The Effect of Cell Phones on Attention and Learning: The Influences of Time and Nomophobia

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**Abstract**

Excessive cellphone use among students stimulates interest to how this usage impacts attention and learning in classrooms. Given the known fluctuations of attention over time, we investigated at what point during a lecture cellphones might negatively impact attention and learning. Across two experiments, participants watched a 20-minute lecture and were either allowed to keep their cellphones or had them removed. Groups who kept their cellphone received text messages during the lecture which served as distractors. After the lecture, participants were tested on lecture material. Test questions were divided into four segments depending on when the material was presented. Lastly, participants’ nomophobia—fear of being without access to one’s cellphone—was assessed. The result showed that participants who retained their cellphone performed worse on the memory test for material presented in the 3rd quarter of the lecture than those whose phones were taken away. Participants who were visibly distracted during the lecture performed worse on the test for the same material than those who were not distracted. Lastly, participants with greater nomophobia performed worse on the memory test and also for material that occurred in the 3rd quarter of the lecture. The finding indicated that having cellphones in a short lecture does not equally impair attention and learning throughout a lecture, but has its largest impact when attention begins to wane (10-15 minutes into the lecture). By combining theory-driven hypotheses into simulated classroom settings, novel insights into the interactions between technology and learning aim to help educators and students optimize learning.

**Keywords:** attention; cellphone; classroom; learning; memory; nomophobia

**When Cellphones Disrupt Attention and Learning: The Influences of Time and Nomophobia**

Cellphones play a major role in the lives of Americans and also have been shown to have a negative impact on college student learning. According to the Pew Research Center, three quarters of Americans go online several times a day and on average they spend at least five hours on smartphones (Pew Research Center, 2015; Andrews, Ellis, Shaw & Piwek,2015). In fact, young adults between the ages of 18-24 send or receive an average of 109 text messages per day (Pew Research Center, 2011). Although smartphones have other features such as voice call and web browsing, text messaging appears to be the convenient method of communication among young adults. Such excessive cellphone use has brought researchers to focus on how this usage impacts attention, learning, and memory in classroom settings. By understanding the interactions between technology and learning, educators and students can optimize learning.

**Attention and Cellphones in the Classroom**

Attention works best when individuals are focused on one task at a time. However, younger generations seem to engage in more than one activity at once, especially when it comes to using digital technology (Carrier, Cheever, Rosen, Benitez, & Chang, 2009). Atkinson and Shiffrin (1968) formalized a model as to how attention impacts learning, which has since helped form our current notions of these interwoven processes. Generally, it is argued that an individual must first process sensory information from the environment and then selectively pay attention to the target information while ignoring distractions (i.e., non-target information) in the environment (Posner, 1994). This ability to selectively pay attention, however, is difficult because people have limits to how much information can be processed at a given time (Broadbent 1958, 1971, Kuznekoff & Titsworth, 2013). That is, attention acts as a bottleneck—a lot of information is available to process, but only a small portion of that information is attended to and processed (Sperling, 1960).

In the context of classroom lectures, these attention processes are necessary to sustain for long periods of time. However, attention is not constant throughout a lecture. Rather, attention and associated learning strategies are greater when information is first presented—known as the primacy effect (Manning, 1980; Phillips & Christie, 1977; Watkins & Watkins, 1974). Furthermore, attention often fluctuates after these initial learning periods (Warm, Parasuraman, & Matthews, 2008), making it difficult to sustain attention at a high level. Attentional states can be tracked and monitored. Therefore, it is possible to avoid the decrease of attention to decrease the likelihood of forgetting learned information (deBettencourt, Norman, & Turk-Browne, 2017). Despite attempts at sustaining attention, in most lecture settings, attention often begins to decline after about 10 to 15 minutes (Benjamin, 2002; McKeachie, 1986, McKeachie & Sviniki, 2006). This pattern of sustained attention in lecture settings has been observed through observation, self-report, and psychological measures (Wilson & Korn, 2007).

