

**The Impact of Cellphone Use on Academic Performance– Does Choosing When to
Use a Cellphone Affect Academic Outcomes?**

BY

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Abstract

Students are using their cellphone multiple times throughout the day, extending into the classroom. Last year, we conducted a study to evaluate whether the frequency of cellphone use correlated with students' course grades. We observed that sending out text messages was not predictive of students' course grades, however the number of text messages a student received within a day was predictive of student's course grades. I aimed to examine this difference on immediate testing performance. Participants watched a 16-minute lecture after which they were tested on the lecture content. Importantly, students were assigned to one of three conditions: No texting condition, where they put their cellphone away, the controlled texting condition, where they decided when to send text messages or the uncontrolled texting condition, where they sent text messages in response to a prompt sent to them by the experimenter. Our analysis revealed that participants who did not use their cellphone performed better on the test than students who use the cell phone. However, there were no differences in test scores between participants in the control texting condition and the uncontrolled texting condition. The absence of these differences in the current study is likely attributable to the differences in memory performance between immediate testing and overall GPA.

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The Impact of Cellphone Use on Academic Performance - Does Choosing When to Use a Cellphone Affect Academic Outcomes?

The use of texting to communicate with individuals has become habitual for many. (Thomé et al., 2010). Often, individuals share the common perception that cellphones require people to be at constant demand and readily available at any moment. This common belief has led to the use of cellphones within the classroom (Thomé et al., 2010). It has been well documented that cellphone use in the classroom has significant negative impacts on students' academic performance (Bjornsen & Archer, 2015; Krylova et al., 2020; Lepp et al., 2015). However, recent studies have shown that cellphones may not always interfere with students' academic performance. Schneeberger et al. (2021) found that the number of incoming texts were predictive of students' course grade point average (GPA), yet the number of text messages sent out by students were not. The results of this study may be attributable to students having the choice of when to send a text and when not to during class. In other words, if a student chooses to use their cellphone at a point in time where there is no new information being presented, it will not interfere with the encoding or retainment of information into one's memory. However, if an incoming text abruptly interrupts a student during class time, they do not have a choice of when their attention has disengaged from learning the material and attended to the cellphone notification. Although the detrimental effects of cellphone use on academic performance have been well documented (Bjornsen & Archer, 2015; Jacobsen and Forste, 2011; Krylova et al., 2020; Lepp et al., 2015), there is a lack of findings that have found whether having the choice of when to use a cellphone will influence academic performance. The current study sought to examine

whether choosing when to use a cellphone during class time will influence test scores in undergraduate students.

Patterns of Cellphone Frequency amongst young adults

The use of cellphones as a means of communication has become widespread among young adults. Notably, Cheever et al. (2014) found that post-secondary undergraduate students are amongst the most avid cellphone users across all age groups. Cheever et al. (2014) conducted a study to examine the relationship between the patterns of cellphone use. Undergraduate students were required to complete a survey measuring their overall cellphone use, the number of hours spent texting, watching online videos, chatting using online platforms and browsing the internet. Researchers found that participants reported using their cellphone 4.80 hours per day solely when exchanging text messages. Moreover, across all participants the activity of exchanging text messages throughout the day was the most prominent use of cellphones compared to any other type of activity on a mobile device. Likewise, the findings from surveys on Americans' use of the internet (Smith et al., 2011) demonstrated that young adults send out an average of 109.5 messages per day. Similarly, Dos (2014) found that students spend an average of 319.60 minutes per day using a cellular device, sending 115 messages per day, and receiving approximately 138 messages per day. This suggests that individuals use cellphones to send and receive text messages multiple times a day, potentially interfering with other tasks at hand.

Although cellphone use appears excessive, individuals are aware of their cellphone use frequency. Gold et al. (2015) provides converging evidence of extensive cellphone use by examining the agreement between self-reported cellphone use

frequency and actual cellphone bills. This provides support to the validity of self-report measures on cellphone use data. Researchers found that there was a 26% agreement between self-reported measures and actual cellphone bill data of number of daily texts sent. Among those who were inaccurate in their assessment, 81% of participants overestimated the frequency with which they send out text messages. The overestimation of cellphone use was consistent across most all participants, therefore Gold et al. (2015) concluded that self-reports are a suitable measure only for comparison within a sample, an important determinant of texting habits within the current research. The use of cellphones to exchange messages between individuals occurs frequently throughout the day, possibly interfering with the processing of information of post-secondary students while inside the classroom.

Cellphone Use in The Classroom

Studies have shown that the use of cellphones occurs during times when they are not permitted, for example during class. Indeed, Tindell and Bohlander (2012) asked undergraduate students to report on their cellphone use and that of their peers' cellphone. Tindell and Bohlander (2012) found that 99% of participants reported having a cellular device that can send and receive text messages, while 97% reported using their cellular device to send text messages. The authors also found that most of the students reported bringing their cellphone to class and additionally reported failing to turn off their cellphone during class time, leaving it readily available to distract themselves and others around them. Additionally, most participants reported sending text messages before class, during class, and after class every day. Participants also reported being distracted by the cellphone use of others within their surroundings inside the classroom.

Through the research conducted by Tindell and Bohlander (2012), it is evident that students are using their cellphone during class which may distract them from attending and consolidating relevant information presented in the classroom.

Similarly, Pettijohn et al. (2015) asked college students to complete a survey regarding their perceived cellphone use inside the classroom. To evaluate cellphone use frequency, the researchers asked participants to respond to questions such as, “How many text messages do you send per hour?”. The authors found that nearly all participants owned a cellphone, while most of the participants indicated texting on a daily basis. Moreover, students indicated that on average they send out 12.21 messages and receive 10.75 messages per hour while attending class. This suggests that a message is being sent out or received every few minutes within each class period. The constant interaction between sending and receiving messages throughout the day is likely to distract students and interfere with their learning inside the classroom. The disengagement from academic material to use a cellular device may influence one’s academic performance.

