

Original research article

Cognitive Optimisation or Decline ? : Impact Analysis of Playing Video Games on the Cognitive Functions of Adolescents.

Meghna Choudhury¹, Dr. Kiran Buge², Dr. Sunita Nighute³

¹Final Year MBBS Students DVVPFS Medical College Ahmednagar Maharashtra

²Associate Professor Department of Physiology DVVPFS Medical College Ahmednagar Maharashtra

³Professor and Head Department of Physiology DVVPFS Medical College Ahmednagar Maharashtra

Corresponding Author: Dr Kiran Buge

Abstract

The word cognition is derived from Latin word “Cognoscere”, meaning ‘to know’ or ‘to come to know’. The Cognition is defined as ‘the mental action or process of acquiring knowledge and understanding through thought, experience and senses. It implies abilities and methods related to attention, working memory, information processing, problem solving and decision making skills. Playing video games has become extremely popular for recreation among youth in recent years. As of now India is one of the top five mobile gaming markets in the world in terms of number of users. Video games are indeed complex activities, which requires devising plans, solving problems and think on one’s feet. It is being increasingly believed that video-games can boost the brain and a variety of cognitive abilities- increase attention span and concentration, improve spatial visualization and memory.

Aim: To study the impact of playing video games on the cognitive functions of adolescents.

Study type: Cross sectional Observational Study.

Materials and Methods: Standardized tests to be employed for gathering quantitative data from adolescents fulfilling the inclusion and exclusion criteria in order to assess their cognitive functions. Data Analysis: Statistical techniques, percentages and proportions to be applied for data analysis.

Study setting: Residential quarters of Maharashtra.

Keywords: Cognitive Functions, Adolescents, Video Games, Recreation, Brain Boost

Introduction

‘Live-wiring- therein lies the secret of the adaptability of human brain .Our experiences which form the essence of our lives, from the activities we indulge in, to the thoughts and beliefs we hold, constantly rewire and reshape the minuscule details of this dynamic circuitry. Our brain's wiring is unusually incomplete at birth in comparison to other fellow animals . Instead, our genes act as blueprints for the formation of synaptic connections while the environment fine-tunes these links^[1]. The gene is the gun and environment, the trigger. With adolescence being a period of significant cognitive changes, it is imperative to study the effect that external experiences or rather the lack thereof, has, on the intricacies of the neural networks of

adolescent brains^{[2][3]}. Cognitive functions is a collection of abilities and methods involving attention, decision making, alertness, information processing, problem solving and visuospatial skills^{[4][5]}.

It is common knowledge that an appreciable number of adolescents leisurely engage in video games^[6]. Video games are indoor games played on electronic devices like computers and mobiles involving audio visual set-up. It is a sedentary activity requiring focused attention^[7]. During a phase when outdoor activities are essential for growth and development, video games act as hindrance to physical and psycho social progress^[8]. They are largely blamed for promoting aggressive behaviour and antisocial personality among adolescents^[9].

Nonetheless, due to increasing interest, many emerging bodies of research undertaken across the globe are now revealing that video games could indeed mould, sculpt and improve the cognitive abilities of adolescents^[10]. However, limited research has been undertaken to illustrate its effects on their Indian counterparts^[11]. Hence, my study here aims to explore whether video games are truly brain-trainers - enhancing the cognitive functions of adolescents, and help furthering the research in this field of neuroscience.

OBJECTIVES-

1. To quantitatively compare 6 cognitive functions-Attention Span, Alertness, Short-Term Working Memory, Executive Function, Visual Scan Speed and Interference-Inhibition, of the gamers (test group) and non-gamers (control group).
2. To quantitatively compare the effect of video games on cognitive functions of male and female gamers.
3. To determine the video game-genre preferences among gamers and its correlation with cognitive functions.

RESEARCH HYPOTHESIS-

1. Playing video games has a significant effect on the cognitive functions of adolescents.
2. The effect of playing video games is significantly higher on the cognitive functions of male gamers than female.
3. "Strategy" genre of video games has a significant effect on the cognitive functions of gamers.