Attention to lectures also can be diminished when shifting from one activity to another. Researchers discovered that there is a 3.8 second delay that occurs when adjusting one’s focus from using a cellphone back to a cognitively demanding task, such as driving (Thapa, Codjoe, Ishak, & McCarter, 2015). Likewise, several studies have demonstrated that the mere presence of a cellphone diminishes attention (Dietz & Henrich, 2014; Lee, Kim, McDonough, Mendoza, & Kim, 2017; Thornton, Faires, Robbins, & Rollins, 2014). For example, studies have shown that when a cellphone rang during a lecture, individuals scored lower on tests related to the lecture content as compared to individuals who were not disrupted by a ringing cellphone (Shelton, Elliot, Eaves, & Exner, 2009; End, Worthman, Mathews, & Wetterau2010). Participants also are less likely to record important information for test-related content when cellphone ringing distractions are present during a lecture. Froese et al. (2012) found that students who could use their cellphones and text in the classroom took 30% fewer notes than those who were asked not to use their cellphones. This finding suggests that there is an attentional cost when paying attention to texts. In lectures, the cost may result in not attending to relevant information on the presented content.

These attentional costs are more likely to occur in younger generations of students who feel socially dependent on their cellphone (e.g., millennials). This dependence can give rise to anxiety when one has not checked their cellphone for a while (Cheever, Rosen, Carrier, & Chavez, 2014). Many students have reported to feel anxious when they do not possess their mobile devices. Interestingly, this anxiety tends to occur within a 10-minute time period (Cheever et al., 2014). A possible explanation for this anxiety is that students who rely on their mobile devices experience a fear of missing out (Pryzbylski, Murayama, DeHaan, & Gladwell, 2013). This phenomenon that has become more recognized in the literature on cellphone dependency is called nomophobia – the fear or discomfort that results from not having access to one’s mobile device (King, Valença, Silva, Sancassiani, Machado, & Nardi, 2014). Although this phenomenon is not included in the DSM-V, it has been proposed to be considered as a disorder as it appears to meet clinical characteristics that have descried other disorders such as anxiety and addiction (Bragazzi & Del Puente, 2014).

**Cellphones Can Impair Learning in the Classroom**

To learn and retain material, an individual must pay close attention to the information being presented. Decades of research have shown that the greater attention paid early on, in a lecture for example, positively impacts memory (e.g., Holen & Oaster, 1976; Johnston & Calhoun, 1969; Morrison, Conway, & Chein, 2014). Learning, however, can become challenging when attention is being divided between lecture materials and distracting activities, such as cellphone use. Research has shown that when attention is divided upon presentation of information, it disrupts the learning of material (Baddeley, Lewis, Eldridge, & Thomson, 1984; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Dudukovic, DuBrow, & Wagner, 2009; Fernandes & Moscovitch, 2000). In relation to classroom learning, Froese et al. (2012) examined the effect of receiving text messages in lecture settings on the retention of content material. This idea was tested by having some participants put their phone on silent and store it out of sight and other participants receive texts from researchers during the lecture. After the lecture, participants completed a quiz for the lecture material. Those who were in the condition that received text messages had lower scores than those who were asked to put their phones away (see also, Lee et al., 2017).

**Do Cellphones Always Impair Attention and Learning?**

Cellphones are an integrated part of students’ daily lives and are likely going to remain a part of the classroom until a new type of communication technology replaces it. In contrast to the research supporting the detrimental effects and relationship between learning and cell phone use, most college students feel that cellphones enhance their learning environment (Eyyam, Ramadan, & Yaratan, 2014; Jan, Ullah, Ali, & Khan, 2016). Research has indicated that cellphones have been shown to be positive predictors for self-directed learning (Rashid & Ashgar, 2016). To some extent, cellphones can benefit students because of their ease of accessibility and their ability to be used as teaching instruments. Thornton and Housser (2005) showed that cellphones can be effective convenient tool for distributing foreign language material to students and demonstrated that students can learn the material using their mobile device. Similar findings suggest that cellphones may be optimal for basic learning materials for those who have low verbal and visual abilities (Chen et al., 2008). These studies differ from the viewpoint discussed earlier that cellphones are detrimental to learning and allow for a more balanced viewpoint on their impact on attention and learning. However, the mixed findings also raise an important question: When do cellphones negatively impact attention and learning?

