International Journal of Current Research and Applied Studies, (IJCRAS)

ISSN: 2583-6781

available at https://ijcras.com/

Volume 4 Issue 4 July-August 2025, Page 21-42

To cite this article: Nuno Cravo Barata, and Ana Raquel do Nascimento Fernandes (2025). VIDEOGAME GENRES AND THEIR INFLUENCE ON THE WORKING MEMORY OF PORTUGUESE UNIVERSITY STUDENTS, International Journal of Current Research and Applied Studies (IJCRAS) 4 (4): Article No. 128, Sub Id 228

VIDEOGAME GENRES AND THEIR INFLUENCE ON THE WORKING MEMORY OF PORTUGUESE UNIVERSITY STUDENTS

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DOI : https://doi.org/10.61646/IJCRAS.vol.4.issue4.128

ABSTRACT

Recent studies show that Working Memory (WM) can be influenced by several factors. One of these factors may be the use of video games, which may be associated with cognitive gains and better WM performance. In this sense, an experimental study was developed with the objective of evaluating the influence that different types of video games have on the WM of university students, seeking to compare 3 groups of students who play different genres of video games: Action, RPG and Strategy. The main hypothesis guiding the study was: the group of students who play Strategy games has better results in the WM test than the other groups. For this, an initial questionnaire was used to collect the sample and collect sociodemographic data and data related to gaming habits, with the sample consisting of 42 students, 23 of the male gender and 19 of the female gender, aged between 18 and 25 years old. Then, the in- person test, developed in SuperLab 5, was scheduled to evaluate the WM performance of the participants. It was found that Strategy game players presented shorter reaction times, as well as shorter duration of the experience, with higher accuracy rates in all stimuli, compared to Action and RPG players, which indicates a superior WM performance. It is expected that this study will contribute to the construction of other more robust scientific studies, as well as help fight stigmatization of video games

Keywords: Working memory; video games; Portuguese university students; video game genres

1. INTRODUCTION

Defining what a video game is is not exactly an easy task, as there is no clear and common definition to be used by the scientific community in scientific research [1]. For the sake of clarity and to make this study more straightforward, we will define a video game as a digital game that can be played online or offline, singleplayer or multiplayer, on different digital platforms, such as computers, cell phones or consoles, of different genres and types, such as Action, RPG and Strategy, and may or may not be based on stories and narratives [1]-[11]. Within the scope of this study, we will only try to define the Roleplaying Games (RPG), Action and Strategy genres, which are the central ones in this research. In the Strategy genre, players face tasks that require problem-solving and planning to achieve certain goals, and this genre is associated with war games or building and managing cities or civilizations, for example [9][10]. When it comes to RPGs, players have the opportunity to create and evolve their character in interaction with the virtual world, adopting an almost theatrical role in which they can make their own decisions about what actions to take and how to achieve certain goals [5], [9], [11]. Games in the Action genre consist mainly of First-Person Shooters (FPS) and Third-Person Shooters (TPS), in which the player faces scenarios of intense performance and action, in which they must, as in any other game genre, achieve a goal, and, since this genre is very broad, it can include characteristics of Strategy and Puzzle games [2], [3], [9]. The video games industry has seen exponential growth globally over the last few years, mainly due to technological improvements and the proliferation of video games through the general population [1], [12]. In Portugal, the growth trend continues, with around 38 million euros generated by this industry in 2022, which is set to increase [12], [13].

Recent studies show that video games of different genres have the potential to enrich certain cognitive functions [7], [14]-[16]. For example, Zioga and colleagues (2024) carried out a study with the aim of investigating the effect of using video games on various cognitive functions, in which they concluded that individuals who play video games have greater capacity for Working Memory (WM) and short-term visuospatial memory, as well as greater psychomotor and attentional speed. The authors also found that different genres of video games have different effects on different cognitive functions [16]. They concluded that Role-playing games (RPGs) are linked to increases in performance in verbal working memory and visuo-spatial short-term memory, despite being negatively correlated with empathy; Action-Adventure games are linked to improvements in psychomotor speed, eye-hand coordination and attentional speed; Puzzle games are associated with better performance in visuo-spatial working memory [16]. Imanian and colleagues (2024) carried out a study to explore the effects of eSports (electronic sports; competitive video games) on cognitive abilities and WM performance among FIFA players. They concluded that WM and attentional control are positively influenced in players who choose to play in single-player mode, as is cognitive flexibility, but only for players who choose to play cooperatively, given the need to work as a team [7]. Shahmoradi and colleagues (2022) carried out a systematic review on the use of video games for attention rehabilitation and found that computer games designed to rehabilitate attention are effective and can be used in therapeutic contexts to improve attentional function [15]. Manci and colleagues (2024) developed a study in which they compared the cognitive performance of players who regularly play FPS games and players who regularly play Multiplayer Online Battle Arena (MOBA) games. The results suggest that FPS players perform better when it comes to sustained attention and inhibitory control compared to MOBA players, however, there were no significant differences between visuospatial attention, WM and timing [14].

