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The Mere Presence of a Cell Phone: Effects on Academic Ability

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Abstract

Prior research has suggested that cell phone use in the classroom and during learning-related tasks is detrimental to academic performance. Recently, the mere presence of a cell phone has been found to negatively affect relationships and to impair performance on learning and cognitive tasks. In this study, presence referred to participants' cell phones; while these were visible to participants, phones were not in use. The present study explored whether the presence of a cell phone negatively impacts one's performance on tests measuring preexisting academic ability. In total, the study evaluated 45 participants; some were enrolled in an introductory psychology course and others were members of the general public. Three subtests from the Wide Range Achievement Test (WRAT-4) were completed: spelling, sentence comprehension, and mathematics. During testing, half of the participants had their cell phones, and the other half did not. Statistical analyses revealed no significant difference between the cell phone-present group and the cell phone-absent group on the sentence comprehension ($p = .52$), spelling ($p = .07$), and mathematics subtest ($p = .11$). Unexpectedly, a non-significant trend was observed in the opposite direction; that is, the cell phone-present group outperformed the cell phone-absent group on all of the subtests. Therefore, the original hypothesis suggesting that the cell phone-present group would be significantly poorer at demonstrating preexisting skills on tests of academic ability in comparison to the cell phone-present group was not supported.

Keywords: mere presence, cell phones, academic ability, achievement

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The Mere Presence of a Cell Phone: Effects on Academic Ability

Electronic devices such as cell phones are ubiquitous in academic settings; students and instructors use and carry these devices around regularly (Baker et al., 2012). In fact, when Baker et al. (2012) surveyed faculty and students about perceptions toward technology use, 99% of participants reported owning a cell phone. However, the use and presence of cell phones are not equally acceptable everywhere, so policies related to technology use and presence in classrooms can vary.

When Campbell (2006) surveyed faculty and students about perceptions toward cell phone use in the classroom, respondents generally agreed that cell phone rings disrupted learning, and policies were needed to curb excessive technology use. Despite efforts to limit or restrict this usage, little is known about how technology in the classroom affects academic ability. Due to the lack of data about the relationship between technology policies and learning, the *mere presence* of cell phones in the classroom is important to investigate.

Moreover, this topic is important to investigate because technology in academic environments is becoming increasingly commonplace. Before discussing the mere presence of cell phones, the following areas must be addressed: the effects of cell phone *use* on individuals in learning contexts, within classroom environments, or during procedural tasks.

Cell Phone Use

Detrimental Effects on Academic Performance

Given the high rates of cell phone ownership, researchers have started to take an even greater interest in studying cell phone use in academia. Two studies, one employing survey methods (Harman & Sato, 2011) and the other amalgamating survey and experimental methodology (Froese et al., 2012), provide thought-provoking evidence for cell phone use related to lowered achievement. First, the more participants reported sending and receiving text messages throughout the course of a day, the lower their reported grade-point average (GPA); secondly, the further along participants were in their program, the less often they sent, received, or checked their cell phone for inbound messages (Harman & Sato, 2011).

A year later, in the first of two related studies by Froese et al. (2012), participants predicted how much learning would occur while texting and watching a presentation. They found when texting was prohibited, participants predicted an average score of 8.93 on a 10-item test; on the other hand, if texting was allowed, the predicted test average was 6.01 (Froese et al., 2012). In Froese et al.'s (2012) second study, as expected, the more time participants spent texting, the lower they scored on a quiz that was completed after the presentation.

In Study 2, when texting occurred, the average quiz score was 6.02; conversely, the average quiz score was 8.25 for the non-texting group (Froese et al., 2012). If survey-based studies have shown that academic performance declines with high rates of cell phone use, similar detrimental effects might be found in research employing solely experimental methods without surveys.

Experimental studies have supported the notion that cell phone use disrupts learning and diminishes academic performance. In an experimental condition, End, et al. (2010) manipulated a cell phone to ring twice during a video presentation and notetaking task; in contrast, they did not manipulate a phone to ring in the control condition. Afterward, to gauge the lecture information participants attended to, the notes from each condition were compared, and academic performance was assessed on two multiple-choice test items pertaining to content delivered during the time of the cell phone rings (End et al., 2010).

