How Does Peppermint Aromatherapy Affect Basic Academic and Manual Skills?

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Abstract

Scents, such as peppermint or lavender, can impact many different cognitive and physical functions. Further studies could explore in-depth applications of aromatherapy to daily lives. Research, such as the *North American Journal of Psychology* study of peppermint essential oil effects on cognitive video game performance and Raudenbush's study on the link between peppermint and improved driving performance, has supported the effectiveness of aromatherapy. Connections between certain scents and various bodily and mental functions have been observed. This study explores the question of whether or not peppermint essential oil improves comprehension, strengthens visual-motor skills, and enhances mathematical reasoning. The diffuser was turned on and placed in the room an hour before students entered the room. Middle and high school students from an advanced academy (a public magnet school) were asked to sit in the classroom for ten minutes to inhale the mist. The students were asked to complete a set of forty basic multiplication and division problems in two minutes, read a standardized test passage in four minutes, answer four standardized test multiple choices in two minutes without the passage in front of them, and tie their shoe as they timed how long it took to double knot, all in the presence of a diffuser filled with either plain water or a peppermint essential oil solution. The solution consisted of seventy-five milliliters water and five drops of peppermint essential oil. After analyzing the results, it can be concluded that peppermint aromatherapy has a small effect on improving daily skills of both middle and high school students at an advanced academy.

Introduction

Scents like lavender, citrus, and peppermint are common aromas found in the diffuser and candle sections of stores. Many people infuse their houses, offices, study spaces, and bathrooms

with these scents. With a seemingly infinite number of natural scents and those altered in labs, aromas can have various effects on people and their brains, making aromatherapy a useful tool. For example, citrus scents, such as orange and lemon, aim towards providing a sense of energy for completing a task or starting the day. This is due to the boost in one's serotonin levels and reduction in norepinephrine that comes from inhaling the scents; these hormones make one feel happier and reduce stress, which help increase mental stimulation. The watermint and spearmint plant were crossbred to create the hybrid mint leaf- peppermint. Watermint and spearmint oils can reduce inflammation and change hormone levels in the body. It can improve memory and increase thinking skills and cognitive function as well. Scents can be used for various purposes, and exploring their functions and effects on the body and mind could give access to beneficial applications.

Many studies have supported a connection between peppermint oil and memory and cognition. Researcher Bryan Raudenbush has published numerous studies and articles investigating the effects of peppermint aromatherapy on being alert and mental processes involved in completing a task. Peppermint scent is mainly used with the expectation that it will help people focus and concentrate. High schoolers are used to strict deadlines and timed assessments. Testing how peppermint aromatherapy affects those taking tests and completing tasks could expose more efficient and ergonomic ways of getting the job done.

For this experiment, the researcher hypothesized that if peppermint essential oil diffuses through an environment, students would perform better on academic and manual skills. They should complete more math questions and score higher on a multiplication and division test, increase reading comprehension based on answering questions without the passage in front of

them, and quicken visual-motor reactions, which will be shown by participants tying their shoes faster.

The scents around us can be a crucial part of our daily lives. If we can manipulate how and when we use them to make the brain focus and function easier, students, teachers, employees, employers, and everyone else can become more productive.

Review of the Literature

Scent and the Brain

When olfactory receptors are activated in the nose by scents, they send signals to the limbic system, where signals are transmitted to the hypothalamus and pituitary glands that control hormones (Lemke, 2017). This process is how the hippocampus registers smell and attributes certain smells to specific memories, which influences the reticular activating system (Żurawicki, 2010). The reticular activating system is a complex network of nerve pathways that connects the spinal cord and cerebellum to control levels of alertness and consciousness.

When scent enters through the nasal cavity and travels to the brain, it enhances the brain's functioning. The motor cortex in the brain sends messages to the different parts of the body to perform the appropriate series of muscle twitches to carry out an action or movement. But the area in front of the motor cortex, the pre-motor cortex, prepares the person to carry out the action (Ramachandran, 2003). The orbitofrontal cortex is the region of the brain that acts as "the principal neocortical element of the olfactory system" (Li, Lopez, & Osher, 2010). Electrophysiological research has noticed common trends of certain aromas affecting spontaneous brain function and cognitive functions due to these scent compounds being able to interact with the central nervous system directly, which gives signals to the cortexes. Scent has

the potential to immediately alter cognition, human behavior, mood, blood pressure, pulse rate, and brain activity (Sowndhararajan & Kim, 2016).

The taste of peppermint lights up the reward centers in the limbic system. Pleasant fragrances and tastes "lead to reflex bronchodilation," which improves exercise potential and physical swiftness (Gandhi & Siddiqui, 2019). When bronchial muscles relax, ventilation increases as well as brain oxygen levels (Meamarbashi & Rajabi, 2013).

Scent on Being Alert

Research has been conducted to determine how peppermint essential oil influences alertness. A study that used cinnamon and peppermint essential oil to test driving performance found that peppermint essential oil caused participants to be more alert. In the study, a driving simulation was accompanied by an oxygen concentrator, which permeated the scents through the air every thirty seconds over a fifteen-minute interval. Sixteen females and nine males all had current driving status. Each wore nasal cannulas as they engaged in virtual reality driving simulations. All of the drivers' actions had consequences that would accurately portray what would have happened in the real world. After an hour and at the end of the two-hour procedure, the participants took two tests. The subjective NASA Task Load Index (NASA-TLX), created by Hart and Staveland in 1988, allowed participants to gauge their effort, frustration, and performance via putting hash marks on a 12cm line indicating their perceived workload. Additionally, they completed McNair, Lorr, and Droppleman's 1971's Profile of Mood States (POMS) test where they indicated the extent to which each of sixty-five adjectives described their disposition. Participants were still exposed to the scent during the questionnaires. Before the experiment, after, and during one-hour intervals, participants indicated their levels of

