

**Comparative Study**

## **A Comparative Study on the Cognitive Functions and Psychological Factors Associated with Google Effect among College Students**

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### **ABSTRACT**

The usage of digital gadgets for academic purposes has increased significantly after the Covid-19 pandemic lockdown. Google Effect is also known as Digital Amnesia which can be stated as the tendency to forget what is being read on a digital gadget believing that they can refer to it whenever they are in need of it. College students were recruited through purposive sampling and screened based on checklist was developed for the study which was validated by experts in the field of psychiatry, neurology and clinical psychology. Cognitive functions were assessed using subtests of Weschler's Memory Scale-III. The DASS-21 was used to measure features of depression, anxiety and stress and EIS was also used to find the difference in emotional intelligence, t-test was used to analyze the significant difference between the two groups. Findings indicates that the students who had Google Effect had shown significant impairment in the cognitive tests of memory and learning compared to the group without Google Effect along with higher scores in depression, anxiety and stress and lower scores in emotional intelligence. This implies the need to bring awareness and interventions in limiting dependence on digital devices.

**Keywords:** *Google Effect, Memory, Depression, Anxiety, Stress, Emotional Intelligence*

### **The Google Effect (Digital Amnesia)**

In the 4<sup>th</sup> century, Socrates, through Plato's work Phaedrus indicated his opposition to writing down information as he believed that it would cause harm to one's memory and wisdom and would subsequently lead to forgetfulness and superficial understanding of the subject matter and can even affect one's intellectual growth (Carr, 2011; Wolf, 2008). Similar fear was caused in the 15<sup>th</sup> century when Johannes Gutenberg started a printing press on his own and that this would lead to 'intellectual laziness' and can harm one's scholarship (Carr, 2008).

In today's generation, we are granted with quick, easy and reliable access to various different stores of information through our smart devices such as mobiles, computers in the internet. Smart phones have gained momentum in the people's everyday life and sometimes even unconsciously. The smartphones have been acting as a personal assistant which helps

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**Received: November 02, 2023; Revision Received: November 15, 2023; Accepted: November 19, 2023**

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people in remembering phone numbers and in their daily schedule. There is an increase in the usage of smartphones in the recent times especially due to reasons such as the global pandemic and also because of the inventions of advanced smartphones and its advanced features. Studies have indicated that college students are developing Nomophobia i.e., no mobile phobia and further states that students tend to lose concentration and have increased stress levels when they do not have access to their mobile phone indicative of an increasing prevalence of Nomophobia among the younger generation (Pavithra et al, 2015).

Dependency on such devices can result in many physiological and behavioral changes; one such being digital amnesia. It was introduced in the year 2007 at Dublin where it was reported as a rising threat to the human memory due to the overuse of smart devices. It can also be called as a technology induced memory atrophy. Therefore, 'Google Effect' can be described as the tendency to forget information that can easily be found online. (Sparrow et al, 2011). It was coined by German Neuroscientist Manfred Spitzer; it can be described as how the overuse of digital technology can result in the cognitive abilities breakdown similar to individuals suffering from a head injury or any psychiatric illness. Negative consequences of dependency such as decreased attention spans, increased anxiety, and decreased social skills are also report (Lodha, 2019).

The Google Effect was described initially in an experiment by Betsy Sparrow (Columbia), Jenny Liu (Wisconsin) and Daniel Wegner (Harvard) in 2011. The results suggested the locality of the was better remembered than the actual information itself. The experiments by Sparrow are suggestive that the individuals tend to share the information more easily as they automatically think of computers when they encounter a gap in their knowledge. We are becoming more dependent on our smart devices thus forming an interconnect system with it by remembering less of it such as where the information is stored, as seen in transactive memory systems. Although this provides us with the ability to store a vast number of information, the feeling of being wired constantly to our smart devices was present.

Transactive memory can be said as a type of collective memory through which teams work together on the encoding, storage and in the retrieval of information (Wegner, 2011). In the concept of 'The Google Effect', the digital storage of the information that one needs is part of our transactive memory system, further stating that the human mind is a part of a network of transactive memory patterns, where here it is the digital sources from where we access information. Therefore, it can be said as that the digital storages which gives us the information similar to how individuals store information with people (Wegner et al, 2011).

