Scents of Efficiency: Discovering How Olfactory Stimuli Affect Caregiver Performance In A Simulated Emergency Department

By

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ABSTRACT

Research has shown that the ability to smell is the most direct sense an individual can experience. With every breath a person takes, the brain recognizes thousands of molecules and makes connections with our memories to determine their composition. With the amount of research looking into how and why we smell, researchers still have little understanding of how the nose and brain process an aroma, and how emotional and physical behavior is impacted.

This research focused on the affects smell has on a caregiver in a simulated Emergency Department setting located in the SimET of Banner Good Samaritan Medical Center in Phoenix, Arizona. The study asked each participant to care for a programmed mannequin, or "patient", while performing simple computer-based tasks, including memory and recall, multi-tasking, and mood-mapping to gauge physical and mental performance. Three different aromatic environments were then introduced through diffusion and indirect inhalation near the participants' task space: 1) a control (no smell), 2) an odor (simulated dirty feet), and 3) an aroma (one of four true essential oils plus a current odor-eliminating compound used in many U.S. Emergency Departments). This study was meant to produce a stressful environment by leading the caregiver to stay in constant movement throughout the study through timed tasks, uncooperative equipment, and a needy "patient".

The goal of this research was to determine if smells, and of what form of pleasantness and repulsiveness, can have an effect on the physical and

mental performance of emergency caregivers. Findings from this study indicated that the "odor eliminating" method currently used in typical Emergency Departments, coffee grounds, is more problematic than helpful, and the introduction of true essential oils may not only reduce stress, but increase efficiency and, in turn, job satisfaction.

DEDICATION

This thesis is dedicated to the four members of this committee. To Professor Jose Bernardi: for always trying to push me forward to ensure a happy and swift graduation. To Professor William Heywood: for helping me find logic in how this thesis would be completed before I became an old woman. To Rachael Rosso: for helping me cope through frustrations and guiding me based on personal experience. And, last, but not least, to Dr. Richard Watts: for being one of the most beneficial members of my thesis committee in helping me with finding participants for my formal study – this would not have been possible without you!

This thesis is also dedicated to my loving family. Thank you for sticking with me through some of the most struggling moments I could seem to experience during this process. We have shared some fantastic ups, and some outlandish "you've got to be kidding me!" downs; but in every instance, I always had you all to turn to. A very special thank you goes to my mother for always giving me the "stay positive" speech - even when 'hitting bottom' seemed to be a consistent occurrence.

Finally, this thesis is dedicated to those who are pursuing their own Master and Doctoral education dreams. I wish you the best of luck and hope you get to be as fortunate as I have been to be able to spend time on a topic I so greatly enjoyed.

ACKNOWLEDGMENTS

This author would like to acknowledge the gracious help, guidance, and absolute patience to the Banner Good Samaritan Medical Center SimET staff. Without such gracious support from this extraordinary team, providing a safe and consistent simulation for participants in the Formal Study would have been unattainable. A very special acknowledgement goes out to the Sim techs would not only helped to set up the simulation every day, but was eager to help in creating the type of simulation needed for this study.

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DEFINITIONS

Aroma: This document will use the term 'aroma' as a pleasant and positive smell. The term aroma will be based on the perception of the investigator throughout the course of this document, as well as the perception given by participants during the experiment.

Aromatherapy: Aromatherapy is an alternative medicine which uses essential oils from plants to help heal. This practice is gaining popularity in Europe's hospitals, and has slowly made it way to the United States. Although aromatherapy can take the form of topical, oral, or aromatic uses, this study will focus only of the effects caused by inhalation of the essential oils through a diffuser (Buckle, 2003).

Essential Oil: "An essential oil is a volatile liquid extracted from various plant parts by . . . distillation" (Cristina, 2004, p. 474). Because of their high concentration, these oils are measured in drops. To give an example of the high concentration, a single drop of an essential oil can be the equivalent of 30 cups of tea (Cristina, 2004).

Odor: An odor will be used to describe an unpleasant or negative-effecting smell. The term will be used based on the perception of participants during interviews, as well as the investigator throughout this study.

Odorants: According to the Oxford American Dictionary, the term 'odorant' is an object or substance that releases or 'gives off' a smell. These substances can give off a particular odor or aroma.

Olfactory: The term 'olfactory' is used by the medical field to describe a system in the body. Similar to how 'auditorial' relates to hearing and

'visual' relates to seeing, 'olfactory' - or olfaction - corresponds to the sense and the perception of smells (Nef, 1998).