alertness. The whole procedure was repeated three times, each with either peppermint, cinnamon, or no scent. There was a 48-hour buffer in between each test. The study determined peppermint scent significantly lowered fatigue compared to the control and cinnamon group. Both peppermint and cinnamon gave participants a quicker sense of time, lowered frustration levels, and increased alertness better than the control (Raudenbush, Grayhem, Sears, & Wilson, 2009). Although the study supports the hypothesis that peppermint scent increases alertness, there was not an even distribution among participants regarding age and gender. Additionally, there were too few participants altogether. In reality, it is highly unlikely people would wear nasal cannulas on their face while driving and performing tasks. This may have been a distraction to the participants if they were not used to wearing them. Also, the participants were asked to measure their mood by assigning numbers and hash marks, which isn't controlled. They could have gauged themselves higher or lower than their actual numbers and levels.

Similar to this study, the 1996 study, conducted by Stampi, Aguirre, Macchi, and Moore-Ede, concluded that peppermint was "associated with faster reaction times" when participants were given tasks requiring divided attention. Similarly, this study only had six male participants that were exposed to peppermint long-term for six hours. These participants were engaged in 40-minute driving simulations. After answering driver alertness questions, they had faster reaction times associated with tasks requiring divided attention (Raudenbush, Grayhem, Sears, & Wilson, 2009). While the study showed higher levels of attention, participants smelled the scent for six hours before driving, making this procedure an impractical application. Additionally, there were too few participants and no females. Both procedures measured only the alertness and perceived effects of a person while driving, but driving employs many other skills,

such as hand-eye coordination and motor skills.

Visual-Motor Skills

A study completed by Kristin McCombs, Bryan Raudenbush, Andrea Bova, and Mark Sappington supported the possibility that peppermint essential oil increases attention span, enhances memory recall, and quickens visual-motor responses. Video games provide goals and positive feedback while increasing challenge difficulty. Like driving, video games require players to be engaged, observe their environment, acknowledge challenges, and solve problems, usually quickly. The games chosen for this study tested math skills, hand-eye coordination, and running/exercise endurance.

The study consisted of thirty-two university students enrolled in a psychology class, ages seventeen to twenty-two. Participants served as their baseline as they played games on the Nintendo Wii Fit Plus with no scent conditions. Each participant wore a nasal cannula. Three video games tested their cognitive functioning and hand-eye reactions. Participants' blood pressure and pulse were measured. They completed the NASA-TLX and POMS. At the end, participants were asked about their video game preferences, the number of hours they play video games weekly, and video game experience. All were asked to repeat the test, but some were assigned peppermint and others nothing. Those in the peppermint group, completed more levels, earned more points, and went further distances. They also self-reported less mental demand, effort, and anxiety. A lack of difference in pulse change and blood pressure indicated that the peppermint scent kept them engaged via an increase in physiological arousal (McCombs, Raudenbush, Bova, & Sappington, 2011).

These studies show that when people are exposed to pleasant aromas, their cognitive

functioning improves, which increases the speed and accuracy at which a task is completed. Peppermint scent enables people to complete tasks faster and concentrate more without working harder.

Memory

A study conducted by Lauren Hoult, Laura Longstaff, and Mark Moss in the United Kingdom tested extended exposure to peppermint essential oil. All of 100 participants were screened via a health questionnaire. Twenty-three males and twenty-seven females were in the peppermint group (ages twenty to forty). The control group had twenty-seven males and twenty-three females (ages twenty to forty). The test consisted of two sessions within the same day. During the morning session, mood scales were completed. For the mood scales, sixteen pairs of bipolar words were separated by 100-millimeter lines. Participants had to put a hash mark on the line to indicate the severity of their current mood. The words were based on feelings of being alert, content, and calm. Then, the aroma patches were applied. Participants were not told if they had the scented ones or not. The participants completed the immediate word recall task. For each of fifteen words, the word would appear on the computer for a second, and there would be a two-second blank screen before another word. After the subject saw it the first time, there was an immediate word recall assessment. Participants were given an envelope and were supposed to return it to the researcher before taking the mood tests that afternoon. Participants were asked to text the researcher when they were getting ready to go for the second session. The time they got there was not always the agreed-upon original time. They were then asked to continue on their daily routine.

Six hours later in the afternoon, participants completed the delayed word recall test. After that, they had to write as many "s" words as they could in one minute, reflecting execution functioning. Some of the participants returned the envelopes. The highest score was given to those who followed directions without being told, while the middle score was given to those who remembered at the wrong time. The lowest score was given to those who didn't return it at all or did so when asked a second time. Then, they completed the mood test again. The morning scores were subtracted from afternoon scores so a positive value meant an increase. Then, the aroma patch was removed.

The study concluded that there was a small effect for immediate and delayed word recall and prospective memory, while there was a medium effect for increase in mood. There was no added benefit of extended exposure when compared to other studies. The researchers concluded that the peppermint group had better attention levels overall. They were more aware and had closer attention to detail. This is due to the peppermint scent causing them to be more physiologically aroused (Hoult, Moss, & Longstaff, 2019).

Mediums

A study done on N.K.P. Salve Institute of Medical Sciences and Research Centre undergraduate medical students tested the effects of chewing gum and peppermint on cognition, memory, and alertness during laboratory-induced stress. Eating peppermints increased participants' attention spans; however, participants had no change in their fatigue, alertness, memory, reaction time, nor arithmetic ability.