Participants who experienced the phone rings recorded less relevant information in their notes and performed more poorly on the two test items containing content presented during the ringing. In a more recent study by Cutino and Ness (2017), before reviewing self-chosen course material during a homework session, researchers asked students to list course tasks and study goals that needed to be accomplished. During the session, students in the control condition were provided no instruction about cell phone use, but participants in the experimental condition had their phones taken away (Cutino & Ness, 2017).

After the session, Cutino and Ness (2017) found that students who had their cell phones removed reported accomplishing more homework tasks and study goals. Most studies to date have indicated that using a cell phone during education-related tasks negatively affects learning. Limiting cell phone use seems like a feasible solution to increasing academic

performance, but cell phone restriction has not always been advantageous.

Cell Phone Presence

Cell phone use has been widely studied over the last decade, but less is known about the effects of cell phone presence (i.e., when phones are physically present but not in use). Recently, the mere presence of a cell phone has been studied in two domains: (1) relationships (e.g., Crowley et al., 2018; Misra et al., 2016); and (2) learning-related and cognitive tasks. Unfortunately, the research produced within the learning-related and cognitive task domain has been minimal.

Learning and Performance Tasks

The presence of a cell phone has the power to affect in-person conversations; additionally, unfavourable consequences can occur during educational, performance-related, and cognitively demanding tasks. Thornton et al. (2014) contributed their efforts to the cell phone presence literature, concluding that when a cell phone was present, whether it belonged to a student or to someone else, attention was reduced, and performance outcomes were poorer for complex tasks.

In contrast, a recent study by Urick et al. (2018) examined the effects of cell phone presence on attention and memory, discovering that cell phone presence did not hinder task performance. Participants were instructed to either put away their cell phones (i.e., the phones were present, but not visible) or keep them visible while they completed three different online games and/or tasks: Concentration, Simon, and an *n-back* task (Urick et al., 2018).

In the first (Concentration) task, participants flipped two cards over at a time, memorized the card placements as best as possible, and tried to match the card pairs as the game progressed (Urick et al., 2018). Urick et al.'s (2018) second (Simon) online task required participants to repeat patterns that became increasingly longer over time. For the third (n-back) task, when participants viewed an image, they indicated when the current image matched what they had seen two presentation trials before (Urick et al., 2018).

When Urick et al. (2018) compared the task performance of the cell phone-present and absent groups, there were no significant differences in accuracy or completion time for any task. Researchers have developed various conclusions about the effect of cell phone presence on individuals, so this paper predicts two reasons why the presence of cell phones may be distracting in everyday life.

Cell Phone Presence Hypotheses

Social Connectivity

There are a few hypotheses for why the presence of a cell phone might pose a distraction to individuals, but one common thread occurs throughout the literature: *social connectivity*. Przybylski and Weinstein (2012) found that cell phones can prime thoughts about social network interactions; as a result, individuals pay less attention to the present task.

According to Misra et al. (2016), mobile devices (i.e., cell phones) act as a gateway; an individual may be in the presence of technology, yet mentally someplace else. Based on Lyngs' (2017) thoughts and Kurzban's model (as cited in Lyngs, 2017), individuals may think about socialization opportunities while they are in the presence of their phone; this thought process requires a high amount of mental effort, which could lead to poor task performance.

Although much of the research noted above has expressed that access to social networks could increase distraction and temporarily remove someone (at least mentally) from the present, other researchers offer a different perspective, suggesting that access to social networks provides a plethora of advantages. Faizi et al. (2013) asserted that the use of social networks improves students' and teachers' learning experience.

As an example, when students and teachers access sites such as Facebook and Twitter for learning-related tasks (e.g., discussing homework problems or reviewing assignment details), boredom is reduced and engagement enhanced (Faizi et al., 2013). Given this mixed debate (i.e., the belief that social networks can be a distraction despite their use often being associated with assisting learning in academic tasks), these networks can only partially explain why cell phone presence might distract an individual from the task at hand.