Performance: This study classifies performance as the resulting factors from an individual's response time, alertness, and personal stress factors. Each of these factors may help or hinder the other, all correlating to the performance of the individual.

Scent: The term 'scent' is classified as distinctive smell that is usually pleasant, or a characteristic smell of animals. This document will use the term as the distinguishing identification for individuals.

Smell: During the course of this thesis, the term 'smell' will be used both as the action of detecting or perceiving an odor or scent, as well as an overarching term to define either a positive aroma or negative odor (McKean, 2005).

INTRODUCTION

Overview

One of the most common complaints about hospitals is the unique odor referred to as "hospital smell", which can be derived from chemicals, equipment off-gassing, and even from those admitted. Although most of the population is exposed to these odors as a patient or visitor, these same stimuli and distractions are present to those from whom the expectation is nothing less than "peak performance" in every aspect of patient care. Generally, the staff of an Emergency Department is exposed to intense negative odors at a higher frequency than most employees in a typical non-hospital work environment. The question then becomes how staff – and more importantly, the caregivers who interact with these odiferous persons and situations – is affected by these continuously lingering and constantly evolving odors.

The fact that nurses can become easily acclimated into their environment - especially if they are stationed in a department where patients can stay from days to months - is not an exciting new idea in olfaction research. However, when patient turnaround is less than 24 hours, and new occupants are brought in on average of every three hours, plus the added increased population of homeless, a very different story plays out. For many inner-city Emergency Departments across the U.S. this scenario can be a daily occurrence providing a cornucopia of smells that can waft throughout the department within minutes.

The following thesis discusses how different odors and aromas can affect the performance of Emergency Department nurses through research and experimentation. The pilot study focuses on the effects of performance for a general population through monitoring their physical stress while performing web-based computerized tasks. The formal study concentrates on Emergency Department nurses and their reaction to smells while working on simple web-based computer tasks and caring for a mock patient in a simulated emergency environment.

The following chapter will introduce the reader to the research scope which includes current problems that influenced the conception of this topic, the objectives and intentions of the study, the justification and significance to pursuing this research, the methodology, and assumptions and limitations of the study.

Problem Statement

Today's Emergency Departments are expanding with an aging population of caregivers. The average age of these nurses has recently increased to 46.8 years, leaving only 8% of all Registered Nurses to be under the age of 30 (Minority Nursing, 2009). With these statistics, and the rate of retention decreasing, it is clear that improvements need to be considered in these high environmentally stimulating departments for increasing the performance and job satisfaction of caregivers by providing pleasant ambiance, and the ability to safely and naturally reduce stress. With the persuasive effect of odors providing a baseline, this study measured performance through olfactory stimulus – as a way to simulate a common

occurrence in a typical Emergency Department. This explored a seemingly uncharted topic for research with a focus on how to improve the working environment for these individuals.

The goal of this study focused on how smells - both, positive (pleasant) aromas as well as negative (unpleasant) odors - affect caregiver productivity. The diagram below depicts the conceptual framework of this study, focusing on odors and aromas as the environmental influence acting on the performance and wellbeing of the caregivers measured through response time, alertness, physical stress, and job satisfaction.

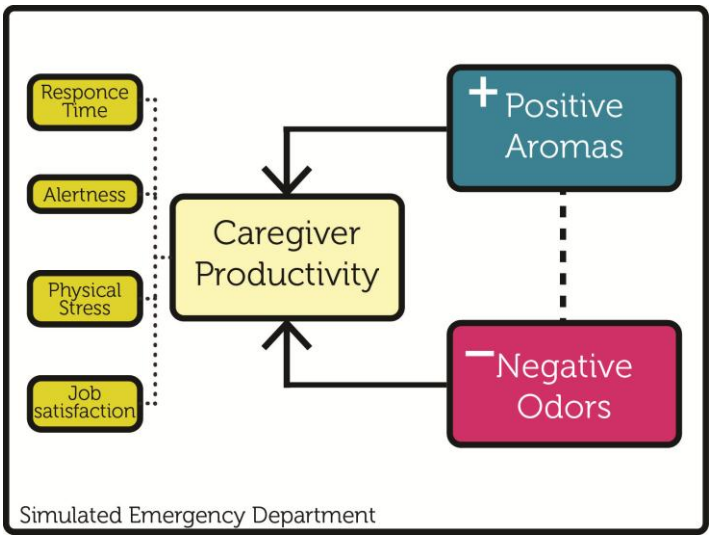


Figure 1: Conceptual framework. This diagram depicts how two different smell types (odor and aroma) affect caregiver productivity which was based on their response time, alertness, physical stress, and job satisfaction.