In this study, there were only five males and five females in the whole experiment. They were all undergrad medical students, ages eighteen to twenty-one. On the first day, participants

were not given anything to consume. They completed seven tests. They self-rated their alertness levels using the Stanford Sleepiness Scale. Each score had a detailed description. Washington University's Click Reaction Time test involved participants tapping on their phones when given a visible cue. The time between the cue and response was recorded. Each participant completed three consecutive trials. During the Arithmetic Ability Test, participants were given randomly generated two-digit addition and subtraction problems; accuracy was calculated. Participants had thirty seconds to cancel out a certain digit within a list for the Standard Digit Vigilance Test. In a similar test, participants were asked to substitute as many digits as they could, given a symbol to substitute for the digit. In the Digit Span Test, participants were shown random digits on a screen for ten seconds and had to recall them in ascending order. If they were correct, the number of digits increased by one, and the test started over. For the Harvard Step Test, participants had to step up and down on a bench so many centimeters high at thirty times per minute over four minutes. The height was different for males and females. Their pulse rates were measured at 1.5, 2.5, and 3.5 minutes. Their fatigue index was calculated and recorded. On the same day, noise was introduced to induce stress. All tests were repeated in the stressed environment. Each of the next three days, each participant completed the same tests while consuming peppermint, chewing gum, or mint gum. The participants had it for five minutes before the study commenced.

The researchers concluded there was no change in the sleepiness scale, click test, arithmetic ability, short term memory, and fatigue index. There was a significant change in attention span of the peppermint candy group in the stressed environment, but not the unstressed. There was also a significant increase in intelligence in stress-free environments for both the peppermint candy group and mint gum group (Gandhi & Siddiqui, 2019).

Although mediums involved chewing and sucking, both include the sense of smell. There was an uncontrolled method of isolating the diffusion of scent. Additionally, there were too few participants to make a valid conclusion. This research negates the idea that peppermint has a significant effect on cognition. Although there are studies that support aromatherapy, many others are inconclusive. Within those conclusive studies, peppermint yields various effects. This experiment will explore how peppermint affects school performance by measuring speed and accuracy. The study is in line with testing participants on their visual-motor skills, arithmetic abilities, and memory.

Gap

Previous studies have focused on college students, the middle-aged, and all ages in between. Middle and high school students at a public magnet school, ranked as the number one Science, Technology, Engineering, and Mathematics high school in the state, know the stress and struggle of a hard core curriculum. Students spend much of their time studying and completing homework in addition to working part-time jobs and honoring family responsibilities. The ability to learn and comprehend faster and better would enable them to decrease the amount of stress and increase test scores. Previous studies support the idea that peppermint essential oil increases alertness, cognitive functioning, and memory recall.

Researchers have studied the effects of peppermint over a few hours or a day's length. This study will explore how short-term exposure to peppermint essential oil affects memory and cognitive function via a diffuser.

Procedures

Permissions

The researcher had to obtain permission from the Review Board per school guidelines. Forms had to be filled out regarding the nature of the experiment, possible threats, and access to the school nurse if needed. Permission forms were approved and sent out to the entirety of the middle and high schools. Students had to bring back their forms signed by a parent by a deadline (see Appendix D).

Subject Selection and Demographics

This study used students from sixth through twelfth grade from the same public magnet school within a suburban area. There is much racial and economic diversity among students. 98% of the school is proficient in math and 99% in reading. Many students are in gifted programs and take AP and Honors courses. With a 95% graduation rate and an average ACT score of 29, this school is the number one best high school for STEM in the state ([School Statistics]). Students volunteered their participation. They had to sign a permission form and receive a parent's signature. Upon taking the tests, students were asked to record their gender and grade level. This information was recorded to ensure fair comparison among the different grade levels and genders. The majority of the middle schoolers consisted of sixth and seventh graders. The majority of high schoolers consisted of tenth and eleventh graders. There was an even distribution between males and females. Due to privacy restrictions from the review board, all subjects were treated as a homogeneous group. There was no pretest nor access to previous scores to compare individual testing performance and average levels of success. Each student took only one test. The researcher could not determine whether each student's scores were atypical or typical.

The Math Test

Each subject completed one math test, which consisted of twenty multiplication questions and twenty division questions. None of the problems included remainders. Enough white space was included to provide ample workspace. The same test was given to all students (see Appendix A).

The Reading Test

Each subject completed the same reading test (see Appendix B). A sample was taken from a standardized practice test site, which listed the test as older material. Students would be unfamiliar with an older work considering that the most recent material is best for studying for current tests. After the reading time was completed, the passage was picked up. Students were given four questions that dealt with the overall purpose of the passage and the effect of a situation on the main character. The questions reflected the same level of comprehension asked of the students on daily assignments. These questions were chosen to test how well the students remembered details. The same questions were given to all students (see Appendix C).

Shoe-Tying

Participants were asked to tie their shoe, a seemingly easy task. To tie a shoe, one must have enough visual-motor skills to exercise hand-eye coordination effectively. Students were not given a specific way to tie their shoes. Whichever way they normally tie their shoes would give a better reaction time, considering it is their normal routine in that it's an automatic motion. They were asked to record the time in seconds.

Testing Procedure

Seventy-five milliliters of water and five drops of Woolzies peppermint essential oil were put into the diffuser. The diffuser was turned on and in the front of the room on a four-foot stool

for thirty minutes before participants came in. It remained visible to all students and was functioning throughout the experiment. There was no difference in appearance; participants saw the steam when there was just water and when the peppermint essential oil in the diffuser. The peppermint groups, in total, consisted of thirty-six middle schoolers and twenty-five high schoolers. Thirty participants total were tested on November 20, 2019. Thirty-one participants total were tested on December 3, 2019. The control groups, in total, consisted of twenty-six middle schoolers and nineteen high schoolers. They repeated the same procedure except that there was plain water in the diffuser without the peppermint essential oil. Twenty-two participants total were tested on December 4, 2019. Twenty-three participants total were tested on December 10, 2019. The researcher timed the students with a cell phone.