MATERIAL AND METHODS:

In this cross-sectional study, a total of 100 adolescents living in a residential complex were considered. They were segregated into a test group of gamers and a control group of non-gamers, comprising 50 adolescents each. The age bracket was set at 11-19 years in accordance with WHO definition of adolescence.

A comprehensive list of inclusion and exclusion criteria was prepared in order to divide the participants into the two above mentioned groups. Inclusion criteria common to both the groups were an IQ range of 80-119, and absence of any acute or chronic illness i.e. healthy adolescents. For the purpose of segregation, an inclusion criteria of playing video games for 15-20 hours per week for 2 years was kept for the test group only. The exclusion criteria consisted of a history of colour blindness; recent hand injury; developmental delays and disorders such as dyslexia, autism, cerebral palsy; and musculoskeletal disorders. The male: female ratio was deliberately kept to 1:1 in both the groups in order to fulfil and achieve the second objective of the study. The ratio of strategy: action genre players was also deliberately kept 1:1 in order to fulfil and achieve the third objective of the study.

Method of obtaining sample size- SF-36 health questionnaire and ADHD questionnaire were administered to identify healthy subjects and rule out illnesses from among volunteering adolescents 11-19 years of age. Wechsler Intelligence Scale was used to ensure participants have IQ within the expected range. Self-Prepared Structured Questionnaire was administered to gather demographic data and enquire about desirable gaming habits plus genre for identifying subjects of test and control group. Written Informed Consent was obtained from participants (by guardians in case of minors).

Participants were then divided into 2 categories – test and control group based on gaming habits. They were asked to perform a battery of tests requiring their active participation, individually, which will assess their cognitive abilities across 6 parameters. The subjects will be graded and an average grade will be calculated for both the categories for comparison and analysis.

Study design: Standardized tests were employed to gather quantitative data relevant to the study for comparison and statistical analysis .

Plan of Analysis/ Statistical tools: Expert statistical guidance to be obtained for analysis of data gathered in this study.

Ethical clearance - Ethical approval certificate was obtained from our medical college, Ethical Committee.

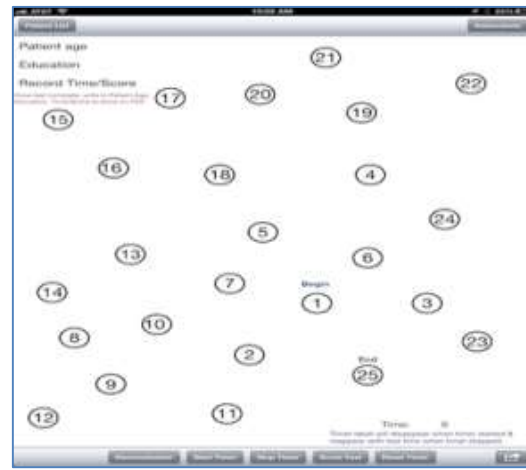
Tests Employed-

VARIABLE NAME	MEASUREMENT METHOD (TEST)	INSTRUMENTS USED (if any)
Executive function-umbrella term involving critical thinking, planning and prioritizing, self-monitoring, self-control, time management, and organization. Governed by prefrontal cortex.	Trail Making Test	Pen- paper
Attention Span - a component of higher cortical cognitive functioning and refers to a person's ability to (a) detect and focus on general environmental stimuli, and (b) select important environmental stimuli.	6 Letter Cancellation Task	Pen-paper
Alertness - a general state of cognitive readiness, reflected in cortical arousal.	Digit Letter Substitution Task	Pen-paper
Interference-Inhibition - Cognitive interference occurs when the processing of one stimulus feature impedes/ inhibits the simultaneous processing of a second stimulus attribute.	Stroop Color and Word Test	Computerized program
Visual Scan Speed - reaction time (RT) needed to correctly search and/or reach for a visual stimulus. VPS depends on six main brain processing systems: auditory-cognitive, attentional, working memory, visuocognitive, visuomotor, and executive.	Corsi Block Tapping Test	Computerized program
Short-Term Working Memory- a framework that refers to structures and processes used for temporarily storing and manipulating information.	Digit Span Test	Oral recollection

