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“What did u say?”

Examining Multi-Tasking Effects on Academic Performance

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Abstract

The ability to multi-task—that is the ability to simultaneously complete more than one activity—has become increasingly essential in the high-tech world that we operate in. However, one's capacity to multi-task efficiently has become a concern among researchers, especially in regards to the influence of technology. Cellular phones play a major role in distracting individuals from completing tasks that require sustained attention. A recent study demonstrated that the mere receipt of smart-phone notifications without interaction with the phone itself, can cause significant distraction and error in an assigned task (Stothart and Mitchum, 2015). Proposed results from this study as well as others, could prove worthwhile to explore in the education realm. Technology is being utilized more and more in classrooms to enhance learning, whether through instructor use or student use. However, students' direct use of their mobile phones for reasons unrelated to learning could be even more distracting than receipt of mobile notifications. The spike in multi-tasking efforts and push to be able to divide one's attention responsibly, especially with learning, complicate the debate of the use technology being a part of multi-tasking or a distraction. If mere mobile phone notifications can result in task disruption, it will be useful to examine to what extent can one efficiently balance direct mobile phone use through texting, and learning, in a classroom environment. Participants will listen to short neutral passages, and answer quiz-like multiple choice questions at the end after texting while listening, or solely listening. Results showed that in this study design, text messaging did not have a negative effect on retaining information.

Executive Summary

Multi-tasking has become an informally required skill in the academic setting and in the workforce. Employers often ask if their potential employees are able to handle many tasks at once, while universities look for students who are well-rounded and able to juggle many activities. Is multi-tasking even possible? Can one mentally handle completing more than one task simultaneously?

Technology makes this balancing act extremely difficult. Have you ever been in a conversation with your friend, and they stopped mid-sentence to ignore you and text or check their social media? Is it that difficult to manage cell phone use and a conversation? Imagine replicating this situation in a classroom, in which a professor is lecturing and a student is attempting to participate in an academic conversation, while attending to a social conversation on their cell phone. The study put undergraduate students to the test, determining if they can balance listening to a lecture-like recording and text messaging. It was expected that participants would not be able to retain as much information while texting, compared to solely listening to the recording. Each participant was required to listen to neutral stories, and texted throughout half of the stories. Immediately following, the participants took a quiz on all of the recordings, to see how well they were able to retain information and message on their phones.

The study found that participants retained information slightly better while texting compared to only listening to the stories. Other previous studies prove multi-tasking is not feasible, and thus this research cannot be satisfied with this conclusion. It is recommended that to further the study, more participants, quiz questions, and natural texting patterns should be included. More participants will allow for a more fair representation of the undergraduate population. With more quiz questions, the grades could be more spread out and comparison analysis could be more detailed. Instead of the experimenter texting the subject, friends can be

recruited to participate in pairs. In this manner, the pair can text each other more organically, and reduce the anticipation effect of wanting to be able to multi-task the experimenter's text messages and listening to the story. This recommendation is most vital, because it replicates a lecture environment in which students become distracted by replying to unexpected texts and lose the ability to effectively retain information. Although this study found that participants received better grades while texting, these recommendations will complicate the results.

1. Introduction

As we delve deeper into the digital age, the concept of multi-tasking, or completing more than one activity at the same time, is becoming more prominent among the youth, especially college students. A main component of the digital world is the constant means of instant communication through mobile devices and social media. People find themselves checking social media sites such as Facebook, Instagram, and Twitter more often, as well as utilizing instant modes of communication through instant messaging (IM) and text messaging. In 2012, Twitter was reported to have 550 million users, while Facebook was reported to have over 700 million users in 2011 (Karpinski & Kirschner, 2012). Many of those users tend to come from the younger generation. This same study also found that 87-92% of undergraduate students use Facebook and spend a daily average of 1h and 40 min on this social networking site. Moreover, technology users are now able to access social networking sites on their mobile devices, adding to the communication value of cell phones. A recent study found that 96% of all undergraduates owned cellphones (Junco, 2012). If so many young adults own cell phones, and there is a constant need for instant communication, then one could assume that cell phones are being used on a consistent basis. Over 73% of undergraduates in a recent EDUCAUSE Center for Applied Research study were found to text message daily (Junco, 2012). The need and use of digital communication has become so profound, that researchers have grouped these digital devices and modes of communications to be known as Information and Communication Technology (ICTs) (Junco & Cotten, 2011).