In fact, one of the cognitive functions of interest to study is Working Memory (WM). The definition of WM is a matter of debate in the scientific community, and there are various theories and definitions for the same cognitive function, given its complexity (see [17]; [18]). Cowan (2017) refers to a generic definition of WM, which will be used in this study. This definition describes WM as the set of cognitive mechanisms that maintain, for a short period of time, a limited number of pieces of information in a state of high accessibility, essential for the continuous flow of mental processing and the performance of daily activities [17], [19]-[21]. Therefore, it is possible to state that this cognitive function is of high importance, as it allows information to be temporarily retained and manipulated, in the absence of the stimulus, which is necessary for a specific task, such as comprehension, language, learning, memorization, consolidation of information and problem solving, and can therefore lead to positive academic performance in students [17], [19], [20], [22]-[27]. It is important to mention that WM is not a constant cognitive function and that its capacity can change depending on individual characteristics and the environment in which one is inserted [23], [28]-[31]. In the study by Pliatsikas and colleagues (2018), the researchers concluded that age is negatively associated with WM, while education is positively associated, i.e. the more education an individual has, the better their WM performance. The gender of the individual also has an influence, with tests showing that males are more likely to be negatively impacted by age [30]. Stress can also have a negative impact on WM, as indicated by the study by Almarzouki (2024) and Shields and colleagues (2019), just as socioeconomic status and academic education have an impact on WM, with a negative and positive correlation, respectively [23] [30]-[33].

With regard to the impact that video games can have on WM, the studies by Imanian and colleagues (2024) and Zioga and colleagues (2024) have already been mentioned, in which they noted improvements in WM of individuals who play video games [7], [16]. In 2012, Colzato and colleagues carried out a study with the aim of assessing whether FPS games were related to improvements in cognitive control, in this case in relation to response inhibition and WM updating. They concluded that FPS players have a better ability to update the information present in the WM, which consequently leads to better WM performance compared to non-players [34]. Mention should also be made of the study by Cutting and colleagues (2023), which compared the results of WM tests performed by individuals who play Puzzle, Strategy or Action games and individuals who do not play games. They concluded that there were no differences in WM performance when comparing players of action, puzzle and non-action games [35]. On the other hand, players of Strategy games showed superior performance compared to the other groups, which could mean that games with strategic components are beneficial for WM performance [35]. Barata (2024), on the other hand, carried out a study with university students, in which he sought to ascertain the influence of digital games on WM [36]. He concluded that using digital games on a more regular basis can bring benefits to WM performance, compared to individuals who play little or nothing, and that digital games can be effective cognitive training tools [36]. With this, it can be said that WM is an important and multifaceted cognitive function that can be influenced, positively or negatively, by various factors, which inherently leads to the scientific curiosity of understanding whether exposure to video games has any impact, positive or negative, on WM, while also trying to understand which aspects of this exposure may have the greatest influence, such as the amount of time played per week, the type of video game most played and how long the individual has been playing.

Navigating the complexities of the effects of video games on human cognitive functions is a challenging but necessary path, given the widespread use of this entertainment medium, which has the potential to be much more than just a recreational and leisure activity. Thus, through the systematic analysis of empirical studies and the data collected, this research hopes to contribute to a better understanding of the relationship between the use of video games and WM performance, potentially helping to pave the way for the integration of video games in educational and academic areas.

Thus, the main objective of this study is to explore the influence that different types of video games have on the working memory of university students.