This study brings to the forefront the relationship between attentional decline as it relates to cell phone dependency. We know that over time, students begin to feel worried and show behaviors related to anxiety when they are not allowed to check their cell phone (Cheever et al., 2014). It is also known that a cell phone ring, regardless of whose phone it is, can serve as a distractor in classroom settings (Shelton et all, 2009; End et al, 2010). However, the point during a lecture where individuals are likely to experience attentional decline has been scarcely studied.

**The Current Study**

We conducted a secondary analysis on a data set that investigated the impact of cellphone policies on learning in a simulated classroom environment (Lee et al., 2017). In that study, 160 college students were randomly assigned to one of four group conditions that varied how cellphones could be used: Group 1 (cellphone use and possession permitted), Group 2 (cellphone use not permitted—put it in silent mode with possession), Group 3 (complete removal of cellphone from participants’ possession), and a Control Group (no instruction on cellphone use). All students were presented with a 20-minute videotaped lecture, took a short quiz on that lecture material, and completed a questionnaire that assessed their general experience of nomophobia. Unbeknownst to the students, the experimenters texted the students four predetermined times throughout the lecture to simulate cellphone distraction (with the exception of Group 3 who had their phones taken away from them). The finding showed that students who had their cellphones taken away performed best on the quiz compared to the other three groups, which did not differ from each other.

For the purposes of the present study, we collapsed the groups of participants that retained their cellphone (Group 1, Group 2, and the Control Group) to compare the findings with the group that did not retain their cellphone (Group 3). We then divided the quiz questions by the quarter in the lecture to which they corresponded. We predict that the detrimental effects of having a cellphone in a classroom setting will vary on how attention fluctuates over time. Attention is expected to be at its highest early on in the lecture, thus leading to the best quiz performance for lecture materials occurring during the first quarter across both groups. This idea is consistent with the known primacy effects of learning.

However, as attention decreased during the later parts of the lecture, we predicted that having a cellphone would begin to have its negative impact on quiz performance. Because of the supporting evidence on sustained attention decreasing at about 10-15 minutes into lectures and cellphone-induced anxiety peaking after about 10 minutes (Cheever et al., 2014), we also predicted that the cellphone group would perform more poorly on the quiz than the non-cellphone group for questions that fell in later quarters of the lecture (i.e., 10-20 minutes into the lecture). To provide additional evidence that cellphone-induced anxiety contributed to detriments in attention and subsequent quiz performance, we also correlated levels of nomophobia with quiz performance separately for each quarter. We hypothesized that higher levels of nomophobia would be associated with worse quiz performance, and that this relationship would be strongest in the later quarters of the lecture.

**Experiment 1**

**Method**

**Participants**

Participants (N = 160) were recruited from undergraduate psychology courses at a small, liberal arts college in Southeastern Arkansas. Participants received partial course credit for their completion of the study. All participants were randomly assigned to one of the four group conditions and each group consisted of 40 participants: Group 1 (cellphone use and possession permitted), Group 2 (cellphone use not permitted—put it in silent mode with possession), Group 3 (complete removal of cellphone from participants’ possession), and a Control Group (no instruction on cellphone use). Groups that retained their cellphone were collapsed together (n = 140). All sessions were conducted in a classroom, with the number of participants per session ranging from 5 to 14.

