champion: The behavioral and neural correlates of expertise in multiplayer online battle arena games. International Journal of Human-Computer Interaction, 34*(8), 682–694. https://doi.org/10.1080/10447318.2018.1461761.

Doron, J., & Gaudreau, P. (2014). *A point-by-point analysis of performance in a fencing match: Psychological processes associated with winning and losing streaks. Journal of Sport & Exercise Psychology, 36*(1), 3–13. https://doi.org/10.1123/jsep.2013-0043.

Escolano, C., Aguilar Herrero, M., & Minguez, J. (2011). *EEG-based upper alpha neurofeedback training improves working memory performance. 33rd Annual International Conference of the IEEE EMBS*, 2327–2330.

Ferrari, S. (2013). *From generative to conventional play: MOBA and league of Legends. Proceedings of DiGRA, 2013.* (DeFragging GameStudies).

García Jarillo, M., De Francisco, C., Ortín, F. J., & Garcés de Los Fayos, E. J. (2020). *Sintomatología del síndrome de burnout en deportistas: Un estudio con metodología delphi. Cuadernos de Psicología del Deporte, 20*(3), 15–25. https://doi.org/10.6018/cpd.367531.

Gilgen Ammann, R., Schweizer, T., & Wyss, T. (2019). *RR interval signal quality of a heart rate monitor and an ECG Holter at rest and during exercise. European Journal of Applied Physiology, 119*(7), 1525–1532. https://doi.org/10.1007/s00421-019-04142-5.

Himmelstein, D., Liu, Y., & Shapiro, J. L. (2017). *An exploration of mental skills among*

