Biomedical & Pharmacology Journal, December 2022. Vol. **15**(4), p. 2185-2191

Neuropsychological Evaluation of Cognitive Failure and Excessive Smart Phone Use: A Path Model Analysis

Kinjari Kancharla*, Sagayaraj Kanagaraj and C.N. Ram Gopal*

Faculty of Allied Health Sciences, Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education, Kelambakkam - 603 103, Tamil Nadu, India.
*Corresponding Author E-mail: kinjarik@gmail.com

https://dx.doi.org/10.13005/bpj/2555

(Received: 13 April 2022; accepted: 13 October 2022)

Smartphones and other mobile-related technologies are commonly viewed as indispensable tools for enhancing human cognition; prolonged use of these devices may have a detrimental and long-term effect on users' abilities to think, recall, and pay attention. The purpose of this study is to determine the effect of phone usage on people's cognitive capacities. Excessive smartphone use may have a detrimental effect on an individual's mental health. It has the ability to affect an individual's memory, capacity for effective thought, and cognitive and learning capacities. The purpose of this study is to determine the effect of smartphone use on people's cognitive abilities. Excessive smartphone use and cognitive failures were measured using the Smartphone Addiction Scale (Kwon et al., 2013) and the Cognitive Failures Questionnaire (Broadbent et al., 1982; revised by Wallace et al., 2002), which were used to collect data from 200 young adults using a purposive sampling strategy. Pearson's product-moment correlation was used to measure the strength of the relationship between the variables, and regression analysis was used to measure the function relating to the variables. The results of the study conclude that excessive smartphone use is related to forgetfulness, distractibility, and false triggering. Hence, it can be concluded that excessive use of smartphones may be prone to cognitive failures such as forgetfulness, distractibility, and false triggering. Excessive smartphone use has been linked to a higher risk of cognitive impairment.

Keywords: Cognitive Failure; Memory; Smartphone Use; Young Adults.

The phone has grown from a device used solely for communication–calls–to a computer-replacement device capable of online surfing, gaming, instant communication via social media platforms, and work-related productivity applications. Within the last decade, the Western world has witnessed a remarkable expansion in the use of mobile technologies. While smartphones have become a more integrated part of everyday life, they have also become more capable of enhancing, if not entirely replacing, critical cognitive processes. With the ability to act as a telephone directory, appointment scheduler, tip calculator, navigator, and gaming device, smartphones appear capable of doing an unlimited number of cognitive activities and satisfying a significant number of our affective demands on our behalf.[1] While smartphones clearly keep us connected, many people have developed an unhealthy obsession with them.

Smartphones have a tendency to immediately capture the attention of those engaged in an activity that is unrelated to the smartphone.[2-4] A three-second distraction such as reaching for a

cell phone is sufficient to divert attention away from a cognitive task[5,] and it has been demonstrated that the mere possession of a smartphone has a detrimental effect on working memory capacity, fluid intelligence, and attentional processes.[4-6] Additionally, compulsive use of these devices can cause disruptions in the workplace, school, and personal relationships when individuals spend more time on social media or gaming than on actual human interaction. Also, a recent study reveals that psychological dependence on a mobile phone diminishes the effect of smartphone presence on cognitive function.[4]

Cognitive failures are considered a normal occurrence in everyday life and typically manifest as lapses in attention. Exogenous variables, such as distracting stimuli, or endogenous processes, such as ruminations or daydreaming, may contribute to these attentional deficiencies.[7] This distraction is detrimental to following cognitive tasks, resulting in increased errors as the distraction interval lengthens, which is especially noticeable in the classroom where students who use their phones in class take less notes[8] and perform poorly academically.[9-10] Students at college are likely to suffer unfavorable repercussions as a result of these exogenous disruptions.[11-14] Indeed, recent research indicates that smartphone use during class and study time is distracting and reduces information retention.