The human brain especially in the developing stages, needs the full range of stimuli that is ideally obtained from the interaction with the outside world. Plasticity forms in response to the way the brain is used. When compared to the outside world, the virtual world has less stimuli for the developing brain to reach its full potential. Parts of the brain may not be used at times which can lead to atrophy. (Spitzer,2014). The rapid switching between tabs when on the internet can hinder the brain's ability in building the neural pathways that come in use during the long-term recall or other cognitive skills. As individuals get dependent on their gadgets for searching information, the functionality of the brain in searching for the information increases while the ability in remembering the searched information (Spitzer, 2014). The source of the information will be better remembered than the information looked up. Thus, every time an individual wants to look up on an information, it is available at the click of a button (instead of recalling the information / data, one says, "let's Google it").

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On comparison, individuals who prefer studying from the internet and individuals who prefer study from books and encyclopedia, needed a shorter duration of time to search online but had decreased ability in recalling the information they were asked to study. Less brain activation was observed in the association area of the temporal-parietal-occipital cortex. These areas are responsible for integrating the information obtained from the sensory areas and in linking it with the past memories. Decreased activation was seen in the temporal gyrus, which is responsible for memory processing, during recollection which is suggestive that there is difficulty in using this region during recollection of facts. Decreased activation was seen in the ventral stream particularly in the occipital gyrus, inferior temporal gyrus and the fusiform area in the left hemisphere of the brain which are said to be the areas where the 'what' of a specific information is stored and is linked to object identification and recognition in individuals preferring to use the internet than books. Further reduced activation in the temporal gyrus is observed which is indicative that there is low accuracy in the facts being recalled. (Doug et al, 2015) The medial temporal gyrus in the right hemisphere is responsible for the encoding for the declarative long-term memory and a decreased activation of it in the individuals who use the internet more can suggest that there is reduced engagement to the medial temporal gyrus when encountering new information which is proven by the increased reaction time taken in recalling. Longer reaction time is indicative that an increased amount of time is needed to process and in understanding whether such novel information was previously encountered. (Doug et al, 2015) The orbitofrontal cortex is important in the functioning of executive control, emotional regulation, impulse inhibition. Higher activation of the orbitofrontal cortex is seen in individuals using the internet which can be interpreted as having higher impulsivity to search the internet when encountered with new information (Doug et al, 2015).

Psychologically, the effect of digital amnesia can have effects on sleep patterns and other factors as well. It can cause disruption in one's sleep and further in decreasing the ability for the synaptic pruning to take place thus in turn affecting the ability to retain and form memories (Kadhiravan, 2022). The use of smartphones can affect sleep as it is increasingly used more before going to bed which can cause shorter and disturbed sleep and in longer sleep latency (Arora et al 2021). Further it can also include time displacement i.e., the time spent on the smart devices is more than the other activities, the lights emitted from them causing the disruption of one's circadian rhythm, alertness and in sleep physiology. Alongside, it can cause the individual to be physically passive in nature and in experiencing issues in their social and emotional life (Arora et al, 2021). As a consequence of it, feelings of anxiety and stress can develop in the individual.

In today's generation, especially due to the on-going pandemic, there has been a significant increase in the use of digital technology. Googling academics have been normalized. This would be considered beneficial in a business setting as it can help in promoting it. However, from a learning perspective, it can have a negative impact as it can affect one's motivation, memory power thereby resulting in poor learning along with increased dependence on technology. Quality of life can also be affected. The past research concerning the present study area do not provide a quantitative measure of 'The Google Effect'. There has been no comparative study done between to understand the consequence of the google effect. The present study aims to bridge this gap.

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### METHODOLOGY

To study if the 'Google Effect' (Digital Amnesia) has any impact on the cognitive functions and psychological factors of final year college students. Participants were taken between 21-30, currently pursuing a final year in a college level degree and using gadgets for academic purpose by a purposive snowball sampling technique. The sample size was taken as 20 in each group (group with google effect and the group without google effect) making the total sample size as 40 for the study. The participants were first screen for cognitive deficits using the MoCA. t-test to find the difference between the two groups in the study. Minitab Software was used for statistical analysis and P value <0.05 will be considered as statistically significant.