**Measures**

Participants were presented with a 20-minute TED talk given by Dr. Sam Richards, called “A Radical Experiment in Empathy.” After the lecture was given, participants took a multiple-choice quiz that consisted of 20 questions pertaining to topics distributed throughout the lecture. Each question had 4 choices and participants were asked to choose 1 correct answer. All questions were created to ensure that participants sufficiently comprehended the given lecture. The questions were then divided into which quarter (every 5 minutes) of the lecture they fell (1st quarter: six questions, 2nd quarter: five questions, 3rd quarter: four questions, 4th quarter: five questions). Two questions from the 4th quarter of the lecture were removed from the analyses because performance was significantly below chance (*M* = .03, *SD* = .17, *t*(159) = 15.83, *p* < .001 and *M* = .19, *SD* = .39, *t*(159) = 2.02, *p* = .045), suggesting that the questions were misleading and/or poorly written. Questions from each quarter were then averaged together to provide a more reliable measure of quiz performance for each quarter.

Following the quiz, participants filled out several self-report measures, including the Nomophobia Questionnaire (NMP-Q; Yildrim & Correia, 2015). The NMP-Q consists of 20 items that covers four main dimensions of nomophobia: not being able to communicate, losing connectedness, not being able to access information, and giving up convenience. Each item is measured by a 7-point Likert scale, with 1 being “strongly disagree” and with 7 being “strongly disagree.” The NMP-Q is designed to assess situational emotional distress or anxiety resulting from being unable to access a cellphone or other mobile device, which has a Cronbach’s reliability of .94 (e.g., Bragazzi et al. 2016; Yildrim & Correia, 2015).

**Procedure**

After participants read and signed a consent form, the experimenter informed them that they would watch a 20-minute long, video-recorded lecture. In the current study, students were recruited to watch a 20-minute video lecture and were either allowed to keep their cellphone or their cellphone was not allowed in the study. During the lecture, all participants except for those who had their cellphone taken away received four text messages sent by a student research assistant at four predetermined times (3, 7, 11, and 15 minutes after the lecture started). After a 1-minute break, all participants took the 20-item quiz about the lecture and were asked to fill out the NMP-Q.

**Results**

**Test Performance Over Time Across All Groups**

Consistent with the difficulty to sustain attention over time, test performance dropped from questions in the first quarter to the second quarter, remained similar from the second quarter to third quarter, and decreased from third quarter to the fourth quarter (see Figure 1, left panel).

**Test Performance Varied Within Cellphone Groups**

This study predicted that scores from those who did not experience distraction would be be higher than those who were distracted by cell phones. Independent samples *t*-tests were conducted between the groups of participants that were allowed to keep their cellphone compared with those who had their cellphones taken away for each of the four quarters, correcting for multiple comparisons as above. Having a cellphone only impacted performance for content that occurred in the third quarter of the lecture, *t*(158) = 2.88, *p* = .005 (Figure 2, left panel). Specifically, being allowed to retain one’s cellphone lead to worse performance than having their cellphone taken away.

**Correlations with Test Performance and Nomophobia**

 To test the extent that anxiety regarding one’s cellphone might have impacted test performance differently across the four quarters, Pearson correlations were conducted between NMP-Q and test performance scores separately for the four quarters. While greater nomophobia was associated with worse test performance for each of the four quarters (r(158)’s = -0.01, -.04, -0.19, -0.07), only the third quarter was significant (*p* = .016), converging with the finding above that having one’s cellphone might be more negatively impactful in the 3rd quarter of the lecture. Note that when correcting for multiple comparisons, this correlation would no longer be considered significant.

**Additive Effects of Cell Phone Use and Nomophobia**

 Lastly, we tested whether the effects of having a cell phone and having nomophobia exerted independent and additive effects on test performance for test questions occurring in the third quarter of the lecture, or whether the same mechanism explained the poor test performance. Towards this aim, we used multiple regression with Cell Phone Group and Nomophobia as independent variables to predict test performance for material presented in the third quarter of the lecture. We found that both Cell Phone Group (*ß* = -0.19, *p* = .02) and nomophobia (*ß* = -0.15, *p* = .05) exerted independent effects on test performance. Since the majority of students fell within 50 to 101 of NMPQ (+/- 1 SD), this would result in a difference of 5% to 10% in grade level for those low and high in nomophobia, respectively.