Similarly, the sound of a notification from the smartphone or even the mere existence of a smartphone can impair a college student's ability to concentrate on a lecture, and both the ringing of a cell phone during class and the mere presence of a smartphone, negatively affect college students' performance.[10-12,15] While smartphones and other mobile technologies have the potential to alter a wide variety of cognitive areas, empirical research on the cognitive effects of smartphone technology is currently fairly limited. This is acceptable, given that technology is still continually evolving. As a result, it is critical to understand how smartphones impact us in order to take the required precautions to avoid harmful outcomes.[1] The aim of the present study is to investigate the correlation between smartphone use and different dimensions of cognitive failure in daily life among young adults.

MATERIALS AND METHODS

Hypotheses: Based on the review of the literature, the following alternative research hypotheses were formed:

H_1 There will be a significant relationship between smartphone use and forgetfulness.

H_2 There will be a significant relationship between smartphone use and distractibility.

H_3 There will be a significant relationship between smartphone use and false triggering.

Sample Description

An ex-post facto survey research design was used, where the researchers examined the operation of variables without manipulating them to assess the relationship between smartphone use and cognitive failure variables in young adults. A total of 200 young adult students from Chennai, India, were included in the study out of which 99 are male and 101 are female. The average was 22.54± 2.75 years. A purposive sampling technique was used in the study where participants between the ages of 18 and 35 were included, and participants above age 35 were excluded. Similarly, participants diagnosed with severe cognitive impairment and other psychiatric disorders were excluded.

Tools Used

The Smartphone Addiction Scale by Kwon et al., 2013 is a 33-item self-report measure of problematic smartphone use habits.[17] The measure has a six-point Likert scale response format, with a maximum total score of 198. Responses range from "1" (strongly disagree) to "6" (strongly agree). In the initial validation research, the measure revealed a relatively good level of internal consistency (Cronbach's alpha = 0.967). A high score implies increased smartphone use and is associated with a greater risk of smartphone addiction.

The Cognitive Failures Questionnaire by Broadbent et al., 1982,[17] focuses on cognitive failures in daily life and was developed to examine cognitive failures in three critical areas: perception, memory, and motor performance. Later, researchers recognized that the CFQ has multiple additional elements, with Wallace and his colleagues presenting a four-factor solution.[18] They discovered four factors: Memory, Distractibility,

Blunders, and: Names. Later, Rast and his colleagues did a study and found that CFQ has three factors: Forgetfulness, Distractibility, and False Triggering.[19] Subscale scores representing these aspects are obtained by adding the scores from all relevant items. The simplest way to score the scale is to add up the ratings of the 25 separate items, providing a score between 0 and 100.

Procedure

Online and offline versions of the Smartphone Addiction Scale and Cognitive Failure Questionnaire were accessible to the participants, and the participants chose whether to fill out the questionnaire online or not based on their comfort and desires. Before the questionnaire was distributed, participants signed an informed consent form, and only after consent was obtained the Smartphone Addiction Scale and Cognitive Failure Questionnaire were distributed for data collection. The participants were informed that "There is no correct or incorrect response. Kindly circle/click the values between 1 and 7 that most accurately reflects your memory assessment. Consider your options carefully and strive to be truthful. Your responses will be kept private. Kindly respond to all questions."

Additionally, participants were informed of their choice to withdraw and guaranteed that the information gathered would be kept confidential and utilized for research purposes only. 140 individuals completed the Smartphone Addiction Scale and Cognitive Failure Questionnaire, and 60 completed the data via the Smartphone Addiction Scale and Cognitive Failure Questionnaire's online form.

Data Analysis

Following data collection, it was analyzed using SPSS 20.0 (Statistical Package for the Social Sciences). Descriptive statistics and Pearson's product-moment correlation were utilized to determine the strength of the association between the variables. Also, regression analysis was used to measure the function relating to the variables.

Table 1. Demographic details of the participants

Variables	n = 200	Percentage %
Gender		
Male	99	49
Female	101	51
Age		
18	15	6
19	35	15
20	28	12
21	45	20
22	32	14
23	18	8
24	25	11
27	32	14

RESULTS AND DISCUSSIONS

Smartphone usage levels are observed among young adults as the increased amount of smartphone use is associated with a greater risk of smartphone addiction. From the results, we can see that 55% of young adults' smartphone usage is at a normal level, and about 45% of young adults' smartphone usage is at a high level.