Ten minutes before students entered the room, the diffuser was moved to the middle of the room and remained on. The wall clock was made easily visible to students. Participants were asked to report to the classroom at the beginning of their study hall. They sat in the room with the diffuser in the middle of the room for ten minutes. Participants were spaced adequately far enough to prevent cheating. Students were given instructions by both the researcher and the teacher whose room they were in. They were asked not to cheat because no scores would be calculated into their class grades. They would not receive their scores. They should not inform other students of the testing content and materials. The researcher and teacher answered any questions participants had. If a student came in late or arrived during one of the tests, they were told to sit down in the back of the room. The researcher or the teacher gave them the same information from when the first students arrived. The late students began taking the same test as the others. The tests they missed they made up when all other students left.

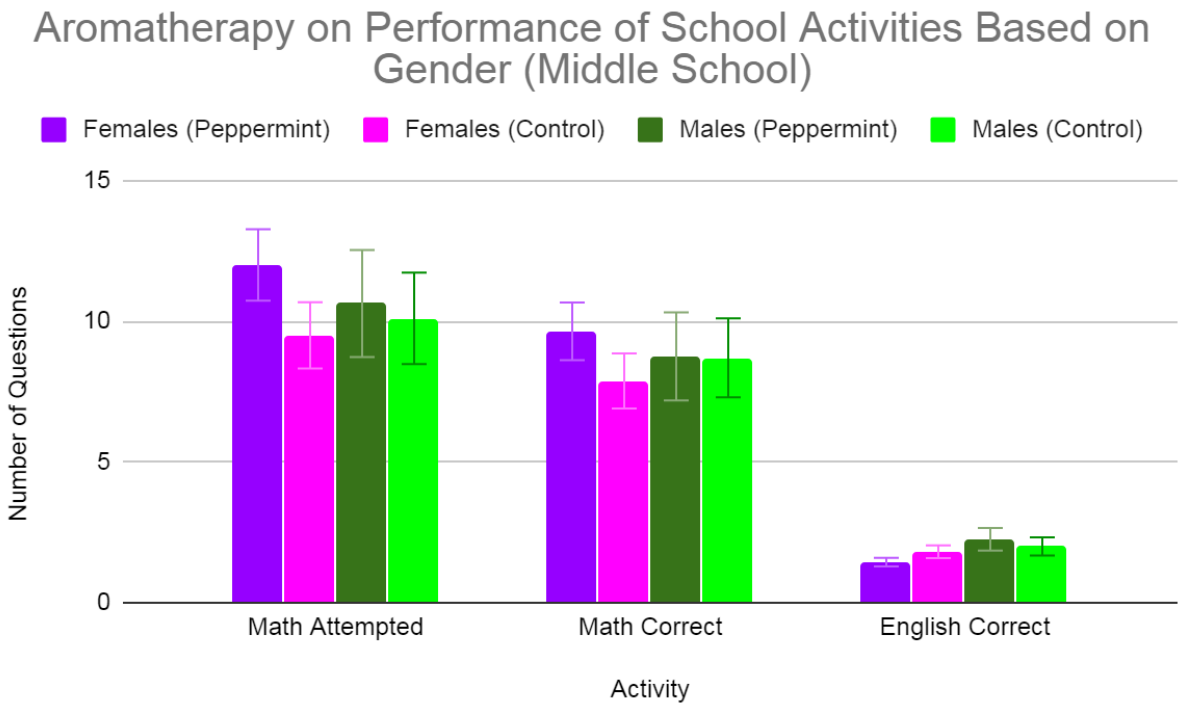
The math tests were placed face down on the tables in front of them. They all started at the same time and were given two minutes to complete as much as they could. They were told they could skip around. They were given a thirty-second warning. After time was called, the test was taken away from them.

The reading passage was placed face down on the tables in front of them. They had four minutes to read. They were given a thirty-second warning. After time was called, the passage was taken away from them. Four multiple-choice questions were placed face down on the tables in front of them. They had two minutes to answer. They were given a thirty-second warning. After time was called, the questions were taken away from them.

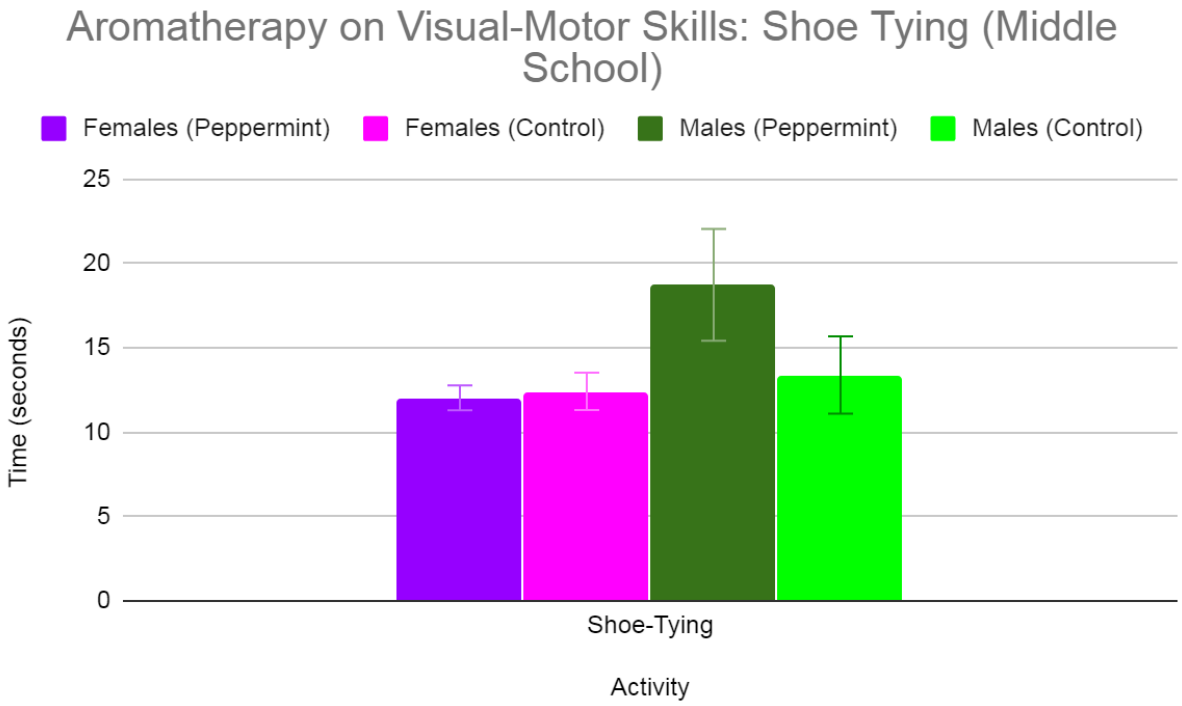
Participants were asked to take out their phones and place them flat on the table. Before starting the timer, they untied their shoes. Those without laces tied another person's shoe. They hit start on their phone's timer and tied the shoe with a double knot. They immediately hit stop and recorded their time. Then they left.