2. METHOD

In order to carry out this research, authorization was sought from the Ethics Committee of Fernando Pessoa University, whose opinion is attached (Annex A). Permission was also sought from the current Director of the Cognitive Psychology Laboratory at Fernando Pessoa University, Prof. Dr. Inês Gomes, in order to be able to carry out the face-to-face component in the Laboratory (Appendix B), allowing for a more controlled environment and avoiding parasitic variables from the environment. The aim was to have as robust a sample as possible, without hindering the progress of the research. An initial online questionnaire (Appendix C) was used to collect the sample, also trying to gather information about the hours the respondent plays and what type of game they play the most, and also asking about their practice with video games, i.e. whether they have been playing for a long time or not. It should be noted that the questionnaire asks about the medication the respondent takes, but this answer is not compulsory, as this is for the sake of the individual's well-being. This question is only intended to avoid possible parasitic variables, since there are certain drugs that can influence performance in working memory tests, both positively and negatively. At the end of the questionnaire, the participant was asked for the e-mail address they wished to be contacted by in order to schedule the face-to-face part. They were also asked to write down two key words of their choice, which allowed the data from this questionnaire and the face-to-face test to be integrated. As with all the other data, the email and keywords will be anonymous and confidential and will only be used for contact and data integration, respectively. Subsequently, respondents who met the defined inclusion criteria were contacted by e-mail and the face-to-face component was scheduled, in which the participant signed an Informed Consent Form (Appendix D) and took the WM test, developed in SuperLab 5 (Appendix E). This test consisted of presenting several visual stimuli, namely words (Verbal Span Stimuli (VS12)) (Figure 1) and sequences of numbers (Direct Digit Span (DDS6) and Indirect Digit Span (IDS6)) (Figure 2 and Figure 3), which the participant had to memorize for a short period of time. This made it possible to assess WM ability. Before starting the test, the participant had to write the same key words as in the questionnaire, as a form of identification (Figure 4), so that the answers from the questionnaire and the WM test could be incorporated without jeopardizing the anonymity of the data.

Casa	Anáfora	Livro
Sol	Chuva	Riso
Metamorfose	Amigo	Personalidade
Flor	Caminho	Fotossíntese

Figure 1: Words that the participants had to memorize for the VS12 exercises

In total, there were 12 verbal stimulus exercises in which the participant had to match the words that had been presented in the initial image (Figure 1), between a list of words and a text, which appeared at the end of the verbal phase.

7-4-9

Figure 2: Example of the sequence of numbers in the DDS6 stimulus

There is a total of 6 Direct Digit Span exercises. The aim was for the participant to read and memorize the numbers while they were displayed on the screen for 2 seconds. Then they had to say them out loud to the researcher. The number of numbers presented gradually increased up to 8, i.e. 1 number per exercise. The presentation time of the stimulus also increased gradually, increasing by 2 seconds per exercise, except from the 3rd to the 4th exercise, where it increased by 4 seconds, in order to not make the test too difficult.

6-2-9

Figure 3: Example of the IDS6 stimulus number sequence

This stimulus is presented in the same way as DDS6, progressively increasing the number of numbers and the time presented. The main difference is that in these 6 exercises the participant must say the numbers in reverse order, i.e. in this case they would have to say 9-2-6 instead of 6-2-9. The participant was instructed to put the keywords from the initial questionnaire in the box corresponding to Participant Name, in the dialog box that appears as soon as the Start Experiment button is pressed (Figure 4). The experiment was then started by pressing the *Run* button.

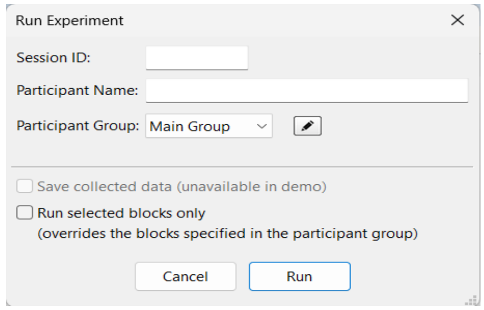

Figure 4: Initial dialog box in which the participant enters the keywords (Participant Name).

This study identifies itself as a quantitative, experimental and exploratory study. The main variables under study are the use of video games of different genres (independent variable) and the impact on working memory performance (dependent variable).

The instruments used in this research were the online questionnaire, developed in Google Forms. WM was assessed using the SuperLab 5 program, which developed a specific test for working memory. IBM®SPSS® (Statistical Package for the Social Sciences, version 28) was used for data analysis.

3. Sample

The sample was collected through an initial online questionnaire, developed using Google Forms. Initially, the participant's informed consent was requested, followed by sociodemographic questions and questions about the respondents' gaming habits. This made it possible to collect a sample that was consistent with the inclusion criteria, which were: being a university student, being over 18, playing video games and having accepted and signed the informed consent in the online and face-to-face questionnaire. Another in-person informed consent form was presented in the second phase of the study, which also had to be read, accepted and signed by the participant, otherwise their participation would be terminated at that point. This initial questionnaire was disseminated through internal media at Fernando Pessoa University, and we tried to collect information by convenience and through the snowball method, allowing respondents to share the questionnaire with acquaintances. 42 individuals responded to the sample questionnaire, all of whom met the inclusion criteria. The total sample was therefore 42, with university students aged between 18 and 25 (Table 1), with an average age of 20.79 (Table 2). Of these 42 participants, 54.8% (23) were male, while the rest were female (19) (Table 3), which makes the sample balanced and representative.