Use, Attachment, and Dependence

Frequency of cell phone use and attachment/dependence (i.e., to cell phones and the Internet) are additional factors that need to be considered. In Thornton et al.'s (2014) study,

participants completed a survey about cell phone use and dependence; although older participants reported less attachment to and dependence on their cell phones, the researchers found that task performance was not significantly related to attachment or dependence. However, Ward et al. (2017) found that when participants who reported using their phones daily were in presence of a cell phone, they performed more poorly on cognitive tasks.

Present Study

Gaps in the Literature

In the relationship domain, a few key studies have been produced (Allred & Crowley, 2017; Crowley et al., 2018; Lanette, 2018; Misra et al., 2016; Przybylski & Weinstein, 2012). Within the learning-related and cognitive-task domain, some studies suggested that the presence of a cell phone impairs performance (Ito & Kawahara, 2017; Thornton et al., 2014; Ward et al., 2017). Other studies suggested that the presence of a cell phone may not impair task performance (Lyngs, 2017; Urick et al., 2018). The contradictory outcomes within these studies reveal that there are few definitive findings to suggest that cell phone presence has both positive and negative effects.

Three issues arise from the learning-related and cognitive-task domain. First, because of conflicting results, replicating methods used in previous studies or replication with extension, which adds something new to the method of a previous study, should be considered. Second, future studies would likely benefit from larger sample sizes. Third, no one has directly investigated the influence that the presence of a cell phone has on previously learned skills and academic abilities; rather, outcome measures have often been related to fluid intelligence.

Focusing on the learning-related and cognitive task domain, the most disconcerting problem appears to be the lack of research on prior skills and previous learning. For instance, Thornton et al. (2014) did not assess whether participants' ability to utilize their previously acquired skills was impaired by cell phone presence (Thornton et al., 2014). Drawing upon this knowledge of outcome measures, the present study sought to understand whether cell phone presence influenced the demonstration of preexisting academic skills and abilities.

Research Question and Relevance

The study focused on whether the presence of a cell phone affected the demonstration of preexisting sentence comprehension, spelling, and mathematics skills. To this end, it was essential to investigate this area of study and how it relates to learning. *Scaffolding*, originally labeled by Wood et al. (1976) and related to Vygotsky's (1962) *zone of proximal development* (ZPD), is the process by which a new, emergent skill or piece of knowledge is taught and eventually applied. Because this type of new learning frequently depends on prior learning and because cell phone presence has become increasingly common in learning environments, it is important to consider how cell phone presence may interfere with the demonstration of preexisting skills and abilities.

Hypotheses

The present study manipulated the presence of a cell phone to see how cell phone presence or absence affected the demonstration of preexisting sentence comprehension, spelling, and mathematics skills. When a personal cell phone was present, it was predicted that: (1) the demonstration of preexisting skills on a sentence comprehension subtest would be poorer in a cell phone-present group compared to a cell phone-absent group; (2) the demonstration of preexisting skills on a spelling subtest would be poorer in a cell phone-present group compared to a cell phone-absent group; and (3) the demonstration of preexisting skills on a mathematics subtest would be poorer in a cell phone-present group compared to a cell phone-absent group.

Method

Participants

Undergraduate students from a mid-size Canadian university and the general public (N = 45), ranging in age from 17.92 to 41.83, participated in the study (M_{age} = 22.33, SD_{age} = 5.23); all but two participants were from the introductory psychology pool. The sample consisted of female participants (n = 34), male participants (n = 10), and other participants (n = 1) who were randomly assigned to a cell phone-present group (n = 23, M_{age} = 23.46, SD_{age} = 6.65) and a cell phone-absent group (n = 22, M_{age} = 21.15, SD_{age} = 2.83).

To meet inclusion criteria, participants' first language had to be English and they could not have any known learning issues that would affect

reading, writing, attention, or mathematics. As well, participants were required to have access to a personal cell phone that had the potential to connect to the Internet and they had to bring the cell phone with them on the day of testing.

A few additional restrictions were in place; participants could not have signed up for any prior studies that had utilized the same literacy measures. For introductory psychology students, a total of 1% course credit was provided for participation. Participants from the general public were entered into a random draw for a $50 gift card for a place of the winner's choosing. All methods were approved by the Human Research Ethics Board (HREB).