If one takes into consideration this current and growing demand of ICT use, and factors in the added time devoted to digital communication, one must wonder: how do people manage to balance that and other daily activities? Multi-tasking is the idea that one can simultaneously attend to and execute multiple tasks that require information processing (Karpinski & Kirschner,

2012). Many people believe that they can successfully multi-task, especially those from the younger generation. More young adults are beginning to believe that interruptions are an unavoidable part of life to be dealt with along with other daily activities. Even employers hold this idea that their employees should be able to multitask (Rosen & Carrier, 2013). In this modern age, ICT interruptions have become common-place, and we're expected to be able to handle them. Is true multi-tasking possible for humans? A recent study reviewed the existing literature and found evidence that multi-tasking is not possible, at least without losing effectiveness and efficiency (Rosen & Carrier, 2013). Investigators argue that the cognitive structure of the brain limits the simultaneous processing of more than one flow of information. An information bottleneck is believed to help make up this cognitive structure of information processing, which allows for the execution of only one task while the other is postponed until completion of the first (Karpinski & Kirschner, 2012). Therefore, task-switching has become the more appropriate description of attempting to execute more than one cognitive task. One must stop what one is doing in order for the brain to process the information of the other task and switch. However due to referencing and the commonality of the term, "multi-tasking" will be used rather than the term "task-switching".

Young adults, especially college students, usually attend to many activities at a time. They have their academics to tend to, along with the possibility of a part-time job, and/or numerous student organizations. How then are they supposed to attend to these activities, as well as the ever present existence of ICTs? Although many young adults feel that they can multi-task efficiently, studies have proved that this belief does not hold true. Even a simple notification from one's cell phone is enough to distract somebody from efficiently completing a task. In their study, Stothart and Mitchum (2015) investigated the effect that a cell phone notification would

have on their undergraduate student participants completing the Sustained Attention to Response Task (SART). This attention demanding task requires that the participants view a computer screen that displays a number (1-9) every second and indicate which number appears, except for the number 3. Participants were randomly assigned to the call, text message, or no notification condition and were given no instructions about their phone. If they were to receive a notification, the investigators did so while they were executing the SART. This study found that the students in the notification condition (call and text) committed more errors in the SART than those who did not receive any notification. If young adults cannot handle multi-tasking an attention demanding activity and just acknowledging notifications from an ICT, imagine their performance in an academic setting when they actually use their cell phones.

One such study (Ellis, Daniels & Jauregui, 2010) analyzed the exam scores across two groups of students in a lecture hall: one group was allowed to multitask by texting during the lecture, while the other group was not. Irrespective of GPA and gender, exam scores of the group of students who texted, were significantly lower than those who did not multitask during the lecture. Other experiments have expanded upon this research, to examine the long-term effects that multi-tasking has on academic performance. For example, Junco (2012) assessed the effect that multi-tasking with ICTs has on college students' GPAs. These investigators distributed surveys to a group of Northeastern college students that evaluated whether they were multi-tasking in class using ICTs and how they did so. According to the study, 69% of students reported texting in class, 28% use Facebook, and others reported various activities. The higher frequency activities (Rosen & Carrier 2013) were negatively predictive of GPA. The lower frequency activities, such as searching the internet for unrelated material and checking one's email, were not predictive of GPA. The results show some potential for the argument that

successful multi-tasking is possible among the younger population, seeing that email and internet surfing was not predicted to negatively affect GPA. However, the major attention demanding tasks such as texting and using Facebook, show support for claims made by other investigators that it is highly unlikely to be able to multitask effectively.

Junco (2012) provides a possible explanation for the improbability of multitasking, especially in an academic setting. The investigators propose that one's mind is limited by a processing capacity and cognitive overload can happen when one's brain attempts to process too many cognitive demands at once (multitask). There are three types of cognitive demands: essential processing, incidental processing and representational holding (Junco, 2012). Informational processing is the basic level of processing used to make sense of presented information, incidental processing registers outside stimuli, and representational holding involves maintaining mental representations in one's working memory to be manipulated. Essential processing and representational holding are argued to be vital for learning, while an overload in incidental processing is suggested to cause the lack of learning. In the case of multi-tasking in an academic setting with ICTs, a cell phone would be considered off-task stimuli that would trigger incidental processing and hinder representational holding of the presented lesson as well as the essential processing of it.

