

ORIGINAL RESEARCH

Effect of mild to moderate level of Internet addiction on cognition using computerised 'Victoria Stroop Test'

¹Dr. Pooja Sakshi, ²Dr. Chandan Kumar, ³Dr. Manish Kumar, ⁴Dr. Tarun Kumar, ⁵Dr. Sunita, ⁶Dr. Niska Sinha

^{1,2}Assistant Professor, ^{3,5}Additional Professor, ⁴Professor, Department of Physiology, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India

⁶Assistant Professor, Department of Psychiatry, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India

Correspondence:

Dr. Tarun Kumar

Professor, Department of Physiology, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India

Email: tarunigims2018@gmail.com

ABSTRACT

Background: Nowadays, internet is being extensively used in all scientific, educational, business, cultural, and political areas. But there is growing concern about the addictive nature of the Internet and its side effects on cognitive functions.

Aims and Objectives: This study was aimed to investigate the effect of mild to moderate level of Internet addiction on cognition by using computerised 'Victoria Stroop Test (VST)'.

Materials and methods: This study was a cross-sectional study. Questionnaire for internet addiction test (IAT) and sleep quality were administered among 100 healthy adults. They were divided in two groups based on their internet use (45 subject with normal internet use and 55 with mild or moderate level of internet addiction) and matched for distribution of Age, Weight, Height, BMI and sleep quality. The Psychology Experiment PEBL-Victoria Stroop Test was used to evaluate cognitive function. The Stroop effect was compared by independent t-test and multiple correlation analysis was performed for Stroop effect with all components of IAT using IBM SPSS (version 28.0).

Results: 45% of subjects were using the internet normally whereas Mild and Moderate level of Internet addiction was present in 39% and 16% of subjects respectively. There were significantly less Stroop effect (0.99 ± 0.28) [$P < 0.05$] and less attempts (25.95 ± 2.09) [$P < 0.05$] made by subjects with mild to moderate Internet addiction than Normal level of internet user. IAT Scores of all component of Internet addiction were negatively correlated with Stroop effect except for 'Neglect Social Life' ($R = 0.23$, $P < 0.05$).

Conclusion: Participants with mild to moderate level of internet had better cognitive performance than Normal level of internet user.

Keywords: Internet Addiction Test, Victoria Stroop Test, Internet Addiction.

INTRODUCTION

The Internet is a cognitive technology, making information easily accessible first-time human history. It thereby transforms our memory practices [1]. Nowadays, internet has become indistinct part of life. As of 31 Mar 2021, more than 5.1 billion people (almost 65.6%) of the world's population have access to the Internet [2].

To prevent the spread of COVID-19, nearly 3 billion people worldwide were required to stay at home, and over 130 countries have ordered different levels of restrictions to limit movement in order [3]. A study revealed that probable problematic internet use prevalence has increased by 1.5 times during the pandemic may be due to lifestyle changes imposed by the coronavirus 2019 (COVID-19) [4].

Computers and internet are very effective communicative tools in all scientific, business, educational, cultural, and political areas. However, various theorists had expressed their concerns about the adverse effects of the Internet on cognition. Internet addiction (IA) was introduced as a new disorder in mid-1990s. Since then, there is growing concern about the addictive nature of the Internet [5,6]. Several studies have been conducted on internet addiction. Treuer [7], Yellowlees [8], and Li and Chung [9] stated that internet overuse has a detrimental effect on students' psychological well-being. In addition, they noted that students who use internet excessively show more pathological and psychological problems than those who do not.

With such severe negative impacts on life, the seriousness of this problem has been increasingly recognized. But still, it is not officially recognized as a disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), [10].

To assess several components of executive functions, such as cognitive flexibility, selective attention, cognitive inhibition, and information processing speed, the Stroop Test (Stroop, 1935) [11] is among the most frequently used tools. This task measures the ability with which an individual can maintain a goal and inhibit an automatic, over learned response, in favour of a less familiar one [12]. Several versions of the Stroop test have been developed. Among which, the Victoria Stroop Test (VST) is sensitive to several neuropsychological states, namely frontal lobe damage, mild cognitive impairment and dementia [13]. It examines 3 basic processes: selective attention, word reading, and colour naming as a reflection of frontal cortical area activity. Performance measures the individual's cognitive rigidity-flexibility, information processing speed, ability to change goals in line with changing demands, parallel processing of stimuli, and the ability to resist automatic processes [14]. Considering the importance of internet addiction and its effects in people's lives, this study aims to determine the effect of internet use on cognitive functions among young adults.