Results

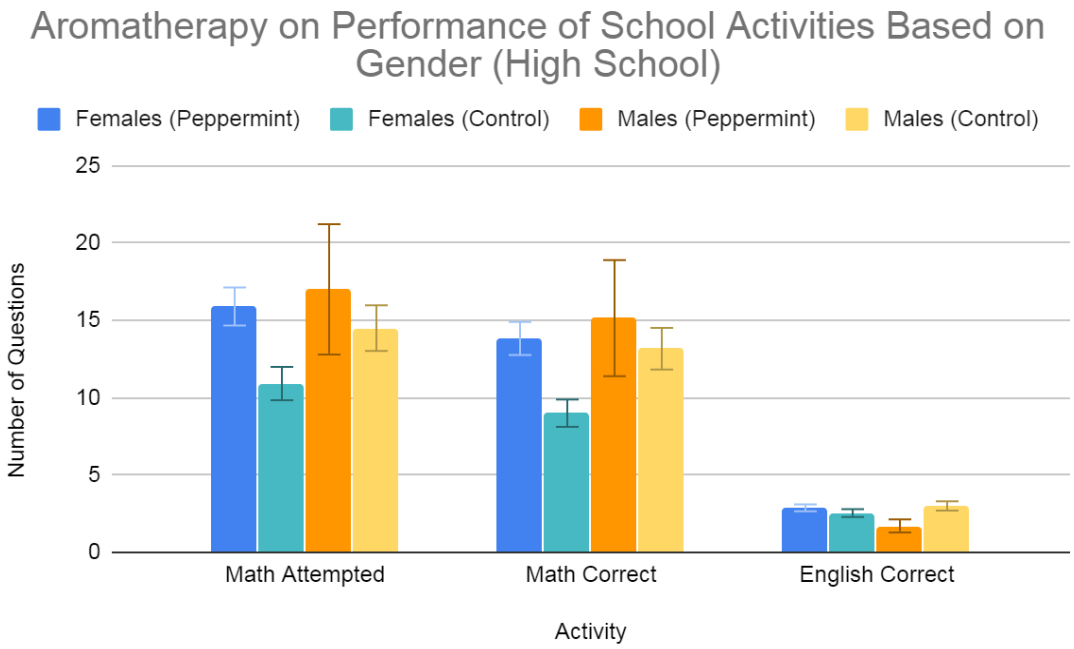
Graph 1


Aromatherapy on Performance of School Activities Based on Gender (Middle School)
Females (Peppermint)
Females (Control)
Males (Peppermint)
Males (Control)
15
10
5
0
Number of Questions
Math Attempted
Math Correct
English Correct
Activity

Graph 2


Aromatherapy on Visual-Motor Skills: Shoe Tying (Middle School)
Females (Peppermint)
Females (Control)
Males (Peppermint)
Males (Control)
25
20
15
10
5
0
Time (seconds)
Shoe-Tying
Activity

