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Essential Oils Peppermint and Rosemary Exposed to the Olfactory Sense and the Effects on Cognition and Perceived Mood

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Abstract

Recent research suggests that essential oils of a certain quality can enhance memory consolidation and cognitive performance. The present study examined whether the essential oils rosemary and peppermint were powerful enough to significantly improve short-term memory in recall and recognition tasks. Participants were in a room with a device that diffused a scent or water (no scent) for ten minutes prior to their entry. The participants viewed word lists and were later tested for accuracy in terms of recall and recognition. Results from a one-way analyses of variance demonstrated that peppermint and rosemary did not significantly improve short-term memory or mood. Stipulations showed marginally significant and significant results in post-hoc analyses.

Introduction

Simple solutions to support and help improve memory have been sought after by many. Reliance on memory supplements such as gingko biloba, caffeine, and the use of mobile devices are common practices to aid memory. Eating powerful brain food such as blueberries or spinach which are high in antioxidants, getting a good night's sleep, exercising, and avoiding dangerous chemicals, such as drugs and alcohol, are also sensible ways to empower memory. Another simple aid that can help improve memory is aromatherapy. Aromatherapy is a form of alternative medicine that uses plants to improve physiological or psychological well-being. Using a scent would make improving memory as easy as breathing. The use of therapeutic-grade essential oils in scent form may also improve emotional state and attention to tasks. Research has shown that peppermint has the "ability to improve concentration and mental sharpness" (YoungLiving, 2010, pg. 1)

Essential oils are concentrated extracts from plants. Hundreds of different extracts are available, such as lemon, which is purifying, and rosewood, which has a "balancing effect on emotions" (YoungLiving, 2010, pg. 1). These extracts also have antimicrobial, antiviral and antioxidant properties (YoungLiving, 2010). Oil blends comprised of spruce, rosewood, blue tansy, and frankincense can induce feelings of "strength, courage and self-esteem" (YoungLiving, 2010). Companies and producers of these oils claim that therapeutic-grade essential oils can have a significant effect on ailments such as easing respiratory problems, and help the prevention of scarring.

Two essential oils that companies claim can have significant impact on memory improvement are peppermint and rosemary. The current research utilizes peppermint and rosemary to assess if there is any evidence for the claims that essential oils can help improve

memory, specifically, short-term memory. While essential oil companies claim that memory can improve in positive ways by using these oils, there are also claims that essential oils can stimulate, relax, or improve one's emotional state. Emotional state is a quality of feeling at a particular time ("Mood", 2011, para. 1). Therefore, it would be appropriate to test whether the subject's mood could be improved as well. Some of the initial research in this field has shown that lavender can have calming and relaxing effects (Moss, Cook, Wesnes, & Duckett, 2003). Contrasting these findings, stimulatory oils such as peppermint and rosemary will be tested to assess if the effects can significantly motivate or arouse one's emotional state.

Literature Review

Research involving olfactory memory (memory associated with odors) has focused mainly on the relationship between scents and episodic memory (recollection of events within one's own historical setting) (Episodic memory, 2011, para. 1). Because olfactory memory is a powerful factor in episodic memory, it could also strengthen ties to semantic memory (memory based on knowledge or facts). Rinck, Rouby, and Bensafi (2009) conducted a review of previous research involved in testing associations between olfactory images, mental imagery and scent. From the review, two important things were relevant to the current study. Much of the research Rinck et al. (2009) reviewed supported the argument that olfactory mental imagery shares neural processes with real olfactory perception (olfactory refers to the sense of smell). Support for these findings includes when Bensafi and Rouby (2007) used fMRI to confirm that the same areas of the brain were active when a person smelled and odor and when a person was imagining an odor. If the same areas of the brain are active when a scent is present and when it is not, this shows a powerful association between olfactory memories and perception.

Other research they reviewed questioned whether the olfactomotor system (sniffing) is involved in creating visual images. In research on visual imagery, when participants are shown an image, then asked to close their eyes and recreate the image, they move their eyes. Also when these eye movements are blocked, image quality decreases. Analogous to this are the findings by Kleeman et al. (2008) in which sniff volume increased significantly in odor perception groups as well as odor imaging groups when compared with the control condition. This research supports the notion that the act of sniffing allows us to activate stored memories for easier access and retrieval. If people encode memories strongly by using a mental image, the image could be strengthened by scent.