Materials

The Wide Range Achievement Test (WRAT-4) (Wilkinson & Robertson, 2006) was chosen for group administration; typically, the WRAT-4 consists of four subtests: word reading, sentence comprehension, spelling, and mathematics. However, due to testing in a group setting, word reading was omitted. Dell et al. (2008) reported that the internal consistency ranged from .92 to .98 for the overall test, and a range of .87 to .93 was reported for the subtests. Finally, the researchers also used stopwatches to ensure that the timing of each subtest remained consistent.

Sentence Comprehension Subtest

In the original version, participants would receive a comprehension card with 50 fill-in-the blank sentences, and the researcher would have a testing form similar to an answer key (i.e., the testing booklet contained a list of common correct and incorrect answers for each sentence). Participants would read each sentence on the comprehension card to themselves, and then they would speak a word that would complete the corresponding sentence.

Due to group testing in the current study, the comprehension card was not used. Instead, a modified version of the sentence comprehension test provided the participants with the testing booklet, but the answer key (normally in plain view on the form) was covered up by coloured paper so participants could not see the answers. Sentences were read silently, and participants wrote their responses in the blank spaces in the booklet.

The sentence comprehension subtest became progressively more difficult. Twelve minutes were allotted. For scoring, correct responses were assigned 1 point and incorrect answers were not given a score. The higher the standardized score, the greater the participant's preexisting sentence comprehension skills.

Spelling Subtest

The spelling subtest was comprised of 42 words. For each item, a researcher read a word from a spelling list, said the word aloud in a sentence, and then repeated the word. After each item was read, participants spelled the word on a response form. Like the sentence comprehension subtest, the words became increasingly more difficult as the subtest progressed. On average, this test took about five-to-six minutes. Correct answers were awarded 1 point, whereas incorrect answers were not. The higher the standardized score, the better the participant's preexisting spelling skills.

Mathematics Subtest

A total of 40 mathematics questions were completed on a computation response form. Participants read the questions to themselves, and they recorded their answers on the form. As participants completed the subtest, the questions became increasingly more difficult. Altogether, 15 minutes were provided for this subtest. Each correct answer was allocated 1 point, whereas incorrect answers were not. The higher the standardized score, the greater the participant's preexisting math skills.

Procedure

Procedural steps were generally the same for both groups. First, the participants arrived at a Psychology Lab and were randomly assigned to either Group A or Group B. Next, the groups were separated because they were sent to one of two preassigned rooms. Each group then completed the informed consent portion, following which, the phone-absent group handed in their phones, while the phone-present group placed theirs on the desk in front of them. After the manipulation, the procedural steps were the same for both groups. These steps, in order, were as follows: comprehension subtest, spelling subtest, math subtest, and debrief.

Random Assignment

The participants arrived at the Psychology Lab, and they were greeted by a research assistant. Participants drew a piece of paper, which had an "A" or "B" written on it, from a bag. This draw randomly

assigned participants to Group A (cell phone-present) or Group B (cell phone-absent).

Consent and Demographics

In the respective testing classrooms, an assistant was waiting to review the consent forms. Participants thought that they would be performing tests of academic ability and then a social-media survey. After consent was obtained, each group filled in basic demographic information, such as gender and age. Age-related information was needed for standardized scoring as required by Wilkinson and Robertson (2006).

Cell Phone Presence or Absence Manipulation

Participants in Group A were asked to turn off their cell phones and to place them on the desks in front of them, whereas participants in Group B were asked to turn off their phones and temporarily surrender them. The greeter who assisted with random assignment also helped to gather Group B's phones using a collection box. After the collection, this assistant took a replica box (previously planted behind a computer podium) and removed it from the classroom. This gave the appearance that phones were removed from the room without ever leaving them unattended.

Tests of Preexisting Ability

Following the phone-presence or absence manipulation, participants completed the same tasks in the same order: sentence comprehension, spelling, and mathematics. Because the order of the tests is part of the standardization, counterbalancing was not used (Wilkinson & Robertson, 2006). When the subtests were finished, participants in Group A were told that they could use their phones again, and participants in Group B had their phones returned to them.