METHOD AND MATERIAL

SAMPLE

This study was conducted in department of physiology. The study protocol was approved by the institutional ethical committee. The design of study was across-sectional study. 100 young adults of age 18 -25 years both male and female who gave written informed consent for this study were included. They were divided in two groups based on their internet use (45 subject with normal internet use and 55 with mild or moderate level of internet addiction).

Exclusion criteria: Subjects with history of psychiatric or neurological illness, acute or chronic diseases and those, who were physically unable to hear, read or understand written and explained instructions properly, or had motor deficit that affects writing skills were excluded from the study.

INSTRUMENTS

KIMBERLY'S INTERNET ADDICTION TEST (IAT)[15]

Most utilized instrument to measure addiction to internet are Internet addiction test (IAT), the Young of the Internet Addiction Questionnaire (YDQI), the Chen's Internet addiction scale (CIAS) and the Internet addiction scale (IAS). The Internet Addiction Test (IAT) was created by Young (1998) to evaluate the existence and intensity of internet addiction in a North

American population sample. It comprises of 20 questions based upon a five-point Likert scale which measures the severity of internet addiction. Some specific questions are grouped in different categories to signify a pattern of symptom and complaints like Salience, Excessive Use, Neglect Work, Anticipation, Lack of Control and Neglect Social Life. The highest score is 100.

A higher score signifies a higher level of intensity in internet obsession and addiction. A total score that does not exceed 30 indicates a normal level of internet consumption, whereas total scores between 31 and 49 indicates mild level addiction, 50–79 designates moderate addiction, and scores of 80 or above reflect a severe internet dependency [16].

PITTSBURGH'S SLEEP QUALITY INDEXES (PSQI) [17]

It is one of the most widely-utilized self-reported questionnaires that assess sleep quality over a 4-week time interval. The survey contains set of questions, each weighted on a 0-3 interval scale indicating no, moderate and severe sleep disorder respectively. The lower scores correlate to better sleep quality.

PEBL STROOP COLOR WORD TEST [18,19]

Victoria version of Stroop Color Word Test will be used. The VST uses 3 conditions in which the participants must name the color of dots (D), neutral words (W), and words for a color (C) printed in another color.

The responses are in Part D (Dots): the subject is instructed to name as quickly as possible the color of 24 dots printed in blue, green, red, or yellow ink. Each color is used six times, and the four colors are arranged in a pseudorandom order within the array, each color appearing once in each row. Part W (Words) is similar to Part D, except that the dots are replaced by common words, printed in lowercase letters. The subject is required to name the colors in which the stimuli are printed and to disregard their verbal content. Part C (Colors) is similar to Parts D and W, but here the colored stimuli are the color names "blue, green, red, and yellow" printed in lowercase so that the print color never corresponds to the color name. The respondent is asked to inhibit incongruent inferences, the first and second parts of the test are used to measure cognitive speed, and the third part is used to measure response inhibition. Stroop effect is the delay in reaction and processing [20–22]. Longer response duration indicates impaired processing [20]. For each condition, the completion time and the number of errors are compiled, and interferences scores are derived by calculating the ratio between the time required to name the colors in the Interference and the time required to name the color of dots in the Dot conditions (high interference) [12]

STATISTICAL ANALYSIS

The data were described using means \pm standard deviations for continuous variables and counts and percentages for categorical variables. Likert's scale was used to get scores of IAT. Two groups formed on basis of IAT Score were compared and analyzed by independent t-test for Stroop effect. A multiple correlation analysis was performed for number of attempts in part C and C/D with all components of IAT. All statistical analysis was performed by using IBM SPSS (version 28.0). The significance level was set at $P < 0.05$.

RESULTS

The study questionnaires and computerized VST were administered in 100 subjects. Among them 45 subjects were normally using the internet and 55 subject had mild or moderate level of internet addiction. On this basis 2 groups were formed. As shown in table 1, no significant difference was observed in distribution of Age, Weight, Height, BMI and PSQI in between the

2 groups.

Table 1 Subject characteristics and studied variables

Parameters	IAT score ≤ 30 , (Normal level of internet use) n=45 [Mean \pm SD]	IAT score 30-79, (Mild to moderate Internet addiction) n=55 [Mean \pm SD]	t stat	df	P value
Age	20.42 \pm 1.14	20.75 \pm 1.02	-1.48	89	0.14
Weight	59.16 \pm 10.98	61.68 \pm 9.81	-1.20	89	0.23
Height	163.44 \pm 9.82	165.14 \pm 8.19	-0.93	86	0.36
BMI	22.11 \pm 3.46	22.64 \pm 3.44	-0.76	94	0.45
PSQI	5.96 \pm 3.75	5.25 \pm 2.65	0.84	75	0.40

IAT: Internet Addiction Test, SD: Standard Deviation

45% of subjects were using the internet normally whereas mild and moderate level of Internet addiction was present in 39% and 16 % of subjects respectively (Table 2).