STROOP TEST (Image 1)



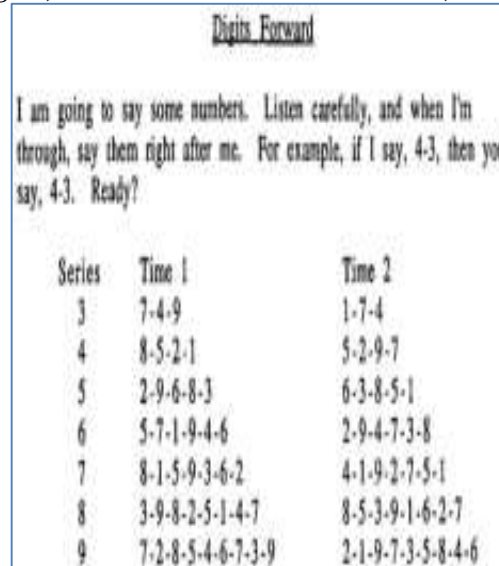
TRAIL MAKING TEST (Image 2)



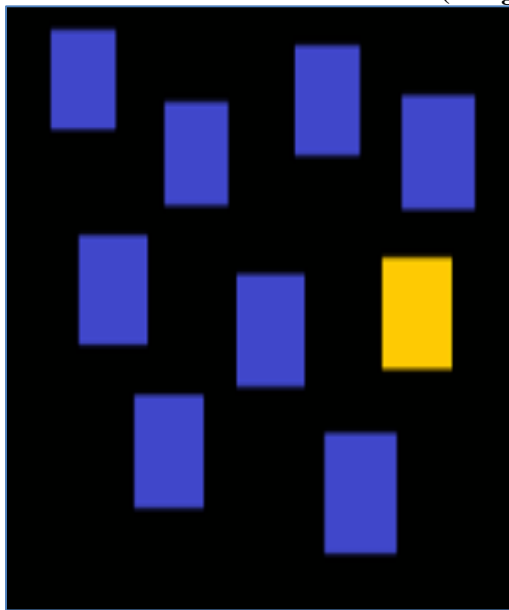
6 LETTER CANCELLATION TEST (Image 3)



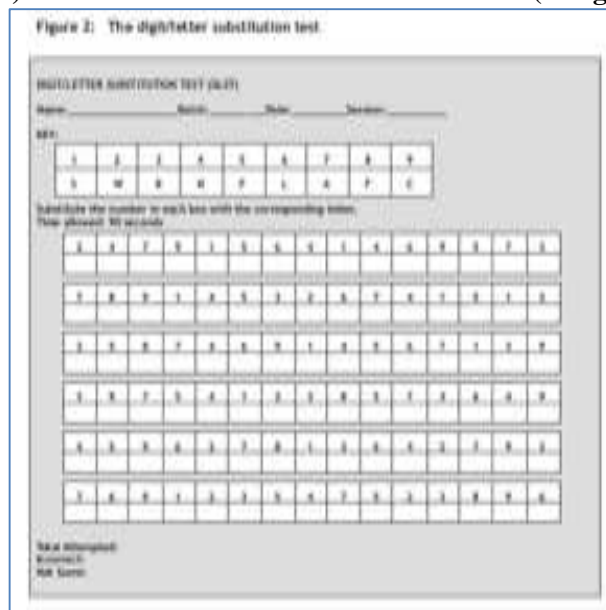
DIGIT SPAN TEST (Image 4)



CORSI BLOCK TAPPING TEST (Image 5)



LETTER SUBSTITUTION TEST (Image 6)



RESULT:

The average grade of control and test group category will be compared and analyzed for its impact on cognitive abilities. The same method is employed for analysis of male and female test sub-group. The statistical analysis was done by paired t-test for studying the correlation between playing video games and the 6 parameters.