Table 1

Age frequencies and percentages

		Frequency	%
Valid	18	6	14,3
	19	7	16,7
	20	6	14,3
	21	7	16,7
	22	7	16,7
	23	6	14,3
	24	2	4,8
	25	1	2,4
	Total	42	100,0

Table 2

Mean and median ages

N	Valid	42
Mean		20,79
Median		21,00
Deviation Error		1,920
Min.		18
Max.		25

Table 3

Gender frequencies and percentages

		Frequency	%
Valid	Masculine	23	54,8
	Feminine	19	45,2
	Total	42	100,0

Regarding the area of the course they are attending, 42.9% (18) are studying in the area of Social and Behavioral Sciences, while the rest are studying in the area of Health (24), with 57.1% attending a bachelor's degree and 42.9% a master's degree. Regarding the faculty, 18 students were enrolled in the Faculty of Human and Social Sciences, 14 in the School of Health and 10 in the Faculty of Health Sciences. None of the participants reported taking medication that could influence memory performance, which allows us to eliminate this parasitic variable from the equation. As far as the gaming platform is concerned, the participants play more on computers than on consoles, and none of them reported using their cell phone as a gaming platform (Table 4).

Table 4

Preferred game platform

		Frequency	%
Valid	Computer	28	66,7
	Console	14	33,3
	Total	42	100,0

Table 5 shows the participants' reports of the average number of hours they play during the week, as well as a report of hours played in the week prior to the study. Only 2 participants play for 6 hours or less and 12 (28.6%) report playing between 7 and 9 hours a week. Only 1 reported playing between 10 and 12 hours and 3 between 12 and 15 hours. 57.2% of the participants play 16 hours or more, of which 28.6% play between 19 and 21 hours a week. In the week prior to the study, the majority played 16 hours or more (57.1%), which coincides with the average values reported by the students. This trend continues across all the figures. It can therefore be deduced that the number of hours played remains relatively constant over the weeks of the school year.

Table 5

Frequencies and percentages of number of hours played per week

How many hours do you play per week		
	Frequency	%
6 hours or less	2	4,8
7-9 hours	12	28,6
10-12 hours	1	2,4
13-15 hours	3	7,1
16-18 hours	12	28,6
19-21 hours	12	28,6
Total	42	100,0
How many hours did you play last week		
	Frequency	%
3	1	2,4
4	1	2,4
7	8	19,0
8	3	7,1
9	1	2,4
10	1	2,4

14	2	4,8
15	1	2,4
16	6	14,3
17	5	11,9
18	1	2,4
19	3	7,1
20	5	11,9
21	4	9,5
Total	42	100,0

Table 6 shows the frequencies of the day of the week the participants play the most games, the genre of game they play the most and how long they have been playing video games. Regarding the genres of games that the participants play the most, the Action genre is in first place with 16 players, Strategy in second with 15 players and RPG in last with 11. Regarding how long the participants have been playing, 7 participants reported playing for 2-3 years, 6 have been playing for 4-5 years, 9 have been playing for 6-7 years, 13 have been playing for 8-9 years and 7 have been playing for 10 years or more. Thus, we can see that 69.1% of the participants are relatively experienced, having been playing video games for 6 years or more.

Table 6

Frequencies and percentages of the most played game genre and how long participants have been playing videogames

Most played videogame genre

		Frequency	%
Va lid	Action	16	38,1
	Strategy	15	35,7
	RPG	11	26,2
	Total	42	100.0

How many years have you been playing videogames for

		Frequency	%
Va lid	2-3 years	7	16,7
	4-5 years	6	14,3
	6-7 years	9	21,4

8-9 years	13	31,0
10+ years	7	16,7
Total	42	100,0

Students were also asked about the number of hours they play each type of game per week (Table 7). As for Action games, 12 reported not spending any time playing this type of game and 52.4% play less than 3 hours. About Strategy games, 52.4% play less than 3 hours, interestingly the same statistic as for Action games, with 12 participants also reporting not playing Strategy games. Regarding role-playing games, 14 reported not playing this type of game and, interestingly, 52.4% played for 3 hours or less, as seen in the other game categories.

Table 7

Hours spent playing videogames per genre (mean)

Hours played Action per week (Mean)

		Frequency	%
Valid	0	12	28,6
	1	4	9,5
	2	3	7,1
	3	3	7,1
	4	2	4,8
	5	1	2,4
	6	1	2,4
	7	1	2,4
	10	2	4,8
	11	2	4,8
	12	6	14,3
	14	2	4,8
	15	1	2,4
	16	1	2,4
	20	1	2,4
	Total	42	100,0

Hours played Strategy per week (Mean)

		Frequency	%
Valid	0	12	28,6
	1	2	4,8

	2	5	11,9
	3	3	7,1
	4	6	14,3
	5	3	7,1
	7	5	11,9
	8	1	2,4
	9	1	2,4
	11	1	2,4
	12	1	2,4
	15	2	4,8
	Total	42	100,0

Hours played RPG per week (Mean)

		Frequency	%
Valid	0	14	33,3
	1	3	7,1
	2	3	7,1
	3	2	4,8
	4	6	14,3
	5	2	4,8
	6	3	7,1
	7	2	4,8
	8	1	2,4
	10	1	2,4
	11	2	4,8
	12	1	2,4
	15	1	2,4
	17	1	2,4
	Total	42	100,0

3. RESULTS

The data was analyzed using the IBM®SPSS® program, through descriptive analyses, Pearson's correlations were used to compare and check the correlations between the different variables, and the ANOVA test was used to compare the values obtained in the different groups (Action, Strategy and RPG).

