The Effect of the Presence of a Smartphone and Smartphone Usage on Concentration Levels and Academic Performance

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ABSTRACT

The use of smartphones worldwide is increasing at an exponential rate. In 2011, just 35% of Americans owned a smartphone, whereas in 2019 96% do (Pew Research, 2019). With the recent increase in smartphone usage there are changes in the way humans live, especially in how they complete tasks. In France, a law was recently passed banning the use of cellphones in school and it was found that test scores already have climbed by 6%. While these results allow professionals to make some conclusions about the effects of smartphones, there are still gaps in research pertaining to the effect of the presence of a smartphone and smartphone usage on concentration levels and academic performance. The question asked was, "How do the effect of the presence of a smartphone and smartphone usage impact concentration levels and academic performance in high school students?" In the study, participants were given concentration tests with and without their smartphone. The results show that concentration levels decreased with solely the presence of a smartphone. Next, teachers reported participants' unit test score and smartphone usage rated on a likert scale. Results indicate that a higher smartphone usage rating assigned by a teacher correlated with decreased test scores on the subject specific unit test. The trend demonstrates a negative correlation between in class smartphone usage and academic performance. The results of this experiment can help people to understand if their smartphone is a significant hindrance to their concentration and distraction in an academic setting.

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INTRODUCTION

In the past decade, smartphones have become almost ubiquitous. In 2019, 96% of Americans owned a smartphone compared to just 35% in 2011 (Pew Research, 2019). Americans confess to having become more and more dependent upon smartphones. Of current smartphone users, 91% say that they will not leave the house without their phone and many students admit to using their smartphones during the school day (Pew Research, 2019). Attempts to regulate smartphone usage in schools has mostly failed. In 2015, a ban on smartphone usage in schools in New York was lifted as parents expressed concerns about being in contact with their children during the school day. California has recently passed legislation that allows school districts to restrict or prohibit device use in class; although the decision as to whether to regulate Smartphone use is up to each district. California is the only state in the United States that has some type of regulation in place (Lardieri, 2019).

Smartphone overuse is not a uniquely American problem. According to the Ministry of Science and Information and Communications Technology (MSIT), more than 98% of South Korean teens used smartphones in 2018, and many showed signs of addiction. In 2018, approximately 30% of South Korean children aged 10 to 19 were classed as "overdependent" on their phones, and middle school and high school students were who extremely addicted were admitted to government-run detox camps. Similarly, in 2018, concerns of overuse led France to ban the use of smartphones for students in schools through ninth grade. France enforced this ban with the hope that school children would pay more attention in class and interact more (Rubin & Peltier, 2018). Under France's law, students were able to bring their smartphones to school but must store them in their lockers or bags during the school day. Smartphones were confiscated if students were caught using them in school. South Korea and France are rare examples though; Denmark is examining a possible similar approach but has not crafted legislation thus far (Ritzau, 2019). In Britain, schools create policies regarding smartphones for themselves but there is no nationwide legislation that exists at this time (Wright, 2018).

Several studies have explored how smartphone use affects concentration levels and academic performance. For example, Duke, Gneezy & Bos (2017) found that when solving

matrices, participants on average completed 8.3 out of 10 correctly when the smartphone was in another room but completely only 7.8 correctly when the smartphone was near them on their desk. Participants whose phone was on their desk (high salience) displayed the lowest available cognitive capacity whereas those whose phone was in another room (low salience) displayed the highest available cognitive capacity. In addition, Kuznekoff & Titsworth (2013) found that students who did not have access to their mobile phones wrote down 62% more information in their notes, took more detailed notes, were able to recall more detailed information from the lecture, and scored a full letter grade and a half higher on a multiple choice test than those students who actively used their mobile phones. Lepp, Barkley & Karpinski (2015) also found that grade point average and overall smartphone use (not specifically in classrooms)were found to have a significant negative correlation in college students. However, Kuznekoff & Titsworth (2013) tested their hypothesis in a controlled setting and therefore the results may not reflect actual behavior in a classroom. Similarly, Lepp, Barkley & Karpinski (2015) examined smartphone usage out of class and did not directly measure the effect of students' proximity to their smartphone in class had on their academic performance.

Not all studies report negative correlations between smartphone use and academics though. Kelly (2017) reported that 94% of participants who responded to their survey used smartphones in the classroom for academic purposes. 75% of participants believed personal devices in the classroom improved their ability to learn and retain information, 58% used their phones to take pictures of lecture slides, 41% used Google answers for help with in-class questions, and 39% liked having access a digital textbook.

