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Research Article

Save Your Cognitive Resources: Using Meditation as an Intervention for Smartphone Distractions

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ABSTRACT

Introduction: As we turn to smartphones for managing our lives, we must ask how our dependence on these devices is affecting our ability to think and function in the world off-screen. The mere presence of these devices occupies our limited attentional resources, thus leaving fewer resources available for the task at hand and ultimately undercutting cognitive performance. As technology diminishes our cognitive capabilities, yoga has proven to be effective for cognitive enhancement.

Objective: This paper aims to explore the extent of whether meditating for fifteen minutes immediately before a domain-general test increases ninth grade students' ability to maintain their attention on the test while their smartphones are on their desks.

Method: The independent variable in this study was simply engaging in the meditation before the test or receiving nothing. The dependent variable was the ability to maintain focus on the working memory task, which was measured using the Automated Operation Span Task (Ospan) which is the most widely used working memory test. Two classes were chosen; one as the experimental and one as the control. On the first day, both classes took the Ospan Task. On the second day, the experimental group engaged in meditation immediately before taking a different version of the Ospan Task. The control group took the Ospan Task without any intervention.

Results: After gathering the scores and running a Two Mean T-Test, the low p-value result proved meditations effectiveness as a way to manage smartphone distractions.

Conclusions: For students to succeed academically, it is pressing that students use all of their cognitive resources to pay attention and to stay engaged in class. This conclusion has implication for the education sector, as it sheds light on how students can be taught how to cope with smartphone distractions, especially in the classroom.

Keywords: Yoga; Meditation; Attention; Working memory; Mindfulness; Smartphones

Abbreviations: Prefrontal Cortex (PFC); Automated Operation Span Task (Ospan); Working memory (WM); Working Memory Capacity (WMC); Singapore American School (SAS); Attention Deficit Hyperactivity Disorder (ADHD)

INTRODUCTION

Smartphones provide us with unlimited connectivity [1]. We use them for tasks such as posting on social media, checking the weather, browsing online shops, watching live-streams and much more [2]. In fact, smartphone owners use their phones around 85 times a day and sometimes even in the middle of the night [3]. As we turn to smartphones for managing and enhancing our daily lives, we must ask how our dependence on these devices is affecting our ability to think and function in the world off-screen [4].

There is a problem with the usage of smartphones by high school students [5]. Despite its impact on our cognitive performance, the prevalence and usage of smartphones continue to exponentially grow [6]. Currently, nearly three-quarters of teenagers, from the ages of 13 to 19, have smartphones [7]. Smartphones put the world at our fingertips; however, they come with cognitive cost [4]. Specifically, they impact Prefrontal Cortex (PFC) development in young adults. PFC areas associated with functions such as attentional control and inhibition are affected as a result [8]. Smartphones are becoming an obstacle for young adults to pay attention which is

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especially detrimental in the classroom as much of their academic performance depends on their ability to pay attention. With the growing prevalence of smartphones in our lives, it is important to understand their implications [7].

The mere presence of one's smartphone can occupy limited-capacity cognitive resources, our attention, thus leaving fewer resources available for other tasks and ultimately undercutting cognitive performance. Essentially, smartphones act as a distraction from the task at hand because they occupy our limited attentional resources which could have been used to pay attention to the task at hand [4]. This is especially detrimental to students in school as it is pressing that students use all of their cognitive resources to pay attention and to stay engaged in class [9].

As technology diminishes our attention span, memory, fluid intelligence and more, yoga has proven to be effective for cognitive enhancement [10]. As an individual and avid smartphone user, this concerns me. However, as a yoga practitioner, instructor and therapist it is clear how yoga can aid this situation.

Yoga is an umbrella term which includes breathing exercises, meditation and physical postures [11]. Most of all, yoga is about maintaining cognitive control and not letting the mind wander, even in the presence of smartphones [12]. Meditation is a type of yoga practice which focuses on pointedness of mind. It is commonly defined to be a state of "single-minded concentration". It is often used loosely to describe activities such as relaxation techniques, concentration exercises, contemplation, reflection and guided imagery. Meditation, however, is more than just physical relaxation for it engages the mind as well as relaxing the body. It is often regarded as a heightened state of conscious awareness [13]. Meditation practices invite practitioners to focus one thing; this could be a thought, a feeling, the breath, even a light [14]. For these reasons, meditation is known to help individuals increase their ability to pay and maintain attention of certain tasks [15]. Although yoga, specifically meditation, can stand as an intervention for managing distractions, little studies have incorporated it as a tool.