Table 2 Percentage of subject having different levels of internet addiction

IAT score	PATTERN	% OF SUBJECTS
<30	Normal level of Internet usage	45
31-49	Mild level of Internet addiction	39
50-79	Moderate level of Internet addiction	16
80-100	Severe level of Internet addiction	0

IAT= Internet addiction Test

No subject was severely addicted to internet. The two groups were compared for Number of attempts in part C and C/D (Table 3).

Table 3 Comparison of VST scores between groups

Stroop test	Normal level of internet use IAT score ≤ 30 , n=45 [Mean \pm SD]	IAT score 30-79, (Mild to moderate Internet addiction) n=55 [Mean \pm SD]	t stat	df	P value
No. of attempts in part C	27.49 \pm 3.58	25.95 \pm 2.09	-2.56	68	0.01
C/D	1.16 \pm 0.29	0.99 \pm 0.28	-2.95	92	0.00

IAT: Internet Addiction Test, SD: Standard Deviation

There were significantly more attempts made by Normal level of internet user than subjects with mild to moderate Internet addiction. Similarly, higher interference was found in Normal level of internet user. Multiple correlation analysis (Table 4) showed that IAT Scores of all component of Internet addiction were negatively associated with Stroop effect except for 'Neglect Social Life'.

Table 4 Corelation of items of IAT and VST scores. (r=Pearson's correlation coefficient)

Stroop test	Salience	Excessive Use	Neglect Work	Anticipation	Lack of Control	Neglect Social Life	IAT total score
No. of attempts in part C	-0.22*	-0.19	-0.22*	-0.26*	-0.15	0.27*	-0.21*
C/D	-0.17	-0.24*	-0.22*	-0.12	-0.18	0.23*	-0.21*

* $P < 0.05$. IAT: Internet Addiction Test, VST: Victoria Stroop Test, Part D: Dots, Part W: Words, Part C: Colors, SD: Standard Deviation

DISCUSSION

The aim of this study was to compare Stroop effect between Normal level of internet user and subjects with mild to moderate level of Internet addiction. It was found that mild to moderate level of Internet addiction had significantly decreased the Stroop effect. Bostrom and Sandberg claimed that the “World Wide Web and e-mail are among the most powerful kinds of cognitive enhancement software developed to date” [23]. Another study found the Internet users tended to score higher on cognitive tests than non-users.[24] Therefore, findings in our study supports the results of these studies. It might have occurred due to mild to moderate internet use.

As evident by this study, IAT Scores of all component of Internet addiction such as Saliency, Excessive Use, Neglect Work, Anticipation, and Lack of Control were negatively associated with Stroop effect except for ‘Neglect Social Life’. Similarly, in a study done by Nile et al, it was found that people with larger social networks and greater social activities participation had better cognitive function [25]. Further, some studies found extensive media multi- tasking during childhood and adolescence could also negatively impact cognitive development through indirect means, by reducing engagement with academic and social activities, as well as by interfering with sleep [26].

There are several factors to consider why Internet addiction showed negative associations with Stroop effect in our sample of healthy young adults. First, it is possible that they had only mild to moderate level of Internet addiction not severe level of addiction. Second, in this study we matched both group for sleep quality as poor sleep quality especially sleep disturbances, daytime dysfunction, and long sleep duration are found to be associated with Cognitive impairment [27].

CONCLUSION

Our findings showed that mild to moderate level of internet users had lesser Stroop effect that is, better cognitive performance than Normal level of internet users. Whereas Neglect Social Life was found to be significantly associated with high Stroop effect. Future studies with larger sample sizes are needed to fully explore the effect of Internet addiction on different types of cognitive functions among young adults in India.