We chose to consider Cognitive Performance Factors to be all the tasks that made it possible to assess WM. Table 8 summarizes the results of the analysis in relation to the gender and cognitive performance variable (duration of the experiment, reaction time, hit rate in the direct digit range, hit rate in the indirect digit range and hit rate in the verbal digit range). It can be seen that male participants have higher values for the duration of the experiment, which indicates that females finish the experiment more quickly and have a shorter reaction time. As far as the number of hits is concerned, females also have better results.

Table 8

Descriptive statistics of cognitive performance factors in relation to gender

	Gender	N	Mean	Standard Deviation	Standard Mean Error
ED	M	23	243,17	24,412	5,090
	F	19	208,05	16,338	3,748
RT	M	23	1513,30	231,490	48,269
	F	19	1222,74	299,207	68,643
DDS6	M	23	4,13	,694	,145
	F	19	5,42	,769	,176
IDS6	M	23	3,83	,650	,136
	F	19	5,58	,607	,139
VS12	M	23	9,39	1,588	,331
	F	19	11,00	1,414	,324

Caption: **DDS6**: Direct Digit Span 6; **IDS6**: Indirect Digit Span 6; **VS12**: Verbal Span 12; **ED**: Experience duration; **RT**: Reaction time.

Table 9 shows the comparison between the Action game, Strategy game and RPG game groups. Strategy game players finish the experience more quickly, with lower Duration of Experience values than the other groups and, consistently, lower Reaction Time values. In second place are the times taken by RPG players and in last place are Action players, with the longest duration of experience and the longest reaction time. Regarding DDS6 Stimuli, Strategy players have the highest hit rate, with a score of 5.20 out of 6. Players in this category also have the best scores for IDS6 and VS12 Stimuli, with scores of 5.13 out of 6 and 10.53 out of 12, respectively. Action gamers have the worst scores in their responses to the DDS6 and IDS6 stimuli. Role-playing gamers scored worst in their responses to the VS12 stimuli.

Table 9

ANOVA descriptive statistics regarding Cognitive performance factors and Videogame genre

						95% Confidence Interval for Mean			
		N	Mean	Standard deviation	Standard error	Lower limit	Upper limit	Min.	Max.
ED	Action	16	242,31	31,007	7,752	225,79	258,83	198	293
	Strategy	15	214,53	21,145	5,460	202,82	226,24	178	262
	RPG	11	222,82	19,488	5,876	209,73	235,91	196	254
	Total	42	227,29	27,386	4,226	218,75	235,82	178	293
RT	Action	16	1548,25	238,049	59,512	1421,40	1675,10	983	1890
	Strategy	15	1217,07	294,279	75,982	1054,10	1380,03	856	1681
	RPG	11	1364,55	274,373	82,727	1180,22	1548,87	975	1678
	Total	42	1381,86	299,138	46,158	1288,64	1475,08	856	1890
DDS6	Action	16	4,19	,750	,187	3,79	4,59	3	6
	Strategy	15	5,20	1,014	,262	4,64	5,76	3	6
	RPG	11	4,82	,874	,263	4,23	5,41	4	6
	Total	42	4,71	,970	,150	4,41	5,02	3	6
IDS6	Action	16	4,19	,834	,209	3,74	4,63	3	6
	Strategy	15	5,13	1,125	,291	4,51	5,76	3	6
	RPG	11	4,55	1,128	,340	3,79	5,30	3	6
	Total	42	4,62	1,081	,167	4,28	4,96	3	6
VS12	Action	16	10,06	1,526	,382	9,25	10,88	7	12
	Strategy	15	10,53	1,642	,424	9,62	11,44	7	12
	RPG	11	9,64	2,014	,607	8,28	10,99	7	12
	Total	42	10,12	1,699	,262	9,59	10,65	7	12

Caption: **DDS6**: Direct Digit Span 6; **IDS6**: Indirect Digit Span 6; **VS12**: Verbal Span 12; **ED**: Experience duration; **RT**: Reaction time.