**Experiment 2**

The goal of Experiment 2 was to replicate the findings from Experiment 1 and to examine the extent that test performance would be most negatively impaired by students who were distracted by the text messages. As in Experiment 1, the participants received text messages from the experimenters. However, in this experiment, we recorded which students looked at their cellphones (and thus were distracted) versus which students successfully maintained focus on the lecture. We predicted that we would replicate the findings from Experiment 1 and that students who were noticeably distracted by the text messages would show the poorer test performance, especially for questions corresponding to the later parts of the lecture.

**Method**

**Participants**

Participants (N = 233) were recruited from undergraduate psychology courses at a large, research university in West Alabama. Participants received partial course credit for their completion of the study and were randomly assigned to the four group conditions as in Experiment 1. All groups where participants retained their cellphone were collapsed together (n = 166). Sessions were conducted in a classroom, with the number of participants per session ranging from 3 to 15.

**Measures and Procedure**

The measures and procedure were identical to Experiment 1 (including the two test questions that were dropped) with the exception that the Experimenter assessed the degree of cellphone distraction. Specifically, for each participant, the Experimenter marked each time a student looked at their cellphone, picked up and checked their cellphone, or texted from their cellphone. Participants were then sorted into a “distracted” group (n = 40) if they had at least one instance of any of the above behaviors, or were otherwise sorted into a “non-distracted” group (n = 193).

**Results**

**Test Performance Over Time Across All Groups**

Consistent with a primacy effect, test performance dropped from questions in the first quarter to the second quarter, remained similar from the second quarter to third quarter, and decreased from third quarter to the fourth quarter. These results replicate the findings from Experiment 1 and can be found in Figure 1 (right panel).

**Test Performance Varied With Cellphone Group**

Independent samples *t*-tests were conducted between the groups of participants that were allowed to keep their cellphone compared with those who had their cellphones taken away for each of the four quarters, correcting for multiple comparisons as above. In contrast to Experiment 1, having a cellphone did not impact test performance across any of the quarters of the lecture, all *p*’s > .24.

**Correlations with Test Performance and Nomophobia**

 To test the extent that anxiety regarding one’s cellphone might have impacted test performance differently across the four quarters, Pearson correlations were conducted between NMP-Q and test performance scores separately for the four quarters. While greater nomophobia was associated with worse test performance for each of the four quarters (r(231)’s = -0.10, -.05, -0.16, -0.04), only the third quarter was significant (*p* = .016), replicating Experiment 1. However, when correcting for multiple comparisons, this correlation was no longer significant. In the context of both experiments, we conclude that this effect is somewhat weak, but reliable.

**Test Performance Varied Among Distracted Participants**

Independent samples *t*-tests were conducted between the groups of participants who were distracted by their cellphones compared with those who were not distracted, correcting for multiple comparisons. Levene’s test for equality of variances was also inspected due to the imbalance in size between groups, adjusting the degrees of freedom and significance if necessary. Overall, distracted participants showed lower test performance than non-distracted performance, but this difference was only significant for material covered in the third quarter of the lecture, *t*(49.84) = 2.63, *p* = .011 (Figure 2, right panel). Distractions caused by cell phones yield lower test performance overall. However, students’ test performance suffers most when they are distracted at three quarters into the lecture.

**Additive Effects of Cell Phone Use, Nomophobia, and Distraction**

 Similar to Experiment 1, we tested whether the effects of having a cell phone and having nomophobia exerted independent effects on test performance for test questions occurring in the third quarter of the lecture. In addition to these two factors, we also included the additional factor of distraction. Multiple regression was employed with Cell Phone Group, Nomophobia, and Distraction Group as independent variables to predict test performance for material presented in the third quarter of the lecture. We found that both nomophobia (*ß* = -0.16, *p* = .02) and Distraction Group (*ß* = -0.21, *p* = .002) exerted independent effects on test performance. Cell Phone Group did not exert an independent effect on test performance (*ß* = -0.03 *p* = .63). The majority of participants in this study fell within 55 to 103 of NMPQ (+/- 1 SD), resulting in a difference of 6% to 10% in grade for those low and high in nomophobia, respectively