Rinck et al. (2009) reviewed research examining why olfactory memory is so powerful. The research suggests that the olfactory system is a more primitive system. Because it is an older, more simple system, communication is more direct. Olfactory perceptions (perception of an odor) do not relay through the thalamus (the sensory relay center for all senses except smell) to other parts of the brain as other senses do. Associations with scent have a more direct connection from when they are perceived to when they are encoded. This would support the idea that olfactory memories are easily stored and retrieved because of this connection. This review added evidence to the body of information about orthonasal memory. The current study also added information by examining whether essential oils significantly influence semantic memory instead of just episodic memories. The fact that storage of memories associated with orthonasal perception (sensory perception through smelling an odor) is direct makes it important to test whether the scents directly associated with semantic memory can be improved.

Research shows that the olfactory system has a powerful advantage in the realm of memory. The direct connection that orthonasal perception has with memory consolidation

suggests that these memories are encoded efficiently and are easily accessible when compared with other types of memories (Rinck et al., 2009). Moss et al. (2003) used rosemary and lavender to examine the effects of essential oils when administered orthonasally. The oils were presented during cognitive and memory performance tasks. Affect was also assessed during this study.

Type of Scent

Moss et al. (2003) tested the effects of the essential oils rosemary and lavender on cognition and affect. Scents were diffused into individual cubicles inconspicuously. Participants completed several tasks including a spatial working memory task (memories about one's environment and its spatial orientation) and a word recognition task (recognition of written words when they have been previously presented). Tukey post-hoc (Looking at data after the experiment has concluded for patterns that were not specified *a priori)* comparisons showed that compared with the control, the effects of lavender were detrimental to concentration, attention, and memory. Results also showed that the essential oil rosemary significantly improved memory performance compared to the lavender condition and the control condition of no odor. Memory performance was significantly better in a quality of memory task (accuracy of scores combined from six memory tasks), a secondary memory task, and a working memory task (accuracy scores combined from the spatial and numeric memory), as well as speed of memory and attention tasks. Specific memory tasks in which rosemary was significantly better than lavender were word recognition tasks and spatial memory tasks. Tasks for which rosemary was significantly better than the control were the spatial memory reaction time task and the numerical working memory reaction time task. In the accuracy of the attention task no significant differences were

shown. These results suggest that the stimulatory oil rosemary can affect memory and reaction time in memory tasks, but not attention.

Previous research has shown the essential oils rosemary and lavender have stimulating and calming effects, respectively, in specific memory tasks (Moss et al., 2003). Scents that could be advantageous in the area of improving cognition include peppermint because of its stimulating properties. Moss et al. (2003) orthonasally administered peppermint as well as Ylang-Ylang to assess the effects on emotional state and cognition. Ylang-Ylang has recently been shown to effect physiological parameters such as reduction in blood pressure but has not yet been tested in a cognitive arena (Hongratanaworakit & Buchbauer, 2004).

Moss et al. (2008) experimented with a number of factors related to emotional state and cognition. As in the previous study, researchers presented scents of peppermint and Ylang-Ylang in a cubicle. The participants were asked to complete various tasks on a computer in a cubicle while a diffuser under each bench dispersed the scent. While additional tasks were assessed, three involved memory: a word presentation task (fifteen words were sequentially presented at one second each) paired with an immediate word recall task (participants had sixty seconds to write down as many words as they could remember from the list), and a picture presentation task (twenty photographs were shown, for two seconds each, at one second intervals). The participants were not told about scents in the room to avoid expectancy effects. Participants exposed to the peppermint scent had significantly better memory performance in the immediate word recall task compared with Ylang-Ylang. There were no significant differences between conditions for the picture presentation task.

Emotional state effects included a significant increase in calmness in the Ylang-Ylang condition compared to a decrease in the control and peppermint conditions. In tandem with these

findings, there was a significant increase in alertness in the peppermint condition compared with a decrease in alertness in the Ylang-Ylang condition. These results compiled show that for specific memory tasks, stimulatory oils can positively affect performance. Stimulatory or relaxing oils can also positively or negatively affect alertness, respectively.