Objectives/Intentions

There were three main objectives of this study:

1) The first objective to determine if unpleasant odors in an Emergency Department positively or negatively affect caregiver productivity - specifically, how accuracy, retention, and stress is affected compared to a controlled environment with no olfactory stimuli.

2) The second objective sought to determine if introducing a pleasant aroma could positively or negatively affect caregiver productivity by influencing performance and physical reactions.
3) The third objective aimed to determine if the introduction of an aroma following the presence of an odor played any affect by improving or hindering caregiver productivity. This final objective was tested during the formal study only.

Justification

This research topic is important for two reasons:

1) The first reason correlates with the fact that there is a lack of research to determine if smells can play a part in how a caregiver performs in a high-intensity environment.
2) The second reason is to find a safe and effective tool busy nurses can turn to in stressful situations that can help increase their performance without producing a residual counteractive reaction hours later.

Availability of Current Research.

There are numerous studies on how to better improve performance for nurses, and an even more abundant amount of information on how essential oils, the more pleasant aromas used in this study, can recover emotional and physical distress. Research has shown that human behavior may be most persuaded by odor; however, there is very little information on how these smells can affect how a nurse reacts to their patients via purely olfactory stimulus (Rosso, 2007). This knowledge is important to determine if a nurse

subconsciously reacts slower, or less enthusiastically, when caring for a patient who emits an unpleasant odor.

In addition to unpleasant odors causing reaction to caregivers, this study uses a technique called "aromatherapy" to diffuse, or introduce, pleasant aromas into the air in order to determine how performance could be modified. However, as Sylvina Tate describes, ". . . although holistic in nature, [aromatherapy] is not a research-based practice" therefore, has no definite confirmation on how each essential oil truly affects the individual using it (1997). It is an unfortunate fact that olfaction research and information on caregiver performance are not common topics, let alone information on how nurse performance is affected by olfactory stimulus. This research will hope to bridge a gap between the current lack of research regarding nurse productivity and a currently under-researched topic of olfactory persuasion.

Positive Influence to Increase Caregiver Performance.

For many people, stress is an everyday effect of work, school, and additional activities that can, in fact, be healthy in moderation. However, when anxiety elevates the stress response beyond capacity, "the brain loses the ability to think clearly and memory function is eroded" (McCaffrey, Thomas, & Kinzelman, 2009, p. 88). In a 2002 study, 37% of Emergency Department Registered Nurses reported feeling a daily occurrence of being under a great deal of stress which may, in turn, affect their performance of treating patients (McGinnis, Moore, & Armstrong, 2006). Currently, caregivers turn to over-the-counter prescriptions, coffee, and energy drinks to

change, or improve, their own state of being. This may allow for an immediate increase in alertness, but may consequently result in "crashes" later in the shift.

A potentially simple solution to assisting caregivers to de-stress and stay alert is by introducing an aroma for them to inhale at their leisure which may have a better result, and perform better, than the current remedies. Much of the research encompassing essential oils exhibit a strong positive response from its use; these can range from reducing stress, to easing manacles such as headaches and joint pain.

Significance

The statistics regarding Registered Nurses (RNs) in the US is nearly three million strong. 56.2% of these RNs work primarily in hospitals, with 92% being women – the gender most affected by smells (Minority Nursing, 2009). This next section will review the significance to pursuing this thesis, starting from the most basic of inhalation benefits, to the financial gain from the results of this study, and then the potential for an overall indoor environmental quality of future Emergency Departments.

Smelling is Absolute

Other than the rare few who lack the complete or sometimes partial ability to smell, every person is programed with olfactory receptors to enable them to experience the different odors and aromas even before they are born, while in utero, which can predetermine odor preferences influenced by environmental factors (Poncelet, et al., 2010). Because these connections are created at such an early period in the development process, each person is

pre-programmed to initially react a certain way to different odors and aromas. As a person takes a breath, the brain is able to process hundreds of the different odors and aromas that are encountered (Ackerman, 1991). In a single day, an individual can breathe over 23,000 times, exposing themselves to a multitude of smells (Rosso, 2007). In Emergency Departments across the nation, the odds of inadvertently inhaling something malodorous by simply doing this mechanical task further emphasizes the essence of this thesis.