Several dimensions of cognitive failure, such as forgetfulness, distractibility, and false triggering, are observed in young adults. The mean and standard deviation of forgetfulness is 14.60

Table 2. Smartphone usage levels among young adults (n=200)

Smartphone usage levels	n	Percentage %
High	110	55%
Normal	90	45%

Table 3. Characteristics of Cognitive Failure among young adults (n=200)

Cognitive Failure Dimensions	Mean	Std. Deviation	Std. Error Mean
Forgetfulness	14.60	3.49	0.20
Distractibility	17.92	3.13	0.18
False Triggering	15.04	3.27	0.18

± 3.49, distractibility is 17.92 ± 3.13, and false triggering is 15.04 ± 3.27, as shown in Table 3.

According to Table 4, the most frequent cognitive failure at a high level of smartphone usage was distractibility (18.13 ± 3.10), followed by false triggering (15.07 ± 3.32) and forgetfulness (14.82 ± 3.71). Similarly, it was discovered that the most frequent cognitive failure at a normal level of smartphone usage was distractibility (17.68 ± 3.10), followed by false triggering (15.01 ± 3.23) and forgetfulness (14.35 ± 3.22).

Figure 1. represents the participants' dimension-specific responses and the overall mean score of cognitive failure. Error bars convey a broad sense of how precise a measurement is or how far the reported value may be from the true or error-free value.

Preliminary results revealed that there is a significant moderate relationship between smartphone usage and dimensions of cognitive failure (forgetfulness, distractibility, and false triggering). This indicates that forgetfulness, distractibility, and false triggering increase as smartphone usage increases. Similarly, there is a significant relationship between dimensions of cognitive failure as well. There is a significant weak relationship between false triggering and forgetfulness. In other words, when false triggering occurs, the individual tends to forget what they were remembering or were trying to recall. Similarly, there is a significantly moderate negative relationship between false triggering and distractibility. This indicates that when false triggering occurs, distractibility is reduced among individuals (Table 5). Hence, we can conclude that H_1 (There will be a significant relationship between smartphone usage and forgetfulness), H_2 (There will be a significant relationship between smartphone

Table 4. Cognitive Failure dimension scores based on Smartphone Usage levels (n=200)

Cognitive Failure Domains	Smartphone Usage Levels	n	Mean	Std. Deviation	Std. Error Mean
Forgetfulness	High	110	14.82	3.71	0.29
	Normal	90	14.35	3.22	0.27
Distractibility	High	110	18.13	3.10	0.24
	Normal	90	17.68	3.16	0.27
False Triggering	High	110	15.07	3.32	0.26
	Normal	90	15.01	3.23	0.27