Moss et al. (2008) found that peppermint is a stimulatory extract that can improve memory when compared to a calming scent but not when compared to a control condition. Though peppermint as a stimulatory oil did not improve memory, research has shown that scents belonging to the sage family influence memory. Tildesley, Kennedy, Perry, Ballard, Wesnes, and Scholey (2005) focused on common sage and Spanish sage, and how each affected cognition, speed of memory, mood, calmness, and alertness.

Tildesley et al. (2005) conducted a study that aimed to find out whether 25 micro liter and 50 micro liter doses of sage and Spanish sage as essential oils could improve cognition in five different types of tasks. Twenty-four subjects participated in a "placebo (a substance having no pharmacological effect but given merely to satisfy a patient who supposes it to be a medicine)-controlled, double-blind (experiment in which neither the experimenter, nor participant knows what treatment is received), balanced, crossover" study (Tildesley et al., 2005), (Placebo, 2011, para. 1). The study employed the use of a computerized assessment specialized for analyzing small cognitive changes. Results showed that performance was significantly better in all tasks in the scented conditions compared to the placebo and control groups. The 50 micro liter dose of sage elicited significant results. Participants did significantly better in speed of memory, secondary memory, and accuracy tasks. Perceived emotional state and calmness also improved.

Tildesley et al. (2005) looked at orthonasal administration of sage and Spanish sage. Results showed that in all tasks participants performed better when in the scent was presented in a concentration of 50 micro liter doses. Realizing the advantageous effect of sage-like herbs and that they can be stimulatory for cognitive improvement as well as calming, Kennedy and Scholey (2006) reviewed extensive research that had been conducted with sage and members of this herb family to consolidate the available information and evaluate the research.

Kennedy and Scholey (2006) reviewed the history of and research done with herbs belonging to the Labiatae (mint) family. Sage, Spanish sage, lemon balm and rosemary were examined because of their "long tradition in...memory enhancement" (Kennedy & Scholey, 2006, p.4614). Historical uses of sage date back to the Greek empire. They considered the scent to be helpful in diminution of the senses as well as memory loss (Ryman, 2011, pg. 1). Uses such as "alleviation of flatulent dyspepsia, treatment for cases of respiratory allergy, and use as a gargle or mouthwash for inflammation of the mouth," add to the claims that members of the mint family are beneficial for a variety of reasons as well as the ability to enhance cognition (Kennedy and Scholey, 2006, p.4615). Research concerning concentrations of sage and Spanish sage strives to find which concentration is most beneficial to enhancing cognition. Doses used were 150, 100, and 50 micro liters. Results showed the 50 micro liter dose was potent enough to be effective (Tildesley et. al., 2003). After finding that a dose as low as 50 micro liters could be effective, the previous study tested 50 micro liters against a 25 micro liter dose (Tildesley et al., 2005). Both proved to be effective in different ways as discussed earlier. This study also supports previous results such as those found in a study by Moss et al. (2003) that added evidence to the claims that members of the sage family can enhance cognition. This study, also mentioned

earlier, included results that showed that rosemary could significantly enhance cognition in spatial memory tasks and word recognition tasks.

Kennedy and Scholey (2006) reviewed research that had been done in regards to the sage family. The information they reviewed supported claims that there are cognitive benefits when herbs from of the sage family are used. Tildesley et al. (2005) found that using sage during word-list learning tasks showed improved memory performance during these tasks. They also found that 50 micro liters was the most effective concentration to obtain these results. Evidence that scents can affect participant's attention while they are awake, influenced Raudenbush, Koon, Smith, and Zoladz (2003) to look at the effects of scents during the sleep cycle. Sleep is an essential part of memory consolidation and Raudenbush et al. (2003) conducted a study that administered essential oils during the sleep cycle to evaluate memory consolidation by testing quality of sleep and cognition the following day.