To say that olfaction exploration is a menially-researched topic is no understatement, but what is known is critical to human existence. As Diane Ackerman notes, "smell is the most direct of all of our senses" but the least noted about in textbooks (1991, p. 10). It can take only seconds for the brain to process hundreds of volatile chemicals and correlate the mixtures from memory to decipher what we know it to be something common or new. There is an immediate reaction by a person when they smell something that determines if it is pleasant or unpleasant, as well as targets memories to arouse (Buckle, 2003). The sense of smell does not only provide individuals with an exciting ability to interact with their environment differently, it has multiple roles that include: responding to pleasant aromas through activating salivary and gastric secretions, influencing sexual behavior and emotional states, and providing social and food hygiene information (Nef, 1998). In addition, the ability to smell is the only one of the five senses to directly influence another sense. Without the ability to smell, a person has concurrently lost the ability to taste; making this ability primal and absolute.

Cost Efficiency

For many caregivers, the exposure, complexities, and stress of working in an Emergency Department can bring on a series of ill effects that can prohibit their ability to perform at their peak. Many of these ailments could include: headaches, nausea, allergic reactions, etc. In most cases, the immediate response to this scenario is for nurses to take over-the-counter medication, which can take time to make an improvement, and some have undesirable side effects which may further hinder the caregiver. In the case of using essential oils as an inhaled remedy, a number of common illnesses, such as headaches or nausea, can be quickly, safely, and economically used to better assist these individuals. For example, in a 1996 study with 164 individuals who were experiencing a headache, a 10% *Mentha piperita* (peppermint) preparation resulted in 41 subjects who experienced their headache intensity decrease significantly within 15 minutes of using the oil (Kligler & Chaudhary, 2007). This type of rapid, natural effectiveness could be the missing tool in today's hectic hospitals.

Many of the essential oils are non-invasive, causing very few adversarial effects and the product operational and distribution cost can be cheaper than many pharmacological treatments (Hines, Steels, Chang, & Gibbins, 2010). With only three to five drops of an essential oil placed on a cotton ball or handkerchief, the aroma of these oils can last for four to six hours – up to half of an average twelve-hour shift for Emergency Department nurses. In addition, because the dosage used for these oils are measured in drops, and a five ml bottle of essential oil can contain about 100 drops, the

cost savings is significant compared to that of over-the-counter medications. As a comparison, Advil consists of 200 milligrams of medication per dose, and costs about seven dollars for 50 caplets, or $0.14 per single dose (assuming the user only takes one pill for relief). Whereas, only 25% of a single milliliter of essential oil can equal the same dosage needed, but costs about six dollars for a five ml bottle, or $0.04 per dose. If an individual needs to combat a headache twice a week for a year, they could spend up to $21 dollars for two pills of Advil while have taken 20,800 milligrams of medication, or $6 for an essential oil and only use 11.44 milliliters per year.

Advil:

$$50\ {}^{caplets}/_{bottle} \times 200\ {}^{mg}/_{dose} = 10{,}000\ {}^{mg}/_{bottle}$$

$$200\ {}^{mg}/_{dose} \times 2\ {}^{times}/_{week} \times 52\ weeks = 20{,}800\ {}^{mg}/_{year}$$

$$104\ {}^{doses}/_{year} \times \$0.14/dose = \$14.56/year = minimum\ of\ 3\ bottles$$

$$= \approx \$21.00$$

Essential Oil:

$$5\ {}^{ml}/_{bottle} = 1\ {}^{bottle}/_{100\ drops} \times \frac{4\ drops}{1\ dose} = 20\ {}^{ml}/_{dose} = 0.2\ {}^{ml}/_{dose}$$

$$0.2\ {}^{ml}/_{dose} \times 2\ {}^{times}/_{week} \times 52\ weeks = 11.44\ {}^{ml}/_{year}$$

$$104\ {}^{doses}/_{year} \times \$0.04/dose = \$4.16/year = minimum\ of\ 1\ bottle =$$

$$\approx \$6.00$$

In addition, David Stewart notes that “death or serious injury from proper use of essential oils is unheard of and non-existent.” However, even when using a prescription drug properly, the threat of a serious injury or death is still a plausible situation (2010).