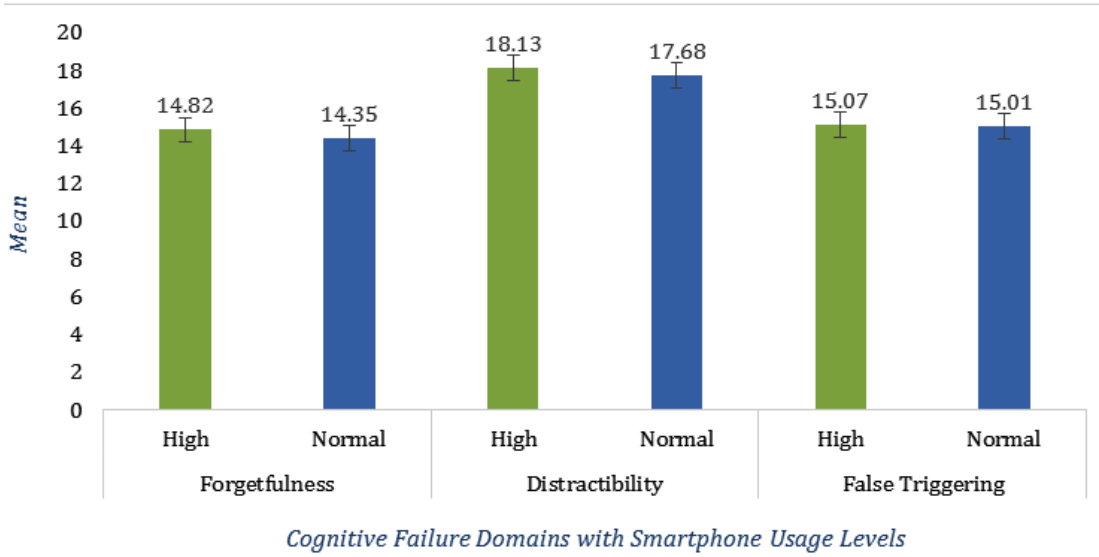

Fig. 1. Cognitive Failure dimension scores with error bar based on Smartphone Usage levels

usage and distractibility), and H_3 (There will be a significant relationship between smartphone usage and false triggering) are accepted.

Figure 2 depicts the path analysis model and the significant correlation between Excessive Smartphone Use and Cognitive Failures in domains such as forgetfulness, distractibility, and False triggering.

While previous studies show that cell phone addiction is related to negative emotional effects, very intermittent study has looked into the relationships between mobile phone use and cognitive outcomes related to daily cognitive functioning. The prevalence of smartphones nowadays is a topic of discussion for healthcare practitioners, mental health professionals, educators, parents, and anyone who regularly uses a smartphone. A recent study reveals that smartphone use has an effect on the brain, while the long-term ramifications are unknown.[20] Many people check their phones when they wake up, use them on the way to work, and keep an eye on them at all times while at work. Many people's last sight before falling asleep is a phone screen. These habits have become so engrained in people's lives that they rarely take a step back to assess the effects on their bodies and brains.[21]

Interaction with technology typically requires mental shifts from one context to another. Phones make individuals always available for contact and information from various aspects of life. Work-related emails, personal instant chats, social media posts, news, and entertainment are all mingled and intertwined in a never-ending stream

Table 5. Correlates of smartphone use and cognitive failure (n=200)

Variables	Forgetfulness	Distractibility	False Triggering	Smartphone Usage
Forgetfulness	1			
Distractibility	0.104	1		
False Triggering	0.164*	-0.451**	1	
Smartphone Usage	0.354*	0.427**	0.317*	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

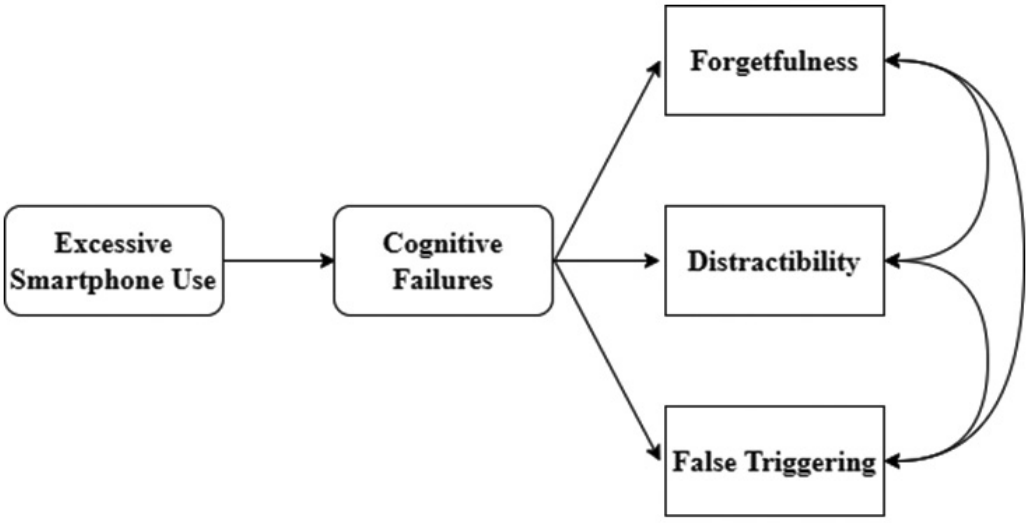

Fig. 2. Path Model of Excessive Smartphone usage leading to Cognitive failures among young adults.
Note: Excessive Smartphone Usage: Assessed by Smartphone Addiction Scale by Kwon et al., 2013. Cognitive Failures: Assessed by Cognitive Failures Questionnaire by Broadbent et al., 1982

of beeps, pings, and flashing notification symbols.[22] People have evolved in various ways during the last decade to deal with this onslaught of information. The most noticeable feature is media multitasking, which involves continually juggling media and non-media tasks while often utilizing numerous digital devices linked to various internet sites.[23]