Cellphone Use and Academic Performance

Cellphone use during class time influences students’ overall and immediate academic performance (Bjornsen & Archer, 2015; Jacobsen and Forste, 2011; Krylova et al., 2020; Lepp et al., 2015). Pettijohn et al. (2015) suggest that students attend to their cellphone during ‘dull’ moments in a lecture, supporting that it is possible to choose when to attend to cellphone notifications during class time. Lepp et al. (2015) evaluated academic performance using participants’ cumulative grade point average. Participants were asked to complete a survey where they provided an estimation of how

many hours per day they use their cellphone. The authors found a significant negative relationship between academic performance and total daily cellphone use, such that the more frequently one uses a cellphone throughout the day, the lower their overall academic performance will be. These findings were replicated in a study conducted by Jacobsen and Forste (2011) where participants recorded their cellphone use frequency in self-report diaries and surveys in relation to their first semester grades and academic outcomes.

Although previous studies explored daily cellphone use and grades, Bjornsen and Archer (2015) specifically investigated the relationship between cellphone frequency during class time and grades among college students. The authors asked students to frequently complete a cellphone use questionnaire that comprised questions about students understanding of the course material presented that day, as well as how often they used their cellphone during the lecture. The researchers measured students' academic performance by obtaining their scores from administered tests that occurred at equal intervals throughout the semester. From these findings, the authors found that cellphone use was significantly and negatively associated with test scores amongst students. The results from this study suggest that students who use their cellphone more during class time will have poorer academic performance than those who do not use their cellphone during class time.

Froese et al. (2012) examined students' perceptions of cellphone texting frequency in class in relation to academic performance. In the first study, college students were required to report on how often they texted during class. Following this, researchers then asked students to estimate how many questions they may get incorrect

(out of 10 questions) if they were to get tested on material they learned while texting. The researchers conducted a second experiment with a simulated lecture during which the participants participated in text messaging, compared to not participating in text messaging during a lecture. The researchers concluded that the comprehension was worse for material learned while texting compared to material learned when not texting. Further, the results demonstrate that texting is likely preventing the encoding of material from the lecture. Interestingly, when participants estimated a decline in their performance on the quiz, their actual performance did indeed drop by 30%, further indicating that students are aware of the detrimental effects of cellphone use on academic performance.

The detrimental influence of cellphone use during class time has also been measured experimentally by Chaklader and Bohlander (2009) who asked students to respond to prompted messages while viewing an instructional video. They found that participants' performance on test scores declined significantly when multiple prompted text messages were received in comparison to when cellphones were not used. This further suggests the influence that texting in the classroom has on students' performance. It is evident that there are detrimental effects to one's academic performance when engaging with a cellphone during class, yet students continue to attend to their cellphone during this time. Rosen et al. (2011) found that students who engage in high frequency texting during an instructional video had less accurate memory on the lecture material. Participants were required to view an instructional learning video during which they were distracted by receiving a variable number of text messages. Participants were randomly assigned to different texting conditions low

texting condition, moderate texting, and high texting which included over 16 messages throughout the duration of the lecture video. The participants in the high frequency texting condition did significantly worse on the recall test following the lecture than the participants in low frequency texting condition. Similarly, additional studies have demonstrated the direct effects of texting on test scores. This idea demonstrated by Dietz and Henrich (2014), who evaluated test scores directly following the presentation of a pre-recorded lecture. Participants who used their cellphone performed significantly poorer on the test than those who did not use their cellphone during the lecture. Studies display overarching evidence of the direct effects of cellphone use on not only general academic performance, but immediate testing abilities as a performance indicator.

Previous studies have suggested that the number of text messages sent or received during class has a direct influence on how low an individuals' grade point average will be (Harman & Sato, 2011). Harman and Sato (2011) found that with the more an individual texts on their cellphone, the lower an individuals' grade point average will be. Yet, students who have a higher grade point average are found to be more relaxed with using a cellphone during class time. A plausible explanation to why students with a higher grade point average are more comfortable using their cellphone during class time is because these students may know how they learn best, are aware of the teachers' expectations and are aware of the negative influence of distractions during a time of encoding important information. Harman and Sato (2011) found that these students may also feel more comfortable using their cellphone during class time as they can learn the relevant material outside of class.

Although many of the studies have reported a negative influence of cellphone use and academic performance, Wang et al. (2009) found positive effects of cellphone use during class time. Wang et al. (2009) found that if cellphones are integrated into a professor's lecture as an instrument for teaching, students will be more likely to become engaged and participate in the lecture. Essentially, Wang et al. (2009) found that there was more engagement with class material when using a cellphone to respond to course questions during a lecture, rather than when professors used a traditional learning system. In this study, the use of a cellphone is used to attend to relevant material presented in class rather than distracting students from what is being taught in class. However, when cellphones are used inside the classroom for non-academic related things such as texting, it influences ones' academic performance.

Divided Attention and Academic Performance

The direct effects of cellphone use on academic performance can be explained by the impact of divided attention on one's memory (Mulligan & Hartman 1996; Naveh-Benjamin & Brubaker 2019; Thornton et al., 2014). Cellphone use during class time takes away the necessary cognitive resources to effectively complete a primary task. Mulligan and Hartman (1996) demonstrate this notion through investigating the effects of divided attention on indirect memory tests through two experiments. Participants were required to read a list of words under one of two conditions: a divided attention condition and a full attention condition. The participants' ability to remember the list of words was tested through various memory tests. The researchers found that participants recalled fewer words for the list for which they were distracted during encoding in comparison to when they were not distracted during encoding. The results from this

study provide a plausible explanation to how one's memory and thus recall will be negatively influenced by divided attention at encoding. This may provide insight into why students perform worse on tests when they are using a cellphone during class. Ultimately, if a student is disengaging from class material, they will perform worse on a task that requires activation of the students' memory, similarly, to writing a test or an exam.