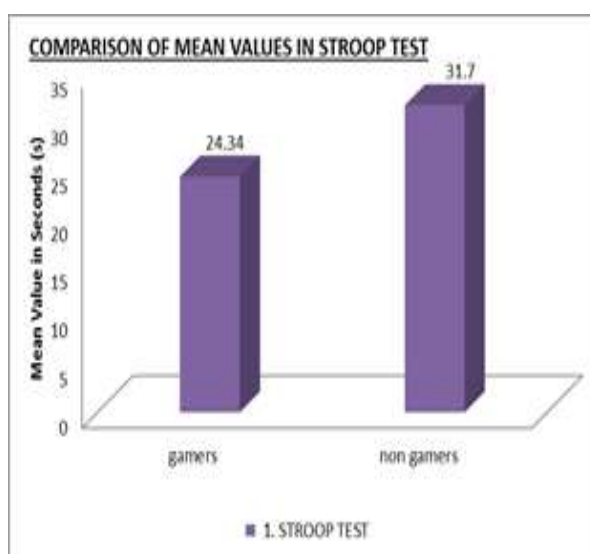
Table 1: Descriptive statistical analysis of t-test with standard deviation in brackets below mean values

Sr. no	Test	Mean values (Gamer)	Mean values (Non Gamer)	t	df	P value
1.	Stroop Test (response inhibition)	20.18	29.7	6.27	29	<0.05
2.	Trail Making Test (executive functioning)	27.16	31.01	0.23	29	<0.05
3.	Letter Cancellation Test (attention span)	44.50	18.86	0.08	29	<0.05
4.	Letter Substitution Test (alertness)	59.25	50.86	1.57	29	<0.05
5.	Digit Span Test (short term working memory)	6.56	5.6	0.27	29	<0.05
6.	Corsi Block text (visuospatial memory)	5.6	1.68	0.684	29	>0.05

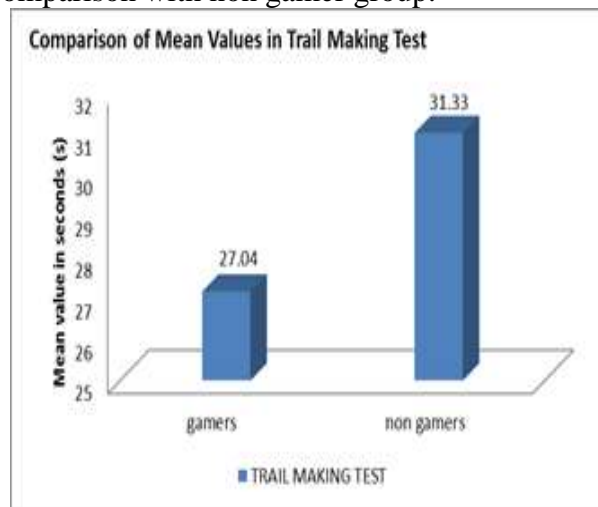
According to Table 1, there is positive association between playing video games and 5 cognitive functions- Executive Function, Short Term Working Memory, Alertness, Attention Span, Interference-Inhibition, of adolescents. No significant difference was detected between the groups with respect to their Visual Scan Speed.

The following tables illustrate the performance of gamers and non-gamers w.r.t each parameter. For Stroop test and trail making test, the mean values are obtained in seconds. For letter substitution and 6 letter cancellation test, the mean values are obtained as a score out of 90. The mean values for digit span and Corsi block tapping test are scored out of 8.

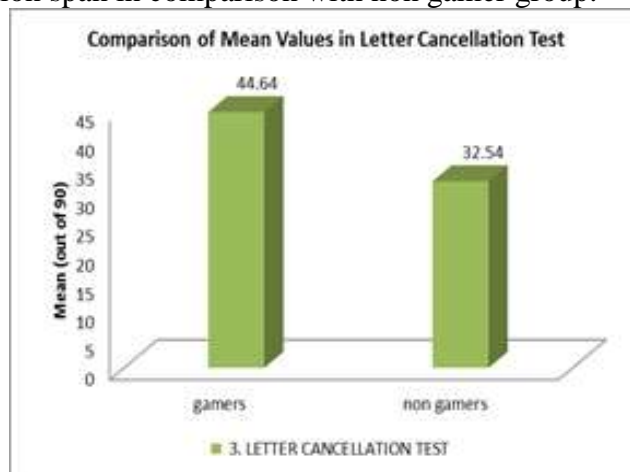
1. Stroop test- Gamer group took significantly lesser time in seconds, implying higher Interference-Inhibition, in comparison to non-gamer group.