Debrief

During the debriefing, participants learned about mild deception. That is, cell phones were not being used for a social-media survey or to investigate a relationship between ability and social-media use; rather, participants were assigned to Group A or B to investigate how cell phone presence influenced the demonstration of preexisting academic skills and abilities. Importantly, participants were asked not to divulge the deception to others who may participate in a later session.

Additional Considerations

Deceptive Methodology

To avoid demand characteristics, researchers were required to produce some deceptive manipulations. In the present study, prior knowledge about a cell phone presence or absence manipulation might have influenced the participants' responses. In effect, participants were not informed about a phone presence or absence manipulation until at a debriefing. Also, to avoid suspicions about the true nature of the present study, the actual title was publicised under a fictitious name (i.e., *Academic Ability*) when soliciting participants. Nevertheless, these were not the only deceptive methods required.

Seeing that the purpose in the present study could not be revealed too early, some additional deception was needed. In Thornton et al.'s (2014) study, near the beginning of a statistics lecture, participants were told to have their phones on their desks for a cell phone-use survey; this survey was to be completed at the end of the class. Similarly, in the present study some participants were told to have their cell phones on their desk for a survey about social media. Participants in the cell phone-absent condition were told that their phones would be taken away but then returned later so that they could complete a survey.

Device Visibility and Location

Some researchers have suggested that when a cell phone is present and in a high-visibility area, it may be distracting or lead to increased anxiety (Sapacz & Clark, 2016; Ward et al., 2017). Sapacz and Clark (2016) were interested in examining addictive properties of cell phones; after manipulating cell phone visibility, an interesting result was found. Participants whose phone was in a high-visibility location (i.e., on a table) self-reported higher levels of state anxiety (SA) than participants whose phone was less visible or removed from the room (Sapacz & Clark, 2016). In the present study, cell phones belonging to participants in a cell phone-present group remained on a desk directly in front of them. For participants who were randomly assigned to the cell phone-absent group, their cell phones were removed from their possession, and they were led to believe that their phones were not in the room.

Data Analyses

Descriptive statistics, such as participants' mean age and the standard deviation of age, were calculated to determine participant demographics. Boxplots were generated to detect outliers (i.e., defined as any point 1.50 times greater than the interquartile range). Outliers beyond the acceptable area were removed from the analysis. Participants who failed to complete one or more of the subtests (i.e., they left an entire subtest blank but completed another) were not eliminated from the analysis; rather, only the individual subtest score (i.e., a score of 0) was eliminated.

If a participant left a question blank, but still proceeded to complete the subtest, their subtest score was still calculated and included in the analyses. Means and standard deviations for each subtest were calculated to compare the demonstration of preexisting skills between the two groups.

To determine if the means on the sentence comprehension, spelling, and mathematics subtests were significantly different between the groups, three two-tailed *t*-tests for independent samples were performed. Following data collection, a retrospective power analysis was also done to determine the likelihood of detecting statistically significant effects. On each subtest, when the treatment groups were compared, it was expected that a statistically significant difference in the demonstration of preexisting skills would be observed.

Results

Preliminary Analyses

After the initial outlier check, six outliers were detected. Four of these outliers were detected in the cell phone-present group, and the remaining two outliers were observed in the other group. After the outlying scores were removed and boxplots revealed no new outliers, the number of subtest participants in the cell phone-present group ranged from 21 to 22; the number of participants in the cell phone-absent group ranged from 20 to 22.

Descriptive Statistics and Independent Samples *t*-Tests

When a cell phone was present during testing, the demonstration of preexisting skills on the sentence comprehension subtest (M = 100.45, SD = 10.17) was not significantly different from the cell phone-absent group who also completed the sentence comprehension test (M = 98.18, SD = 12.96), $t(42) = 0.65$, $p = .52$, $d = 0.19$, 95% confidence interval (CI) [-4.82, 9.36].

Subsequently, when participants completed the spelling subtest in the presence of their cell phone (M = 106.71, SD = 6.80), the demonstration of preexisting skills was not significantly different compared to a cell phone-absent group (M = 102.35, SD = 8.09), $t(39) = 1.87$, $p = .07$, $d = 0.58$, 95% CI [-0.35, 9.08].

