

Effects of Mobile Technology Use on Human Cognition

Tina Gada¹, Namaswi Chandarana², Shreya Chudasama³

¹Sr. User Experience Designer
Email: tgada@oswego.edu

²Sr. Software Engineer
Email: namaswic@gmail.com

³Business Intelligent Manage
Email: chudasama.shreya@gmail.com

Abstract: *Smartphones enable and encourage constant connection to information, entertainment, and each other. Smartphones and their related technologies are recognized as flexible and powerful tools. They put the world at our fingertips and rarely leave our sides. It has also been proven that "When used prudently, it can augment human cognition." Although these devices have immense potential to improve welfare, their persistent presence on one's smartphone may occupy limited - capacity cognitive resources, leaving fewer resources available for other tasks and undercutting cognitive performance. There is also a growing perception that habitual involvement with these devices may negatively impact users' ability to think, remember, pay attention, and regulate emotions. Research consistently demonstrates that the active use of cell phones, whether talking or texting, is distracting and contributes to diminished performance when multitasking. In this study, 30 participants participated. They were shown 30 images they needed to memorize and gave the test afterward. Fifteen participants could use cellphones to take pictures of the images shown to them, and the rest, 15, must see the pictures and give the test. The result showed that the group that did not use the cell phone when showing pictures got better memory test results than the group that used the cell phone.*

"Life was much easier when Apple and blackberry was just a fruit"

Megha Chanan

Keywords: cell phone, brain drain, text messaging, distracting, mobile device use, diminish human cognition and memory test

1. Introduction

Mobile cell phones are ubiquitous, and "smartphones" are becoming increasingly prevalent. Recent surveys indicate that at least 85% of people in the United States have cell phones, and that over 50% of these users now have smartphones (Duggan & Rainie, 2012; Nielsen, 2013; Smith, 2012; Time Mobility Poll, 2012). Overall, users note that mobile technology has changed their lives with most indicating it has helped them maintain or enhance their relationships with friends and family. Aside from calling, it is texting that has become the predominate use of the cell phone, followed by email and social networking. Indeed, in the 10 years since 2002, text messaging in the United States alone has gone from 31 million per day to 6 billion (Cellular Telecommunications Industry Association, 2012).

The "constant connectivity" afforded by mobile technology has contributed to a preoccupation with the cell phone – an overwhelming majority of users check their phone upon waking and as the last thing before bed, are continually checking for calls and texts, and report they could not go without their phone for one day (Perlow, 2012; Smith, 2012; Time, 2012). Such "cognitive salience," when the cell phone dominates one's thoughts or focus, along with "behavioral salience," a preoccupation with checking/using the cell phone are primary symptoms of behavioral addiction (Walsh, White, & Young, 2008). Moreover, this constant connectivity throughout the day provides for a continual source of interruptions and distractions and potentially diminishes our

ability to maintain attention and to concentrate and think deeply about things (Carr, 2010; Wajcman & Rose, 2011). Yet, most of the user's report "no problem" with regard to being able to disconnect from work at home, give people undivided attention, or focus on a task without being distracted (Smith, 2012). Just a decade ago people primarily relied on face - to - face interactions, the phone, and e - mail to connect. Today, such connections often occur instantly via online social networks such as Facebook, Instagram, snapchat etc. Each day, people share almost 5 billion posts to Facebook, 500 million tweets to Twitter, 70 million pictures on Instagram, and 12year worth of video to YouTube (Krikorian, 2013; LePage, 2015; Zephoria, 2016). Media use might impact experience for multiple reasons. First, using media can interrupt an experience by inducing multitasking (Bowman, Levine, Waite, & Gendron, 2010). Second, media allow people to externalize their experience by giving them a way to capture aspects of experience. Third, media allow people to save experiences in the form of photographs or posts. Fourth, social media allow people to share their experiences—to record and save experiences not just for themselves, but also for others.