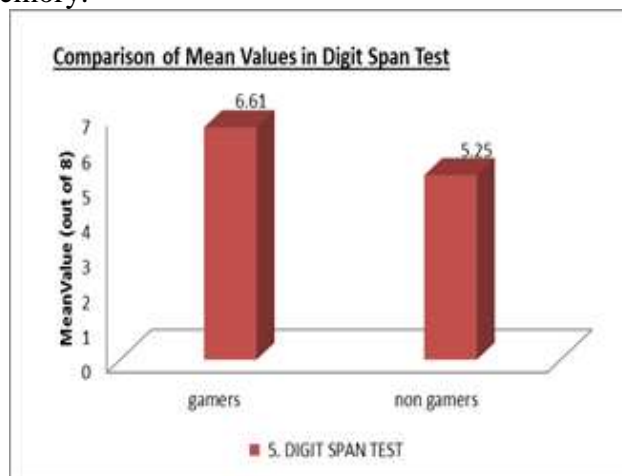
2. Trail making test- Gamer group took significantly lesser time in seconds, implying better executive function in comparison with non gamer group.



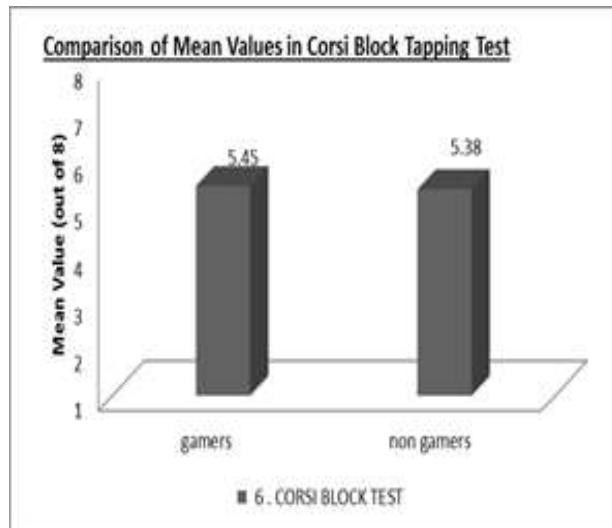
3. Letter cancellation test- Gamers group scored significantly higher out of 90 on a average, implying better attention span in comparison with non gamer group.



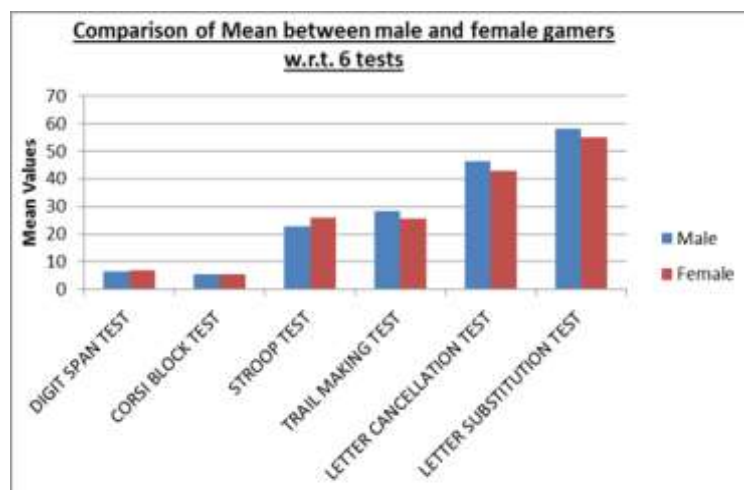
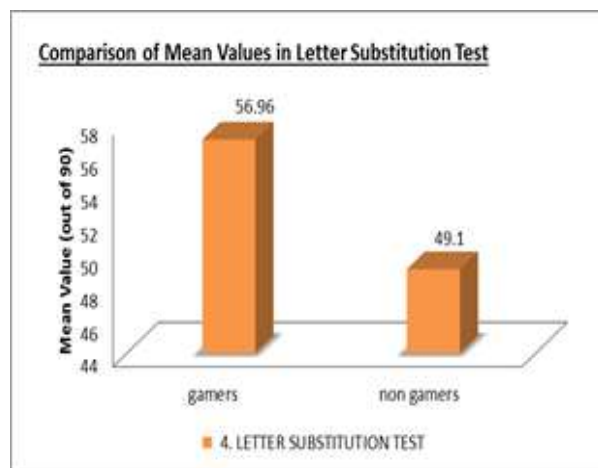
4. Digit Span test- Gamers scored significantly higher out of 8 in an average, implying better short term working memory.