Based on the knowledge that meditation provides many cognitive benefits and that the presence of smartphones occupy attentional resources, this research is essentially trying to find out if practicing meditation helps individuals maintain their attentional resources on a task and not get distracted by smartphones. Thus, it was hypothesized that meditation will be a successful intervention for managing smartphone distractions.

Considering the purpose of yoga is to pay attention and sustain focus on what may be your thoughts, breath or body, yoga has been thought to greatly impact one's cognitive abilities [13]. Many even consider yoga to be an exercise for the brain and that over time and with consistent practice, your brain can be trained to become more aware, sustain focus for longer periods for time and pay more attention [16]. A significant lack of research has looked at meditation for distractions let alone for smartphone distractions. Most studies use physical yoga or meditation to look at its benefits, for cognitive abilities such as processing speed, working memory and more. To my knowledge, little to no research has studied whether the meditation, increases individual's ability to maintain their attentional resources on the task at hand. Perhaps a study which investigates this by an experimental research method could remedy this situation.

Thus the research question: Through an experimental research method, to what extent does meditating for fifteen minutes immediately before a working memory test increase ninth grade students' ability to maintain their attentional resources on the test while their smartphones are on their desks?

The independent variable was either receiving the meditation before the test or receiving nothing. The dependent variable is the ability to maintain focus on the working memory task, was measured using the Automated Operation Span Task (Ospan) which is a working memory test.

The following research essentially aims to study whether or not meditation helps students stay focused on the task at hand even with the presence of their smartphones on their desks.

Professor Adrian F. Ward, an assistant professor in the McComb School of Business at the University of Texas at Austin, was able to conclude that the mere presence of one's smartphone may induce "Brain Drain" by occupying our attentional resources. Because the same finite pool of attentional resources supports both attentional control and other cognitive processes, resources recruited to inhibit automatic attention to one's phone are made unavailable for other tasks and performance on these tasks suffers as a result [4]. He was also able to further conclude that the closer the phone is to the individual, the more the phone affects the individual's ability to focus on the task. He tested this using three conditions, one had the phone on the desk in front of the student, one had the phone in the bag or pocket and one had the phone in a different room. The bag pocket and desk condition were pretty close in terms of their results. Keeping the phone in a different room was the only condition which was able to escape the smartphone's distractibility. Because of these findings, in the study, only the 'desk' condition was used. During his study, phones were switched on but kept face down with vibrations and sounds switched off and that was replicating that in the study.

There are many cognitive processes that demand a certain amount of our attention and only work if given that amount. Like a flower, which only grows if given enough water, certain cognitive processes only work if allocated enough attentional resources. Working memory is one example of those cognitive processes [9]. Working Memory (WM) refers to the cognitive system that supports complex cognition by actively selecting, maintaining and processing information relevant to current tasks and or goals [4]. This cognitive system's capabilities and restraints are largely determined by the availability attentional resources [5]. Working memory is a very important system and we need to use it for almost any task, from cooking to talking to your friends. The WM system needs enough attentional resources allocated to it or else it will not work. Our minds are constantly being bombarded by stimuli begging for our attention and when we give our attention to those things, we then cannot give enough to our working memory system thereby undercutting the ability for the working memory system to function [4]. This characteristic of the WM system makes it the ideal system for me to use to test the hypothesis. If the smartphone is actually occupying student's attentional resources, then not enough will be allocated to the working memory and this will be reflected in a low score on a working memory test.

Working memory can be measured using the Automated Operation Span Test (Ospan). The Ospan task, a prominent measure of

Working Memory Capacity (WMC), assesses the ability to keep track of task-relevant information while engaging in complex cognitive tasks [17]. It is the most widely working memory test.

In each trial set, participants complete a series of math problems while simultaneously updating and remembering a randomly generated digit sequence. Performance on the Ospan assesses the domain-general attentional resources "available to the individual on a moment-to-moment basis" [18].