Graph 3



Graph 4

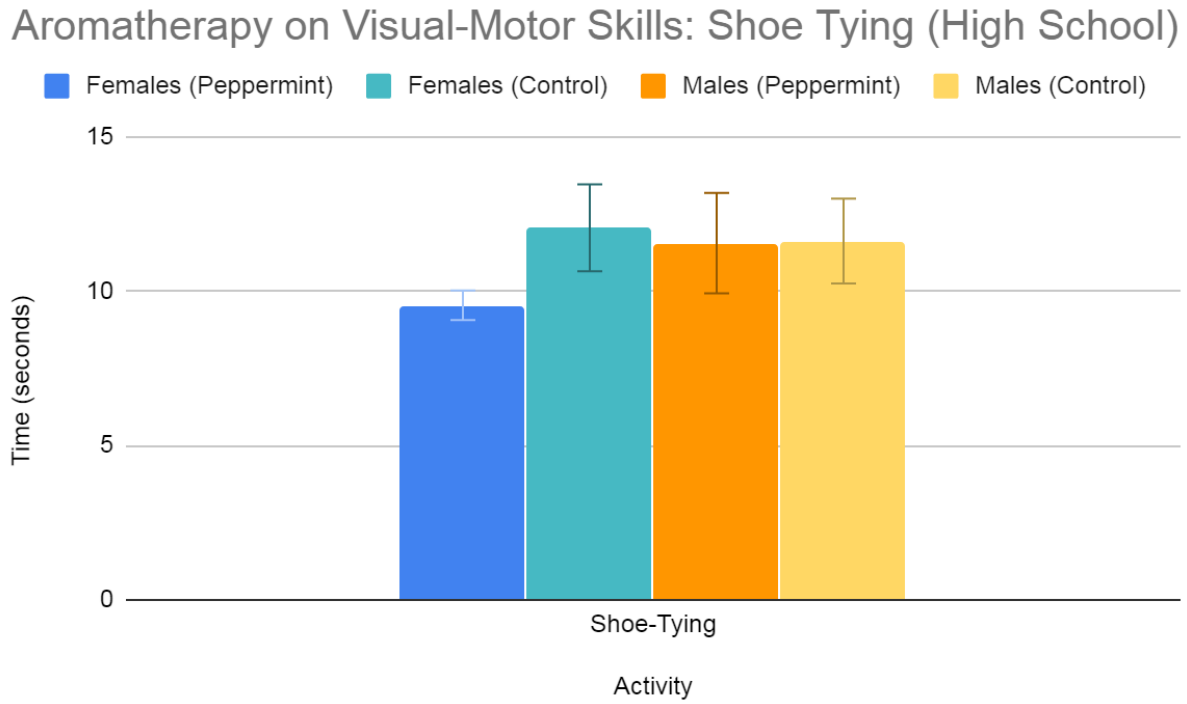


Chart 1: Change from Control to Aromatherapy Group, {N=106}

Group	Math Attempted (number of questions)	Math Correct (number of questions)	English Correct (number of questions)	Shoe-Tying Time (seconds)
Middle School Females	+2.5	+1.77	-0.37	-0.38
Middle School Males	+0.53	+0.05	+0.25	+5.35
High School Females	+4.97	+4.83	+0.34	-2.51
High School Males	+2.5	+1.98	-1.29	-0.06

Chart 2: Percent Change from Control to Aromatherapy Group, {N=106}

Group	Math Attempted (difference of number of questions/ control group)	Math Correct (difference of number of questions/ control group)	English Correct (difference of number of questions/ control group)	Shoe-Tying Time (difference of number of seconds/control group)
Middle School Females	+26.32	+22.48	-20.41	-3.06
Middle School Males	+0.52	+0.57	+12.50	+39.97
High School Females	+45.50	+53.67	+13.39	-20.82
High School Males	+17.24	+15.04	-43.00	-0.52

Graph 1 shows the effect of aromatherapy on tasks completed by middle school students. The number of questions attempted and completed with aromatherapy was significantly different for female participants in math but not English; there was a 26.32% question increase in math attempted, a 22.48% question increase in math correct, and a 20.41% question decrease in English. However, there was no significant difference between treatment and control groups when middle school boys were tested in the same way. Middle school males had a 0.52% question increase in math attempted, a 0.57% question increase in math correct, and a 12.5% question increase in English.

Graph 2 shows the effect of peppermint aroma on how long it took middle school students to tie their shoes. There was no difference for females, which was a 3.06% second decrease, but there was a noticeable change in middle school males, which was a 39.97% second increase.

Graph 3 shows how peppermint essential oil affected tasks completed by high school students. The number of questions attempted and completed with aromatherapy was significantly different for female participants only in math, while there was no difference in the number of English questions. There was a 45.5% question increase in math attempted, a 53.67% question increase in math correct, and a 13.39% question increase in English. Conversely, high school males showed no significant change in math, but they did in English. There was a 17.24% question increase in math attempted, a 15.04% question increase in math correct, and a 43% question decrease in English.

Graph 4 shows the effect of peppermint aroma on how long it took high school students to tie their shoes. There was a significant difference for female participants, which was a 20.82%

second decrease, and none for male participants, which is supported by the 0.52% second increase.

Analysis

Originally, each peppermint grade level and gender combination would have been compared to the corresponding control group, but there were not enough of each gender and grade level to analyze in this manner. Data was collected and analyzed between overall high school and middle school. The terms “statistically significant” and “significant” refer to the minimal overlap of error bars.

As seen in the relationships between peppermint essential oil and correct math questions, correct multiple-choice, and faster shoe-tying times, it can be concluded that peppermint scent sometimes enhances basic academic and visual-motor skills. Middle school and high school females showed a statistically significant improvement during the math test when exposed to the peppermint. High school females were also able to tie their shoes in less time when they were exposed to the peppermint scent. This data supports the idea that when focusing and repeating basic academic and manual skills, women are more sensitive to smell than men. There are about seven million more cells in the olfactory region in women than there are in men, and there are about 3.5 million more neurons in females than males. Due to the more sites for the scent to “activate,” women's brains may respond more to scent than men (Oliveira-Pinto, Santos, Coutinho, Oliveira, & Santos, 2014). The results of the experiment align with these findings, supporting the idea that women may have a higher level of neural activity when exposed to peppermint aroma.

When exposed to the aroma, middle school males took significantly more time to tie their

shoes than the control group. The fact that some of the middle school males in the peppermint group did not know how to tie their shoes and attempted to try anyway contributed to the increase in time. These males either wore Vel-Cro, slip-on shoes without laces or laced shoes that they did not untie to put on.

High school males got fewer English questions correct when exposed to the aroma. The majority of high school males tested were from ninth and tenth grade; they had not practiced the level of standardized testing procedures and formats yet in their education, which may have contributed to the decrease.