1.1. Memory

To date, most research on media use suggests that both recording and sharing experiences should diminish the extent to which a person retains detailed memories of that experience, for at least two reasons. First, media use requires multitasking (e. g., recording and posting about an event

while it occurs). Multitasking has been shown to decrease concentration (Fried, 2008) and reduce absorption in experiences (Ross, 2011). In academic environments, media multitasking (e. g., laptop use in classrooms) has been linked to decreases in academic success, presumably because multitasking impairs memory for lecture content (Dietz & Henrich, 2014; Gaudreau, Miranda, & Gareau, 2014; Hembrooke & Gay, 2003; Sana, Weston, & Cepeda, 2013). Together, these studies suggest that the broader impact of using media is that it should impair memory for that experience. Second, people sometimes use such devices as a mnemonic “crutch,” offloading information onto them and then forgetting that information (Soares & Storm, 2017; Sparrow, Liu, & Wegner, 2011; Ward, 2013). Indeed, recent work provides direct evidence that taking photographs impairs memory (Barasch, Diehl, Silverman, & Zauberman, 2017; Henkel, 2014). In one study, participants who took photos of objects in a museum remembered fewer objects and fewer details about these objects (Henkel, 2014). Media use may further impair memory for the features of an experience one does not record. For example, in a study that allowed participants to freely take photographs, participants showed enhanced visual memory but impaired auditory memory for photographed events (Barasch et al., 2017). This research provides converging support for our prediction that media use will impair memory for experiences.

Mobile Technology Use, Memory, and Knowledge

Smartphones provide constant access to an endless and ever improving database of collective knowledge. Having this access enables people to search for, locate, and learn seemingly any fact that they desire. Prior to the advent of the World Wide Web, the closest available approximation of this sort of resource was a multi - volume encyclopedia, the cost and limited portability of which precluded ubiquitous use. Internet search engines enable anyone on a connected device to have access to an unfathomably large amount of information, often at very low cost. Moreover, smartphone technology allows people to take this information wherever they wish, and access it within a matter of seconds. Though it may seem as if constant access to a limitless database of knowledge should improve cognition, much has been written about how the rapidly changing landscape of technology is negatively affecting how we remember our own lives, the places we have been, and those with whom we have interacted (e. g., Kuhn, 2010; Humphreys and Liao, 2011; Pentzold and Sommer, 2011; Frith and Kalin, 2015; Özkul and Humphreys, 2015). However, as with attentional impact, the body of empirical evidence demonstrating tangible effects of mobile media devices on memory and knowledge is limited. One topic that has been investigated is the oft - cited claim that modern technology is leading us to depend upon our devices to store information for us. In a highly influential and informative study, Sparrow et al. (2011) asked participants to type a series of newly learned trivia facts into a computer. Half of the participants were told that the computer would store their typed information for them and that they would be able to access it later, whereas the other half believed that the information would soon be erased. The individuals who believed they would maintain access to the typed information performed more poorly on a later recall task. Importantly, an explicit instruction to remember the facts vs. not being told to remember had no impact on participants’ rates of recall. This

finding, dubbed by the authors as the “Google Effect,” and later referred to by other researchers as “digital amnesia” (Kaspersky Lab, 2015) demonstrates that the expectation of having later access to information can make us less inclined to encode and store that information in long - term memory.