#### Tools Used:

- **Socio Demographic Performa:** To understand the socio demographic characteristics of the sample under study.
- **Checklist to screen usage of Gadgets for Academic Purposes**
  - A 30-item checklist was developed to screen the participants on their usage of electronic resources for academic purposes. This helped in classifying them into two groups as follows:
  - Group with Google Effect – Students scoring more than 18
  - Group without Google Effect – Students scoring less than 18

The checklist was validated by experts in the field of Mental Health and Neurology from the hospital the research was being conducted in,

- **Depression, Anxiety, Stress Scale- 21 (Lovibond & Lovibond, 1995):** It is a self-report scale that is used to measure the level of depression, anxiety and stress. The reliability of DASS-21 has high Cronbach's alpha values of 0.81, 0.89 and 0.78 for the subscales of depressive, anxiety and stress respectively. It was found to have high internal consistency, discriminative, concurrent and convergent validities.
- **Emotional Intelligence Scale (Schutte, 1998):** It is a self-report questionnaire that measures the level of emotional intelligence. Higher the scores indicate higher the emotional intelligence. The test was interpreted to have a Cronbach coefficient of 0.79 and had high test-retest reliability.
- **Wechsler's Memory Scale-III (Wechsler, 2009):** The Wechsler's Memory Scale-III consists of a total of 11 subtests. Most of the subtests have been divided into two categories: the immediate condition (I) and the delayed condition (II). For the present study, subtests of the scale will be used to measure attention and memory. The subtests used in the study are Verbal Pair Association I & II, Word list I & II, Visual Reproduction I & II, Letter Number Sequencing, Digit Span, Mental Control and Logical Memory.

### RESULTS

*Table 1: Socio demographic characteristics*

Variables	Description	With Google Effect		Without Google Effect	
		Frequency	Percentage	Frequency	Percentage
Age	21-25	19	95%	20	100%
	25-30	1	5%	0	0
Gender	Female	17	85%	13	65%
	Male	3	15%	7	35%

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Variables	Description	With Google Effect		Without Google Effect	
		Frequency	Percentage	Frequency	Percentage
Degree	B. Com	2	10%	3	15%
Pursuing	MBBS	3	15%	3	15%
Currently	B Tech	2	10%	6	30%
	M Tech	1	5%	1	5%
	B Sc	6	30%	5	25%
	M Sc	2	10%	1	5%
	MBA	1	5%	0	0
	Nursing	3	15%	1	5%
	Residence	Rural	0	0	0
Semi-urban		0	0	0	0
Urban		20	100%	20	100%

**Table 2: Perceived usage of gadgets for educational purposes in both groups**

Time (in hours)	With Google Effect group		Without Google Effect group	
	Frequency	Percentage	Frequency	Percentage
1-3	12	60%	17	85%
3-6	4	20%	3	15%
6-9	2	10%	0	5%
9-12	2	10%	0	0

**Table 3: Mean, Standard Error, t-value of the cognitive functioning of the group with and without the google effect**

Variables	With Google Effect (Mean ± SE)	Without Google Effect (Mean ± SE)	T test	P value
Overall	260.4± 15	335± 11	-3.95	0.000*
Cognitive Functioning				
Short Term Memory	139.7±8.5	173.6±5.8	-3.30	0.002*
Long Term Memory	86.4	117	-3.52	0.001*
Working Memory	34.3± 1.2	44.45 ± 1.8	-4.70	0.000*
Auditory Immediate	72.4±4.7	87.4±4.4	-2.34	0.025*
Visual Immediate	67.3±4.9	86.2 ±3.2	-3.25	0.003*
Auditory Delayed	31.4±2.8	40.7±1.9	-2.80	0.009*
Visual Delayed	55±5	76.2 ±4.8	-3.06	0.004*
Attention Span	10.55±0.55	11.1±0.73	-0.60	0.055
Learning	10.2±1.3	12±0.9	-1.09	0.082*
Retention	79.3±3.6	90.1±2.7	-2.40	0.002*

\*Significant at 0.05 level

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**Table 4: Mean, Standard Error, t-value computed between the two groups in the psychological variables**

<b>Variables</b>	<b>With Google Effect (Mean ± SE)</b>	<b>Without Google Effect (Mean ± SE)</b>	<b>T test</b>	<b>P value</b>
Depression	8.15±1.2	4.10±0.7	2.85	0.008*
Anxiety	9.90±1.1	3.35±0.5	5.23	0.000*
Stress	9.10±1.1	5.55 ± 0.7	2.79	0.009*
Emotional Intelligence	121±2.7	145.7±3.5	1.14	0.009*