The values given by the ANOVA test (Table 10) show some significant differences between the different types of video games. As far as Duration of experience is concerned, there are significant differences between players of Action games and Strategy games. As for Reaction Time, there are also very significant differences between players of Action games and Strategy games, again as would be expected given the values just described. In responses to DDS6 stimuli, there are only significant differences between the same players, as in responses to IDS6 stimuli. In the responses to the VS12 stimuli, there were no significant differences between groups.

Table 10

Multiple comparisons by ANOVA

Dependent variable	(I) Most played game genre	(J) Most played game genre	Mean difference (I-J)	Standard error	Sig.
ED	Action	Strategy	27,779*	9,004	,004
		RPG	19,494	9,813	,054
	Strategy	Action	-27,779*	9,004	,004
		RPG	-8,285	9,945	,410
	RPG	Action	-19,494	9,813	,054
		Strategy	8,285	9,945	,410
RT	Action	Strategy	331,183*	96,560	,001
		RPG	183,705	105,232	,089
	Strategy	Action	-331,183*	96,560	,001
		RPG	-147,479	106,652	,175
	RPG	Action	-183,705	105,232	,089
		Strategy	147,479	106,652	,175
DDS6	Action	Strategy	-1,013*	,318	,003
		RPG	-,631	,346	,076
	Strategy	Action	1,013*	,318	,003
		RPG	,382	,351	,283
	RPG	Action	,631	,346	,076
		Strategy	-,382	,351	,283
IDS6	Action	Strategy	-,946*	,368	,014
		RPG	-,358	,401	,378
	Strategy	Action	,946*	,368	,014
		RPG	,588	,407	,156
	RPG	Action	,358	,401	,378
		Strategy	-,588	,407	,156
VS12	Action	Strategy	-,471	,612	,447
		RPG	,426	,667	,527
	Strategy	Action	,471	,612	,447
		RPG	,897	,676	,192
	RPG	Action	-,426	,667	,527
		Strategy	-,897	,676	,192

*. The mean difference is significant at 0.05

Caption: **DDS6**: Direct Digit Span 6; **IDS6**: Indirect Digit Span 6; **VS12**: Verbal Span 12; **ED**: Experience duration; **RT**: Reaction time.

Table 11 shows the results obtained from Pearson's correlations, with several significant and even highly significant correlations found. In the Duration of experience variable, there is a significant negative correlation with the responses to the IDS6 stimuli, i.e. the longer the duration of the experience, the lower the number of correct responses to the questions in these stimuli. There are also highly significant positive

correlations with Reaction time (more reaction time equals longer duration of experience); Hours played per week, on average, which means that the more hours the individual plays per week, on average, the longer the duration of the experience, in line with the similar correlation with hours played in the previous week; and with the hours the participant plays Action games, which implies that the more hours they play Action games, the longer the duration of the experience.

As for Reaction Time, there is a significant positive correlation with the hours the participant plays RPG, which means that the more hours of RPG the individual plays, the greater the reaction time; and a significant negative correlation with the hit rate for DDS6 Stimuli, which means that the shorter the reaction time, the higher the hit rate. There are also very significant positive correlations, these being with Duration of experience, as already mentioned; with hours played per week, the week before and spent playing Action games, being consistent with the results seen for Duration of experience. It is also possible to see that reaction time increases when the individual has been playing for more years, with a very significant correlation.

Regarding the DDS6 stimuli hit rate, there is a significant positive correlation with the IDS6 stimuli hit rate, which indicates that when there are good DDS6 values, there will be good IDS6 values, as is the case with the VS12 hit rate, which is a very significant positive correlation. The hours played per week, in the previous week and spent playing Action games correlate significantly, negatively, with the latter being a very significant correlation. This implies that the hit rate decreases when the number of hours played per week increases, especially with the hours spent playing Action games. The number of years the individual has been playing is also strongly and negatively correlated with the hit rate, with the number of hits decreasing as the number of years played increases.

The hit rate on the IDS6 stimuli is positively correlated, very significantly, with the hit rates on the DDS6 and VS12 stimuli, which leads us to deduce that when an individual performs well on the IDS6 stimuli, they will also perform well on the other stimuli. The hours spent playing games per week, in the previous week and spent playing RPG games are negatively correlated, implying that the more hours played, the lower the performance in the IDS6 stimuli, especially when there are more hours spent playing RPG.

The last stimuli to be analyzed are the VS12 stimuli, which have a very significant positive correlation with the DDS6 stimuli hit rate and a not so significant positive correlation with the IDS6 stimuli hit rate. As with the IDS6 stimuli, the hours spent playing games per week, in the previous week and spent playing RPG games are negatively correlated.