Lastly, when participants completed the mathematics subtest in the presence of their cell phone (M = 92.64, SD = 9.05), the demonstration of preexisting skills was not significantly different than when participants completed the mathematics subtest in the absence of their phone (M = 88.32, SD = 8.49), $t(42) = 1.63$, $p = .11$, $d = 0.49$, 95% CI [-1.02, 9.66].

Considering this result, for all the subtests, there was insufficient evidence to suggest the cell phone presence hindered performance. Unexpectedly, a trend was observed in the opposite direction. On each subtest, the mean of the cell phone-present group was higher than the mean of the cell phone-absent group; this trend was non-significant, albeit the spelling subtest approached significance (p was between .05 and .10).

Retrospective power reported for these *t*-tests were 9.70%, 44.72%, and 35.77%, respectively. Table 1 presents an overview of basic descriptive statistics, such as means and standard deviations for the groups and subtests.

Discussion

Participants took three subtests to determine if their preexisting skills on sentence comprehension, spelling, and mathematics were poorer in the presence or absence a cell phone. This

Table 1

Descriptive Statistics for the Treatment Groups Per Subtest

	Group (N = 45)									
	Phone-present (n = 23)					Phone-absent (n = 22)				
Subtest	*n*	*M*	*SD*	Min	Max	*n*	*M*	*SD*	Min	Max
Comprehension	22	100.45	10.17	82.00	119.00	22	98.18	12.96	80.00	129.00
Spelling	21	106.71	6.80	90.00	117.00	20	102.35	8.09	88.00	119.00
Mathematics	22	92.64	9.05	72.00	111.00	22	88.32	8.49	70.00	104.00

Note. N = population size; n = sample size; M = mean; SD = standard deviation. Sample sizes vary due to the removal of outlying scores on each subtest. Based on participants' age and birthdate, standardized sentence comprehension scores could range from 55 (i.e., a score of 0) to 132 (i.e., a perfect score), standardized spelling scores could range from 55 to 145, and standardized mathematics scores could range from 55 to 144.

manipulation was done for a few reasons. First, cell phone presence has been prevalent in two recently studied domains: relationships (e.g., Allred & Crowley, 2017, or Przybylski & Weinstein, 2012) and the learning-related and cognitive domain (e.g., Thornton et al., 2014, or Ward et al., 2017).

Next, all these studies examined cell phone presence, but the outcome measures in the learning-related and cognitive domain primarily represented the ability to solve problems and generate answers using logic and reason (i.e., measures more related to that of fluid intelligence). Its effects on preexisting ability, or to put it another way, ability more related to crystallized intelligence, remained to be explored; that is, until now.

In the present study, three predictions were made. When participants completed each subtest in the presence of their cell phone, the demonstration of preexisting skills was predicted to be poorer on the: (1) sentence comprehension subtest; the (2) spelling subtest; and the (3) mathematics subtest. Surprisingly, when scores were compared between the groups, there was no statistically significant difference in the demonstration of preexisting skills on any of the tests, except the spelling test, where the between-group comparison was marginally significant.

Therefore, none of the hypotheses were supported. What was observed, however, was a non-significant mean difference in the reverse direction. When participants completed the subtests in the presence of their phone, the mean score was consistently higher than the other group.

Possible Explanations for the Findings

What a Cell Phone Represents

Thornton et al. (2014) expressed that phones may be distracting because they represent omnipresent social networks. Granted that the cell phone-present group outperformed the comparison group in the present study, when a cell phone is present, thinking about social networks may not be so detrimental after all. In Faizi et al.'s (2013) article, they conveyed that both learners and instructors can benefit from using social networks because both parties can learn from one another, work together, and achieve shared goals.

If the presence of a cell phone prompts students to think about their social network interactions, which are occasionally associated with learning, the presence of a cell phone may be beneficial for individuals in some instances. On the other hand, it is possible that the presence of the cell phones did not lead participants to think about social networks anymore than the phone-absent group, so this may explain why there was no significant difference in the demonstration of academic ability between the two groups.

If a cell phone can potentially prime thoughts about social connectivity, another possibility remains: the presence of a phone may invoke thoughts related to cell phone functions used for learning and academic tasks. Individuals who own cell phones may recognize they can be used for a plethora of academic-related activities, such as taking notes, locating words in an online dictionary, and computing solutions to mathematics problems.