Working memory is also a very relevant cognitive function in an individual's life [19]. Working memory is also domain-general, which means that it doesn't pertain to any particular subject like math or English which would allow me to generalize the results of this study to all other domain-general cognitive systems, such as fluid intelligence, as well.

This study focuses on ninth grade students at the Singapore American School (SAS). Ninth grade is a time of change [20]. "More and more of us are realizing that it is the make or break year for many 14- and 15-year-olds," says Jon Zaff, director of the Center for Promise at Tufts University. "It's a time when the cognitive, emotional and physical are all coming together. Students have more autonomy and more homework [21]. Not only are youths entering the intimidating institution that is high school, they are experiencing the usual adolescent angst and depending on poor decision-making skills [22]. "Students entering high school—just at the time brains are in flux—still have the propensity to be impulsive and are prone to making mistakes," says Washington D.C. psychoanalyst Dr. Linda Stern. "They are therefore experimental and trying to separate and might try substances that interfere with the normal developmental process. Put all that together with raging hormones, the normal academic pressures and meeting a whole new group [23]. "We are ending up with something now called the ninth-grade bulge," explains Zaff, "which means a glut of students who have to repeat the grade". So they are stigmatized socially as well as academically, which can also lead to their finding it easier to just give up. A lengthy, detailed guide from the National High School Center states that "more students fail ninth grade than any other grade in high school and a disproportionate number of students who are held back in ninth grade subsequently drop out." Ninth grade is arguably the most important year in high school thus studying these students and providing them with this intervention would be most beneficial.

The main focus of this study is whether or not meditation increases student's ability to maintain their attentional resources on the task at hand. The significance of this stems from the fact that in school and in classes, being able to concentrate and pay attention is essential to student's learning. If students are not devoting their attentional resources to the teacher and instead to their smartphones, this poses a barrier for student learning and will have detrimental effects on their grades and test scores. Moreover, for tests, whether these are standardized tests like the ACT or SAT, or even subject-specific tests like for math or biology, being able to focus, concentration and pay attention is essential [24]. Students cannot expect to score well and receive good grades if they are not paying attention.

If the yoga does increase student's ability to maintain their attentional resources on the task at hand, the implications of that result could mean that students can use meditation immediately before a test. Meditation is much more feasible to do right before a test compared to a breathing exercise or physical yoga postures. For that reason, meditation was to be studied over breathing exercises or yoga postures. Furthermore, meditation is not an activity which requires much assistance or guidance (Appendix 1).

METHOD

A World Studies Class was randomly chosen as the targeted population to run by study on. World Studies is a class taught at the Singapore American School (SAS) and is only for ninth grade students. The class is a combination of English 9 and World History. It is not a higher level class. This class meets every day which is different to other classes offered at SAS which meet every second day. In World Studies classes, at the beginning of class, teachers offer students an activity unrelated to the class or content they are studying, this is a prime time for me to administer a test or teach meditation. Students are randomly assigned to classes at SAS; this means that one World Studies class has 'smarter' children or 'less smart' children. There is also no higher or advanced version of World Studies. It is a requirement to either take English 9 and World History separately or together in the combined course of World Studies. For the study, 2 World Studies classes were chosen with 22 students each and taught by the same teacher. Both the experimental and control groups had 22 students each.

After getting approval from the teacher they used their class. The teacher was told to administer the working memory test as a 'professional development' assessment. Professional Development assessments are done often at SAS and students usually take these seriously because they contribute to research conducted at SAS. This is so that the students have an incentive to take the test seriously and not just answer the questions randomly. The teacher was given a packet of very detailed instructions and all they had to do was read the instructions off the paper.