1.2. Technology use, delay of gratification and reward processing

In addition to their effects on memory and attention, smartphones and related media are often implicated as the cause of a perceived cultural shift toward a necessity for immediate gratification (Alsop, 2014). Indeed, there is a common belief that the current generation of children and teenagers are less capable of waiting for rewards, due in part to the omnipresence of various types of multimedia in their lives (Richtel, 2010b). As with the previous sections, the empirical work exploring this claim is still in its nascent stages. In this section, we outline some studies that inform our understanding of the potential impacts that smartphones can have on individuals’ tendencies to choose smaller, more immediate, rewards over larger rewards after a delay, and then offer a summary on the status of the claim. Some work in this realm has begun by exploring the motivations that drive individuals to engage with media in the first place. In one such study, Wang and Tchernev (2012) investigated media multitasking in terms of the Uses and Gratifications theory (Katz et al., 1973). Based on this theory, “Needs” could be defined as “the combined product of psychological dispositions, sociological factors, and environmental conditions that motivate media consumption” and “Gratifications” as the “perceived fulfillment” of those needs, in this case because of media use or exposure (p.495). In their experiment, Wang and Tchernev (2012) collected self - reported data over a period of 4 weeks. Participants were asked to submit three reports daily, in which they indicated the types of media that they had used in the time that had passed since the previous report, and whether they performed any of these activities simultaneously (i. e., multitasking). The participants were also asked to indicate the specific “motivation” (emotional, cognitive, social, or habitual) that drove them to engage in each media interaction, and the strength of that motivation on a 1–10 scale. The participants indicated the degree to which each “need” was satisfied on a 1–4 scale, and this data was aggregated into “gratification” measures used in data analysis. By comparing the various types and strengths of motivations and gratifications across time points, the experimenters were able to draw interesting conclusions regarding the short - term causes and effects of multimedia interaction. Specifically, participants most often reported that “cognitive” motivations drove the reinteractions with media devices. However, subjective reports indicated that the ensuing interaction with a media device rarely satisfied the cognitive needs. Instead, participants experienced an emotional gratification that they did not report pursuing in the first place. Ultimately, these emotional gratifications may be driving subsequent media interactions at an unconscious level [for related findings, see Zhang and Zhang (2012)].

What is distraction? What is distraction learning?

A thing that prevents someone from giving full attention to something else. Which means that, one who is not distracted

has higher rate of concentration. Multitasking is way for being efficient, but when it is compared with Mobile use and another task perform, it is noticed that it reduces the performance of the task. Especially while learning or doing task which requires more concentration & no distraction. If you've been anywhere near a college campus, you've probably noticed the extent to which students are glued to their mobile devices. What do they do with them when they walk into the classroom? In one survey at six different universities, college students reported using their phones an average of 11 times per day in class. In another study, 92% of college students reported using their phones to send text messages during class. In of the survey, 80% of students agreed that using a mobile phone in class decreases their ability to pay attention. This is nothing but the distracted learning and diminishes the working memory.

Distraction associated with cellphone use

Multitasking is very common with mobile technology (e. g., talking/texting while driving, walking, shopping, or watching television) and perhaps contributes to the users' belief that the cell phone makes it easier to stay in touch with people, helps coordinate daily activities, and contributes to greater productivity (Smith, 2012). Indeed, multitasking with the cell phone has the appearance of not taking up extra time; instead, it creates the illusion of "giving you more time" (Turkle, 2011).

Distraction associated with cell phone presence

As for interpersonal relationships, mobile technology indeed does have the potential to expand people's social connections and maintain or enhance their relationships with friends and family (Geser, 2002; Leung & Wei, 2000; Mathews, 2004; Srivastava, 2005; Wajcman, Bittman, & Brown, 2008; Wei & Lo, 2006). However, this technology may have unintended negative consequences for immediate social interactions as its presence may serve as a constant reminder of the broader social network that is potentially available. Thus, in social situations, people may often disengage from their present company to attend, either in thought or action, to other people or events elsewhere in cyberspace (Geser, 2002; Ling, 2004; Plant, 2000; Srivastava, 2005; Turkle, 2011); "Thumbs are stronger, attention shorter, temptation everywhere: we can always be, mentally, digitally, someplace other than where we are" (Time, 2012). Indeed, recent research has demonstrated the potential for the "mere presence" of the cell phone to be a distraction in a social situation and have a detrimental effect on an interpersonal experience. Przybylski and Weinstein (2013) innocuously manipulated the presence or absence of a cell phone while two strangers took part in a relationship formation task, a 10 - min face - to - face interaction discussing an assigned topic (e. g., most interesting event in the past month). Participants' evaluations of the relationship quality (i. e., "liking of their partner") and feelings associated with the other person (e. g., closeness, trust, and empathy) were significantly lower in the cell phone condition. These differences were most apparent when the discussion topic was personally meaningful (your most important event last year) rather than casual (attitudes about artificial holiday trees).