Indeed, students who had their cellphone with them while learning new class material paid less attention to the materials presented in class than those who did not have their cellphone present, further explaining why students perform worse when cellphones are used inside the classroom (Gutiérrez-Puertas et al., 2020). Gutiérrez-Puertas et al. (2020) evaluated the effect of cellphones on attention and learning in undergraduate nursing students. The undergraduate nursing students were required to complete survey questions to examine students' cellphone use and attention during class. Students were placed into two groups respectively; a group who did not use their cellphone during a class lecture, and a group who did. The authors found that students who reported not using their cellphones during class paid better attention to what was being taught than those who used their cellphones.

Not only has research concluded that using a cellphone divides attention (Mulligan & Hartman, 1996; Naveh-Benjamin & Brubaker, 2019; Thornton et al., 2014) leading to impaired recall, it has been found that students are able to better distinguish the relevant content from a presentation in comparison to false or misleading information when cellphones are absent, further supporting an explanation to ones' success on a test. Smith et al. (2011) sought to examine the impact of cell phone

distractions on true and false recognition. To evaluate true and false recognitions, participants were asked to remember a list of semantically related words under two different conditions: with the presence of a cellphone and without the presence of a cellphone. Participants were required to recall or recognize previously presented words and were evaluated on their memory for non-presented words, in other words, false memories. The researchers found that participants could better distinguish between true and false targets when there were no cell phone distractions during the presentation of the words. Therefore, students who do not use a cellphone during a lecture presentation may be able to better distinguish relevant from irrelevant or misleading information on a test better than those who use a cellphone during a lecture presentation. Further, this could result in better academic outcomes.

Craik et al. (1996) use a similar task, but the researchers evaluate the effects of divided attention on encoding and retrieval. Participants were required to complete a memory task under either full attention or divided attention. The CRT task was used either at encoding, retrieval or both encoding and retrieval. The CRT required participants to hit the correct button associated with the target cue location as fast as possible. Under the dual-task conditions the continuous reaction task accuracy and reaction time was best for the full attention at both the memory and the distractor task. Interestingly, participants whose attention was divided at encoding suffered more on recall accuracy than those who's attention was only divided at the retrieval period, although both were significantly worse than those who had full attention. Finally, if participants' attention was divided at both encoding and retrieval, they performed the worse for reaction time and recall on the task. The results from this study suggest that

dividing attention leads to performance deficits at both encoding and retrieval as there are not enough resources to complete both tasks.

Although researchers have indicated that divided attention at encoding negatively impacts memory consolidation (Mulligan and Hartman, 1996) and further leads to negative impacts on academic performance (Gutierrez-Puertas, 2020), the mechanisms behind this impact are uncharacterized. Naveh-Benjamin and Brubaker (2019) conducted research to investigate how the deep-level semantic networks are influenced by divided attention at stages of encoding. Researchers either told participants that they were examining their physiological response to the presentation of word-pairings (incidental learning) or told participants that they would be tested on the word-pairs (intentional learning). All participants studied lists under full attention as well as divided attention. The authors found that the participants whose attention was divided during the encoding of word-pairings did significantly poorer on their respective memory performance test. They also found that participants who engaged in incidental learning did significantly worse than those who engaged in the intentional learning task. The support that participants did poorer when attention was divided during encoding suggests that divided attention during the encoding of newly learned information will decrease consolidation and performance.

Not only has research suggested that cellphone use during class time negatively influences the encoding of information, but researchers have also found that even the presence of a cellphone is enough to be distracting (Thornton et al., 2014). In a two-experiment study, Thornton and colleagues asked participants to complete a digit cancellation task and a trail making test, each task consisted of a simple and complex

trial. Following each task participants were required to complete the cell phone use and possession survey that asked them about their frequency of cell phone use throughout the day and in class. The second experiment was crucially this same with the exception that the authors wanted to replicate their findings from study one into a true academic environment. In both experiments, the researchers found that the mere presence of a cell phone only influenced performance and accuracy in the complex tasks, such that, impairments were only found when the task was more attentionally and cognitively demanding. The researchers attempted to replicate the findings of the effects of mere presence of cellphone use across two conditions, in the first experiment where the experiments' cellphone was present, and a second experiment where the participants cellphone was present. Across both conditions, the mere presence of a cellphone was enough to distract participants from the primary task at hand. This suggests that although some students may not physically use their cellphone during class time, simply the presence of a cellphone itself is enough to serve as a distractor, resulting in poorer performance. Additionally, the presence of another person's cellphone, such as another student inside the classroom will produce enough of a distraction to divide others attention from what is being taught. However, the degree to which cellphones interfere on academic performance has been demonstrated to be variable.