1.1 Research questions and hypothesis

This study attempts to expand upon similar research completed by other investigators, by assessing multi-tasking in action, as opposed to relying on self-report surveys. The advantage of this work is that multi-tasking with ICT will be investigated in a controlled, experimental setting. This experiment will focus on the most frequently used ICT, the cellphone, and examine if multitasking learning and using a cellphone can be successful in an academic environment.

Participants will be tested on comprehension of auditory information while either focusing on the audio stream (unitasking) or simultaneously responding to a text message on their phones (multitasking). It is hypothesized that texting while processing information in an academic setting will prove to be detrimental to essential processing and representational holding of the information, thus detrimental to learning.

2. Methods

2.1 Participants

Participants (N=40) were undergraduate students from Syracuse University. They were PSY 205 students that were recruited through the Department of Psychology Research Participation Pool (SONA). Participants were reimbursed with credit towards their psychology courses. Each participant was also instructed to have a working cell phone. Experimental sessions typically lasted 45 minutes to an hour.

2.2 Materials

This study used a computer along with headphones, and the participants' cell phones. It took place in a room similar to that of an academic environment, with a study desk and chair. On the computer were audio pre-recorded stories based on neutral history and laws, as well as a 32 question test at the end of all the recordings. Twelve pre-determined text messages were used to send to the subjects.

2.3 Procedure

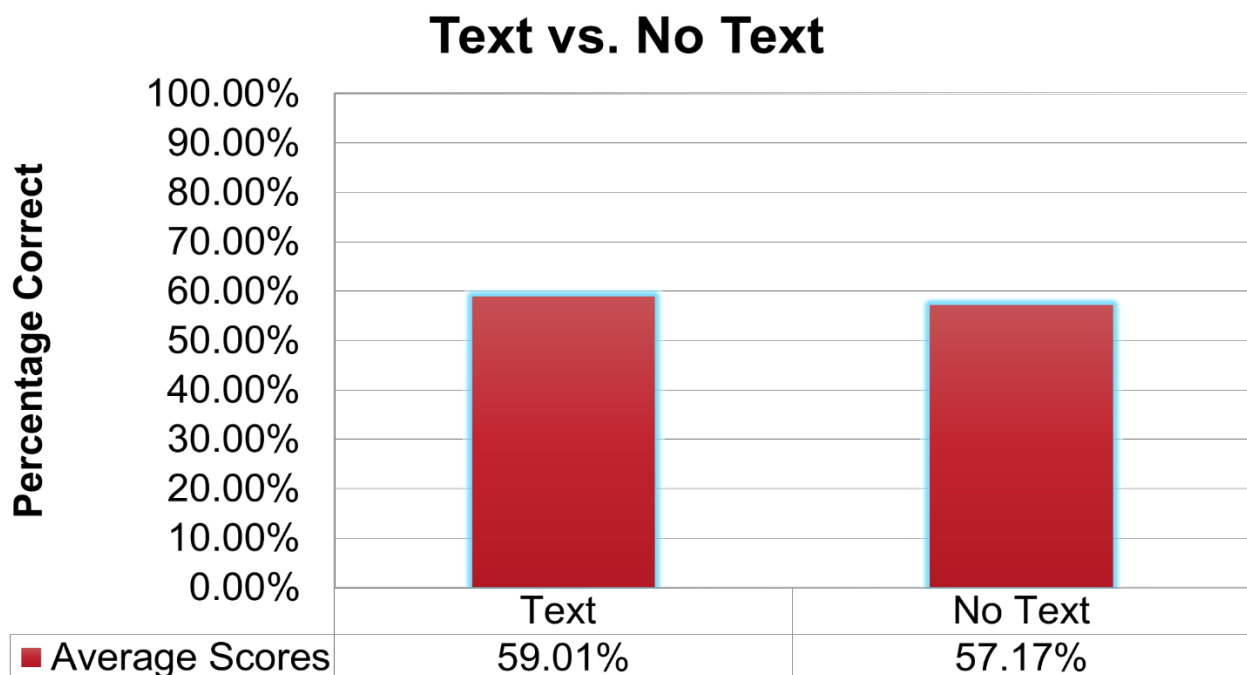
This study is within-subject design, and thus all subjects received both the texting and non-texting conditions. Each participant was brought into a study room, and was seated at a desk in front of a laptop with headphones. After signing the consent form, participants put on the headphones and allowed the experimenter to play 8 story recordings. If the subject was in the