The Ospan test which was coded had multiple 'trials'. Trials consist of 'sets'. Sets consist of two things, one, flashing numbers and then a math equation to which you have to answer true or false (2x4=8 would be true and 3x2=8 would be false). The number could be 78 and the equation could be 3x4=14, for example. At the end of one trial, it asked what number was flashed. In the Ospan, the smallest number of trials you can have is 2 and the largest is 9. In the trial test, there was one trial of 2 sets and 1 trial of 3 sets. In the modified version, there were 7 seven trials which had 1 trial of 2 sets, 1 trial of 3 sets, 3 trials of 4 sets, 1 trial of 5 sets and 1 trial of 6 sets. This was randomized which means that the trials did not appear in that order (a student might have a trial of 2 sets first and then of 4 sets and then 2 sets and then 5 and then 3, for example). Both of the tests created followed this. Because the design of the study required testing twice, before and after the intervention was administered, two version of the test were created. The two different versions asked different math equations and flashed different numbers and showed the trials in different orders; although the basic structure remained the same.

This study spanned two days. The reason it took two days is due to the mental strain of the test as it requires a decent amount of focus and concentration. If the tests were administered on the same day, not only would that have taken the whole class period (90 minutes) but the second time encountering the test, students would have

been mentally fatigued from the first time [25]. There is no need for it to be longer which is why one day is enough.

On the first day, two classes completed a version of the Ospan test on their computers. Students had no tabs open and since this test only works on a separate window in full screen, it removes possible distractions of the laptop. Students had as long as they wanted to complete the test with no restrictions or time limits. Students took an average of 15 minutes to complete the task. Although the phone was 'on', it was on 'silent mode' and there was no ringing or vibrating. Students were also asked to place the phone upside down in front of them. The students walked into class and sat on desks which were in rows so nobody sat next to anybody. On their desks they had two packets, one packet had instructions and one had a disclaimer. Then students were told to switch off their vibration and ringers and place their phones upside down on their desks in front of them. There was one student who did not have their phone and so their score was not used in the results. They then followed the instructions provided and downloaded and installed the Ospan test and software onto their laptops. Students closed and quit any applications or tabs and once everybody was ready, they started the Ospan test. First, students were asked to take a trial test to prepare them for the forthcoming test as the test was slightly complicated to understand and their confusion should not be a confounding variable. The entire process took students around 45 minutes while the actual test only took students around 15 minutes. This was the same for both experimental and control groups.

The next day, the randomly selected experimental group practiced 15 minutes of mindfulness meditation immediately before they take a different version of the Ospan test. A professional meditation instructor conducted the meditation and was asked to state the following: "I have been called to relax everybody and help you focus; I understand you have some tests coming up. I would like for you to use what you learn in this meditation about focusing and not letting the mind wander while you take your tests". This is so they use the skills they learn from meditation - focusing on one thing - on the test. During the meditation, the phones were collected and kept in another classroom in a box (from the Ward Study we know that the only way to escape the distraction of the smartphone is to place it in another room). The meditation was also read from a set of very detailed instructions. After the meditation, students were asked to take another version of the Ospan test and then completed a short questionnaire. The questionnaire was given to find out if any students have attentional disorders that their lack of attention can be attributed to. The control group, on the other hand, started the test immediately, with no meditation and also completed a questionnaire. The experimental group had one child with dyslexia and the control group had two children with Attention Deficit Hyperactivity Disorder (ADHD). Their scores were not used in the results.

The teacher received detailed instructions which they were asked to read off of the students got two packets, one with instructions on how to install and use the Ospan software and one with a disclaimer.

To reiterate, the method is as follows: on the first day, two separate world studies classes took the Automated Operation Span Task (Ospan) which was taken on their own computer. The next day, one of the classes received the intervention, a guided meditation by a professional instructor. The other class started the task immediately without the guided meditation or any other intervention.

Method Simplified

Class A- Control

Day 1:

1. Phone on desk (silent, face down, no vibration or ringing)

2. Ospan Test

Day 2:

1. Phone on desk (silent, face down, no vibration or ringing)

2. Ospan Test

3. Questionnaire

Class B - Experimental

Day 1:

1. Phone on desk (silent, face down, no vibration or ringing)

2. Ospan Test

Day 2:

1. Meditation (no phone, all phones in another room)

2. Phone on desk (silent, face down, no vibration or ringing)

3. Ospan Test

4. Questionnaire

RESULTS AND ANALYSIS

The scores were calculated as follows: a trial of two sets flashes a number, a math equation, a number, a math equation and at the end of the trial, asks for the 2 numbers which were flashed. The Ospan score uses the absolute scoring method, the sum of all perfectly recalled sets. For example, if an individual correctly recalled 3 numbers in a trial size of 3, 4 numbers in a trial size of 4 and 3 numbers in a trial size of 5, his or her Ospan score would be 7 (3 + 4 + 0). In the modified version, the max score you could get was 28 (Table 1).