**Discussion**

The goal of this study was to examine when cellphones disrupt student learning and to investigate how individual differences in nomophobia might impact learning at different times during the lecture. We also wanted to re-examine how the restriction of cellphone use would influence learning for different periods during the lecture. The approach was to examine test performance throughout four quarters of a 20-minute video recorded lecture while text messages were sent to the participants throughout four time periods during lecture. Those who were permitted to use their phones performed worse than those who were not allowed to use their phones throughout the lecture, but these effects were only significant at the third quarter of the lecture. Interestingly, cell phone possession played a role in the differences between the quiz scores, nomophobia scores, and across the quarters of the lecture. The findings from Experiment 2 suggest that these performance decrements were due to the distraction of the text messages. Participants that were distracted by their cellphones also performed worse for material presented in the third quarter of the lecture than participants who remained focus throughout the lecture. Results from Experiment 2 also suggest that the current conditions generalize to a new university and a larger group of participants. Experiment 1 helped create a foundation for the second experiment in that Experiment 1 provided a baseline for whether or not cell phone possession itself served as a distraction. On the other hand, Experiment 2 provided evidence on the extent to which actively checking a cell phone during a lecture served as a distraction. Overall, these findings are consistent with research that has observed a decline in attention after a 10 to 15-minute time period (Benjamin, 2002; McKeachie, 1986, McKeachie & Sviniki, 2006; Wilson & Korn, 2007). The findings also were in line with research that suggests that when attention is no longer sustained, it can result in negative consequences for the memory of learned information (deBettencourt et al., 2017).

 Another finding was that nomophobia was closely associated with numerically poorer performance across all four time points. However, the third quarter showed a statistically significant relationship between nomophobia and test performance. Students at that time point may have been approaching a low point in their attention span and may have lost their interest in the lecture, which led to the possibility of having wandering thoughts. According to Smallwood, Nind, and O’Conner (2009), mind wandering is likely to occur when a task does not require undivided attention. Since students were not asked to take notes during the lecture and only pay attention, viewing the lecture alone may have not been a sufficient task to keep their attention. In the third quarter of the lecture, students may have begun to divert their attention to the possibility of unread messages on their phones. Consistent with this idea, students often report a sensational fear of missing out when they are away from their cellphones (Przbylski et al., 2013).

Moreover, the lack of difference in quiz performance that occurred in the last quarter of the lecture may be explained by negative recency. According to the idea of “negative recency”, a delay of as little as 18 seconds between when the last information was presented and when a memory test is given, will lead to a loss of that information in short-term memory (Craik, 1970). Either way, it appears that students had trouble remembering the content toward the end of the lecture, regardless of cellphone use or nomophobia level. Having a cell phone, as in Experiment 1, or being distracted by checking one’s cell phone, as in Experiment 2, can drop scores as far as an additional 11% on top of nomophobia. Experiencing nomophobia can vary on the decrease of performance from 5% (low nomophobia) to 10% (high nomophobia).

This study is guided by prior knowledge on how cellphones impact on student learning. Some research suggests that cellphones can bring a positive experience when learning material (Jan et al., 2016; Rashid et al., 2016). However, other research argues that cellphones are intrusive and disruptive to learning (Dietz & Henrich, 2014; Froese et al., 2012; Thornton et al., 2014). This study further corroborates the research on how cellphones result in poorer test performance and sheds light on when students are most likely to be distracted by their cellphones during a lecture.

The importance of knowing when attention is most likely to decrease is important for educators so that they can prepare their lectures accordingly. With the findings of this study supporting that attention begins to decline at three quarters of the lecture period, perhaps some educators may want to consider including short breaks every 15 minutes or assign a brief activity to maintain freshness in the lecture. Research suggests that allowing students who feel cognitively fatigued benefit from breaks to restore their attention (Felsten, 2009). However, educators may want to presume caution when assigning these short breaks and keep in mind that if students chose to use their phones during the break, a slight delay in adjusting back to the lecture may result from looking at the phone screen (Thapa et al., 2015). Rather than having students use their devices during short breaks, research suggests that allowing students to view some form of nature (through painting or in person) may have a positive influence on restoring attention (Felsten, 2009). Another suggestion is for educators to implement a no cellphone policy despite the fact that some students may experience nomophobia. It is important to inform students of how learning suffers from using cellphone in class and draw awareness as to how one person’s cellphone use may have an effect other students’ concentration.