texting condition, he/she listened to the first story and receive a text from a research assistant at 1 minute intervals, starting at the 15 seconds mark in the story. The subject was asked to type each message they received and send it back to the number that they received the text from. The participant did this for every other story following. Eight stories were played in total, 4 of which were played in the texting condition and the other 4 were played in the non-texting condition.

The subject received 3 texts per texting condition, totaling 12 text messages per study.

Immediately following the recordings, the participant took a short quiz. If the participant was in the non-texting condition, he/she listened to the first story uninterrupted and in every other story following, the participant was required to text in the same manner as those in the texting condition. Every subject listened to 8 audio recordings, 4 of which required texting while listening to the recording, and the other 4 just required listening. The order of conditions was counterbalanced across subjects. For example, Participant 1 participated in the conditions in this order: text, no-text, text, no-text, text, and no-text. Participant 2 participated in the conditions as follows: no-text, text, no-text, text, no-text, and text. Each condition was executed alternatively with the participant and between participants.

3. Results



The study began with 40 participants, but data from 6 participants were omitted due to either distraction or technical difficulties. The quiz assessment included 32 questions, which were divided into 4 questions per story. Each 4 question section received a percentage grade out of 100%. Therefore, each participant received 8 grades, 4 of which came from the texting condition, and the remaining 4 from the non-texting condition. The percentage grades from all the texting conditions were averaged at 59.01% and the average from the non-texting condition was 57.17%. A 2 sample t-test was conducted and the p-value was found to be 0.609. The data did not support the hypothesis.

4. Discussion

The results showed that participants who texted while listening to the audio recordings did slightly better than those who did not text. However, these results were not significant ($p=0.609$). Although the participants that texted had higher averages, they were not much higher than those who did not attempt to multi-task. Therefore, the results suggest a slightly better efficiency in balancing texting and listening comprehension. If one takes into consideration the limits and future directions of the study, these results lack conclusiveness.

One limit of this study was the small margin of error in the grades of each story's questions. With each grade based on only 4 questions, if a participant received 1 question wrong, then they received a 75%. In other words, 25% was lost for each question answered incorrectly, which allowed participants only 4 opportunities before they earned a 0% for a quiz section. With this small window of error, participants' levels of distraction may not have been adequately represented in the data. For example, one participant may have guessed the answers and received a 75%, while another participant may have been intently listening but received a 50%. They were only off by 1 question, but this incorrect answer cost the participant 25%, plummeting the

average. If there were more questions per story, then the quiz would be able to counteract the guessing effect. A participant can only guess but so many questions correctly, and on the contrary, an attentive listener would be given more opportunity to prove their information retention. Although these are not the only complications among participants, providing more questions per story allows more a chance to attest to whether or not information was actually retained.

Other limitations on the study include various related external factors. One such factor is apathy. Some participants may have begun to lose focus in the experiment, since there were 8 stories to listen to. Even though there was a quiz at the end, the grade did not affect the research credit awarded by their Psychology class. In the future, if there was more incentive specifically related to the quiz grade, then subjects may be more inclined not to lose interest and focus on performing at their best in the listening and testing sections. Another issue related to apathy is distraction. The instructions were either unclear or ignored in terms of cell phone usage during the study. Participants' cellphones were only supposed to be in use when the experimenter texted them in the texting condition. A few participants found themselves using their phones otherwise in both conditions causing additional distraction. This added distraction interfered with the condition in which they should only be listening to the recording. An additional interference in the texting condition was that some subjects were copying and pasting the text messages sent by the experimenter, instead of typing them out and sending them. The goal behind typing each message out was to increase interfering cognitive effort and thus distraction from listening to the story. Copying, pasting and then sending the message received reduced the amount of time and cognition spent on the text message and thus reduced the distraction. This intrusive matter however was not pervasive throughout the study. The experimenters specified to the participants

that they should be typing out every message. In the future, it would be helpful to specify these instructions from the beginning of data collection.