*\*Significant at 0.05 level*

From Table 1, the age group taken for the present study is 21-30 in which 95% of the participants were between the age range of 21-25 and 5% in the age range of 26-30 with the google effect. The group without the google effect had 100% of its participants between the age range of 21-25. In the study, 85% were female and 15% were male in the group with the google effect and the group without the google effect had 65% female and 35% male participants. Participants who were currently pursuing a final year degree were taken in the present study. In the group without the google effect, 10% were from B. Com, 15% were from MBBS, 10% were from B Tech, 5% were from M.Tech, 30% were from BSc, 10% were from MSc, 5% from MBA and 15% from Nursing stream. The group without google effect had 15% from B. Com, 15% from MBBS, 30% from B Tech, 5% from M.Tech, 25% from BSc, 5% from MSc and 5% from Nursing stream. All participants in the both the groups under study were from an urban background. From Table 2, in the participants with google effect, 60% were reported to be using the gadgets for educational purpose for a duration of 1-3 hours, 20 % reporting between 3-6 hours, 10% reported 6-9 hours and 10% reported 9-12 hours. The group without the google effect had 85% of the participants reporting that the perceived use of gadgets for academic purpose was between 1-3 hours, 15% reporting 3-6 hours, 5% reporting 6-9 hours. Majority of the participants have reported the perceived usage of gadgets between 3-12 hours which is greater than the group without the google effect. Further from Table 3, it can be interpreted that there is a significant difference between the two groups under study in the areas of overall cognitive functioning, short term memory, long term memory, working memory, immediate memory, delayed memory, learning and retention capacity with the group without google effect performing better than the group with google effect. The difference between the groups is not significant in the area of the attention span.

## **DISCUSSION**

### ***Socio demographic variables in relation to the Google Effect***

The sample taken for the present study is college students who are currently pursuing final year in either an undergraduate or postgraduate degree. The average age of the students is 21 years and all the participants are from urban residence. The participants from taken from different streams such as medicine, para medical, commerce and engineering. All the participants were taken from an urban domicile in the present study. Past studies have shown that individuals residing in urban setups have an increased likelihood to make use of gadgets. They further concluded that this could be because of the vast availability of the Internet and in updated technology gadgets in urban areas. Further, urban areas also have developed infrastructure such as advanced mobile networking like 4G and 5G and fast Wi-Fi services which makes the individual have an efficient use in gadgets thereby increasing the time spent on it (Hong et al, 2018). The participants were asked to report the perceived

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usage of gadgets such as mobile phones, laptops for educational purposes in the number of hours in a day. The group with google effect reported high usage of gadgets in comparison with the group without google effect on time intervals of 3-6, 6-9 and 9-12 hours in a day. Similar study findings reported by Parasuraman in the year 2017 showed 70% of the students were using their device for a longer period than intended and 66% of the students were reported to be using the smartphone for longer duration.

### ***Cognitive functioning in relation to the Google Effect***

From the results obtained in the present study, it can be inferred that there is a significant difference in the cognitive performance between the individuals with google effect and the group with the google effect performing lesser in comparison with the group without google effect. This result is in concordance with a previous study where individuals with increased levels of smartphone use showed significant reduction in the cognitive function of response inhibition (Fabio et al, 2022). Further, it was noted that the increase in one hour of additional smartphone usage in a day can lower a student's score by 0.152 on an average as a result thereby resulting in decreased academic productivity and learning (Sapci, 2021, King, 2017).

Further, in the present study, there is no significant difference in the attention span between the two groups but the difference was seen was in the cognitive domains of memory, learning and retention capacity. This can be interpreted as the individual is attending to the information being given online at the time of reading but does not encode it to the short term and long-term memory. Similar results were found with the experiment done by Sparrow in the year 2011 where directed forgetting is indicated when the information can be looked upon later on when required. Further it also highlights that the increased usage has been demonstrated to have caused a dependency on the devices as these devices grant the individual to instant access to any needed information which can be accessible at any point of time and place. Having an easy and instant access to information has led the individuals to store the information in gadgets rather than one's short-term memory (Dirin et al, 2019). According to the Atkinson Shiffrin Model of memory (1968) the stimulus in the environment first goes in the respective sensory stores such as vision, auditory and touch where the stimulus is stored for a very brief period. The individual has to attend to the stimulus for it to be transferred to the short-term memory. The sensory register encodes the information that is to be processed. The short-term memory is the next stage in the model where the information can be stored up to a duration of 30 seconds and needs to be rehearsed for it to be remembered beyond the thirty seconds. Maintenance rehearsal is done where the stimulus is verbally or mentally repeated without understanding its meaning and its relation to the past stimuli. The short-term memory has a capacity to remember  $7 \pm 2$  chunks. If the maintenance rehearsal is not done by the individual, the stimulus does not get passed on to the further long-term memory and is either displaced or decayed from the short-term memory. The long-term memory has an unlimited storage and is the next step in the model. Through elaborative rehearsal, the stimulus is linked with previous information and is stored in the long-term memory which can be retrieved at any point of time. Keeping this model in mind, if the information is not rehearsed and attended properly as it cannot be retrieved when required (Atkinson, 1968). In the present study, when the individual does not encode the stimulus, it does not reach the short term and the long term memory thereby leading to poorer memory performances as seen in the group with Google Effect. Studies have also shown that a decreased performance in the working memory capacity is seen along with decreased academic performance along with an increase in impulsive behaviour with the