With regard to the experience of the participants in video games, it was noted that more years played means more reaction time, more hours played during the week, on average, and in the previous week, with very significant positive correlations here, and there is also a positive correlation with the time spent playing Action games. However, there is also a negative correlation with the hit rate for DDS6 stimuli, which means that more experience can lead to more errors when it comes to this type of stimuli.

The correlations between the DDS6, IDS6 and VS12 stimuli are positive and very significant, which means that the hit rates are heading in the same direction, i.e. when there are hits on the DDS6 stimuli, it is very likely that there will also be hits on the IDS6 and VS12 stimuli, and vice versa. Finally, age was also analyzed, and this variable has a positive correlation with reaction time, which increases as the individual gets older. It also has a very significant positive correlation with the hit rate on DDS6 stimuli, which means that older individuals perform better on these stimuli. On the other hand, it has negative correlations with hours played per week and in the previous week, as well as with hours spent playing Action games. This means that older participants tend to play for less time, especially Action games. However, these values may not be scientifically significant, given the small sample size and the lack of age diversification.

Table 11

Pearson Correlations

		ED	RT	DDS6	IDS6	VS12	Age	HPW	HPLW	HPA	HPS	HPRPG	YP
ED	R	1	,691**	-,343*	-,440**	-,298	-,208	,510**	,494**	,443**	-,118	,091	,303
	Sig.		<,001	,026	,004	,055	,187	<,001	<,001	,003	,458	,565	,051
	N	42	42	42	42	42	42	42	42	42	42	42	42
RT	R	,691**	1	-,547**	-,438**	-,272	-,385*	,883**	,870**	,552**	-,026	,306*	,659**
	Sig.	<,001		<,001	,004	,081	,012	<,001	<,001	<,001	,869	,049	<,001
	N	42	42	42	42	42	42	42	42	42	42	42	42
DDS6	R	-,343*	-,547**	1	,731**	,524**	,569**	-,653**	-,647**	-,415**	-,024	-,295	-,506**
	Sig.	,026	<,001		<,001	<,001	<,001	<,001	<,001	,006	,881	,058	<,001
	N	42	42	42	42	42	42	42	42	42	42	42	42
IDS6	R	-,440**	-,438**	,731**	1	,424**	,265	-,425**	-,415**	-,282	,021	-,343*	-,291
	Sig.	,004	,004	<,001		,005	,089	,005	,006	,071	,893	,026	,061
	N	42	42	42	42	42	42	42	42	42	42	42	42
VS	R	-,298	-,272	,524**	,424**	1	,210	-,315*	-,311*	-,040	,065	-,356*	-,298

12	Sig.	,055	,081	<,001	,005		,182	,042	,045	,802	,683	,021	,056
	N	42	42	42	42	42	42	42	42	42	42	42	42
Age	R	-,208	-,385*	,569**	,265	,210	1	-,397**	-,410**	-,353*	,010	,013	-,317*
	Sig.	,187	,012	<,001	,089	,182		,009	,007	,022	,947	,937	,041
	N	42	42	42	42	42	42	42	42	42	42	42	42
HPW	R	,510**	,883**	-,653**	-,425**	-,315*	-,397**	1	,992**	,581**	,176	,284	,768**
	Sig.	<,001	<,001	<,001	,005	,042	,009		<,001	<,001	,266	,068	<,001
	N	42	42	42	42	42	42	42	42	42	42	42	42
HPLW	R	,494**	,870**	-,647**	-,415**	-,311*	-,410**	,992**	1	,584**	,169	,301	,762**
	Sig.	<,001	<,001	<,001	,006	,045	,007	<,001		<,001	,286	,053	<,001
	N	42	42	42	42	42	42	42	42	42	42	42	42
HPA	R	,443**	,552**	-,415**	-,282	-,040	-,353*	,581**	,584**	1	-,264	-,229	,351*
	Sig.	,003	<,001	,006	,071	,802	,022	<,001	<,001		,092	,144	,023
	N	42	42	42	42	42	42	42	42	42	42	42	42
HPS	R	-,118	-,026	-,024	,021	,065	,010	,176	,169	-,264	1	-,310*	,208
	Sig.	,458	,869	,881	,893	,683	,947	,266	,286	,092		,046	,186
	N	42	42	42	42	42	42	42	42	42	42	42	42
HPRPG	R	,091	,306*	-,295	-,343*	-,356*	,013	,284	,301	-,229	-,310*	1	,278
	Sig.	,565	,049	,058	,026	,021	,937	,068	,053	,144	,046		,075
	N	42	42	42	42	42	42	42	42	42	42	42	42
YP	R	,303	,659**	-,506**	-,291	-,298	-,317*	,768**	,762**	,351*	,208	,278	1
	Sig.	,051	<,001	<,001	,061	,056	,041	<,001	<,001	,023	,186	,075	
	N	42	42	42	42	42	42	42	42	42	42	42	42

**. Correlation is significant at level 0,01.

*. Correlation is significant at level 0,05.