Improved Indoor Air Quality

Last, but not least, this thesis has been derived from the increased toxic air quality seen in many of today's Emergency Departments and the promising remedial affects from true essential oils. Over the past few years, there has been more evidence to suggest that the topical and inhaled use of essential oils "can positively impact the immune system by improving mood, increasing brain activity, and enhancing other biological functions important to health and healing" (Buckle, 2003, p. 310). In the design of a healthcare facility, especially a hospital, the requirement to improve indoor air quality is a top priority to prevent contaminates from spreading between departments and infecting their patients, as well as to ensure the reduction of "stale air". Currently, little is done to reduce this tainted air from spreading in a safe and efficient method. Essential oils not only provide a more pleasant aroma in the air, the antibacterial effects can provide a safer environment for caregivers to work and breathe in.

Although, there are current remedies for nurses during their shifts to help change their physical states, from reducing headaches to increasing alertness, this thesis focuses on the naturalistic approach to ease pain and discomfort while providing a cost efficient tool for the facility without the use of artificial chemical compositions impacting the brain.

Methodology

This quasi-experimental research was developed to compare and contrast different aromatic environment groups in order to find a correlation between smell inhaled and performance.

The pilot study consisted of 16 participants, none of whom were licensed Registered Nurses. Groups were formed semi-randomly to ensure an even distribution to each smell category and were asked to partake in six web-based computerized tasks. Participants were initially informed that the study was to gauge performance but information on the use of aromas and odors was stated clearly on the consent form. Complete deception was unfortunately unavailable during the pilot study as the odor-producing smell could not be accurately controlled without participant awareness and some participants were previously aware smell would be used – they were, however, were not informed of the type of smell.

The formal study consisted of eight caregivers (Registered Nurses, Emergency Department techs, and Physicians) who were all currently, or previously, employed with the Banner Health System. Subjects participated in three aromatic environments (control, odor, and aroma) and were asked to care for a simulated patient (programmable mannequin) as they performed a series of four web-based computerized tests similar to the pilot study. All subjects were made fully aware that they would participate in three aromatic environments, however, were not informed of the smells being used and at what point in the study they were introduced.

Assumptions/Limitations

The hypothesis for this study determined that an unpleasant odor would drastically decrease the performance of a caregiver due to negative environmental distractions and atmospheric stimuli. In contrast, the assumed outcome of the pleasant aroma was an increase in the caregiver's

productivity due to a more pleasant atmospheric stimulus causing reduced stress and satisfaction in completion of the task at hand.

Limitations to the study included the ability to perform tests in the physical Emergency Department environment for safety and accurateness of data. Because every person reacts to a smell (pleasant or unpleasant) differently, and the occurrence of an unpleasant odor could not be planned or scheduled in an active Emergency Department, the study location was moved to a more controlled environment for both the pilot and formal study. This removed actual patients from the study, thus reducing potential variables.

Conclusion

This chapter highlighted the main purpose of this study being geared towards the effects of odors and aromas on caregiver performance in a simulated Emergency Department. A problem statement was given, followed by the main objectives that were sought to answer the research questions. Justification and significance was then added to bring more reason to the purpose of this study and the benefits that may arise from positive results. Finally, the methodology of the pilot study and formal study was provided succeeded by the assumptions and limitations to both studies. The superseding chapters discussed the research behind the study, descriptions of both the pilot and formal study - and the modifications made to better improve the formal study based on the findings of the pilot, the findings of the formal study, and the research conclusion.

LITERATURE REVIEW

Introduction

The following chapter will discuss subject matter on the research found to support the importance of this thesis topic. To begin, the chapter will review the basic ability to smell: what smell is, why we smell, and how we are able to do so. Following the logistics, the chapter will propose how odors affect performance and why olfaction is important to caregivers in an Emergency Department. To conclude, a description of, and positive benefits to, using aromatherapy will be examined - which will include the different effects from the essential oils used in both experiments of this research study.

What is Smell

The human brain is an extraordinary tool able to distinguish even the simplest of objects. Take a book, for example, which might seem to have a distinctive smell on its own; however, the human brain does not register the olfactory sensation as "book". Instead, it compares hundreds of volatile compounds - including those that make up the binding, the pages, and the dust, forming a concoction of olfactory flavors (Nef, 1998). These compounds waft over the olfactory receptor sheet, located near the back of the nasal cavity, which recognizes the mixture as a singular object: "book" (Wilson & Stevenson, 2006). Unlike other senses which have evolved to create a range for themselves - such as light for vision, pressure for touch, and sound for hearing - the olfactory sensation appears to have no limit with its sense of smell, and in conjunction, the ability to taste. Unfortunately, smell and taste are the most misunderstood of the five senses, seem to be the most forgotten

in research, and largely taken for granted in everyday living (Brewer, Castle, & Pantelis, 2006). Although the human's dependence on smell in order to survive has been reduced over many generations, this sense is a huge portion of a person's individual makeup. Take, for instance, a single genome, which is a full set of chromosomes that contains all of the inheritable traits of an organism. Three genes, or three full sets of chromosomes, are needed for a person to view the full color pallet; however, the olfactory system makes up only 1/13 of a genome in an individual (Brewer, Castle, & Pantelis, 2006).