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increase in media multitasking usage (Cain et al, 2016). With individuals with google effect, the task of the working memory is only locating the information in the gadget instead of understanding the concept of the information as it is easy for the individual to locate it when in need of it. As there is no information being encoded in the memory system other than the location of the needed information, there is no rehearsal that occurs thereby leading to a quick decay of information finally where the long-term memory does not have anything to store in it.

Further, Cognitive effort can be said to be at a mechanistic level and is said to be aversive in nature (Saunders et al, 2017). Hence, avoidance of tasks that demand high cognitive effort is seen in individuals (Kool et al,2010). Research has proposed that such cognitive effort is limited in nature and individuals strive to conserve their abilities in maximum way possible (Baumeister et al, 2007) and that the use of effort in one task can have an effect on another task (Kurzban et al, 2013). Hence, individuals tend to avoid tasks that require active cognitive effort and that remembering an intention or information can be effortful in nature when compared to offloading it to external devices. There are limits that are known for maintaining information actively in one's short term or in one's working memory and that maintaining one intention actively can have an effect on the maintenance of another intention due to the opportunity cost mentioned above. By contrast, an external device such as smartphones, laptops are known to have an unlimited capacity in remembering and is also effective in nature (Bays et al, 2008) due to which over dependence of such devices is preferred when compared to the internal memory due to both effectiveness and due to the possible opportunity cost. Therefore, depending on the varying level of confidence individuals have on their memory, stable biases are formed whether to engage in using their own memory or in using any external device for remembering a particular intention or information (Gilbert et al, 2015).

Further, distraction from proper and sequential encoding of the information is also present when reading from a gadget which can further cause the retention to be poor and weak as the encoding is not done with adequate sensory inputs. Using senses holistically such as the use of vision, auditory and other senses can help in storing a particular information rather than using only one sense such as using only the vision sense when using a digital device for encoding (Lodha,2019). Studies on cognitive style and smartphone use have showed that individuals tend to look up for answers or information online or in gadgets when they are less motivated to think on their own and do not want to invest the cognitive load that is linked to encoding and the retrieval process where from their own memory. The feeling of uncertainty that one might not be able to answer or retrieve correctly could further prompt the individual to search in their gadgets rather than analytical engagement. Further, one might choose to get the information from an external source instead of engaging in cognitive costing elaborative encoding and retrieval (Barr et al, 2015)

### ***Google Effect and Psychological Distress***

Significant difference between the two groups was found in the psychological factors such as depression, anxiety, stress and emotional intelligence was accepted with the group with the google effect having high scores in the domains of depression, anxiety and stress and low scores in emotional intelligence as compared to the group without google effect. Previous studies have reported that the separation from smartphone can cause increased levels of anxiety in the individual. Further, this anxiety plays a mediating role in different fields of executive functions due to the smartphone separation. Individuals who were



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experiencing such anxiety showed poorer performance in assessed task switching, inhibitory control and in working memory. Impaired self-regulation is also reported due to the anxiety which causes an increased urge to use the smartphone to diminishing the distress caused without it. This can explain why it is extremely difficult for college students to go on a media abstinence even for a day (Hartanto et al, 2016). The use of gadgets can be seen as a form of internet addiction as the individual is relying on the internet when they are faced with a novel situation or in need of any new information (Younes et al,2016). Further, the increased use of the internet and problematic smartphone usage can lead to increase in loneliness and subsequent decrease in social interactions and self-esteem which leads to depressive features in the individual (Ko,Yen,Chen at al, 2005) and can reinforce perceive stress especially in students that this perceived stress can further mediate the relationship between problematic smartphone use and depression (Zhao et al, 2020). Feeling of being wired to gadgets can cause anxiety can result in case it is misplaced or if information or help is not available in a novel situation. Such concerns with depression and anxiety can affect one's emotional intelligence as well (Parvathy et al, 2020). Excessive use of digital devices can cause the increased dependency on it which can also lead to the individual feeling pressured to be connected to the device at all times. Present study showed significant difference in the emotional intelligence between the two groups with the group with google effect having low scores in emotional intelligence. The results obtained were in concordance with previous studies where it showed that smartphone dependence can affect one' emotional intelligence negatively. Though the use of smartphone can increase one's work efficacy as it aids for better and efficient communication which comes under social skills in emotional intelligence, it can cause addiction towards it that might cause decreased productivity in one's work and one's emotions. (Setyanto et al, 2021).