Raudenbush and Grayhem's study corroborates the idea that peppermint scent makes people more alert. This same idea is supported in this study, particularly benefiting teenage females. Likewise, Stampi's 1996 driving experiment supports the notion that peppermint quickens reaction times, although the experiment performed showed extremely minimal improvement (Raudenbush, Grayhem, Sears, & Wilson, 2009). The current experiment yielded similar findings to McCombs and Raudenbush's video game experiment in that more problems were attempted and answered correctly (McCombs, Raudenbush, Bova, & Sappington, 2011). The researcher's study is also in line with Hoult's in that the results showed a small effect on memory (Hoult, Moss, & Longstaff, 2019). By informing students that they were being timed may have given them a stressed environment, which would indicate similar findings to Gandhi and Siddiqui's study in that there was significant improvement. However, their results showed no effect when in the unstressed environment (Gandhi & Siddiqui, 2019). It is unclear to determine whether the fact that the students being told their scores would not impact their school grades, contributing to an unstressed environment, would or would not overrule the conditions for a

stressed environment. Unlike all these studies, the researcher experimented on a much younger and larger group, aged from ten to eighteen.

Overall, there was minimal improvement in both combinations of gender and grade level. The hypothesis was partially correct. Had the experiment been free of human error and controlled factors, the results may have been more in line with the hypothesis.

Implications

By exploring how aromatherapy affects memory recall and levels of alertness, teachers and employers can put different scents in the work environments to help students perform better and employees remain alert. People can simply add a diffuser in their workspace at home, work, or school to help them maintain work ethic, which in turn would help students earn higher grades and may benefit workers in the form of bonuses. The data from this study supports the conclusion that peppermint essential oil increases work ethic, accuracy, visual-motor skills, and levels of consciousness when given a task. Because of peppermint's connection with memory and consciousness, aromatherapy can help Alzheimer's and dementia patients feel more at ease and possibly help them remember certain aspects of their life. Even by simply adding a scent to a daily aspect of life can make the task or time of day more interesting and enjoyable. Those exposed to a scent at their work or school may even develop a better relationship with the person who put it in the room. According to past research, scent may be able to further benefit the body during exercise. The positive effects of aromatherapy have yet to be fully explored. Knowing how it has impacted middle and high school students, others may be more interested in trying it for themselves or their kids.

Another implication of the experiment is that some people may not like a certain smell or even be allergic. This demonstrates that if teachers or employers want to put a scent or diffuser into the workspace, they must be careful they are not putting others in harm's way. This would most likely yield the opposite effect.

Limitations and Further Research

To improve this project and further support the data collected, further trials will be conducted using a larger population of participants from each grade level and gender to ensure a more accurate data set. The current experiment used about 13.5% of a middle/ high school's population, with sixty-two coming from middle school and forty-four coming from high school. Further experimentation will use the same type and color of pen or pencil for all participants. The temperature of the room will be constant. The current study did not take into account a constant temperature. On one of the experiment days, the room was significantly warmer than the other days. On another occasion, the room was significantly colder. To eliminate outside stress and bias of personal schedules, the experiment should be conducted on a normal school day (i.e. no tests, pop quizzes, or lengthy assignments). There were only four total English questions, which may not have yielded an accurate representation. This study should be conducted with more comprehension questions and questions that are specific to the grade levels. Although the diffuser was in the middle of the room, not all students were the same distance away. In addition to these uncontrolled variables, there were not enough of each male and female in each grade to compare specific grade levels and genders.

This study tested only memory and levels of alertness; there could be many other possible benefits that have yet to be explored. Additionally, this study only explored the effects of

peppermint and not any other essential oil. Studies have shown that lavender is useful for winding down and relaxing, which may yield different results if compared to peppermint. This information may be further used to explore efficient methods of studying and testing by using aromatherapy to not only eliminate stress but also enhance alertness and increase academic performance and visual-motor skills.

Conclusion

Overall, peppermint aromatherapy showed improvement, even if it was minor, in all categories, just not for all grade levels and all genders all the time. While many studies showed both positive and no effects, the benefits of aromatherapy may be limited to physiological and environmental factors. The benefits of aromatherapy require further study. This study attempted to add to the body of research supporting aromatherapy's potential as an academic and manual aid in a school environment. In a world full of various aromas and plants, the possibilities of aromatherapy are endless, showing that the scents we inhale can impact our lives, even if it is the slightest improvement.

Appendix (each test/form was printed to fit on a single sheet so there was nothing on the back**)**

Appendix A: Math Test

Please circle the one that corresponds to you. Answer as honestly as possible.

Grade: 6 7 8 9 10 11 12 Gender: M F Other

162 ÷ 18	102 ÷ 17	12 x 11	136 ÷ 17	13 x 14
144 ÷ 16	9 x 8	75 ÷ 15	5 x 16	44 ÷ 11
10 x 11	90 ÷ 15	15 x 7	104 ÷ 13	17 x 11
133 ÷ 19	18 x 21	128 ÷ 16	19 x 5	85 ÷ 17
4 x 16	12 ÷ (.25)	6 x 23	126 ÷ 14	32 x 8
9 x 43	.25 x 52	156 ÷ 13	65 x .1	32 x 16
65 ÷ 5	48 ÷ 3	4 x 8	78 ÷ 6	6 x 16

162 ÷ 9	195 ÷ 13	5 x 8	13 x 40	10 ÷ 1

Appendix B: Reading Passage *(Source:* [Standardized Test])

Please do not write on this.

Tennessee Williams: Celebrated Southern Gothic Writer

American literature encompasses many unique styles and genres, including Southern Gothic. As its name implies, the literature reflects life in the American South. It maintains some of the characteristics of Gothic writing, such as use of the supernatural or the ironic; however, Southern Gothic does not focus on creating tension and suspense as do other Gothic genres. Instead, its storylines examine Southern people and their postbellum social structure.