Smell is also a continuously evolving sense which can peak around a person's middle age, typically between 20-40 years (Rosso, 2007). After this peak, a slow deterioration can occur that can range from a minimal reduction in the ability to smell to the complete inability (Doty, 1984). This section will further discuss the biological science of smell.

What is Considered a Smell

The idea of smell can be as unique as the person who perceives it; and can be further sub-categorized into either "odor" or "aroma". In first considering odors, it is important to know that there are two categories: source and ambient. Source odors are those that exist at the point of origin, or at the point of exit, to the general surroundings, while ambient odors are those existing in the global atmosphere (Rosso, 2007). Smell can then be broken down even further to distinguish the type of olfactory sensation a person senses.

The diagram below is an illustration designed by Hans Henning in 1916 to depict the classification of smells, much like how the taste

classifications of bitter, salty, and sweet interact to create a taste sensation. This prism design was created as a way to accurately place smell awareness in a three-dimensional form to better understand how people perceive olfactory sensations (Wilson & Stevenson, 2006). However, in the end, smells are only considered what they are by the individual who experiences them; therefore, what is considered to be a smell, depends primarily on the person.

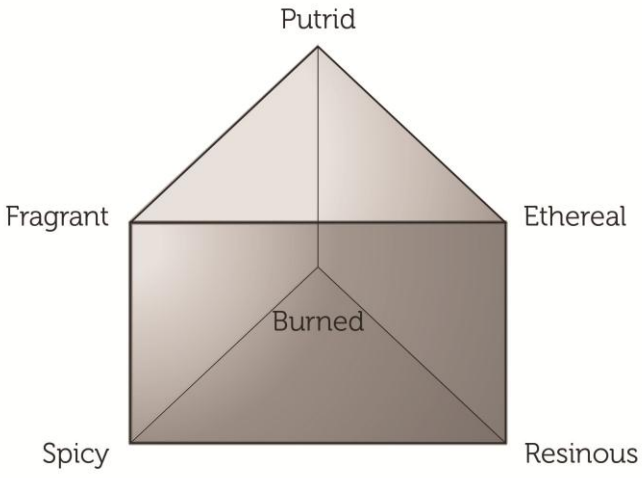


Figure 2: Odor prism of the relationship of different smells. This diagram depicts the complexity of classifications related to smell.

Why We Smell

The phenomenon to perceive odors and aromas by means of the olfactory nerves extends far beyond the simple capability to experience different odors and aromas. The human body utilizes the dexterity to smell for biological, survival, and memorable needs. This section will discuss these different purposes as to why humans were built to have the ability to perceive fragrances and emanations.

Biological

From the moment humans are first born, infants use their sense of smell to make connections. During the very first moments of life, a newborn identifies its mother by her aroma, and her scent sensation can last a lifetime (Buckle, 2003). However, just like an individual's ability to hear, humans have evolved to have an apex performance in their ability to smell followed by a depression in performance. In a study using 1,955 participants, results revealed that a person's ability to identify and associate smells progresses from birth until it reaches its apex performance between the ages of 20 and 40 years, also considered the prime mating age (Siksorski, 1984). It is during this time that in order to attract a mate, humans and many animals release pheromones, which are voluntarily expelled airborne chemicals that affect members of the same species physiologically and behaviorally (Buckle, 2003). This act of pheromone release can be hardly noticeable to the opposite sex but can provide an intense sensation to the potential mate experiencing it. Amazingly, this pheromone release also acts as an important barrier for humans to steer clear of potential relatives, indicating the immune system's make-up does not provide adequate diversity in order to thrive. In a study were women were asked to smell a used shirt from males who had done an extensive workout to determine the effects of potential arousal, the women indicated that they were more strongly unattracted to the shirts worn by their male family members. This negative attraction acted as a biological warning system to provide security in finding better mates, and the mate

most suited would have an immune system different that their own which would allow for stronger offspring (Fischer, et al., 2009).