competitive league of legend players. *International Journal of Gaming and Computer-Mediated Simulations*, *9*(2), 1–21. https://doi.org/10.4018/IJGCMS.2017040101.
Ismail, M., Jani, H., & Amer, A. (2017). *Mood differences between the winning and losing team during the final match of Razak cup hockey competition 2016*. *International Journal of Sports Science*, *7*(1), 15–17. https://doi.org/10.5923/j.sports.20170701.04.
Jaenes, J., & Caracuel, J. (2005). *Maratón. Preparación psicológica para el entrenamiento y la competición*.
Jaenes, J., Caracuel, J., & Pérez-Gil, J. (1999). *Adaptación española del test CSAI-2: Un estudio en corredores españoles de maratón*. VII Congreso Nacional de La Actividad Física y Del Deporte.
Jenny, S. E., Keiper, M. C., Taylor, B. J., Williams, D. P., Gawrysiak, J., Manning, R. D., & Tutka, P. M. (2018). *eSports venues: A new sport business opportunity*. *Journal of Applied Sport Management*, *10*(1), 34–49.
Johnson, D., Nacke, L. E., & Wyeth, P. (2015). *All about that base: Differing player experiences in video game genres and the unique case of MOBA games*. *Proceedingsof the 33rd annual ACM conference on human factors in computing systems*. https://doi.org/10.1145/2702123.2702447.
Jonasson, K., & Thiborg, J. (2010). *Electronic sport and its impact on future sport*. *Sport in Society*, *13*(2), 287–299. https://doi.org/10.1080/17430430903522996.
Krupinski, E. A. (2019). *Impact of patient photos on detection accuracy, decision confidence and eye-tracking parameters in chest and abdomen images with tubes and lines*. *Journal of Digital Imaging*, *32*(5), 827–831. https://doi.org/10.1007/s10278-019-00202-6.
Leis, O., & Lautenbach, F. (2020). *Psychological and physiological stress in non-competitive and competitive esports settings: A systematic review*. *Psychology of Sport and Exercise*, *51*, 101738. https://doi.org/10.1016/j.psychsport.2020.101738.
Lochbaum, M., Zanatta, T., Kirschling, D., & May, E. (2021). *The profile of moods states and athletic performance: A meta-analysis of published studies*. *European Journal of Investigation in Health, Psychology and Education*, *11*(1), 50–70. https://doi.org/10.3390/ejihpe11010005.
Martens, R., Vealey, R., & Burton, D. (1990). *Competitive anxiety in sport*.
Matuszewski, P., Dobrowolski, P., & Zawadzki, B. (2020). *The association between personality traits and eSports performance*. *Frontiers in Psychology*, *11*(July), 1–5. https://doi.org/10.3389/fpsyg.2020.01490.
Ma, H., Wu, Y., & Wu, X. (2013). *Research on essential difference of e-sport and online game*. *Informatics and management science V*.
McGowan, R. W., Talton, B. J., & Thompson, M. (1996). *Changes in scores on the profile of mood states following a single bout of physical activity: Heart rate and changes in affect*. *Perceptual & Motor Skills*, *85*(3), 859–866. https://doi.org/10.2466/pms.1996.83.3.859.
McNair, D., Lorr, M., & Droppleman, L. (1971). *Manual for the profile of mood states*.
Mora Cantallops, M., & Sicilia, M. Á. (2018a). *Exploring player experience in ranked League of Legends*. *Behaviour & Information Technology*, *37*(12), 1224–1236. https://doi.org/10.1080/0144929X.2018.1492631.
Mora Cantallops, M., & Sicilia, M. Á. (2018b). *MOBA games: A literature review*. *Entertainment Computing*, *26*, 128–138. https://doi.org/10.1016/j.entcom.2018.02.005. February 2017.
Mora Cantallops, M., & Sicilia, M. Á. (2019). *Team efficiency and network structure: The case of professional League of Legends*. *Social Networks*, *58*, 105–115. https://doi.org/10.1016/j.socnet.2019.03.004.
Morgan, W. (1978). The credulous-sceptical argument in perspective. *An analysis of athlete behavior*. Movement Publications. S. W. F..
Morgan, W. (1980). *The trait psychology controversy*. *Research Quarterly for Exercise & Sport*, *51*, 50–76.
Morgan, W. P. (1980). *Test of champions: The icerberg profile*. *Psychology Today*, *14*, 92–108.
Núñez Prats, A., & Garcia Mas, A. (2017). *Relación entre el rendimiento y la ansiedad en el deporte: Una revisión sistemática (relationship between performance and anxiety in sports: A systematic review)*. *Retos*, *2041*(32), 172–177. https://doi.org/10.47197/retos.v0i32.53297.
Pizzo, A. D., Baker, B. J., Na, S., Lee, M. A., Kim, D., & Funk, D. C. (2018). *eSport vs. Sport: A comparison of spectator motives*. *Sport Marketing Quarterly*, *27*(2), 108–123.
Poulus, D., Coulter, T. J., Trotter, M. G., & Polman, R. (2020). *Stress and coping in esports and the influence of mental toughness*. *Frontiers in Psychology*, *11*(April), 1–11. https://doi.org/10.3389/fpsyg.2020.00628.
Reynaga Estrada, P., Robles, D. A. M., Valadez Jiménez, A., Rodríguez Villalobos, A., & González Hernández, J. (2017). *Síndrome de burnout en deportistas universitarios Mexicanos*. *Revista de Psicologia del Deporte*, *26*(2), 209–214.
Samełko, A., Guszkowska, M., & Gala-Kwiatkowska, A. (2018). *Affective states influence sport performance in swimming*. *Polish Journal of Sport and Tourism*, *25*(4), 21–26. https://doi.org/10.2478/pjst-2018-0023.
Samełko, A., Guszkowska, M., & Kuk, A. (2020). *Subjective rank of the competition as a factor differentiating between the affective states of swimmers and their sport performance*. *Frontiers in Psychology*, *11*(December), 1–6. https://doi.org/10.3389/fpsyg.2020.615746.
Thiel, A., & John, J. M. (2018). *Is eSport a "real" sport? Reflections on the spread of virtual competitions*. *European Journal for Sport and Society*, *15*(4), 311–315. https://doi.org/10.1080/16138171.2018.1559019.
Totterdell, P. (1999). *Mood scores: Mood and performance in professional cricketers*. *British Journal of Psychology*, *90*(3), 317–332. https://doi.org/10.1348/000712699161422.
Vandenbroucke, J. P., von Elm, E., Altman, D. G., Gøtzsche, P. C., Mulrow, C. D., Pocock, S. J., … Egger, M. (2014). *Strengthening the reporting of observational studies in epidemiology (STROBE): Explanation and elaboration*. *International Journal of Surgery*, *12*(12), 1500–1524. https://doi.org/10.1016/j.ijsu.2014.07.014.
Wagner, M. (2006). *On the scientific relevance of eSports*. International Conference on Internet Com- Puting & Conference on Computer Games Development.