Writers in the genre generally spurn the pre-Civil War stereotype of the plantation gentleman and the glamorous Southern belle. Instead, the authors develop characters that are sinister or reclusive and not particularly pleasant on the surface. Nevertheless, these characters usually have redeeming qualities that allow and encourage the reader to sympathize with their situations and dilemmas. It is through these immoral and unhappy personalities that the Southern Gothic writer is able to present and explore moral issues of the American South, such as slavery and bigotry, without blatant accusations.

Many American authors are known for their Southern Gothic style. Playwright Tennessee Williams (1911–1983) is among the most celebrated. Williams' long list of plays and novels include the Pulitzer Prize winning stage dramas A Streetcar Named Desire (1948) and Cat on a Hot Tin Roof (1955). Williams' characters are known to be modeled directly on members of his own family. For instance, it is speculated that the pitiable character Laura in The Glass Menagerie (1944) is modeled after Williams' mentally disabled sister Rose. In the same play, Amanda Wingfield is said to mirror Williams' own mother. Williams even portrays himself in Suddenly, Last Summer (1958) and The Glass Menagerie. His adult life, plagued with depression and alcoholism, appears to play out in his embroiled characters.

If Tennessee Williams was a tormented man, it was due in no small part to his troubled family. As a seven-year-old in Mississippi, Williams contracted diphtheria and remained housebound for two years. His mother, fearing for Tennessee's mental wellbeing, pushed him toward creative arts

during his period of illness. It was she who bought him a typewriter at age 13, which he heartily accepted.

Having already moved once, the Williams family eventually relocated to St. Louis, where Tennessee's increasingly abusive father Cornelius squeaked out a living as a traveling shoe salesman. Tennessee's mother Edwina was a genteel sort prone to smothering. The most traumatic event in the young writer's life, however, occurred when his sister Rose, described as a slender, refined beauty, was diagnosed with schizophrenia.

Various treatments were unsuccessful during Rose's years of residence in mental asylums. In 1943, the Williams parents consented to the now-defunct prefrontal lobotomy in an effort to treat her schizophrenia. The operation was ruinous and Rose lay vegetative for the rest of her life. The fallout came when Tennessee blamed his parents for authorizing the operation. In the 1960s, he wrestled with the notion that he, too, would go insane. A decade of depression took hold. He would, at least nominally, overcome it, but Tennessee Williams' family life would haunt him the rest of his days.

Appendix C: Comprehension Questions *(Source:* [Standardized Test])

Please circle the one that corresponds to you. Answer as honestly as possible.

Grade: 6 7 8 9 10 11 12 Gender: M F Other

1. The main purpose of the passage can best be described as an effort to:

A. explain how and why Tennessee Williams's life suited writing in the Southern Gothic style.

B. illustrate what the South was like at the time Tennessee Williams was writing his body of work.

C. discuss how Tennessee Williams's life changed during his youth and young adulthood.

D. describe the different elements of Southern Gothic style present in Tennessee Williams's works.

2. As described in the passage, the effect Tennessee's family had on him can best be summarized by which of the following statements?

A. His family's impact can be safely overlooked because many other authors with less traumatic pasts have written in the Southern Gothic style.

B. His family gave Tennessee his sense of melancholy, which faded in his prosperous later years.

C. His family problems directly influenced his decades of writing and left Tennessee conflicted and distraught.
D. The destruction of the Williams family caused Tennessee's plays to turn to darker themes that did not appeal well to audiences.

3. The passage indicates that Tennessee Williams's creative streak began because:
A. he was trapped in an abusive household where his only refuge was in the fantasies he wrote.
B. he was tortured by his sister's condition and took to writing as a way of searching for an explanation for her decline.
C. he was severely ill as a boy and his mother took care to engage him in creative pursuits when he could not be physically active.
D. he was inspired by the success of other family members and wished to capture the feeling in prose.

4. According to the author, the primary characteristic of the Southern Gothic genre is that it:
A. indirectly uses distant or malevolent characters to raise issues of social justice.
B. incorporates the haunting religious themes of traditional Gothic literature into 20th-century Southern society.
C. is the first American genre to be able to set aside the issue of slavery.
D. carefully avoids volatile characters, in spite of plots set in tumultuous time periods.

Appendix D: Volunteer Participation/Permission Form *(Source:* Greater New Orleans *[used* Human Informed Consent Form as *template in accordance with Review Board guidelines])*

Volunteer Participation Form ☺

Student Researcher: [name of student researcher], AP Research
Title of Project: Effect of Aromatherapy on Basic Academic and Manual Skills

I am asking for your voluntary participation in my science fair project. Please read the following information about the project. If you would like to participate, please sign in the appropriate area below.

This project intends to better concentration, increase comprehension, and strengthen visual-motor skills. If you participate, you will be asked to sit in a room with a scent while you take a small multiplication/division test (not for a grade), read a short article and answer some multiple choice questions, and tie a shoe.

Time required for participation: 10 to 15 minutes

Potential Risks of Study: Participants will be exposed to peppermint essential oil. The nurse can be contacted if needed.

Benefits: This can be a possible tool used to help study.

How confidentiality will be maintained: No names will be recorded (just grade level and gender).

If you have any questions about this study, feel free to contact:
Adult Sponsor: [name of adult sponsor] Phone/email: [phone number of adult sponsor]

Voluntary Participation:
Participation in this study is completely voluntary. If you decide not to participate there will not be negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

By signing this form I am attesting that I have read and understand the information above and I freely give my consent/assent to participate or permission for my child to participate.

Participant's Signature:

Participant's Printed Name	**Signature**	**Date Reviewed and Signed**

Parental Signature:

Parent's Printed Name	**Signature**	**Date Reviewed and Signed**

Grade Level:_____ Study Hall:_____

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