Researchers have found that once an individual reaches between 65 to 80 years of age, more than 60% show olfactory impairment with a quarter of those having no ability to smell. Once these individuals pass the age of 80 years, over 80% show having major olfactory impairment – half of those having no ability to smell at all (Siksorski, 1984). However, a number of research studies have shown that no matter the age, women tend to show a higher sensitivity to smells than men - especially during pregnancy (Ackerman, 1991). This heightened awareness may not only be the result of the biological need to reproduce healthy, stronger offspring, but the basic need for survival.

Survival

The biological need to reproduce has been an important factor to human evolution, but the capability to use the sense of smell as a way to survive has truly allowed generations to grow and be better immune to diseases and ailments. The ability for humans to experience and recognize odors serves as a warning system to allow for detecting such hazards as polluted environments, fire, and dangerous fumes - which may otherwise cause harm to an individual (Siksorski, 1984). Likewise, these environments do not allow for the growth and evolution of humans as hazards, such as fires, could not only damage shelters, but damage potential food sources. The idea of instantly recognizing a negative odor could have risen from our ancestors who noted that a bad smell could be the result of a poisonous or

potentially harmful food source (Smeets, Schifferstein, Boelema, & Lensvelt-Mulders, 2008). Deadly food sources could reduce the human population which could potentially corrupt the evolution of human immunity, naturally and through biological networks. It is believed that smell perception serves as a "hedonic agent for the enjoyment of fragrances" as well as the "prototypical sensor for self-preservation against potentially harmful substances in the atmosphere" (Smeets, Schifferstein, Boelema, & Lensvelt-Mulders, 2008, p. 733). The ability to smell allows for the enjoyment of pleasant surroundings, while maintaining a keen perspective on the surrounding environments. Unlike other senses, such as sight, the ability to smell takes on a number of rolls simultaneously, but how?

How We Smell

This section will discuss the biology of how an individual is capable to perform the action of smelling. The following will introduce how a person is first able to perceive an odor or aroma, followed by an explanation of the process by which perceiving the smells occurs, by also delving deeper into the chemical and nerve reactions. To conclude, this section will describe the different degrees of smelling capabilities unique to every person.

Perception

There are currently two theories on how smell perception is possible: the molecular theory and the vibration theory. The vibration theory hypothesizes that vibrations in the atmosphere are used to recognize a smell, whereas the molecular theory speculates that inhaled odor molecules "informs the brain of the presence of a particular aroma" (Rosso, 2007). As

the more accepted of the two theories, researchers believe perception is due to chemoreceptor cells in the olfactory epithelium, a cellular covering of surfaces in and on the body that includes small cavities and the lining of vessels that experience a chemical reaction by gas molecules (Peng, 2009) (Farlex, 2012). Not only is the theory on how perception officially occurs unconfirmed, but the amount of recognizable odors is undetermined. Many scientists would agree that people are capable of differentiating up to 10,000 different smells (Butje, Repede, & Shattell, 2008). However, some believe odor-receptor proteins have the ability to detect over twice that amount (Nef, 1998). With so many potential odor experiences, it may be hard to imagine just how small a smell must be for it to be noticed. In 1998, Patrick Nef believed that the realization of a smell occurred with half the concentration required for identification of the smell (Detection: 4 x 10-15 g/l; identified: 2 x 10-13 g/l) (How We Smell: The Molecular and Cellular Basses of Olfaction). It was only recently, in 2004, that Richard Axel and Linda B. Buck won a Nobel Prize for their understanding of how individuals are capable for recognizing and remembering these thousands of smells. They determined that the olfactory system was composed of receptor cells that have a limited number of detectors for odorant substances resulting in each cell specializing on a few odors (Press Release: The 2004 Nobel Prize in Physiology or Medicine).