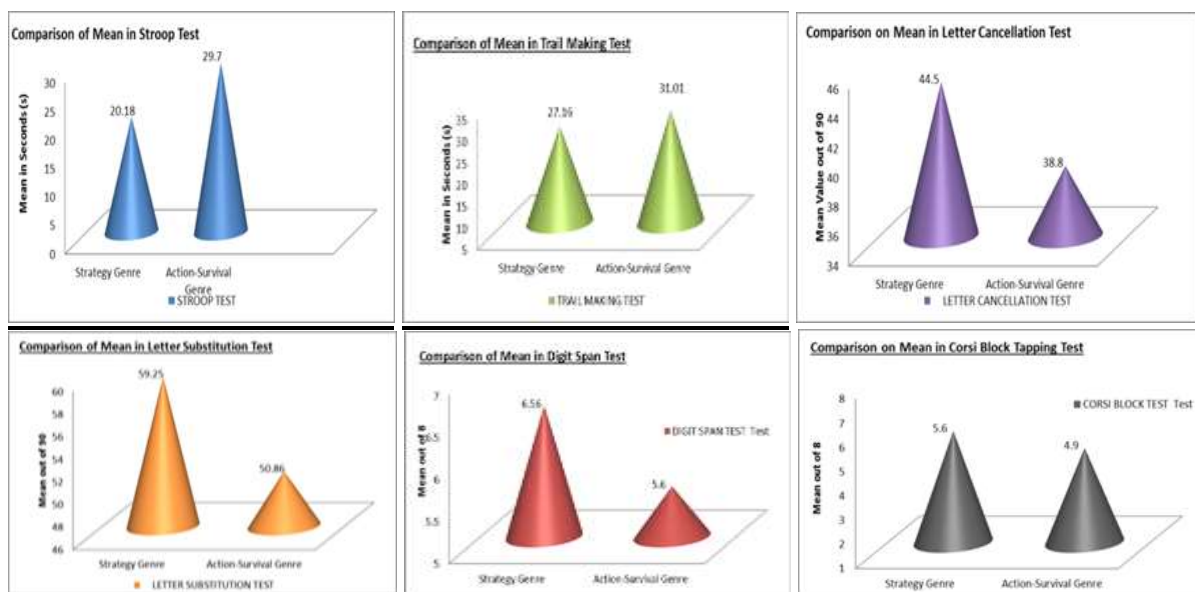
5. Corsi block tapping test- the gamers did not perform significantly better than the non gamers, though their mean value still remains higher.



6. letter substitution test- gamer group scored significantly higher out of 90, implying higher level of alertness in comparison with non gamer group.



In table 2, we can appreciate that though the male gamers scored more than female gamers in letter substitution, letter cancellation and stroop test, there was no significant difference between the performance of male and female gamers. The female group fared better in digit span, corsi block tapping and trail making test, but not statistically significant.