Current Study

The aim of this study is to investigate the effect of the mobile device or social media technology while working or focusing on work which requires no distraction and concentration. As previous work has shown that mobile devices presence also distract the user and in some cases, it is also found that it increases the time taken by the user to perform the same task which can be done in half time spent, and when the mobile phone or social media is used while working on something which requires full attention diminish the memory in the study, similar to the present study, the hypothesis is that if mobile devices are not given to the user while testing the memory will lead to higher Memory test scores in general.

Participant

A total of 19 participants will be recruited from all the department, male & female with age ranging from 18 to 65. The Institutional Review Board at SUNY Oswego approved this study. All participants in all studies provided informed consent.

Design

The study is a between - subject design. The independent variable is the weather participant is using mobile while doing the task with two levels: The Level 1: Use of Cellphone / Social media technology. Level 2: No use of Cellphone / Social media technology and the dependent variable is the number of correct answers given by the participants during the test.

Material

The research study was conducted in a lab with a desk present for participants to sit at using a fixed chair. We used the 24 - inch computer monitor for displaying the images to the user. The lab was noise - free and there was no distraction. One participant per session. Participants from each group were shown 30 images for 10 secs each. One group can use their cellphone to click the photo to the images which were shown. After showing the images, they were asked to give the test. The test consists of the questions in which images were shown to them and they must recognize whether they are able to remember it or not. Participants must press the space bar on the keyboard if they have seen this image at a time of the experiment. And do nothing if the image is not seen or not able to remember until the next image pop's up. The results of the same were recorded. For our experiment, we had used a DELL computer to conduct the test & showcase the images. We allowed the user to use their own phone to click the pictures of the images to not give them a burden to learn the new mobile. After showing the images, the user was asked to give the test immediately to avoid any memory loss issue. We used animal images from google. The question of the quiz contents various images mixture of seen, unseen and repeated. User must click on space bar whenever the question contains the image which was shown to them. Every right answer will be incrementing the value of the Memory Test Score.

Procedure

All the participants will be provided with brief instructions about the study and will be asked to sign the informed consent before starting the experiment. In any circumstances, the participant can leave the experiment in between. To begin the study, participants were seated and told how the study would

proceed and what they should do, and then filled the demographic data. After gathering the information, we divided the group into two subgroups 15 in each. The participant was taken into a room, where they could read the instruction on how to start with the experiment. By clicking the Space bar, the experiment will begin, and they can't stop it manually until it finishes. The experiment had two phases, in the first 10 minutes of the experiment, the participant was showed some guidelines and process about the experiment and then showed 30 images for 10 seconds each. In the second phase, the participant must give the test. The test was conducted immediately after the first phase of showcasing the images. One group was using cellphones, and another group was only concentrating on the task. You can see the figure 1 to understand the steps followed for conducting the test with & without the use of the cellphone to evaluate the memory. Participants were given another opportunity to ask questions before leaving the experiment.

Design

The study used a between - subject design. The independent variable was whether the participant was using mobile to take the pictures shown to them with two levels: mobile was used for taking the pictures and another level was mobile was not used for taking the pictures. The dependent variable was the Memory Test Score (MTS) which was scored by individual participants after giving the quiz.

Measure

Immediately after watching the 30 images from the video, participants are supposed to complete the test. The Memory Test consists of 10 questions ranges with each question is marked one score. The result of the test is measured using the Memory Test Score. Based on the MTS we will determine whether mobile phone affects the memory/concentration if used during the work which requires concentration. The MTS Score will help us determine that. If the score is high than the 7 it is considered as good memory & concentration score else, if it is low then it is not. From the result, we will be able to determine whether mobile devices and technology are diminishing the performance or not. Also, based on the current result we focus, how much time a user takes to finish the test and how many times the user gets distracted by the presence of the mobile device.