Diffusion MRI was employed in a recent study to examine white matter structural connectivity, and it revealed a link between activity in the right amygdala and excessive smartphone use in adolescents.[24] Several reviews have been published in recent years that have evaluated the impact of whether excessive smartphone use may be considered a kind of behavioral addiction.[25] Studies have also investigated whether there are any distinctions between excessive smartphone use and Internet use disorder and additional research is underway.[26] A number of recent research have found that excessive smartphone use is related to mental health concerns and a reduction in psychological well-being. There is persistent evidence of a link between excessive smartphone use and other mental diseases, such as depression, anxiety, OCD, and ADHD, in a manner similar to the link between Internet addiction and other psychiatric disorders.[27]

Our study was supported by previous studies indicating the possible influence of smartphone use which might have a high risk of causing cognitive failures. Though the overall correlation between smartphone use and cognitive failure domains has a significant relationship, the linear regression also predicted that smartphone use might cause cognitive failures. This study will have its uniqueness in the research area on cognitive psychology, digital well-being, and additive behaviors towards technology.

The study's findings can serve as a guide and source of evidence for developing and implementing pertinent intervention strategies aimed at reducing cognitive failure issues and excessive smartphone use, which have a detrimental effect on mental health and cognitive performance, thereby alleviating the burden on family caregivers, the healthcare system, and society as a whole. However, the number of participants analyzed in this study was adequate for the problem we investigated, considering this as pilot work. However, future studies should focus on larger participants with various geographical locations, ages, gender, and working style that might influence the predictors and relationships between the variables.

CONCLUSION

This study establishes a link between excessive smartphone use and forgetfulness, distractibility, and false triggering. According to this study, need-based smartphone use may be causing cognitive failure in young individuals, including forgetfulness, distractibility, and false triggering. Excessive smartphone use has been linked to a higher risk of cognitive impairment.

ACKNOWLEDGMENTS

The First author wishes to thank and acknowledge Prof. Dr. O. T. Sabari Sridhar, Head-Department of Psychiatry, Sri Ramachandra Institute of Higher Education and Research, for their insightful comments and assistance throughout the work. She also wishes to express her gratitude to the study's participants for their unwavering support and cooperation throughout the course of the study. This work was carried out as a part of the Ph.D. research by the first author; hence she is highly thankful to the Chettinad Academy of Research and Education for the Junior Research Fellowship.

Conflict of Interest

There is no conflict of interest.

Funding Sources

The research was funded by Chettinad Academy of Research and Education, Junior Research Fellowship (CARE – JRF) with grant number 083/CARE/AR (Research@-Ph.D.-Program)/2020-01.

REFERENCES

1. Wilmer HH, Sherman LE, Chein JM. Smartphones and Cognition: A Review of Research Exploring the Links between Mobile Technology Habits and Cognitive Functioning. Front Psychol. 2017 Apr 25;8:605–605.
2. Clapp WC, Rubens MT, Gazzaley A. Mechanisms of working memory disruption by external interference. Cereb Cortex. 2010 Apr;20(4):859–72.
3. Clapp WC, Gazzaley A. Distinct mechanisms