Gaming- genre preference- From the above graphs, we can appreciate that out of the two broadly categorised genres of gaming, the gamer playing strategy genre of video games showed a significantly better performance across all 6 parameters, in comparison to players of action genre.

DISCUSSION:

The popular media is replete with “facts” that paint a notorious reputation of video games in the eyes of the people. From having adverse effects on brain to hampering social skills and personality development, an evident bias has been created about video games. However, to begin with, how specifically can we define what video games really mean? Millions of types, sub-types, genre profiles, age specificity, varieties of user interfaces make it difficult to give it a scientific predictive definition- which is why there isn't any. This lack of a scientific definition makes it difficult to categorize and limits our understanding when a scientific study is undertaken regarding it. The sky is the limit, and one has to narrow down the criteria for what video games really mean in the context of the study in question. One question which constantly looms over us is that to what extent can video games enhance cognition? Another limitation of cross sectional study is the baseline differences in the individuals' own learning pace and grasping abilities. A new gamer with naturally better focus and observation can trump a seasoned gamer who takes time to learn skills. Comprehensive assessment and selection of individuals with similar learning curve is hardly ever undertaken.

One common observation which has been made from this study and the literature review, is the importance of the genre of gaming which is the principal factor in determining the outcome of its effects on cognitive abilities. Genre matters the most above all.^[3] In addition, we need to stress on the importance of controlled training regimens with progressively challenging and mind-teasing gaming models which can put our executive function, attention span to test. Time intensive and effective routines are an imperative if we were to overcome the flattening of the learning curve. If we manage to curate video games which offer a complete package of recreation and learning, all practical implications of video games can be realized across all age groups- from rehabilitation of amblyopia to vigilance training of surgeons and slowing down of dementia.^[3]

CONCLUSION:

1. There is significant effect of playing video games on 5 cognitive functions- Executive Function, Short Term Working Memory, Alertness , Attention, Interference-Inhibition , of adolescents. There is no significant effect of playing video games on visuospatial memory of the adolescents.
2. There is no significant difference between the performance of male and female gamers.
3. Strategy genre of video games has a significant effect of the cognitive functions of gamers.

REFERENCES

1. Eagleman D The brain: The story of you. Canongate Books; 2015 Nov 5
2. Kuhn D. Do cognitive changes accompany developments in the adolescent brain?. *Perspectives on Psychological Science*. 2006 Mar;1(1):59-67.
3. Bavelier D, Green CS, Han DH, Renshaw PF, Merzenich MM, Gentile DA. Brains on video games. *Nature reviews neuroscience*. 2011 Dec;12(12):763-8.
4. Boot, W. R., Kramer, A. F., Simons, D. J., Fabiani, M., Gratton, G. (2008). The effects of video game playing on attention, memory, and executive control. *Acta Psychologica*, 129, 387–398.
5. Green CS, Bavelier D. Effect of action video games on the spatial distribution of visuospatial attention. *Journal of experimental psychology: Human perception and performance*. 2006 Dec;32(6):1465.
6. Granic I, Lobel A, Engels RC. The benefits of playing video games. *American psychologist*. 2014 Jan;69(1):66.
7. Özçetin M, Gümüştaş F, Çağ Y, Gökbay İZ, Özmel A. The relationships between video game experience and cognitive abilities in adolescents. *Neuropsychiatric disease and treatment*. 2019;15:1171.
8. Saravanan M. Effects Of Video Game Playing On Children And Adolescent Psychosocial Behaviour (Doctoral dissertation).
9. Naskar S, Victor R, Nath K, Sengupta C. “One level more:” A narrative review on internet gaming disorder. *Industrial psychiatry journal*. 2016 Jul;25(2):145.
10. Achtman RL, Green CS, Bavelier D. Video games as a tool to train visual skills. *Restorative neurology and neuroscience*. 2008 Jan 1;26(4, 5):435-46.
11. Chandra S, Sharma G, Salam AA, Jha D, Mittal AP. Playing action video games a key to cognitive enhancement. *Procedia Computer Science*. 2016 Jan 1;84:115-22.