Indeed, Fox et al. (2009) found that cellphones do undeniably impact academic performance, but not all the time. These researchers evaluated multitasking behaviors in students who engage in instant messaging during a reading comprehension task. Researchers sought to examine whether the use of a cellphone during a cognitively demanding task would impair students' ability to complete a task of reading text and

recall of the text. As could be expected, participants who texted while completing the reading comprehension task took considerably longer to complete the task, indicating poor efficiency. The results from this study can provide a plausible explanation to how students may perform worse on a test due to poor task efficiency resulting in an incomplete test, quiz, or exam. Additionally, it was found that participants who used their cellphone to send text messages while reading the passage did not perform significantly different than those who did not use their cellphone, suggesting that if student is able to choose when to use a cellphone, performance will not be impaired. Although this is contradictory to previous studies, researchers explain that this finding may be attributable to a form of negotiated interruption: in other words, a participant can decide when to switch tasks rather than be required to do so by an intrusive interruption. Voluntarily choosing when to use a cellphone allows the participant to decide when they are available to switch tasks allowing them to do so at a time of low cognitive demand.

Cellphones do Not Always Interfere

Similar to the results found by Fox et al. (2009), Schneeberger et al. (2021) found that using cellphones does not always interfere with ones' academic performance. The researchers used self-report measures to evaluate how cellphone use impacted students' Introduction to Psychology course grades. Participants were required to complete a self-report questionnaire concerning their overall cellphone use and an estimation of the number of texts they send and receive within a day. Schneeberger et al. (2021) observed that the number of text messages sent was not predictive of students' course grade, while the number of text messages received was. The results of this study may be attributable to students having the choice of when to send a text and when not to.

Essentially, a student can choose to send a text message at a time when it does not interfere with the processing of information. For example, when the instructor is responding to a question, a student may decide to use their cellphone because the information is not relevant and does not need to be remembered. However, one cannot control when a text will be received. The notification of a text messages might interrupt and therefore interfere with an important explanation or a thought process that could otherwise help the consolidation of information.

Summary and Current Study

Studies have shown that students use their cell phone regularly throughout the day, including during lectures (Cheever et al., 2014; Gold et al., 2015; Thomée et al., 2010). Numerous studies have demonstrated the negative effects of cellphone use on academic performance (Mulligan & Hartman, 1996; Naveh-Benjamin & Brubaker, 2019; Thornton et al., 2014).

The impact of cellphone use on academic performance may be due to divided attention and interference with encoding (Froese et al., 2012; Mulligan & Hartman, 1996; Naveh-Benjamin & Brubaker, 2019). Although cellphones interfere with academic performance (Thornton et al., 2014), it has been found to not always negatively impact academic performance (Schneeberger et al., 2021; Wang et al., 2009; Wentworth & Middleton 2014). However, few studies have examined if controlling when to use a cellphone to send out text messages has an influence on test scores. Schneeberger et al. (2021) evaluated this through online external surveys, however the study only evaluated the potential correlations between cellphone use and texting on academic performance.

The current study further evaluated whether controlling when to send out a text message will influence performance on a test. Participants sat through a brief lecture and were asked to either turn off their cell phone and leave it with the experimenter, send three texts at a time of their choosing, or send three texts in response to receiving one from the experimenter. After a break period, participants were asked to respond to a test involving multiple choice questions on the topic of the lecture. Based off previous literature, I hypothesized that the students that are allowed to use their cellphone during the lecture will perform significantly worse on the test than those who leave their cellphone with the experimenter. I also hypothesized that there would be a significant difference in test scores for students that are allowed to choose when to send out the text messages, in comparison to students who are required to immediately respond to prompts sent by the experimenter, such that the students that send text messages perform better on the test.

Method

Participants

In all, 91 undergraduate students enrolled in an introductory to psychology course at Mount Allison University completed the study. Participants were recruited through Mount Allison's SONA systems, an online platform which connects students who are interested in participating in academic research studies. All participants received 1.5 course credits to be counted towards their grade in their Introduction to Psychology course.

Materials

Participants were required to complete a consent form prior to participating in the study (Appendix A). The Cellphone and Texting Use Questionnaire (Lepp et al.,

2013) (Appendix B) was used to measure participants' overall cellphone use.

Participants were asked to report the amount of time (in hours) they spend on their phone each day and how many texts they send and receive within a day.

A 16-minute recorded lecture on the topic of dichotomies was presented. The lecture presentation consisted of information that is not covered in the introductory to psychology courses but is at the knowledge level of first-year students. Generally, the questions used in this study were knowledge based and superficial application questions. Participants' comprehension of the material was tested with ten multiple choice questions regarding the content of the lecture which was not timed.

The prompts used in this experiment for sending and responding to text messages consisted of general questions such as *Who is your introduction to psychology professor?* (Appendix C).

Students were also required to report their cellphone use during the lecture. This consisted of one question "*as accurately as possible, please estimate the number of text messages that you send and receive*". This was used to measure the additional distractions that may occur during the experiment. At the end of the study participants received a feedback form concerning their participation and if they would like to receive further information on the study (Appendix D).

Procedure

Participants were randomly assigned to one of three groups: 30 participants were assigned to a control group who were required to turn off their cell phone during the entire experiment and leave it at the front of the class with the experimenter (no texting), 31 participants were assigned to an experimental group that was required to send three

text messages during the lecture at a time of their choosing (controlled texting condition) and 30 participants were assigned to an experimental group that responded to three text messages during the lecture at the time the texts were received (uncontrolled texting condition). Participants first responded to the Cellphone and Texting Use Questionnaire (Lepp et al., 2013), after which they were asked to watch the 16-minute pre-recorded lecture on dichotomies which was projected at the front of the classroom. Participants in the ‘uncontrolled texting’ condition received three text messages from the experimenter during the lecture: one at the 1-minute mark, one at the 5:30 minute mark, and one at the 11:00 minute mark. These times were chosen to coincide with the introduction of specific concepts tested in the quiz. Following the pre-recorded lecture, participants sat through 10-minute break where they were asked to report how many texts they received during the lecture, also during the break the experimenter triggered some general discussion using prompts like those used for texting discussion. Following the 10-minute break participants completed the quiz on the material from the pre-recorded lecture. Participants received a feedback form preceding participation.