Another limit to this study was the small sample size. Even though this experiment was within-subjects designed, there could have been more participants to negate interfering, external variables. In terms of the within-subject design, each participant received 8 grades, 4 from the texting condition and 4 from the non-texting condition. Therefore, multiplied by the number of participant data used, there were 144 trials from the texting condition and 144 from the non-texting condition. Despite these trial numbers, the fact remains that each participant had influence over 8 trials. If a participant was extremely distracted by external factors such as texting outside of the limits of the study, apathy, or copying and pasting the message instead of texting the message by hand, then these variables would negatively impact the data. With more participants included in the study, there would be more opportunity for external interferences to be masked by the number of participants.

Arguably, the most important limitation to this study was anticipation. The experimenters informally spoke with participants after they completed the study and the quiz. The majority of the subjects stated that they concentrated more on listening to the stories in the texting condition compared to the non-texting condition. Their responses suggest that these participants wanted to prove that they can truly multi-task. As seen in the results, the increased concentration factor masked the negative effect of multi-tasking that was projected from the hypothesis and previous studies. It is important to notice that increased focus did not completely mask the effects of multi-tasking. One would expect, for example, that if one doubled their concentration on a particular task, the results would be similarly proportional to the efforts. However, the results showed that the grades from the texting condition were only slightly better than the ones from

non-texting condition. One would expect that the increased concentration in the texting condition would significantly increase the grades, but it did not. It can be determined that multi-tasking still did negatively impact concentration efforts, which could have been more pronounced with some improvements on study design.

One way that the increased concentration effect could be reduced in the future is by utilizing a more observatory approach to the study. For example, the study could have allowed participants to just listen to the story and use their phone how they would normally. The experimenters then could tally up how many times the cell phone was used during one recording, and compare quiz scores to the smaller level of multi-tasking in the other recording. In this method, there would be no anticipation or participant bias, which reduces the increased concentration effects. Another way to minimize the increased focus value could be to recruit subjects in pairs of friends, with one friend playing the role of a confederate. The confederate could be in another room messaging the participant during texting conditions. The conversation specifics would need detail, but the participant would be interacting with his/her cellphone more naturally, similarly to the way he/she would in a classroom setting. The anticipation would more so arise from the more authentic conversation, instead of trying to focus more on the study because the experimenter will soon text them.

5. Conclusion

Results from this study showed that texting while processing information was not detrimental to information retention. Quiz grades proved the opposite of my hypothesis: participants fared better on the quiz and thus retaining information while texting compared to not texting. Nonetheless, these results were not significant, because the average quiz grades from the texting condition was only slightly higher than grades from the non-texting condition. Future

directions for this study should include controlling for the anticipation and increased concentration factors that the participants reported. These effects were the most intrusive on the study and should be minimized in order to organically replicate texting interactions and the academic setting. An augmented number of questions in the quiz assessments would provide a larger margin of error to effectively compare participants. Lastly more direct and clear instructions would prevent use of cellphones outside the realms required for the study. Future research that takes these suggestions into consideration would prevent masking and more clearly represent how multi-tasking reduces efficiency in retaining information in an academic setting.

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Appendices**Appendix A:** Screenshot of texting condition

What's up, how's everything going? I want to see that new movie.

What's up, how's everything going? I want to see that new movie.

It just came out last Friday. It looks like a lot of fun!

It just came out last Friday. It looks like a lot of fun!

Are you free to see it this Friday? We should go before the tickets run out.

Are you free to see it this Friday? We should go before the tickets run out.

Appendix B: Screenshot of quiz sectionMall of America

1. Who signed the deal to develop the nation's largest retail and entertainment complex?
 - a. Mr. Nordstrom
 - b. The Viking Brothers
 - c. Mr. Graceland
 - d. The ~~Ghermezian~~ brothers
2. In what year was the mall completed and its doors opened?
 - a. 1986
 - b. 1992
 - c. 1989
 - d. 1996
3. What is the name of the nation's largest indoor theme park that is housed in the Mall of America?
 - a. Timberland Twister
 - b. Rainforest Café
 - c. Camp Snoopy
 - d. Underwater Adventures
4. About how many people visit the mall each year?
 - a. 42 million
 - b. 4,000
 - c. 900 million
 - d. 1.2 million