Therefore, there is conflicting evidence as to whether or not smartphone usage positively or negatively impacts students' concentration levels and learning. While research has been conducted related to smartphone use in the past, there is little to no data available on the impact of smartphone usage in the classroom on high school students. Therefore, the purpose of this study was to determine if the presence of a smartphone and smartphone usage had an impact on concentration levels and academic performance in high school students. The question asked was, "How does the presence of a smartphone and smartphone usage impact concentration levels and academic performance in high school students?" The hypothesis was that the presence of a

smartphone would decrease decrease concentration levels and that increased smartphone usage would decrease academic performance.

METHODS AND MATERIALS

Recruitment of Participants

Fifteen science teachers were asked and four teachers from a suburban high school in New York, USA, volunteered their classes to participate in the study. In total, 13 science classes, grades 10-12 (ages 14-18) participated. The supervisor of the high school science department sent consent forms to all parents of students in the classes of those teachers. Students whose parents signed consent forms were volunteered. Students were then asked to complete the survey that was attached to the email. Students had to electronically give their own consent before they could begin the survey. In total, 50 students from 13 classes consented to participate in the study. Participants' responses were kept anonymous. Institutional Review Board (IRB) approval was granted for the study. Students were assigned a number at the beginning of the study to maintain their privacy.

Survey

Survey Construction

A survey consisting of fourteen questions was created using google forms. Questions were categorized according to two criteria: quantification of smartphone usage and self-reported effects of smartphone usage on concentration and academic performance. Participants were asked to self-report their smartage usage by accessing the "settings" application on their smartphone and communicate the number of hours they spent on their smartphone per day for the past week. Participants were asked to delineate how they used their smartphone (i.e. describe your style of text messaging, opinions on the impact of their smartphone on their academic performance, the impact of smartphones on understanding of class material, etc…)

Data analysis

De-identified survey data was collected from Google Forms. Names and email addresses were not included in participant responses. Data was analyzed using pie charts and statistical significance was determined using a z- test.

Concentration Tests

Selection of Concentration Tests

Two sets of concentration sets were selected. Both sets of concentration tests consisted of a connect the dots exercise and two letter cancellation exercises. The tests were exactly the same; however, the order of dots differed in the connect the dots exercise and in the letter cancellation students were asked to find different combinations of letters. The same number of targets were present in each test. These tests were designed so as to have as little cultural or intellectual bias as possible. In other words, all participants should have been equally able to complete them.

Concentration test protocol

When participants arrived for testing, they surrendered their smartphones to the study administrators. The first set of concentration tests, consisting of the connect the dot exercise and the two letter cancellation tests, was distributed. Participants were instructed to work as quickly as possible and not to erase mistakes. At the conclusion of the first set of tests, participants were handed their smartphones. Participants were able to complete the second set of concentration tests with their smartphones in close proximity. Participants were again asked to work as quickly as possible and not erase mistakes. Participants completed the second set of concentration tests, consisting of a connect the dots exercise and two letter cancellation tests. All sets of concentration tests were consistent in length (number of targets) and difficulty.

Data analysis

Performance efficiency was calculated to determine if smartphone location affected concentration levels. Performance efficiency without a smartphone present was compared to the performance efficiency of participants when the smartphone was present. Performance efficiency

was calculated using the index developed by Geldmacher (1998). Higher scores reflect more efficient performance: performance = (correct responses/total targets) × (correct responses/total time). A paired, two-sample t-test was used to statistically determine if there was a significant difference between the two groups. The one-tailed t-test value was selected because the change in concentration levels was only tested in one direction.

Academic Performance

Academic performance protocol

The participants' teachers in their science classes were informed of which students agreed to participate in the study. Teachers observed participants' in class smartphone usage for on unit. At the end of the unit, teachers were asked to rate each participant's smartphone on a likert scale. The scale was provided with guidance on how to appropriately rate the students. A rating of one would indicate that the student did not have their phone in eyesight during class and never accessed it during class. Conversely, a rating of ten would indicate that the student was an avid smartphone users during class. A rating of five would indicate that the student occasionally access their phone and had it in sight. A detailed scale was given to teachers prior to the start of the study. The participants took their unit test. The study had no relation to the students' preparation for their exams and performance on the day of the test. The study was in no way a disruption to teaching and learning in the classroom.

The teachers graded all participants' tests as usual and then randomly assigned numbers to the participants in the study . The students were randomly numbered in order to maintain confidentiality and privacy. At the end of the unit, teachers reported the student's test score compared to the average class score. The teachers than provided the participants test scores and smartphone usage rating. Confidentiality was maintained as solely their random number assignment and their test scores in conjunction with their smartphone rating was reported and used as data.