Results

I first evaluated whether there were initial differences in texting habits between the participants in the three experimental groups (no texting, controlled texting, and uncontrolled texting). The total amount of time spent texting per day for each participant was entered into a between subjects Analysis of Variance (ANOVA) that revealed no initial differences found between groups $F(2,88) = .19, ns$. Similarly, the total number of texts sent per day and the total number of texts received per day were entered into a between subjects Analysis of Variance (ANOVA) that indicated no statistically

significant differences $F(2,88) = .41, ns$, and $F(2,88) = .83, ns$, respectively, suggesting that all participants had similar patterns of cellphone use.

I conducted a between subjects ANOVA between participants in the three experimental groups (no texting, controlled texting, and uncontrolled texting) on test scores. The ANOVA revealed marginally significant differences between the conditions, $F(2,88) = 2.78, \eta_p^2 = .06, p = .067$. Recall that I specifically predicted that individuals in texting conditions would obtain a lower score than those in non-texting conditions, I therefore conducted three independent samples t-tests to evaluate the mean differences across the three conditions. The independent-samples t-test on the test score of individuals in the no texting condition performed better ($N = 30, \text{Mean test score} = 7.333, SD = 1.98$) than the individuals in the controlled texting condition ($N = 31, \text{Mean test score} = 6.387, SD = 1.98$), $t(59) = 2.230, p < .01$. The participants in the uncontrolled texting condition ($N = 30, \text{Mean test score} = 6.63, SD = 1.54$), $t(58) = 1.94, p = .015$. The t-test indicated no significant difference such that the controlled texting condition did not perform better on the test than the uncontrolled texting condition $t(59) = -.54, ns$.

Discussion

Participants were then randomly assigned to one of the three conditions (a no texting, a controlled texting, and an uncontrolled texting). We asked participants to watch a lecture presentation followed by a test. Participants in the controlled texting condition were asked to answer three texting prompts at a time of their choosing during the lecture, participants in the uncontrolled texting condition immediately responded to the prompt sent by the experimenter and participants in the uncontrolled texting condition we're required to put their cell phone at the front of the classroom for the

duration of the experiment. We observed that participants who kept their cellphones during the lecture had lower scores on the test than those who did not have access to their cellphone. However, contrary to our prediction there was no difference in performance between those who chose when to send text messages and those who had to immediately respond to the experimenters' prompts.

Although we did not find significant differences between the uncontrolled and controlled texting condition our results are consistent with previous literature that students will perform better academically when cellphones are not used, (Bjornsen & Archer, 2015; Froese et al., 2012; Jacobsen and Forste, 2011; Krylova et al., 2020; Lepp et al., 2015; Pettijohn et al., 2015). Lepp et al., 2015 found a significant negative relationship between academic performance and total daily cellphone use, such that the more frequently one uses a cellphone throughout the day, the lower their overall academic performance will be. These findings were replicated by Jacobsen and Forste (2011) where participants recorded their cellphone use frequency in self-report diaries and surveys in relation to their first semester grades and academic outcomes. Bjornsen and Archer (2015) specifically investigated the relationship between cellphone frequency during class time and grades among college students. The authors found that cellphone use was significantly and negatively associated with test scores amongst students. The results from previous literature and the current study suggests that students who use their cellphone more during class time will have poorer academic performance compared to those who do not use their cellphone during class time.

The decline in academic performance can be attributable to the effects of divided attention on academic performance (Mulligan & Hartman, 1996; Naveh-Benjamin &

Brubaker, 2019; Thornton et al., 2014). Cellphone use during class time takes away the necessary cognitive resources to effectively complete a primary task. Ultimately, if a student is disengaging from class material, they will perform worse on a task that requires activation of the students' memory, similarly, to writing a test or exam.

Gutiérrez-Puertas et al. (2020) produce similar results when evaluating the effects of cellphones on attention and learning in undergraduate nursing students. The authors found that students who did not use their cellphones during class paid better attention to what was being taught than those who did have access to their cellphones. In the current study, students who did not use their cellphone throughout the entirety of the experiment were able to attend to the lecture without dividing their attention or interference of their encoding processes. However, when students used their cellphone during the lecture presentation, they were unable to attentively listen and retain the information that was being delivered, influencing how much information was recalled during the multiple-choice test.

Contrary to Schneeberger et al. (2021) we did not observe this difference. This may be attributable to the differences in GPA and immediate test score outcomes when one's attention is divided. Essentially, GPA is an overall measure of performance over an entire term, while our test score is an acute measure of immediate performance. A recent study conducted by Glass and Kang (2019) evaluated students' performance who were enrolled in a cognition course. Crucially, electronic devices were permitted for half of the students enrolled in the course. Glass and Kang (2019) evaluated students' academic performance through three different methods: daily in-class quizzes, unit tests, and the final exam. The researchers did not find significant differences in performance

between the students who were allowed their cell phones and students who were not when evaluating students' performance on in class quizzes and unit tests. Interestingly, the researchers found differences on final exam scores: participants who had access to a cellphone performed worse on the final exam than those who did not have access to their cellphone. The differences in students' test scores between in class quizzes and the final exam parallels the differences between last year's study in measuring overall GPA and the current study in measuring student's immediate testing performance. This can be explained by the differences in working memory resources in short term and long-term testing or acute and overall testing like immediate testing and GPA respectively.

Indeed, there are differences in working memory resources in delayed and immediate testing (Chen & Kayluga, 2021). Chen and Kayluga (2021) suggest that working memory resources are more prominent and available in delayed testing than in immediate testing, solidifying an explanation for the potential differences in evaluating cellphone use on testing GPA and immediate test scores.