Raudenbush et al. (2003) aimed to find out whether orthonasal administration of an odor during sleep could positively affect emotional state, cognitive functioning, and level of alertness. Participants were recruited for the study through fliers on a college campus and each participated in three separate sleep trials. For each trial, one of three scents was presented: jasmine, lavender, or no odor. Each participant completed a trial with each condition, which was randomly assigned. Participants were allowed to sleep at their discretion and it was verified that anything stressful the following day that could interfere with their sleep would be minimized. The participants were asked to complete ratings of alertness throughout the day.

Results showed that in the jasmine condition, sleep efficiency was significantly greater compared with the lavender condition, and control condition. In the jasmine condition, for the cognitive performance task, participants had significantly faster responses the following day.

Self-perceived mood and alertness also significantly improved during the next day for those participating in the jasmine condition. This study shows that even when a scent is being presented during the sleep state; it can still have a significant effect on cognitive tasks.

As Raudenbush et al. (2003) found, the relaxing effects of certain essential oils such as jasmine and lavender can improve sleep performance for better alertness and faster cognition the following day. In addition to these aspects, mood and sleep efficiency can improve as well. Whether asleep or awake, all previous research has subjected participants to constant exposure to scents. The mass of evidence that scents can have an effect on memory supported Warm, Dember and Parasuraman (1990) in an experiment testing the effects of scents when participants were not constantly exposed to it. They aimed find if these alternating whiffs of scent and pure air could have an effect in a vigilance task.

Type of Task

Warm et al. (1990) conducted a study that focused on whether exposure to certain scents during a vigilance task yielded similar effects to simply getting whiffs of a scent. A pilot study was conducted to assess which scents were pleasant or unpleasant, and which were most stimulating or relaxing. The pilot test results were that Muguet and Peppermint were rated highest as pleasant and Muguet was rated relaxing and Peppermint was rated stimulating. These two scents were used in the main study to assess the rate of signal detection in a vigilance task (remaining alert and detecting infrequent and unpredictable stimulus events over prolonged periods of time).

Results showed that the groups with scents present had significantly better performance during a 40-minute vigilance task than the control condition. During the task, reported emotional state ratings dropped, and fatigue and sleepiness increased in all groups. However, even though

performance declined as the task went on in the scented conditions, positive emotional state decreased less, and fatigue and sleepiness increased less than in the control condition. It was predicted that by using the stimulatory scent peppermint, results would show enhanced memory performance and by using the relaxing scent Muguet, results would show impaired memory performance. However, the fragrances of Peppermint and Muguet as stimulating and relaxing, respectively, were not significantly different at improving cognition.

Paradoxically, a stimulating scent and relaxing scent both positively affected vigilance performances (Warm et al., 1990). This effect suggests that if a scent is pleasant it can universally affect performance. Because research has concluded that stimulating and relaxing scents can both influence fatigue and sleepiness in a vigilance task, perhaps alertness can be affected by different scents including scents from the same family as peppermint. Limberger, Heuberger, Mahrhofer, Sessovic, Kowarik, and Buchbauer (2001) chose to look at human alertness to assess whether different essential oils can have an effect on alertness tasks.

Limberger et al. (2001) assessed the effects of essential oils on alertness. Ylang-Ylang, jasmine, cineole (presented in concentrations of 10 micro liters and 100 micro liters), which is derived from eucalyptus oil, and menthol were used to assess the claims that each scent could have an effect on human alertness. The procedure for inhaling the scents for this experiment was putting the fragrance onto a surgical mask. Water was put on the mask in the control group.

The results showed a detrimental effect in all alertness tasks except one. The scent that had a significant positive effect on alertness by way of reaction time was the cineole concentration of 100 microliters. The change in intensity for the cineole task would suggest that the concentration of a scent is significant. However, in the peppermint and menthol tasks, .02g of peppermint and .05g of menthol was applied to the mask, respectively. Between the different

intensities used the results were not significantly different. The significant effect of different concentrations of scents proves to be inconclusive.

Though it is not part of the sage family, differences in concentration resulted in improvements in alertness for cineole. This scent comes from eucalyptus oil. Eucalyptus oil is not an extract specifically used for memory improvement. However, "cineole controls airway mucus hyper-secretion and asthma" (Zimbio, 2011). Opening airways is a way to increase oxygen that gets to the brain and improving functions such as alertness. This could be why the cineole in a higher concentration was able to improve alertness, even though cineole is not recommended for attention, memory, or alertness improvement.