REFERENCE

1. Heersmink R. The Internet, Cognitive Enhancement, and the Values of Cognition. *Minds & Machines*. 2016;26:389–407.
2. World Internet Usage and Population Statistics (www.internetworldstats.com) Elaboration of data by International Telecommunication Union (ITU), United Nations Population Division and other reliable sources. (Accessed October 2021)
3. Winther DK, Byrne J. Rethinking screen-time in the time of COVID-19. UNICEF, <https://www.unicef.org/globalinsight/stories/rethinking-screen-time-time-covid-19>. 2020 Apr 7.
4. Oka T, Hamamura T, Miyake Y, Kobayashi N, Honjo M, Kawato M, Kubo T, Chiba T. Prevalence and risk factors of internet gaming disorder and problematic internet use before and during the COVID-19 pandemic: A large online survey of Japanese adults. *Journal of Psychiatric Research*. 2021 Oct 1; 142:218-25.
5. Young KS. Psychology of computer use: XL. Addictive use of the Internet: a case that breaks the stereotype. *Psychological Reports*. 1996; 79: 899–902.
6. Griffiths M. Behavioural addictions: an issue for everybody?. *Journal of Workplace Learning*. 1996; 8(3): 19–25.

7. Treuer T, Fabian Z, Furedi J. Internet addiction associated with features of impulse control disorder: is it a real psychiatric disorder? *J Affect Disord.* 2001; 66: 283. PMID: 11686127
8. Yellowlees P, Marks S. Problematic Internet use or Internet addiction? *Comput Human Behav.* 2005; 23(3): 1447-53.
9. Li S, Chung T. Internet function and Internet addictive behavior. *Comput Human Behav.* 2006; 22: 1067-71. doi: 10.1100/2011/308631
10. American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC
11. Stroop JR. Studies of interference in serial verbal reaction. *Journal of Experimental Psychology.* 1935;18:643–662.
12. Strauss E, Sherman EMS, Spreen O (2006). *A compendium of neuropsychological tests (3rd ed.)*. New York: Oxford University Press.
13. Tremblay MP, Potvin O, Belleville S, et al. The Victoria Stroop Test: Normative Data in Quebec-French Adults and Elderly. *Arch Clin Neuropsychol.* 2016;31(8):926-933. doi:10.1093/arclin/acw029
14. Bingol D, Oguzhanoglu NK, & Yucens B. Cognitive functions and childhood traumas in panic disorder. *Dusunen Adam: Journal of Psychiatry & Neurological Sciences.* 2021;34:114-122.
15. Young KS. Internet addiction: the emergence of a new clinical disorder. *Cyber Psychol Behav.* 1998;1:237–44. doi: 10.1089/cpb.1998.1.237
16. Young KS, Abreu CN. (2011). *Internet Addiction: A Handbook and Guide to Evaluation and Treatment*. Hoboken, NJ: John Wiley and Sons.
17. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index (PSQI): A new instrument for psychiatric research and practice. *Psychiatry Research.* 1989;28:193-213.
18. Mueller ST, & Piper BJ. The Psychology Experiment Building Language (PEBL) and PEBL Test Battery. *Journal of neuroscience methods.* 2014;222:250–259.
19. Mueller ST (2012). *The Psychology Experiment Building Language, Version 0.13*. Retrieved from <http://pebl.sourceforge.net>
20. Glaser WR, Glaser MO. Context Effects in Stroop-Like Word and Picture Processing. *J Exp Psychol Gen.* 1989; 118:13-42. [CrossRef]
21. Karakas S, Erdogan E, Sak L, Soysal AS, Ulusoy T, Ulusoy IY, et. al. Stroop test TBAG form: Standardization studies for Turkish culture, reliability and validity. *Turkish Journal of Clinical Psychiatry.* 1999; 2:75-88. [Turkish]
22. MacLeod CM. Half a century of research on the Stroop effect: an integrative review. *Psychol Bull.* 1991; 109:163-203.
23. Bostrom N, & Sandberg A. Cognitive enhancement: Methods, ethics, regulatory challenges. *Science and Engineering Ethics.* 2009;15(3):311–341.
24. Yu D & Fiebig DG. Internet use and cognition among middle-aged and older adults in China: A cross-lagged panel analysis. *The Journal of the Economics of Ageing.* 2020;17:100262.
25. Nie Y, Richards M, Kubinova R et al. Social networks and cognitive function in older adults: findings from the HAPIEE study. *BMC Geriatr.* 2021;21:570.
26. Van Der Schuur WA, Baumgartner SE, Sumter SR et al. The consequences of media multitasking for youth: a review. *Comput Human Behav.* 2015;53:204-15.
27. Tian R, Bai Y, Guo Y, Ye P and Luo Y. Association Between Sleep Disorders and Cognitive Impairment in Middle Age and Older Adult Hemodialysis Patients: A Cross-

Sectional Study. Front. Aging Neurosci. 2021;13:757453. doi:
10.3389/fnagi.2021.757453