An alternative explanation to why our study did not find differences between the controlled and uncontrolled texting condition on immediate test scores may be attributable to the awareness of the multi-tasker. Glass and Kang (2019) suggest that the multi-tasker may be aware of any immediate errors on a task. This can include an error in an immediate test following the lecture presentation. However, when an error has been made, the multi-tasker will not suspect that long-term retention of the current experience will be compromised, therefore failing to take a corrective action for long-term retrieval. Therefore, testing errors may be present in long-term testing evaluations but not immediate testing because the multi-tasker is aware of the error that has been

made. Additionally, the awareness of the multi-tasker would be presented regardless of if the individual was sending or receiving text messages, further explaining why I did not find significant differences between the controlled and uncontrolled condition.

Another plausible explanation for the lack of observed differences between the controlled texting condition and the uncontrolled texting condition may be due to the break period following the lecture presentation: it may have allowed for consolidation of the material. Essentially, participants in all conditions were not permitted cellphone use during the 10-minute break period following the lecture presentation. However, they were permitted to engage in a conversation. The break period likely allowed students to think about the presentation with minimal distraction. To support this idea, Lee and Lee (2011) suggest that forgetting is more effective when participants perform a secondary task after receiving the forget cue (i.e., a lecture presentation). The researchers conducted two experiments: a free recall test experiment and a cued recall test experiment. Across both experiments, the researchers found that the longer the post-cue interval increased in time, the to-be-remembered item preservation decreased. As all participants received a break period following the lecture presentation without a secondary distractor task like using a cellphone, this allowed ample time for reflection and therefore, consolidation of the material that was presented within the lecture presentation. Lee and Lee (2011) suggest that the improved recall that coincides with longer post-cue interval is due to an automatic process because individuals did not engage in a cognitively demanding task upon receiving the forget cue. Similarly, students in our experiment did not engage in a resource demanding task during the break period prior to test taking. This may provide support as the break period likely allowed

students time to not be distracted by a cellphone which influences one's consolidation of material learned during the lecture. Having no distraction to impact the consolidation of material likely standardized both distracted conditions so that there were no differences on test scores.

Contrary to our results, we predicted that sending text messages (controlled texting) and receiving text messages (uncontrolled texting) would produce different effects on testing performance, as choosing when to send a text message allows for students to send it at an optimal time where working memory is not being used by the main task. I believe that this may not have been replicated as the distractor task (texting) was not complex enough as the text message prompts were too superficial. The superficiality of the texting prompts may not have used the resources within the working memory to produce effects of cognitive taxation. The text messaging prompts used in this study consisted of general questions such as *Where is your favourite place to eat in Sackville?* Students generally responded with one-word responses, although they could have responded in a more in-depth manner. This suggests that they did not use up the resources within working memory, explaining the no differences amongst groups. Ibaql et al. (2010) suggest that the more involved the distractor task is, the less processing that occurs in the secondary tasks. The text messaging task may have been too simplistic to create working memory deficit on the primary task when dividing attention.

Future Directions

To address the potential differences between GPA and immediate test score differences, future research should use testing intervals and a longitudinal experimental method where the use of cellphones is the same, but testing occurs between all three

conditions after the break period and a week following the initial presentation to see if there are differences in testing performance across all conditions and across immediate testing and delayed testing.

Moreover, because the complexity of the attention task was not enough to produce differences, future research should replicate this study and include a manipulation within the depths of questions that are used. Increasing the complexity of the texting prompts may produce different results as it may tap into the different levels of processing and cognitive taxation.

Conclusion

We replicated the effects of cellphone use on academic performance like Bjornsen and Archer (2015); Froese et al. (2012); Jacobsen and Forste (2011); Krylova et al. (2020); Lepp et al. (2015) and Pettijohn et al. (2015), such that individuals who do not use their cellphone perform better on academic evaluations than those who use their cellphone. However, upon further investigation, we did not parallel the findings of Schneeberger et al. (2021) that individuals who send out text messages would produce better test scores than individuals who receive text messages during the encoding of academic material. Our findings suggest that cellphone interference does indeed impact academic performance, but it will be important to further investigate our findings using a more complex distractor task to potentially observe differences in test scores amongst all three conditions.

References

- Bjornsen, C. A., & Archer, K. J. (2015). Relations between college students' cell phone use during class and grades. *Scholarship of Teaching and Learning in Psychology, 1*(4), 326–336. <https://doi.org/10.1037/stl0000045>
- Chaklader, A., & R. W. Bohlander. 2009, March. The effects of text messaging on attention. *Paper presented at the meeting of Eastern Psychological Association, Pittsburgh, PA.* <https://doi.org/10.1037/stl0000045>
- Cheever, N. A., Rosen, L. D., Carrier, L. M., & Chavez, A. (2014). Out of sight is not out of mind: The impact of restricting wireless mobile device use on anxiety levels among low, moderate, and high users. *Computers in Human Behavior, 37*, 290–297. <https://doi.org/10.1016/j.chb.2014.05.002>
- Chen, O., & Kalyuga, S. (2021). Working memory resources depletion makes delayed testing beneficial. *Journal of Cognitive Education and Psychology, 20*(1), 38–46. <https://doi.org/10.1891/JCEP-D-20-00024>
- Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General, 125*(2), 159–180. <https://doi.org/10.1037/0096-3445.125.2.159>
- Dietz, S., & Henrich, C. (2014). Texting as a distraction to learning in college students. *Computers in Human Behavior, 36*, 163–167. <https://doi.org/10.1016/j.chb.2014.03.045>