Limberger et al. (2001) found that there were no significant improvements in human alertness when essential oils were presented, except for cineole in a100 micro liter concentration. Though participant's alertness did not significantly improve with the administration of essential oils, other types of tasks also need to be tested with a different route of administration.

Grohmann and Thomas (2001) conducted a study that assessed whether retronasal administration (administration through the mouth) significantly improved a participant's memory for an unfamiliar brand name. Grohmann and Thomas (2001) predicted that this type of administration would increase brand-name recall and brand-name recognition. Peppermint and cinnamon were presented in the form of a retronasal odorant. These retronasal odorants were used because of results demonstrating that cinnamon and peppermint yielded superior results in memory tasks (Zoladz & Raudenbush, 2005). They were administered in the form of gum. Participants were tested on brand recall and also whether they could correctly reject the brand names they had not seen before. It was shown that there were no significant differences between the scented conditions and the control. The only significant difference in recall was between

sexes. There was no effect from retronasal olfaction that improved memory in brand recall and brand recognition tasks.

The lack of effect on attention and specified recall tasks, (Limberger et al., 2001) and (Grohmann & Thomas, 2001), suggests that task and route of administration play important parts in memory formation. Tasks can impact memory formation by how vigorous they are and the length of task. Research has shown that scents can influence short-term memory tasks as well as lessen fatigue in long-term tasks. A route of administration can affect memory formation as well because of the different types of receptors that are associated with memory for each sense. Receptors in the orthonasal region have been shown to be strongly associated with memory tasks when compared to retronasal administration.

Attention has not shown to be able to be affected by essential oils, whether they were stimulating or arousing. Retronasal administration has been shown to effectively enhance memory performance in some tasks but orthonasal administration has proved to be the superior route. Orthonasal administration of scents used as an aid in improving memory would yield further research on how scents can affect short-term learning and recall.

The relationship between scent and memory is strong. Previous research has shown that the right scent can significantly improve memory, emotional state, and attention. Research supports claims that stimulating scents can significantly impact memory when compared with calming scents, but not when participants are in their normal state. Also choosing to use specific oils in opportune situations such as during the sleep cycle or during a specific task can be optimized for success.

The present study aimed to test the essential oils peppermint and rosemary in memory tasks. Three conditions: peppermint, rosemary and a control were paired with two memory

tasks: recall and recognition. These memory tasks were an immediate word recall task and a delayed word recognition task. I predicted that the peppermint and rosemary conditions would significantly improve memory performance compared with the control condition.

Methods

Participants

The participants were fifty students from a small liberal arts college who volunteered to participate. If participants were enrolled in General Psychology or General Psychology Lab, they were eligible to receive extra credit.. Demographics for the sample were a primarily white, college age students.

Materials

The trials were performed in the lab in the basement of the Psychology building. An Ultrasonic Oil Diffuser was used to disperse the oils of rosemary, peppermint or pure water as a control throughout the lab. The essential oils rosemary and peppermint from YoungLiving Essential Oils were used in concentrations of about 14 micro liters. These essential oils are therapeutic-grade and are very potent. Companies claim that unless the extract is therapeutic-grade and non-synthetic, the oils will not be effective and could cause health problems such as irritation to skin or respiratory issues (YoungLiving, 2010). In the initial design of the study, the goal was to compare essential oils to synthetics to determine if the therapeutic-grade essential oil was necessary. However, the condition of synthetic extracts needed to be withdrawn from the current study because of an article stating that the use of these synthetic oils could be harmful to participants (Geck, 2000).

Research that supports this claim states that, "although synthetic components of these essential oils are commercially available, they are considered inferior to the natural products by

herbal medicine practitioners" (Price, 1995). Therefore, for the current study only pure, therapeutic-grade essential oils will be used during trials.

An informed consent form was used (Appendix A), and a 30-question survey was given to the participants to assess their current emotional-state and level of attention prior to the memory tasks (Appendix B) (Ruch et al., 1994). The survey inquired about each participant's current mood. Questions focused on seven qualities of emotional state. The current study examined three of seven types of questions for analysis: cheerfulness, sobriety, and sadness.