Caption: **DDS6**: Direct Digit Span 6; **IDS6**: Indirect Digit Span 6; **VS12**: Verbal Span 12; **ED**: Experience duration; **RT**: Reaction time; **R**: Pearson correlation; **HPW**: Hours played per week; **HPLW**: Hours played last week; **HPA**: Hours played Action; **HPS**: Hours played Strategy; **HPRPG**: Hours played RPG; **YP**: years played.

4. DISCUSSION

Colzato and colleagues (2012), in their study, concluded that FPS games, which fall into the Action genre, increase the ability to renew the information present in the WM, which leads to better performance [34]. The results of the present study show that Action game players have a lower overall performance compared to Strategy and RPG players, except in the VS12 Stimuli variable, in which they scored higher than RPG players, as described in Table 9. It would have been useful to have a control group in order to understand how university students are influenced by action video games. This would have made it possible to compare results and provide a richer study and discussion.

Barata (2024), about cognitive performance, reported finding significant differences between students who play digital games and students who don't, stating that students who play have better hit rates in Direct and Indirect Digit Spans, as well as in digit sequencing [36]. Cutting and colleagues (2024), in their study on different types of video games and their impact on WM, concluded that Strategy games have the greatest impact on WM, while Action and Puzzle games do not have a scientifically significant impact [35]. Imanian and colleagues (2024) assessed the WM of players of FIFA, a soccer game, which could be included in the Strategy category, as it requires strategic thinking to reach the goal [7]. They reported that players have a higher accuracy rate, indicating a greater number of hits [7]. In our study, we found that players of Strategy-type games had more hits in all the types of stimuli evaluated (DDS6, IDS6 and VS12). Therefore, in the present study, we obtained results that are in line with what the aforementioned authors advocate, with Strategy players having shorter reaction times, as well as a longer duration of experience, with higher hit rates, compared to Action and RPG players, which indicates superior WM performance. Differences were also noted with regard to the Gender variable, with females performing better cognitively than males, showing lower Reaction Time and Duration of Experience values, as well as higher hit rates on the various stimuli.

Throughout this study, several results were obtained which are in line with what other authors have concluded in their studies. It is correct to say, based on the literature, that video games do influence working memory performance [7], [16], [34]-[36]. Thus, the main objective of this research was successfully achieved, since the initial hypothesis "The group of students who play Strategy games have better results in the WM test than the other groups" was proven, in line with previous research.

It could also be hypothesized that playing Strategy video games increases the academic performance of university students. This is because Holmes and Gathercole (2014) carried out a study in which they trained the WM of school-age students using software and found that this training led to an improvement in academic performance [26]. This is in line with what Alloway and colleagues (2013) concluded in their study, in which they corroborated that training WM through computerized programs leads to academic gains [22]. Harvey (2025) also found that WM ability is positively correlated with academic performance, as did Amzil (2022) [19], [25]. Hu and Hu (2023) carried out an empirical review in which they confirmed what these authors had discovered [27]. Thus, given that players of Strategy games perform better in the WM test, it could be hypothesized that this type of video game helps to increase academic performance through WM training.

5. CONCLUSION

The main aim of this study was to assess the influence that different types of video games have on the WM of university students. Despite the limitations, we concluded that video games of the Strategy genre have a greater impact on WM performance, given that university students who reported playing this type of game performed better in the WM test, with shorter reaction times, shorter duration of experience and higher hit rates in all the stimuli presented. These results corroborate what other researchers have discovered about the world of video games and their positive impact on human cognition, thus contributing to scientific progress in this area. With this, it is possible to look to the future with hope that the stigma against video games will diminish, so that we can use them as a useful cognitive training tool, and not just as a recreational and leisure instrument, creating a bridge between Clinical Psychology and Experimental Psychology. It will be important, however, to evaluate the long-term effects through longitudinal studies. The limitations of this study are mainly the small sample size, which was collected by convenience, the difficulty in finding reliable studies on the variables and the subject in question, and the time constraints, since this study had to be carried out over a period of less than a year. The presence of a control group would have been useful to measure the difference between groups who play video games and individuals who do not. However, given the aforementioned time constraints, it was feared that there would not be enough time to collect all this information and analyze all these variables.

For future research, it is recommended that a longitudinal study be carried out to understand the possible effects of video games on cognitive functions and their evolution and permanence over time. Given the results obtained in this study, it is expected that the possible effects will remain positive and relatively constant, given that some of the participants have been playing for a long time. It would also be pertinent to evaluate the academic performance of players of different types of video games, in order to corroborate, or not, the hypothesis that video games can have a positive impact on academic performance.

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