Data analysis

An ANOVA for regression test was used to determine if there was a trend or correlation between the use of a smartphone in class and academic performance.

RESULTS

Survey Results

As seen in Figure 1, 71.4% of students reported spending 4-6 hours per day on their smartphones. This value was significantly greater compared to the number of students who reported less than 4 hours ($p < .01$). In addition, 14.3% of respondents reported spending greater than 6 hours per day on their smartphones. This number was significantly greater than the number of students who spent less than 2 hours per day on their smartphones ($p<.01$).

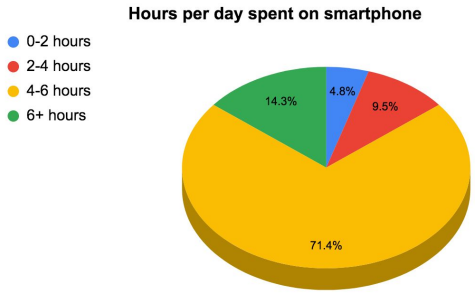

Figure 1: Hours per day spent on smartphone.Significantly more students reported spending 4-6 hours per day than any other category ($p<.01$).

Figure 2 A and B show that participants believe that access to smartphones negatively affect their concentration levels. In Figure 2A, 100% of students reported that their smartphone negatively affects their concentration levels ($p<.01$). In addition, Fig. 2 B shows that significantly more students reported that they view their smartphones as a distraction ($p<.01$).

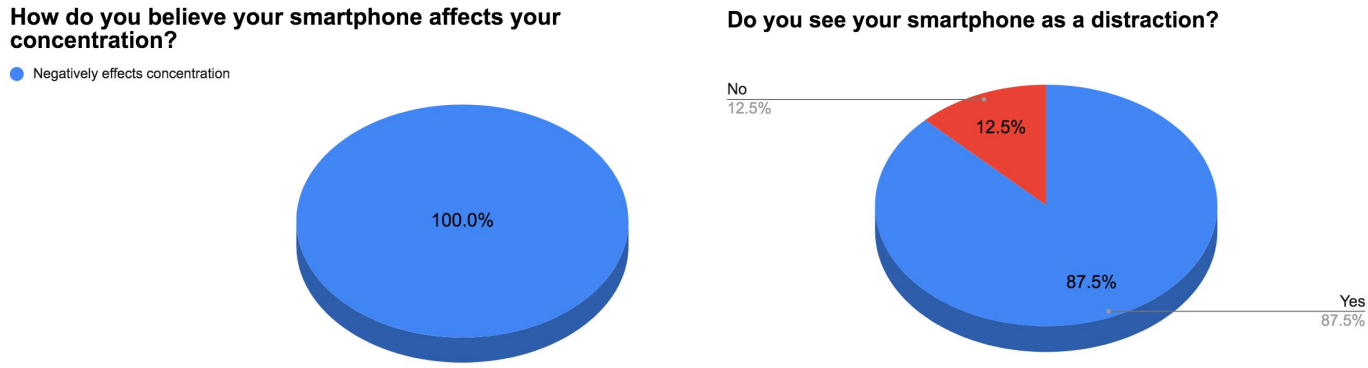

Figure 2 A & B. A: 100% of respondents viewed their smartphones as a distraction. B: 87.5% of respondents see their smartphone as a distraction.

Figure 3A shows that significantly more respondents responded that their smartphone is present when they complete schoolwork ($p<.01$). Figure 3B shows that significantly more respondents answered that they believe that their smartphone negatively affects their academic performance than positively impacts their academic performance ($p<.01$). Figure 3C demonstrates that significantly more respondents answered that they believe that their smartphone is not useful to better understand the class material ($p<.01$).

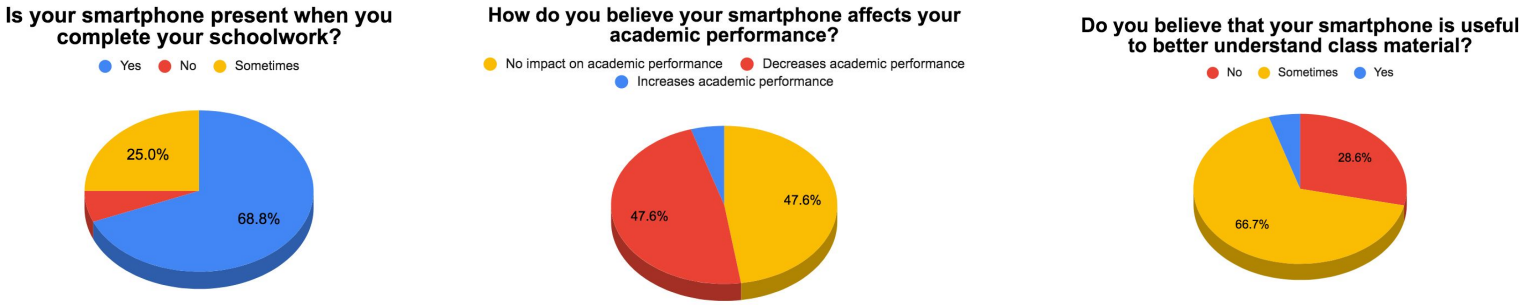

Figure 3 A-C: The Effect of Smartphone Usage on Academic Performance. A: Significantly more participants had their smartphone present when completing school ($p<.01$). B: Significantly