After mood was assessed, the memory tasks began. The first memory task used a PowerPoint display that showed the participants three word lists from Roediger and McDermott's (1995) false memory paradigm (Appendix C). Participants were given packet of three pieces of blank paper to write down the words they could remember after each word list. The second task they completed was a recognition task in which participants had to circle words they remembered seeing (Appendix D).

Procedure

At the start of the experiment, the participants were directed to separate room in the opposite direction from the experimental room. They filled out an informed consent form and current emotional-state survey. Upon entering the experimental room, the informed consent forms and surveys were collected. In the experimental room one of the scents or water had been diffusing for ten minutes prior. The informed consent forms and surveys were collected and participants were informed about the study. Participants were deceived about the purpose of associating memory with the smell of peppermint and rosemary to avoid expectancy effects.

To begin the trial, participants were given a packet of three blank pages. Participants viewed three separate PowerPoint slideshows showing three 15-word lists from a false memory

paradigm (Roediger & McDermott, 1995). After the first list, they were asked to write downthe words they remembered. The same procedure was repeated with the second and third lists. After the recall tasks were completed the packets were collected. Participants were given a sheet of words that included the lists they just seen combined with three other lists not previously seen (Appendix D). The three lists not previously seen were used as distracters for the recognition task and were also from the false memory paradigm (Roediger & McDermott 1995).

For the recognition task, participants were asked to circle every word they remembered seeing on the sheet of paper with the six lists on it. After this task, they completed the current emotional-state survey again. They were then debriefed about the experiment, given their extra credit slips, and were finished with the trial. After all data from all conditions were gathered, statistical analysis was carried out to discern if the differences between treatments were significant.

Results

The data from the immediate word recall task were analyzed using a set of one-way analysis of variance tests (ANOVAs). The independent variable was the type of scent diffused. The three conditions were peppermint scent, rosemary scent, and a control. An alpha level of 0.05 was used for this analysis. Results show that essential oils did not significantly impact emotional state or short-term memory in either of the conditions, $F(2, 47) = 1.747$, $p = 0.185$. The mean for the control condition ($M=22.6$, $SD=4.9$) was not significantly different than the mean of peppermint condition ($M= 25.4$, $SD=5.1$) or rosemary condition ($M=25.4$, $SD=4.9$) in the recall memory task.

The effect of type of scent on memory performance in the recognition task was also not significant $F(2, 47) =1.004$, $p= 0.374$. In the recognition task the mean for the control condition

(M=34.3, SD=6.2) was not significantly different than the mean of the peppermint condition (M=37.1, SD=5.5) or rosemary condition (M=36.2, SD=6.0).

A post hoc analysis was conducted with a more stringent memory stipulation. A one-way ANOVA was conducted using only participants recalling 21 words or more. This included thirty-six participants. This lower limit was chosen based on the average of Miller's (1956) 7 ± 2 paper. Given that the words in each list were semantically related, we expected relatively high rates of recall. Those who had at least 21 words recalled across the three lists in the data set might have been taking the tasks more seriously than those with fewer words recalled. The results were marginally significant in the memory recall task, $F(2, 33)=2.733$, $p=.080$. The results showed that in the memory recognition task there was a significant effect for type of scent, $F(2, 33) =4.21$, $p=0.024$.

To explore the differences for the recognition task, follow up t-tests were utilized. There was a significant difference between the control condition and the peppermint condition, $t(12.31) = -2.28$, $p=0.041$. Between the control and rosemary condition there was a marginally significant difference, $t(22) = -1.99$, $p=0.059$. For the t-test comparing the peppermint and rosemary conditions there was no significant difference between the two scents, $t(23) = -0.77$, $p=0.447$.

The scents also did not significantly improve mood in terms of cheerfulness; $F(2, 47) =0.996$, $p=0.37$, pensiveness; $F(2, 47) =0.975$, $p=0.385$, or sadness; $F(2, 47) =1.283$, $p=0.287$. These three mood subscales were chosen from seven mood subscales in the mood survey. Cheerfulness and sadness were used as a measure of self-perceived mood. Pensiveness was used to measure self-perceived cognitive improvement. Because the current experiment was assessing

mood and cognition, these three subscales were most relevant as another way to measure these factors.