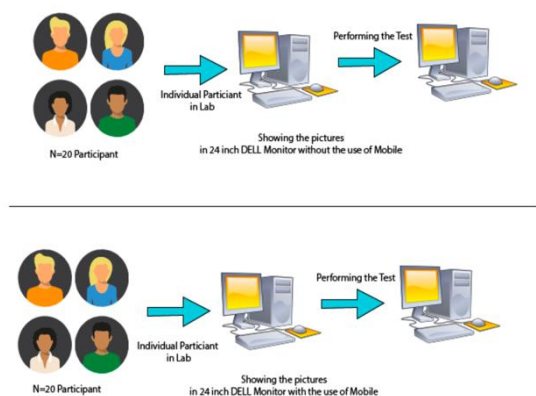


Figure 1: Steps performed by the participant of two group with and without using cellphone to evaluate the memory

2. Result

Overall, based on the study, we confirmed that participant who used mobile during the experiment has less MTS score than the one who did not use it. There was a significant difference between the result and hence we confirmed the alternative hypothesis and rejects the null hypo. Using the Independent t - test we found that, the test result met the assumption of the normality, as assessed by Shapiro - Wilk's test ($P > .05$) and homogeneity (equality) of variance, as assessed by Levene's test ($p > .05$).

Variable	n	M (SE)	t	df	p
Use of mobile to take the pictures.			-7.615	28.00	< .001*
Pictures weren't taken (No use phone)	15	9.4(1.29)			
Pictures were taken (Phone was used)	15	20.33(0.615)			

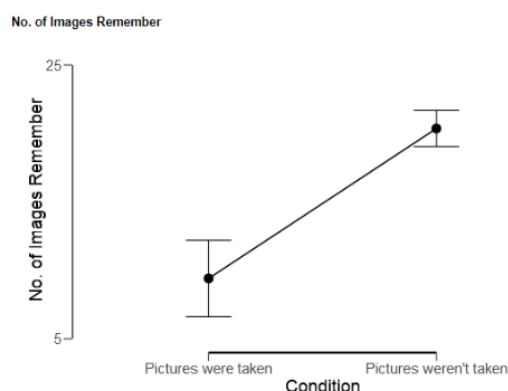


Figure 2: Results of hypothesis testing and descriptive plot.

Results showed a statistically significant difference between how memory impact by using and without use of the phone, $t(28) = -7.615, p < .001$. An examination of the average MTS scores revealed that the without using phone, participant performed better, and their memory is not getting poor as they are focusing on the task. Whereas when phone is used, the chance of the distraction is high and it in return helps diminishing the human cognition ($n = 15, M = 20.33, SE = 0.615$).

3. Discussion

The hypothesis, "Memory will be better for observed images than for photographed images" was supported. The distraction level is high if one is using mobile or any supported technology while doing certain task which requires full attention. Divided attention affects in human cognition and hence leads to diminishes the human memory. The confounding factors in the study was we divided the group, and each group performed the single task, i. e. it was between subject design which leads to individual differences. As it is likely to be possible that, participant who was asked to use mobile, doesn't like to use it & might have got a good MTS score. Another confounding factor is there could be chance that, participant might have entered Space Bar, even without recalling the image & got the MTS score. Smartphones (and