for the impact of distraction and interruption on working memory in aging. Neurobiol Aging. 2012 Jan;33(1):134–48.
4. Ward AF, Duke K, Gneezy A, Bos MW. Brain Drain: The Mere Presence of One s Own Smartphone Reduces Available Cognitive Capacity. Journal of the Association for Consumer Research. 2017;2:140–54.
5. Altmann EM, Trafton JG, Hambrick DZ. Momentary interruptions can derail the train of thought. J Exp Psychol Gen. 2014 Feb;143(1):215–26.
6. Thornton B, Faires A, Robbins M, Rollins E. The Mere Presence of a Cell Phone May be Distracting. Social Psychology. 2014;45:479–88.
7. Unsworth N, McMillan BD, Brewer GA, Spillers GJ. Everyday attention failures: an individual differences investigation. J Exp Psychol Learn Mem Cogn. 2012 Nov;38(6):1765–72.
8. Kuznekoff JH, Titsworth S. The Impact of Mobile Phone Use on Student Learning. null. 2013 Jul 1;62(3):233–52.
9. Froese AD, Carpenter CN, Inman DA, Schooley J, Barnes RB, Brecht PW, et al. Effects of Classroom Cell Phone Use on Expected and Actual Learning. College student journal. 2012;46:323–32.
10. Mendoza JS, Pody BC, Lee S, Kim M, McDonough IM. The effect of cellphones on attention and learning: The influences of time, distraction, and nomophobia. Comput Hum Behav. 2018;86:52–60.
11. Bjornsen CA, Archer KJ. Relations between college students' cell phone use during class and grades. Scholarship of Teaching and Learning in Psychology. 2015;1(4):326–36.
12. Junco R, Cotten SR. No A 4 U: The relationship between multitasking and academic performance. Computers & Education. 2012;59(2):505–14.
13. Yildirim C, Sumuer E, Adnan M, Yildirim S. A growing fear: Prevalence of nomophobia among Turkish college students. Information Development. 2016 Nov 1;32(5):1322–31.
14. Yildirim C, Correia A. Exploring the dimensions of nomophobia: Development and validation of a self-reported questionnaire. Comput Hum Behav. 2015;49:130–7.
15. End CM, Worthman S, Mathews MB, Wetterau K. Costly cell phones: The impact of cell phone rings on academic performance. Teaching of Psychology. 2010;37(1):55–7.
16. Kwon M, Lee J-Y, Won W-Y, Park J-W, Min J-A, Hahn C, et al. Development and Validation of a Smartphone Addiction Scale (SAS). PLOS ONE. 2013 Feb 27;8(2):e56936.
17. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR. The Cognitive Failures Questionnaire (CFQ) and its correlates. Br J Clin Psychol. 1982 Feb;21(1):1–16.
18. Wallace JC, Kass SJ, Stanny CJ. The Cognitive Failures Questionnaire Revisited: Dimensions and Correlates. null. 2002 Jul 1;129(3):238–56.
19. Rast P, Zimprich D, Van Boxtel M, Jolles J. Factor structure and measurement invariance of the cognitive failures questionnaire across the adult life span. Assessment. 2008;16(2):145–158.
20. Hong W, Liu R, Ding Y, Sheng X, Zhen R. Mobile phone addiction and cognitive failures in daily life: The mediating roles of sleep duration and quality and the moderating role of trait self-regulation. Addictive behaviors. 2020;107:106383.
21. Duke É, Montag C. Smartphone addiction, daily interruptions and self-reported productivity. Addictive Behaviors Reports. 2017;6: 90–95.
22. van Velthoven MH, Powell J, Powell G. Problematic smartphone use: Digital approaches to an emerging public health problem. Digital Health. 2018.
23. Pop³awska A, Szumowska E, Kuœ J. Why Do We Need Media Multitasking? A Self-Regulatory Perspective. Front Psychol. 2021;12:624649.
24. Tymofiyeva O, Yuan JP, Kidambi R, Huang CY, Henje E, Rubinstein ML, Jariwala N, Max JE, Yang TT, Xu D. Neural Correlates of Smartphone Dependence in Adolescents. Front Hum Neurosci. 2020 Oct 7;14:564629.
25. Panova T, Carbonell X. Is smartphone addiction really an addiction? J Behav Addict. 2018 Jun 1;7(2):252-259.
26. Montag C, Wegmann E, Sariyska R, Demetrovics Z, Brand M. How to overcome taxonomical problems in the study of Internet use disorders and what to do with "smartphone addiction"? J Behav Addict. 2021 Jan 15;9(4):908-914.
27. Weinstein A, Feder K, Rosenberg K, Dannon P. Internet addiction-criteria evidence and treatment. Behavioral Addictions: Criteria, Evidence and Treatment. 2014;99–117.