Discussion

The results of this study show that the effects of the essential oils compared with a control were not statistically significant. However, with the stipulation of at least 21 words remembered, a significant effect for the recognition task was observed.

The first memory recall task showed neither peppermint, nor rosemary improved memory significantly. The second task was a recognition task. Neither the peppermint, nor the rosemary condition significantly improved memory performance. Emotional state was not significantly affected by the scents. Though the emotional state of the group exposed to the peppermint scent was happier overall than the other groups, there was no relation between the scent and emotional state.

Three 15-word lists measured short-term memory. The first task required participants to recall words from 15-word lists. The results for the peppermint and rosemary condition showed that the recall was not significantly better than the control condition. However, the results of the post hoc test showed that with the stipulation of an average of at least 21 words recalled, the number of correctly recognized words was marginally higher (indicates that with a significance level of 0.05, results showed significance between 0.06 and 0.10; close to significance but not under the specified level) in the peppermint and rosemary conditions. This suggests that peppermint and rosemary may have an effect on memory if those involved are actively trying to learn.

The second task was a recognition task. The recognition task showed that both conditions peppermint and rosemary were not statistically significant compared to the control condition.

However, the post hoc tests showed that with a stipulation of remembering at least 21 words from the recall lists (Miller, 1956), recognition was significantly better in the peppermint condition than the control condition.

Interruptions and inconsistencies during trials that could have affected results included participants showing up late and disrupting the current study. Many participants did not see the sign directing them to the room with the informed consent and emotional state survey in it. In doing so, participants may have been exposed to peppermint or rosemary scents prior to completing the initial mood survey. Another limitation was that the room that was available to test participants was not a closed classroom and was prone to interruptions. Participants complained of distractions in some of the trials. In addition to the distractions, the openness of the room available for trials was easily accessible and airy and may have caused the scent to dissipate, possibly making it less powerful.

Results of the current study would suggest future research include adaptations such as other scents and other tasks. These tasks should take place during sleep as well as not. The memory tasks in this study were relatively simple and only tested short-term recall and recognition. It has been shown that the effects of peppermint and rosemary can be effective in recognition memory tasks. Also, effects of peppermint and rosemary may help memory consolidation in an actual learning situation in which participants have intrinsic motivation (motivation driven by an internal goal or benefit) to learn.

Other adaptations to the current study could include other scents that have claimed to be able to enhance memory performance. These scents include, lemon, frankincense. If these scents were tested as well, a wider breadth of knowledge will start to emerge about what scents are the best at enhancing performance in different situations. Also, information about whether scents

need to be present in the encoding process because they can help encode memory more efficiently should be examined. If scents can efficiently encode memories perhaps they can help efficiently retrieve memories. Research should extend to which of these mechanisms is more important or if each is equally important in improving memory consolidation.

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Appendix A

Informed Consent Agreement

Please read this consent agreement carefully before you decide to participate in the study

Project title: Essential oils and their effect on Memory

Purpose of the research study: The purpose of this study is to investigate the relationship between essential oils and memory of word lists.

What you will do in the study: You will be asked to complete a mood survey and complete word learning tasks. Then you will complete the mood survey again and will be finished.

Time required: Including the time for the pretest the entire procedure will take 30 minutes.

Risks: There are no risks.

Benefits: The benefits are the extra credit you receive towards you classes.

Confidentiality: The information that you give in the study will be handled confidentially. Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file. When the study is completed and the data have been analyzed, this list will be destroyed. Your name will not be used in any report.

Voluntary participation: Your participation in the study is completely voluntary.

Right to withdraw from the study: You have the right to withdraw from the study at any time without penalty.

How to withdraw from the study: If you want to withdraw from the study, tell the experimenter quietly and leave the room. There is no penalty for withdrawing. You will still get class credit for participating in the study.

Payment: You will receive no payment for this study. You will receive participation credit from your class instructor.

Who to contact if you have questions about the study: Dr. Bianca Sumutka, Psychology Department, Lynchburg College, Lynchburg, VA *24501*. Email: Sumutka@lynchburg.edu

Experimenters: Tara Ricciardelli, Cell: (703)-470-8272

Who to contact about your rights in the study: Bianca Sumutka, Ph.D., Psychology Department, Lynchburg College, Lynchburg, VA *24501*. Email: Sumutka@lynchburg.edu

Agreement:

I agree to participate in the research study described above.