- Dos, B. (2014). The relationship between mobile phone use, metacognitive awareness and academic achievement. *European Journal of Educational Research*, 3(4), 192–200. <https://doi.org/10.12973/eu-jer.3.4.192>
- Fox, A. B., Rosen, J., & Crawford, M. (2009). Distractions, distractions: Does instant messaging affect college students' performance on a concurrent reading comprehension task? *Cyberpsychology Behav. Soc. Netw.* <https://doi.org/10.1089/cpb.2008.0107>
- Froese, A. D., Carpenter, C. N., Inman, D. A., Schooley, J. R., Barnes, R. B., Brecht, P. W., & Chacon, J. D. (2012). Effects of classroom cell phone use on expected and actual learning. *College Student Journal*, 46(2), 323–332.
- Glass, A. L., & Kang, M. (2019). Dividing attention in the classroom reduces exam performance. *Educational Psychology*, 39(3), 395–408. <https://doi.org/10.1080/01443410.2018.1489046>
- Gold, J. E., Rauscher, K. J., & Zhu, M. (2015). A validity study of self-reported daily texting frequency, cell phone characteristics, and texting styles among young adults. *BMC Research Notes*, 8(1), 120. <https://doi.org/10.1186/s13104-015-1090-3>
- Gutiérrez-Puertas, L., Márquez-Hernández, V. V., Gutiérrez-Puertas, V., Granados-Gómez, G., & Aguilera-Manrique, G. (2020). The Effect of cell phones on attention and learning in nursing students. *CIN: Computers, Informatics, Nursing*, 38(8), 408–414. <https://doi.org/10.1097/CIN.0000000000000626>
- Harman, B. A., & Sato, T. (2011). Cell phone use and grade point average among undergraduate university students. *College Student Journal*, 45(3), 544–549.

- Iqbal, S. T., Ju, Y.-C., & Horvitz, E. (2010). Cars, calls, and cognition: Investigating driving and divided attention. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1281–1290.
<https://doi.org/10.1145/1753326.1753518>
- Jacobsen, W. C., & Forste, R. (2011). The wired generation: Academic and social outcomes of electronic media use among university students. *Cyberpsychology, Behavior, and Social Networking*, *14*(5), 275–280.
<https://doi.org/10.1089/cyber.2010.0135>
- Krylova, M. V., Dryden, R. P., Perry, R. P., Chipperfield, J. G., Hamm, J. M., Clifton, R. A., Hladkyj, S., & Parker, P. C. (2020). Cell phones and grades: Examining mediation by perceived control and anxiety. *Social Psychology of Education*, *23*(5), 1277–1301. <https://doi.org/10.1007/s11218-020-09581-z>
- Lee, Y., & Lee, H.-M. (2011). Divided attention facilitates intentional forgetting: Evidence from item-method directed forgetting. *Consciousness and Cognition: An International Journal*, *20*(3), 618–626.
<https://doi.org/10.1016/j.concog.2010.09.008>
- Lepp, A., Barkley, J. E., & Karpinski, A. C. (2015). The relationship between cell phone use and academic performance in a sample of U.S. College Students. *SAGE Open*, *5*(1), 2158244015573169. <https://doi.org/10.1177/2158244015573169>
- Lepp, A., Barkley, J. E., Sanders, G. J., Rebold, M., & Gates, P. (2013). The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of U.S. college students. *International*

Journal of Behavioral Nutrition and Physical Activity, 10(1), 79.

<https://doi.org/10.1186/1479-5868-10-79>

Mulligan, N. W., & Hartman, M. (1996). Divided attention and indirect memory tests.

Memory & Cognition, 24(4), 453–465. <https://doi.org/10.3758/bf03200934>

Naveh-Benjamin, M., & Brubaker, M. S. (2019). Are the effects of divided attention on

memory encoding processes due to the disruption of deep-level elaborative

processes? Evidence from cued- and free-recall tasks. *Journal of Memory and*

Language, 106, 108–117. <https://doi.org/10.1016/j.jml.2019.02.007>

Pettijohn, T. F., Frazier, E., Rieser, E., Vaughn, N., & Hupp-Wilds, B. (2015).

Classroom Texting in College Students. *College Student Journal*, 49(4), 513–

516.

Rosen, L., Lim, A., Carrier, M., & Cheever, N. (2011). An empirical examination of the

educational impact of text message-induced task switching in the classroom:

educational implications and strategies to enhance learning. *Revista de*

Psicología Educativa, 17, 163–177. <https://doi.org/10.5093/ed2011v17n2a4>

Schneeberger, L., Kelson, M. A., Desmarais, G., (2021). Cellphone Use on Academic

Performance – Does choosing when to Send a Text Message Impact Academic

Performance. Poster presented at the Canadian Society for Brain, Behavior and

Cognitive Science, Montreal, CA.

Smith, T. S., Isaak, M. I., Senette, C. G., & Abadie, B. G. (2011). Effects of cellphone

and text-message distractions on true and false recognition. *Cyberpsychology,*

Behavior, and Social Networking, 14(6), 351–358.