related mobile technologies) have the potential to affect a wide range of cognitive domains, but empirical research on the cognitive impacts of smartphone technology is still quite limited. This is understandable, given that the relevant technology itself is still young and constantly evolving. However, with each passing year, smartphones become more omnipresent in our lives. Rather than applying to only a niche group of individuals, the research conducted in this domain will soon be relevant to most of the world's population (eMarketer, 2014). Therefore, it is crucial to understand how smartphone technology affects us so that we can take the steps necessary to mitigate the potential negative consequences. The current study helped us understand this negative impact on the everyone's life. Investigating the cognitive impact of filling the small breaks in our days with inputs from smartphone engagement is perhaps another endeavor worth pursuing, but not one that is yet represented in the peer reviewed literature. It is possible, but untested, that frequent smartphone usage could be less harmful to adults, whereas children may experience more negative consequences because of their increased neural plasticity. If emerging research does suggest that there are serious consequences of smartphone usage, we need to investigate potential practical approaches that could mitigate these effects. Finally, most of the literature only speaks broadly about "smartphone usage." Future research should distinguish between specific types of smartphone usage, each of which are likely to have differential effects on the user. It seems likely that social activities such as text messaging, email, and social media use will have different impacts than gaming or browsing the web, yet very little is known about the specific concerns related to these seemingly disparate patterns of use. The research outlined in this paper lays a foundation on which a seemingly endless number of "next steps" can be imagined. There is an immense opportunity for additional research to be performed with the aim of giving psychologists and the world - at large a better understanding the short - term and long - term effects of smartphone technology.

References

- [1] Bates, D., Maechler, M., Bolker, B., & Walker, S. (2013). lme4: Linear mixed - effects models using Eigen and S4 (Version 1.0-4) [Computer software]. Retrieved from <http://CRAN.R-project.org/package=lme4>
- [2] Boot, W. R., Blakely, D. P., & Simons, D. J. (2011). Do action video games improve perception and cognition? *Frontiers in Psychology*, 2, 226.
- [3] Caird, J. K., Johnston, K. A., Willness, C. R., Asbridge, M., & Steel, P. (2014). A meta - analysis of the effects of texting on driving. *Accident Analysis and Prevention*, 71, 311-318
- [4] Spira, J. B., & Feintuch, J. B. (2005). The cost of not paying attention: How interruptions impact knowledge worker productivity. New York, NY: Basex. Retrieved from <http://iorgforum.org/wpcontent/uploads/2011/06/CostOfNotPayingAttention.BasexReport.pdf>
- [5] Srivastava, L. (2005). Mobile phones and the evolution of social behavior. *Behavior & Information Technology*, 24, 111-129.
- [6] Stavrinou, D., Byington, K. W., & Schwebel, D. C. (2011). Distracted walking: Cell phones increase injury

- risk for college pedestrians. *Journal of Safety Research*, 42, 101-107.
- [7] Stothart, C., Mitchum, A., & Yehnert, C. (2015). The attentional cost of receiving a cell phone notification. *Journal of experimental psychology: human perception and performance*, 41 (4), 893.
- [8] Strayer, D. L., & Drews, F. A. (2007). Cell - phone - induced driver distraction. *Current Directions in Psychological Science*, 16, 128-131.
- [9] Strayer, D. L., & Johnston, W. A. (2001). Driven to distraction: Dual - task studies of simulated driving and conversing on a cellular phone. *Psychological Science*, 12, 462-466.
- [10] Strayer, D. L., Drews, F. A., & Crouch, D. J. (2006). Comparing the cell - phone driver and the drunk driver. *Human Factors*, 48, 381-391.
- [11] Strayer, D. L., Drews, F. A., & Johnston, W. A. (2003). Cell phone induced failures of visual attention during simulated driving. *Journal of Experimental Psychology: Applied*, 9, 23-52.
- [12] Thornton, B., Faires, A., Robbins, M., & Rollins, E. (2014). The mere presence of a cell phone may be distracting Implications for attention and task performance. *Social Psychology*, 45 (6), 479.
- [13] Ward, A. F., Duke, K., Gneezy, A., & Bos, M. W. (2017). Brain drain: the mere presence of one's own smartphone reduces available cognitive capacity. *Journal of the Association for Consumer Research*, 2 (2), 140 - 154.
- [14] 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.