### **CONCLUSION**

The present study aimed to understand the cognitive functions and psychological factors that is associated with the google effect in college students. There is a significant difference between the group with google effect and the group without google effect in the areas of cognitive functions and psychological factors where the group with googled effect have lower performance in comparison in the areas measured. The study postulates that the need to spread awareness about digital amnesia and how the overuse of gadgets for academics can affect a person's cognition and psychological well-being among college students. The need for apt usage of gadgets and its related psychoeducation is emphasized to preserve cognitive functions of the student population for efficient performance in learning and academic performance.

#### **Limitations**

- Random sampling technique
- Sample size
- Generalization

### **REFERENCES**

- Akin, A., & Iskender, M. (2011). Internet addiction and depression, anxiety and stress. *International online journal of educational sciences*, 3(1), 138-148.
- Anand, N., Jain, P. A., Prabhu, S., Thomas, C., Bhat, A., Prathyusha, P. V., ... & Cherian, A. V. (2018). Internet use patterns, internet addiction, and psychological distress among engineering university students: A study from India. *Indian journal of psychological medicine*, 40(5), 458-467.

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- Arora, T., Broglia, E., Thomas, G. N. & Taheri, S. (2014). Associations between specific technologies and adolescent sleep quantity, sleep quality, and parasomnias. *Sleep Medicine*, 15(2), 240–247
- Atkinson, R. C. & Shiffrin, R. M. (1968). Human memory: A proposed system and its control. *Psychology of Learning and Memory*, 2, 89-193
- Barr, N., Pennycook, G., Stolz, J. A., & Fugelsang, J. A. (2015). The brain in your pocket: Evidence that Smartphones are used to supplant thinking. *Computers in Human Behavior*, 48, 473-480.
- Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, 16(6), 351–355.
- Bays, P. M., & Husain, M. (2008). Dynamic shifts of limited working memory resources in human vision. *Science*, 321(5890), 851–854.
- Cain, M. S., Leonard, J. A., Gabrieli, J. D., & Finn, A. S. (2016). Media multitasking in adolescence. *Psychonomic bulletin & review*, 23(6), 1932-1941.
- Carr, N. (2008, August). Is Google Making Us Stupid? The Atlantic. Retrieved from <http://www.theatlantic.com/magazine/archive/2008/07/is-google-making-us-stupid/306868/>
- Carr, N. (2011). *The Shallows: What the Internet Is Doing to Our Brains*. W. W. Norton & Company.
- Clark, A. (2001). Natural-Born Cyborgs? In M. Beynon, C. Nehaniv, & K. Dautenhahn (Eds.), *Cognitive Technology: Instruments of Mind*, Lecture Notes in Computer Science (Vol. 2117, pp. 17–24). Springer Berlin / Heidelberg. Retrieved from <http://www.springerlink.com/content/n8khf04j7f006718/abstract/>
- Demirci, K., Akgönül, M., & Akpınar, A. (2015). Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of behavioral addictions*, 4(2), 85-92.
- Dirin A, Alamäki A, Suomala J. Digital Amnesia and Personal Dependency in Smart Devices: A Challenge for AI. Proceedings of Fake Intelligence Online Summit 2019. 2019.
- Dong, G., & Potenza, M. N. (2015). Behavioural and brain responses related to Internet search and memory. *European Journal of Neuroscience*, 42(8), 2546-2554.
- Fabio, R. A., Stracuzzi, A., & Lo Faro, R. (2022). Problematic Smartphone Use Leads to Behavioral and Cognitive Self-Control Deficits. *International Journal of Environmental Research and Public Health*, 19(12), 7445.
- Franzen, M. D., & Iverson, G. L. (2000). The Weschler Memory Scales.
- Ghogare, A. S., Aloney, S. A., Vankar, G. K., Bele, A. W., Patil, P. S., & Ambad, R. S. (2022). A cross-sectional online survey of an impact of COVID-19 lockdown on smartphone addiction and nomophobia among undergraduate health sciences students of a rural tertiary health-care center from Maharashtra, India. *Annals of Indian Psychiatry*, 6(1), 27.
- Gilbert, S. J. (2015). Strategic offloading of delayed intentions into the external environment. *Quarterly journal of experimental psychology*, 68(5), 971-992.
- Hamissi J, Babaie M, Hosseini M, Babaie F. The relationship between emotional intelligence and technology addiction among university students. *International Journal of Collaborative Research on Internal Medicine & Public Health*. 2013;5(5): 0-.
- Hartanto, A., & Yang, H. (2016). Is the smartphone a smart choice? The effect of smartphone separation on executive functions. *Computers in human behavior*, 64, 329-336.