fewer participants stated that smartphones improved academic performance than decreased or had no effect ($p<.05$). C: Similarly, significantly fewer participants stated that they believed their smartphone was useful to better understand class material than was not useful to better understand class material ($p<.01$).

Concentration Test Results

Figure 4 shows the "Effect of Smartphone Proximity on Concentration Level of Individual Participants." These results are approaching significance ($p=0.06$), signaling that nearly significant evidence exists demonstrating how participants had lower concentration levels with the presence of a smartphone. Overall, the performance efficiency without the smartphone present was higher than the performance efficiency with the smartphone present.

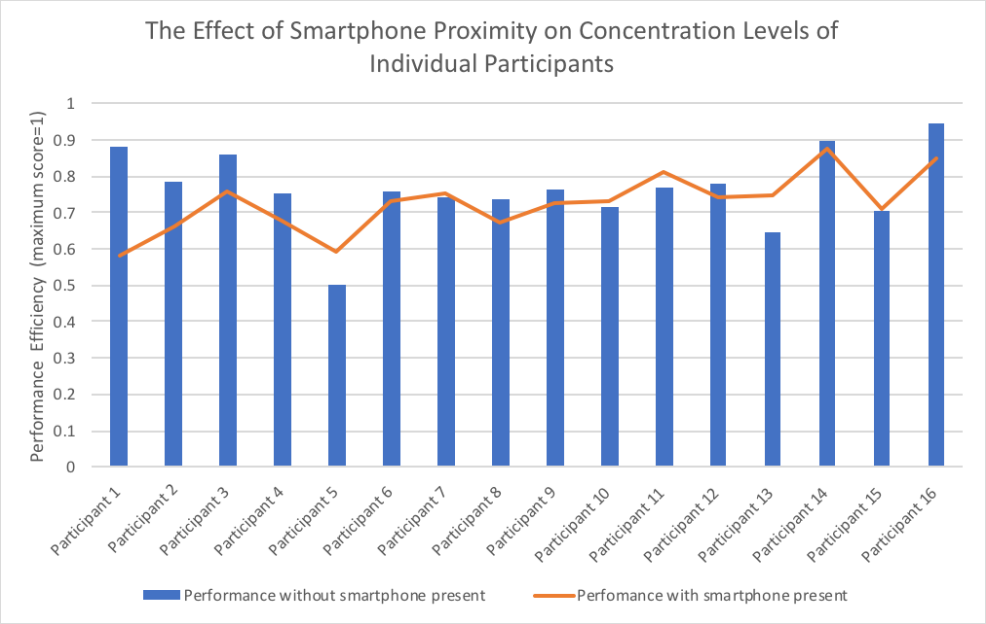

Figure 4: The Effect of Smartphone Proximity on Concentration Levels of Individual Participants.

Academic Performance Results

Smartphone usage affected students academic performance in a classroom setting. As seen in Fig. 5, a higher smartphone usage rating assigned by a teacher correlated with decreased test scores on the subject specific unit test. The trend demonstrates a negative correlation

between in class smartphone usage and academic performance, however, the result of the regression analysis was insignificant. The reason for the insignificance could have been the variance in the test scores.