Signature:_____ **Date:**_____

You will receive a copy of this form for your records

Appendix B

(Code): _____ Age: |__|__| Gender: male O female O

Instructions:

The following statements refer to your **current** mood and mental state. Please try as much as possible to describe your **current** feelings and state of mind by marking an X through one of the four alternatives. Please use the following scale:

(1) strongly disagree

(2) moderately disagree

(3) moderately agree

(4) strongly agree

For example: I have an even temper. (1) (2) (3) (4)

If you strongly agree with this statement, that is, if you have an even temper **at this moment**, mark an X through (4). If you strongly disagree, that is, if you **at present** do *not* have an even temper *at all*, mark an X through (1).

If you have difficulty answering a question, pick the solution that *most* applies.

Please answer *every* question, do not omit any.

1. I am in a bad mood. (1) (2) (3) (4)
2. I am set for serious things. (1) (2) (3) (4)
3. I feel chipper. (1) (2) (3) (4)
4. I am sad. (1) (2) (3) (4)
5. I have important things on my mind. (1) (2) (3) (4)
6. I am cheerful. (1) (2) (3) (4)
7. I am in a thoughtful mood. (1) (2) (3) (4)
8. I could laugh at the drop of a hat. (1) (2) (3) (4)
9. I feel grouchy. (1) (2) (3) (4)
10. I have a serious mental attitude. (1) (2) (3) (4)
11. I feel merry. (1) (2) (3) (4)
12. I feel downhearted. (1) (2) (3) (4)
13. I am in a pensive frame of mind. (1) (2) (3) (4)
14. I am ill-humored. (1) (2) (3) (4)
15. My thoughts are profound. (1) (2) (3) (4)
16. I feel great. (1) (2) (3) (4)
17. My mood is spoiled. (1) (2) (3) (4)
18. I am in a serious frame of mind. (1) (2) (3) (4)
19. I am amused. (1) (2) (3) (4)

(Code):__ (1) (2) (3) (4)

20. I am peeved.
21. I see the funny side of things. (1) (2) (3) (4)
22. I regard my situation objectively and soberly. (1) (2) (3) (4)
23. I'm walking on air. (1) (2) (3) (4)
24. I feel gloomy. (1) (2) (3) (4)
25. I am in a crabby mood. (1) (2) (3) (4)
26. I am delighted. (1) (2) (3) (4)
27. I feel dejected. (1) (2) (3) (4)
28. I'm prepared to do a task in earnest. (1) (2) (3) (4)
29. I am ready to have some fun. (1) (2) (3) (4)
30. I am in a sober frame of mind. (1) (2) (3) (4)

Appendix C

Word list 1	Word List 2	Word List 3
Steal	Sour	Woman
Robber	Candy	Husband
Crook	Sugar	Uncle
Burglar	Bitter	Lady
Money	Good	Mouse
Cop	Taste	Male
Bad	Tooth	Father
Rob	Nice	Strong
Jail	Honey	Friend
Gun	Soda	Beard
Villain	Chocolate	Person
Crime	Heart	Handsome
Bank	Cake	Muscle
Bandit	Tart	Suit
Criminal	Pie	Old
False memory word: thief	False memory word: sweet	False memory word: Man

Appendix D

handsome	criminal	tooth	dough
heart	crust	husband	pie
George	old	arm	crown
strong	crime	honey	jelly
taste	butter	jam	bandit
money	bank	nice	palace
male	crook	bad	leader
tart	wine	food	sugar
mouth	throne	candy	cop
soda	robber	monarch	loaf
flour	walk	chess	muscle
shoe	queen	jail	prince
rule	suit	milk	toast
good	sock	father	sandals
sweet	rob	man	beard
uncle	boot	dictator	ankle
woman	reign	person	thief
subjects	inch	chocolate	sour
gun	smell	sandwich	burglar
yard	slice	toe	hand
mouse	friend	kick	rye
bitter	soccer	cake	eat
England	steal	lady	royal
			villain