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- Henkel, L. A. (2014). Point-and-shoot memories: The influence of taking photos on memory for a museum tour. *Psychological science*, 25(2), 396-402.
- Hong SB, Zalesky A, Cocchi L, Fornito A, Choi EJ, Kim HH, Suh JE, Kim CD, Kim JW, Yi SH. Decreased functional brain connectivity in adolescents with internet addiction. *PLoS one*. 2013 Feb 25;8(2): e57831.
- Hong, J., & Thakuriah, P. (2018). Examining the relationship between different urbanization settings, smartphone use to access the Internet and trip frequencies. *Journal of Transport Geography*, 69, 11-18.
- Kadhiravan, S. (2022). Prevalence of Digital Amnesia, Somatic Symptoms and Sleep Disorders among Youth during COVID-19 Pandemic. *Heliyon*.
- Kim, I., Kim, R., Kim, H., Kim, D., Han, K., Lee, P. H., ... & Lee, U. (2019). Understanding smartphone usage in college classrooms: A long-term measurement study. *Computers & Education*, 141, 103611.
- King, R. C., & Dong, S. (2017). The impact of smartphone on young adults. *The Business & Management Review*, 8(4), 342.
- Ko, C. H., Yen, J. Y., Chen, C. C. et al., 2006. Tridimensional personality of adolescents with internet addiction and substance use experience. *Canadian Journal of Psychiatry*, 51, 887-894.
- Kool, W., McGuire, J. T., Rosen, Z. B., & Botvinick, M. M. (2010). Decision making and the avoidance of cognitive demand. *Journal of Experimental Psychology: General*, 139(4), 665-682
- Kraut, R., Lundmark, V., Patterson, M., Kiesler, S., Mukopadhyahy, T., & Sherlis, W., 1998. Internet paradox: A social technology that reduces social involvement and psychological well being? *American Psychologist*, 53, 1017-1031.
- Kurzban, R., Duckworth, A., Kable, J. W., & Myers, J. (2013). An opportunity cost model of subjective effort and task performance. *The Behavioral and Brain Sciences*, 36(6), 661-6
- Liu J, Esmail F, Li L, Kou Z, Li W, Gao X, Wang Z, Tan C, Zhang Y, Zhou S. Decreased frontal lobe function in people with Internet addiction disorder. *Neural regeneration research*. 2013 Dec 5;8(34):3225.
- Lodha, P. (2019). Digital Amnesia: are we headed towards another amnesia. *Indian Journal of Mental Health*, 6(1), 18.
- Loh KK, Kanai R. How has the Internet reshaped human cognition?. *The Neuroscientist*. 2016 Oct;22(5):506-20.
- Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour research and therapy*, 33(3), 335-343.
- Matar Boumosleh, J., & Jaalouk, D. (2017). Depression, anxiety, and smartphone addiction in university students-A cross sectional study. *PLoS one*, 12(8), e0182239.
- Meeks, J. T., Hicks, J. L., & Marsh, R. L. (2007). Metacognitive awareness of event-based prospective memory. *Consciousness and Cognition*, 16(4), 997-1004.
- Musonda A, Shumba O, Tailoka FP. Validation of the Schutte Self Report Emotional Intelligence Scale in a Zambian Context. *Validation of the Schutte Self Report Emotional Intelligence Scale in a Zambian Context*. 2020 Jan 23;2(2):31-41.
- Parvathy, R. S., & Smitha, C. A. (2020). Emotional intelligence, perceived stress, and internet use behaviour among undergraduate medical students-a cross sectional study. *Kerala Journal of Psychiatry*, 33(2), 105-113.