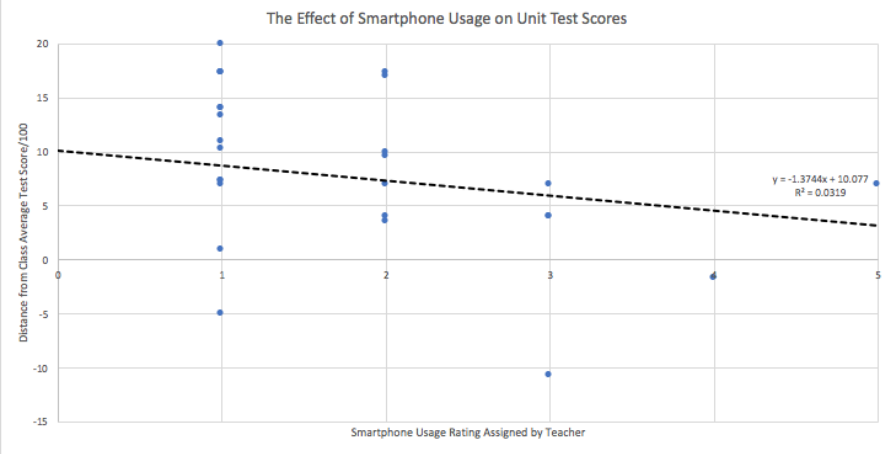

Figure 5:The Effect of Smartphone Usage on Unit Test Scores. n=50. Decreased test scores correlated with increased smartphone usage. However, no significance found.

DISCUSSION AND CONCLUSION

For self- reported smartphone usage, concentration tests and academic performance, participants were self- reportedly distracted or performed less well when the smartphones were present or used. As hypothesized, the survey results indicated that smartphone use was prevalent among high school students. Survey results additionally indicate that high school students believe that their smartphone negatively impacts their concentration ($p<.01$). These two findings contradict each other; although students were aware of the negative impact their smartphone has on their concentration, 85.7% of respondents continue to use their smartphone for 4+ hours a day. Additionally, 68.8% of participants reported that their smartphone is present while completing schoolwork ($p<.01$). This presence of smartphone led to decreased concentration levels. The average performance efficiency (a measure of concentration) of participants with the presence of a smartphone was 0.73 and the average performance efficiency of participants without a smartphone present was 0.79. There was an approaching significance difference

between these performance efficiencies (p=.06). These findings indicate that the mere presence of a smartphone has negative effects on concentration. In addition, concrete smartphone usage in the classroom decreased academic performance. The regression line shows that as smartphone use in class increased, the test scores performed better than their class means. These results were not significant (p>.05).

Findings coincide with findings from previous studies on college students. The results found in this study indicate that concentration levels of high school students decreased with the presence of a smartphone. Similarly, Duke, Gneezy & Bos (2017) found that participants displayed the highest available cognitive capacity when the phone was furthest away and participants displayed the lowest available cognitive capacity when the phone was nearby (on their desk). This similarity indicates that the results of these studies are applicable to both high school and college students. Additionally, for college students, as smartphone use increased, average grade point average consequently dropped (Lepp, Barkley & Karpinski, 2015). Since these findings agree are in agreement, it can be concluded that smartphone usage likely has a negative impact on high school students just like on college students.

Understanding the negative impact of smartphone use at such a young age is essential to the development of children and adolescents. Piaget (1936) was one of the first psychologists to study how a child's brain develops. This cognitive theory states that children learn by reorganizing concepts based on biology and experiences. Consequently, children need to experience the world around them in order to understand new ideas. Until the past decade, face-to- face interactions have been essentially the only way for children to learn. Children learn how to regulate their own emotions by talking with others, watching adults interact. Smartphones are interrupting this learning process; screentime is taking away from learning via interaction and real human experience (Radesky, 2014). In addition, the temporal and frontal lobes are vital to the development of advanced aspects of cognitive functioning during teenage years. After exposing brains with minimal technology experience to increased technology usage for a few days, Small (2008) found that the brain began to adapt. Increased screen time led the brain to neglect circuits in the brain that focus on reading, writing, and concentration. These finds in

conjunction with the results of this study indicate that preventative measures should be taken to limit screen time for adolescents.

Evaluation

This study was successful in determining that there was a negative correlation between smartphone usage and academic performance. Participants of this study were sourced from a single suburban high school in New York. This high school has approximately 25% of students on a reduced lunch program and some ethnic diversity (68.7% of students are white). Based on the population of the study, data may not be universally applicable. Further research should be completed on a more universal population. In working with children under 18, there were many steps in getting consent. First teachers had to consent to participation. After, parents were electronically informed of the study. In order for a parent to consent, they had to open the email and sign the form. Lastly, students were required to consent. This lengthy process limited the number of participants, even after numerous attempts to engage both parents and teachers. In addition, the survey was distributed and completed online. Participants were not supervised while reporting data.

Future Research

In the future, a comparison of the impact of smartphone use on the distraction/academic performance of various demographic groups would create more universally applicable results. Comparing the effects of smartphone usage between different races, genders, ages, socioeconomic statuses will allow for more well- rounded results. Due to theories of child development, the effects of smartphone usage may be more intense for young children. Studying the behavioral patterns of children who regularly interact with a smartphone has the potential to reveal more about the effects of smartphone usage on the brain. Children's brains are more vulnerable to possible alterations due to smartphone usage.

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