**Limitations**

One limitation in the present study is that we are inferring that the quiz effects are due to different levels of attention paid during the lecture. While our rationale is theoretically guided and based on decades of research, attention was not directly measured in the present study. In addition, even though no text messages were given while students were taking the quiz, it could be the case that having a cellphone distracted participants during the quiz. Participants might have been thinking about the previous text messages while taking the quiz or perhaps were anxious to look at their phones after being in the study for about an hour. Relatedly, participants may have developed anxiety about the unknown number that was texting them, rather than because they were receiving text messages. Future studies allowing participants to check their phone between lecture and quiz or using known numbers (e.g., a campus alert system) would strengthen the current results.

Another limitation is that the experiment was limited to 20 minutes when most lectures are at least 50 minutes. Although research has demonstrated that attention is most vulnerable at a time when individuals are engaged in complex tasks (Thornton, Faires, & Rollins, 2014), this study supports evidence that attention suffers even when the task on hand is as simple as listening to a 20-minute lecture.

Research has addressed many variations of how cell phones serve as distractions in classroom setting (Dietz & Henrich, 2014; Thapa et al., 2014; Wood, Zivcakova, Gentile, Archer, De Pasquale, & Josko, 2012). Studies have also addressed how attention of information throughout different time periods plays a role in the remembrance of material (Broadbent 1958, 1971, Kuznekoff & Titsworth, 2013). The relationship between nomophobia and test performance has not been directly investigated within the framework of attentional decline. This study uniquely addresses when nomophobia is likely to contribute to student’s test performance. The findings are in line with research that found supporting evidence on how using technology while attending to a lecture hold a negative impact on learning. The study also is in line with the bottle neck theory which suggests that there is a slowing down of performance of the secondary task at hand (Welford, 1967). In this scenario, students are likely to attend to cell phones first when they are being distracted a lecture and then listening to the material becomes a secondary task.

 In conclusion, this study strengthens the understanding of the time when attention is most likely to decrease during learning and the role that cellphones play in this decreased attention. By observing patterns of when attention begins to decrease, educators and students can plan ahead and use appropriate methods to prevent distractions in classrooms as well as implement break intervals to restore attention.

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**Figure Captions**

**Figure 1.** Test Performance Over Time Across All Groups. In Experiment 1 (left) and Experiment 2 (right), test performance was highest for questions presented in the 1st quarter of the lecture, dropped for questions in the 2nd and 3rd quarter of the lecture, and dropped again for questions in the 4th quarter of the lecture. Error bars represent standard error of the mean (note that due to the small error, some are difficult to see).

**Figure 2.** Test Performance Varied with Cellphone Group and Cellphone Distraction. The left panel shows test performance results across time as a function of cellphone group in Experiment 1. The right panel shows test performance results across time as a function of observed cell-phone distraction, regardless of group membership in Experiment 2. Participants who were allowed to have their cellphone on them or who were observed being distracted by their cellphone during the lecture showed significantly impaired performance only for questions presented in the 3rd quarter of the lecture. Error bars represent standard error of the mean.

**Figure 3.** Test Performance Varied with Level of Nomophobia. Test performance is plotted across time as a function of Nomophobia in Experiment 1 (left panel) and Experiment 2 (right panel). Participants scoring 1 standard deviation above the mean in nomophobia are plotted in solid lines and those scoring 1 standard deviation below the mean in nomophobia are plotted in dotted lines. Participants higher in nomophobia performed showed significantly impaired performance only for questions presented in the 3rd quarter of the lecture.

Figure 1.



Figure 2.



Figure 3.