<https://doi.org/10.1089/cyber.2010.0129>

- Thomé, S., Dellve, L., Härenstam, A., & Hagberg, M. (2010). Perceived connections between information and communication technology use and mental symptoms among young adults—A qualitative study. *BMC Public Health, 10*, 66. <https://doi.org/10.1186/1471-2458-10-66>
- 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), 479–488. <https://doi.org/10.1027/1864-9335/a000216>
- Tindell, D. R., & Bohlander, R. W. (2012). The use and abuse of cell phones and text messaging in the classroom: A Survey of college students. *College Teaching, 60*(1), 1–9. <https://doi.org/10.1080/87567555.2011.604802>
- Wang, M., Shen, R., Novak, D., & Pan, X. (2009). The impact of mobile learning on students' learning behaviours and performance: Report from a large, blended classroom. *British Journal of Educational Technology, 40*(4), 673–695. <https://doi.org/10.1111/j.1467-8535.2008.00846.x>
- Wentworth, D. K., & Middleton, J. H. (2014). Technology use and academic performance. *Computers & Education, 78*, 306–311. <https://doi.org/10.1016/j.compedu.2014.06.012>

Appendix A Consent Form

Consent Form

Cell Phone Use and Academic Performance

Abby Kelson, Honours Student

Nicole Doncaster, Independent Studies student

Logan Grossman, Research Volunteer

Dr. Desmarais, Associate Professor Department of Psychology

Mount Allison University

I am an honours student in the department of Psychology at Mount Allison University, and I am conducting research under the supervision of Dr. Desmarais. I am inviting you to participate in my study. The purpose of this study is to examine the effects of cell phone use on academic performance.

The study involves responding to a brief questionnaire about cell phone use, viewing a 15-min lecture on why it is problematic to think in dichotomies (thinking that something can be one thing or the other), and then completing a short test on the material presented. Some participants will be asked to turn off their cell phone and put it in a tray near the experimenter, while others may be asked to provide their cellphone number so that the experimenter can send them texts messages during the lecture.

For each half hour of participation, you will receive one half credit toward your course 'Introduction to Psychology', and you will also receive an additional 0.5 credits for coming to the lab. **Participation is completely voluntary. You may withdraw from this study at any time without penalty.** You may also choose not to respond to a question.

*All information obtained in this study will be kept strictly **confidential and anonymous**.* Identifying details will be omitted from research findings, and all data will be stored in a secure location on-campus. Additionally, the sheet the experimenter uses to write down cell phone numbers will be shredded immediately after the experiment. The results of this study will be presented as a group and no individual participants will be identified without their permission. Furthermore, Dr. Desmarais will only collect the consent forms from the lab after final grades have been submitted.

As we are currently in the midst of the global COVID-19 pandemic, there is the potential for elevated risk of exposure when in the proximity of another person outside of your immediate household bubble, particularly if physical distancing is difficult to maintain or contact time is prolonged. Older adults, immunocompromised adults, those with certain underlying health conditions are considered high-risk by the Public Health Agency of Canada and should consider this before deciding to participate. This application has been reviewed and approved for adherence to COVID-19 guidelines and operates within the guidelines of Mount Allison's official COVID-19 Operating Plan. However, we cannot guarantee that the risk of contracting COVID-19 is zero. The researchers will be following (at a minimum) all guidelines outlined by Public Health New Brunswick and/or

Mount Allison University and that best practices/requirements may change in response to those directives.

By signing this consent form, you are indicating that you fully understand the above information and agree to participate in this study.

Participant's signature _____

Date: _____

Researcher's signature: _____

Date: _____

If you have any questions about this study, please contact Abby Kelson (amkelson@mta.ca) or Dr. G. Desmarais: gdesmarais@mta.ca. This research has been reviewed and approved by the Mount Allison University Research Ethics Board. If you have any questions or concerns about this study, you may contact Dr. Nancy Garon, Chair of the Mount Allison University Research Ethics Board, by phone (364-2618) or by e-mail at reb@mta.ca.

Appendix B Cellphone Use Questionnaire

Participant Number: _____

Age (in years): _____

Gender (please check one): Male () Female () Other ()

As accurately as possible, please estimate the total amount of time you spend using your mobile phone each day. Please consider all uses except listening to music. For example, consider calling, texting, Facebook, e-mail, sending photos, gaming, surfing the Internet, watching videos, and all other uses driven by 'apps' and software

As accurately as possible, please estimate the total number of text messages that you send and receive each day:

Texts sent:

Texts received:

Appendix C Texting Prompts

Potential questions to ask (Texting prompts):

- Are you a first-generation student?
- Who is your introduction to psychology professor?
- Where is your favourite place to eat in Sackville?
- What is your major or minor? Or are you undecided?
- What kind of bachelor's degree are you currently enrolled in (BA/BSc...)?
- Are many of your courses still online?
- How many courses are online?

Appendix D Feedback form

Feedback form

Cellphone Use and Academic Performance

Abby Kelson, Honours Student
Nicole Doncaster, Independent Studies student
Logan Grossman, Research Volunteer

Dr. Desmarais, Associate Professor Department of Psychology Mount Allison University

Thank you for your participation in this study and your contribution to this research. If you have any questions at any point in time after this study has finished, feel free to contact the principal investigator; Abby Kelson at amkelson@mta.ca, or the supervisor; Dr. Geneviève Desmarais at gdesmarais@mta.ca.

Actively engaging with a cell phone during or after academic periods prevents us from engaging with academic material. When a student uses their cell phone during class or right after class, the information encoded in memory is not consolidated, and can impact academic performance. However, it is possible that not all uses impact performance equally: being able to decide when to send a text may not be as problematic as receiving unexpected notifications that disrupt our engagement with a lecture.

If you would like to know more information about this study, and seek the findings of this research, contact myself (amkelson@mta.ca) and I will deliver the results as soon as they are available.

This research has been reviewed and approved by the Mount Allison University Research Ethics Board. If you have any questions or concerns about this study, please contact Dr. Nancy Garon, Chair of the Mount Allison University Research Ethics Board, by phone at (506) 364- 3458, or by e-mail at reb@mta.ca.

We appreciate your participation in this research. If you are interested in this research and would like to know how to get involved, feel free to contact myself or my supervisor.

Reference for your interest:

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, 893-897. <http://dx.doi.org/10.1037/xhp0000100>