Occasionally, participants in the present study asked if they could use their phone for solving the mathematics problems; obviously, they could not. Because this question arose, it is safe to assume participants were thinking about one or more academic tasks in the presence of their phone.

With regard to this, the presence of a cell phone may have primed thoughts about previous learning that was accomplished with their phone. To put it

another way, when participants completed the subtests, the phone's presence may have reminded them about academic tasks or information related to the subtest content.

When Lowery et al. (2007) subconsciously primed participants with words related to intelligence (e.g., brilliant) or neutral words (e.g., grass) before taking a practice test and a course-related test, participants who were primed with the intelligence words rather than the neutral words and who were not told about the priming manipulation, performed better on both tests.

In the present study, a priming reminder induced in part to the presence of a cell phone and related to academic tasks could explain why the cell phone-present group outperformed the other group.

Revisiting Cell Phone Use, Attachment, and Dependence

When a cell phone-present and absent group were compared in Lyngs (2017), he did not observe significant differences in performance, yet participants who reported being highly attached to their phones found that a complex activity (i.e., an *additive-cancellation task*) required less effort when a phone was present. Likewise, the higher the reported use of and attachment to a cell phone, the more likely participants were to perceive the tasks as more enjoyable when completed in the presence of their phone (Lyngs, 2017).

In the present study, if participants in the cell phone-present group were truly more attached to their phones, though theoretically random assignment should have meant equal chance of attachment levels, perhaps they found the subtests more engaging and less tedious. As Thornton et al. (2014) also mentioned, older participants were less attached and not as dependent on their phones compared to younger participants.

It seems likely that the young participants in the present study could have been highly attached to their phones; this high level of attachment may have facilitated the demonstration of previously learned skills and existing abilities, and this facilitation may have made them less sensitive to the possible disruptive effects of phone presence on academic ability.

Phone Restriction and Anxiety

Interestingly, in a study by Clayton et al. (2015), participants experienced several adverse physiological responses (e.g., high blood pressure and heart rate) when they were unable to answer their nearby cell phones. In the present study, the cell phone-absent group was not told where their phones were supposedly taken, and they could not answer any incoming calls; they only knew that their phone would be returned after testing.

Given the covert manipulation, it is reasonable to think some participants in the phone-absent group had undesirable physiological responses. The present study required participants in the phone-present group to keep their phones turned off, but the devices were still visible. Under these circumstances, participants may have experienced less anxiety because, unlike the cell phone-absent group, their phone remained within arm's reach.

Context-Dependent Memory

Drawing upon cognitive psychology research, context-dependent memory informed the results. In one instance, Godden and Baddeley (1975) showed how recall is greater the more similar a testing environment is like the original learning environment. Relatedly, individuals learn new skills and information through repeated practice sessions; during these tasks, a cell phone may be kept nearby for a "just in case" moment (e.g., receiving an unexpected incoming text or call).

Even if individuals keep their phones on hand for anticipated use, they may not always be using their phone. All things considered, the context wherein participants in the present study practiced newly learned skills (which typically become well-learned after practice, and therefore get 'relabelled' as preexisting skills) might have been similar to the environment wherein they completed the subtests. As the cell phone provides familiarity in a variety of casual situations, it may have increased the participant's ease of demonstrating preexisting skills in a more formal testing setting.

Limitations

Random Assignment

Unfortunately, the present study was not devoid of limitations. In principle, random assignment should have divided the two groups evenly, so the groups should have had approximately the same number of participants with low, medium, and high ability. It is possible that the groups differed in their previously learned skills and academic ability, even after random assignment.

Sample Size and Statistical Power

Akin to other studies, such as Urick et al.'s (2018) who only had 26 participants split between a cell phone-present and cell phone-absent group, the small sample size in the present study was likely problematic. McGrath (2016) indicated that researchers should aim to collect samples with at least 30 participants per group, as this is the agreed upon standard within the field of psychology.

Unfortunately, there were only 45 participants in the present study, so each group had fewer than the recommended minimum amount. In a like manner, the between-groups comparison for the sentence comprehension subtest revealed less than a 10% chance of detecting a significant result (if an effect existed). For the other two *t*-tests, there was less than a 50% likelihood of detecting an effect.