After putting this data in a calculator, a two-sample T-test was run to determine significance between two groups. The two-sample t-test is one of the most commonly used hypothesis tests in statistics. It is applied to compare whether the average difference between two groups is really significant or if it is due instead to random chance. The two-sample T-test was run with the null hypothesis that there is no difference between the means of the two group differences. The resulting p-value was 0.047903, which is significant at $p<0.05$. This means that there is a less than 5% probability that these results happened by chance, which means that there is significance. We reject the null hypothesis because meditation is most probably a successful intervention for smartphone distractions.

Table 1: Processed Data Table

	Control Group	Experimental Group
Day 1	11.3	7.8
Day 2	10.9	8.6
Difference (Day 2-Day 1)	-0.36	0.78

DISCUSSION

From the result, we can conclude that meditation was a successful intervention for managing smartphone distractions. This is consistent with the view held in most studies involving meditation and cognition; that meditation is an effective practice to enhance attention. However, with this study, it can be taken further to show that not only does meditation enhance attention, but it also does so in the presence of smartphones. This research builds on previous studies about meditation's benefits in the classroom and as part of the education but brings on another idea about it being able to do so even in the presence of smartphones. Smartphones are a problem and a lot of research has aimed at studying its negative implications on learning, including its impacts on processing speed, short-term retention, working memory and more. Although meditation may not be the absolute solution, from this study, we know that it is one viable solution.

Some limitations of the study include the fact that this was done during the last block on Friday, one day before what is known as "Interim Semester". Interim Semester is a programme at SAS where high school students sign up for trips which go all the way from Croatia to Australia. For 9th graders, it was their first interim, their first school trip abroad. Students were all probably very anxious and excited and that could have been one factor of their inattention. Also, the students may not have "tried" on this test because it does not affect their grade or them in any way. Although the students didn't know that it was for a student's research project, they still may not have tried their actual best on this. During the meditation, it was expected that students paid attention, however it would not come as a surprise if they were unable to practice the meditation without giggling or fidgeting for instance. There are many factors that their inattention could have been attributed to, for example, if they were having a bad day or if they were stressed about something. Although there were relatively, a large number of participants, these factors could still have affected the results.

CLINICAL IMPLICATIONS

This particular study has implications mainly regarding education and classrooms. Smartphones, as discussed in the introduction pose an obvious obstacle in classrooms. Simply their presence is able to unconsciously and involuntarily capture our attention; it is hard to imagine that they are not having negative impacts in the classroom. With their inhibition and attentional control at the crux of their development, the smartphone is surely not helping. Students' inhibitory control is directly challenged with distraction and instant gratification is just a couple of taps away. The more we get used to this way of life, the more we start to crave distractions. And as a result, we get worse at resisting these distractions. Being constantly distracted is not particularly good for our attention, leading to fragmented attention and a decreased attention span. The implications of this study mostly concern technology in classroom settings. Since smartphone have already become a huge part of everybody's daily lives, it is hard to imagine eradicating them from classrooms, however an introducing an intervention to help combat those negative aspects, such as meditation could be a remedy. Hopefully this study can shed light on involving meditation as an intervention for technology in classrooms. Instead of the first ten minutes of class being allocated for late comers, cramming before tests and settling in, a more effective way to use that time would be to meditate.

CONCLUSION

The results show that meditation is a successful intervention for smartphone distractions in ninth grade classrooms. The problem is clear: students are unable to fully attention in class with the presence of smartphones. Our smartphones constantly occupy some portion of our headspace and because of this; there is no way we can give our full attention to anything. Every day we walk through the world with our back hunched looking down at our screens, how much are we missing, how much are we not seeing in this beautiful world around us. In the classroom, students should be paying 100% of their attention on the teacher and the subject being taught. If students are busy being distracted, they are not going to be able to retain a lot of the information. Students and teachers should implement this strategy in the classroom and take a few minutes to regain cognitive control.

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