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- Pavithra, M.B., Madhukumar, S. and TS, M.M., 2015. A study on nomophobia-mobile phone dependence, among students of a medical college in Bangalore. *National Journal of community medicine*, 6(03), pp.340-344.
- Preiss, M. Manfred Spitzer: Digital dementia: What We and Our Children are Doing to our Minds. Brno: Host, 2014.
- Ranjbar, H., & Bakhshi, M. (2018). The Association between Internet addiction and emotional intelligence: A meta-analysis study. *Acta facultatis medicae Naissensis*, 35(1), 17-29.
- Sachdeva, C., & Gilbert, S. J. (2020). Excessive use of reminders: Metacognition and effort-minimisation in cognitive ofloading. *Consciousness and Cognition*, 85, 103024.
- Saikia, A. M., Das, J., Barman, P., & Bharali, M. D. (2019). Internet addiction and its relationships with depression, anxiety, and stress in urban adolescents of Kamrup District, Assam. *Journal of family & community medicine*, 26(2), 108.
- Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, cognition and personality*, 9(3), 185-211.
- Sapci, O., Elhai, J. D., Amialchuk, A., & Montag, C. (2021). The relationship between smartphone use and students academic performance. *Learning and Individual Differences*, 89, 102035.
- Saunders, B., Lin, H., Milyavskaya, M., & Inzlicht, M. (2017). The emotive nature of conflict monitoring in the medial prefrontal cortex. *International Journal of Psychophysiology*, 119, 31–40.
- Schutte, N. S., Malouff, J. M., & Bhullar, N. (2009). The assessing emotions scale. In *Assessing emotional intelligence* (pp. 119-134). Springer, Boston, MA.
- Setyanto, A., & Franksiska, R. (2021). The smartphone uses and dependency toward emotional intelligence on generation Z. *Jurnal Penelitian dan Pengembangan Sains dan Humaniora*, 5(1), 156-164.
- Sparrow B, Liu J, Wegner DM. Google effects on memory: Cognitive consequences of having information at our fingertips. *science*. 2011 Aug 5;333(6043):776-8.
- Storm, B. C., & Soares, J. S. (2022). Memory in the digital age.
- Wegner, D.M. and Ward, A.F., 2013. How Google is changing your brain. *Scientific American*, 309(6), pp.58-61.
- Weinstein A, Dorani D, Elhadif R, Bukovza Y, Yarmulnik A, Dannon P. Internet addiction is associated with social anxiety in young adults. *Annals of clinical psychiatry*. 2015 Feb 1;27(1):4-9.
- Wilmer, H. H., Sherman, L. E., & Chein, J. M. (2017). Smartphones and cognition: A review of research exploring the links between mobile technology habits and cognitive functioning. *Frontiers in psychology*, 8, 605.
- Wolf, M. (2008). *Proust and the Squid: The Story and Science of the Reading Brain*. Harper Collins.
- Yang, C. K., 2001. Sociopsychiatric characteristics of adolescents who use computers to excess. *Acta Psychiatrica Scandinavica*, 104, 217–222
- Younes, F., Halawi, G., Jabbour, H., El Osta, N., Karam, L., Hajj, A., & Rabbaa Khabbaz, L. (2016). Internet addiction and relationships with insomnia, anxiety, depression, stress and self-esteem in university students: a cross-sectional designed study. *PloS one*, 11(9), e0161126.
- Young, K. S., & Rogers, R. C. (1998). The relationship between depression and Internet addiction. *Cyberpsychology & behavior*, 1(1), 25-28.
- Zhao, P., & Lapierre, M. A. (2020). Stress, dependency, and depression: An examination of the reinforcement effects of problematic smartphone use on perceived stress and later

## **A Comparative Study on the Cognitive Functions and Psychological Factors Associated with Google Effect among College Students**

depression. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 14(4).

Zhou Y, Lin FC, Du YS, Zhao ZM, Xu JR, Lei H. Gray matter abnormalities in Internet addiction: a voxel-based morphometry study. *European journal of radiology*. 2011 Jul 1;79(1):92-5.

### ***Acknowledgment***

The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

### ***Conflict of Interest***

The author(s) declared no conflict of interest.

***How to cite this article:*** Mohan, S. & Ponnusamy, P. (2023). A Comparative Study on the Cognitive Functions and Psychological Factors Associated with Google Effect among College Students. *International Journal of Indian Psychology*, 11(4), 1481-1493. DIP:18.01.133.20231104, DOI:10.25215/1104.133