Manipulation Check

Unlike prior studies, such as Lyngs (2017) whose participants wrote freely about what they thought the true nature of the study was, the present study had no manipulation check. Accordingly, it is possible that participants in the cell phone-absent group failed to notice the box being carried out of the room. In addition, some participants could have suspected mild deception. However, had there been a manipulation check, participants may have felt the need to respond in a desirable manner.

Assessment of Multiple Variables

To achieve parsimony, variables such as the frequency of cell phone use and attachment to and dependence on cell phones were not assessed. This is in contrast to what other researchers have done; precisely, in the learning-related and cognitive domain, various studies assessed participants' dependence on their phones (Lyngs, 2017; Thornton et al., 2014; Urick et al., 2018; and Ward et al., 2017). Ito and Kawahara (2017) administered a test of Internet addiction to determine participants' phone use and degree of phone attachment.

Other research, such as Bianchi Bosch's (2018) recently published thesis, not only assessed cell phone usage and attachment, but it added a Fear of Missing Out (FoMO) Scale (Przybylski et al., as cited in Bianchi Bosch, 2018), which assessed anxiety and fear individuals may feel when thinking about fun activities they cannot readily engage in due to involvement with another task. As the present study omitted these measures, it was beyond its scope to decide if these variables caused the obtained results; only speculation about their influence on and relation to the results is possible.

Applicability of the Subtests

With a mean age of 22.33, the tests of ability may not have been well suited to such a young demographic. The WRAT-4, published by Wilkson and Robertson in 2006, is over a decade old. Reflecting on this information, the standardized scores on the subtests may not have generalized to a young, primarily undergraduate sample.

Future Directions and Conclusion

As Crowley et al. (2018) pointed out, technology-related norms have been changing over time. New norms related to cell phone use and presence are likely to emerge, yet it can be difficult to form an agreed-upon set of guidelines for cell phone use. Namely, some instructors have tolerance for present cell phones in the classroom whereas others do not. Bugeja (2007) noted that some instructors have even started to include technology policies on their course outlines, and Baker et al. (2012) revealed that some academic institutions have started to create and enforce technology policies.

However, inconsistencies about what is labeled acceptable versus unacceptable remain; thus, it is difficult to say what the "right" stance to take on cell phone presence in the classroom is. Perhaps, when cell phones are present, they may not impede the demonstration of already learned skills after all; the presence of a phone may facilitate the demonstration of these skills.

Arguably, more research on cell phone presence is needed to make more informed decisions about these matters. With this in mind while reflecting on the fact that cell phones are not the only devices that are typically present in learning environments, it is important to consider the effects that other technology, such as laptops or tablets, may have on learning and cognitive tasks. After Thornton et al.'s (2014) study, the researchers speculated that some connective technologies, such as tablets, may lead to distractibility.

Some additional research beyond the scope of cell phone presence, reveals that the use of technology (e.g., laptops) negatively affects learning (Fried, 2008; Jacobsen & Forste, 2011; Kraushaar & Novak, 2010; Ravizza et al., 2017; Sana et al., 2013). Sooner or later, the effects of technology's presence,

not just cell phone-related effects on learning and cognitive tasks, may one day be widely studied.

Unlike the emerging interest in studying other merely present technology, a great deal of research exists on cell phone use in learning environments (e.g., Froese et al., 2012; Harman & Sato, 2011; Kuznekoff & Titsworth, 2013). Despite this abundance, fewer studies have investigated cell phone presence and its impact. For that reason, future studies would benefit from manipulating cell phone presence rather than solely exploring cell phone use.

Given that this was the first study of its kind to investigate the relationship between preexisting skills and cell phone presence, researchers should consider using outcome measures related to crystalized intelligence and not just fluid intelligence. Future research can also attempt to design and utilize manipulation checks and other stringent procedural methods while concurrently assessing several variables (e.g., dependence on one's phone) and using up-to-date testing materials.

To add, how the presence of technology influences decisions that students and educators make, both within and outside of a classroom, also remains to be explored in greater depth. Undoubtedly, technology use and presence will have long-lasting consequences, so it important to know how to mitigate their harmful effects and maximize their benefits.

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