For some individuals, the floral fragrance of a rose or the putrid stench of an old gas station restroom will instigate a spontaneous comment or physical reaction. Other individuals will only notice these essences once they have been acknowledged by others (Smeets, Schifferstein, Boelema, &

Lensvelt-Mulders, 2008). Although most individuals have the dexterity to make out smells in a split-second manner, some are not able to quickly make the connection due to their olfactory consciousness. Olfactory consciousness is the "person's awareness of the odoriferous sensation he or she perceives" (Smeets, Schifferstein, Boelema, & Lensvelt-Mulders, 2008, p. 726). This perception can vary widely between people from semantic processing (the deepest level of memory creating, storage, and usage) (Barton, 2010), odor sensitivity, hedonic (the characteristic pleasure) ("Hedonic - Medical Definition and More from Merriam-Webster," n.d.), and higher olfactory cognition (Poncelet, et al., 2010). Therefore, people who lack the ability to involuntarily recognize smells do not experience richer or deeper emotions than those who otherwise would, which reduces their perception of smells creating a cycled effect (Smeets, Schifferstein, Boelema, & Lensvelt-Mulders, 2008). Odor evaluation consists of odor identification, followed by odor concentration assessment, and finally estimating the odor's psychological effect (Yamanaka, Sagara, Kotani, Takemura, & Fujiwara, 2009). Individuals who have a reduced olfactory consciousness therefore have a more difficult time not only in the awareness, but also in the recognition of smells.

Although people have their own perception of a unique scent, sometimes the influences around them can create different sensations that what would be typically expected. One study found that the intensity of an odor was lower when subjects were informed positively that the odor was healthy or natural compared to subjects who were informed neutrally or negatively (Yamanaka, Sagara, Kotani, Takemura, & Fujiwara, 2009). With

this, one can make the assumption that a large part of smell perception is based on the influences of others and on previous knowledge on how to react. All in all, each person's smell perception capability is unique to their own genetic make-up; however, the process on how this occurs is all the same.

Smell Process

To start the perception process, a person must first inhale to experience the smell. Depending on the type of smell, pleasant or unpleasant, the individual may inhale differently. When a person is confronted with a strong negative odor, the initial response is to take fewer, shorter, and smaller sniffs, reducing the amount the odor is exposed to the olfactory bulb. People who tend to inhale long, deep, breaths when a positive aroma is near do so in an attempt to savor the moment (Gilbert, 2008). No matter how a person decides to inhale, many researchers believe a chemical reaction occurs when a person takes a breath that is evoked by receptors in the brain. As a person breathes in, chemicals from the odor or aroma move up through the nose, behind a bridge which lies just beneath the part of the brain connected to the olfactory bulb, and attaches to millions of hair-like receptors. Because of the sensitivity of these receptors, and the ability for diverse chemicals to bind to distinct receptors, people are able to discern thousands of different smells (Buckle, 2003). These receptor sites can detect the most minuscule difference in a molecule due to its high sensitivity (Stewart, P.h.D., D.N.M., 2010). As the chemical process occurs, a neurological effect takes place as well.

As mentioned earlier, not every smell can be recognized. Recognition is dependent upon the number of triggers provoked and, although eight substance molecules are needed to trigger a nerve ending impulse, the action of acknowledging a smell – being able to genuinely smell and distinguish something - takes 40 triggers (Ackerman, 1991). Once these triggers have occurred, nerves within the nostril take the air that is inhaled through the cribriform plate, a perforated horizontal plate in the nasal cavity, to the nerves in the brain. Prior to the discovery of the olfactory nerve cells, where only 10% of inhaled air travels, scientists speculated that smell traveled directly through this area in the nose to the brain itself (Gilbert, 2008). The capability to smell does have a uniqueness factor to it in that the only nerve connected directly to the hemispheres of the brain is the olfactory nerve allowing stimulation to occur two-fold (Gilbert, 2008). Although aromas can be more potent to activate the portion of the brain called the amygdala than other senses (like visual & auditorial), PET (Positron Emission Tomography) scans have revealed that unpleasant odors are more likely to create an intense emotional reaction of the amygdala than pleasant aromas (Brewer, Castle, & Pantelis, 2006). However, no matter how the process occurs, every person has a specific degree of smelling capabilities.

Degrees of Smelling Abilities

Although each person's sensitivity to smell varies dramatically, there are some instances where individuals were born with the reduction or absence of the ability to process smells. Anosmia is the highest and most drastic impaired ability as it relates to the complete loss of the sense of smell

where no memory connections can be made. One out of 200 million Americans suffer from this disease, and unfortunately, because the sense of smell and the sense of taste are linked, a person with anosmia, typically also lacks the ability to taste. One stage below of reduced aptitude to smell is hyposmia. While anosmia is the equivalent of someone who is deaf – completely lacking a sense - a person who suffers from hyposmia is equivalent to someone who is hard of hearing. About one to two percent of the U.S. population is estimated to suffer from anosmia or hyposmia; in some cases these diseases are not caused from birth defects (Gilbert, 2008). Some instances of anosmia or hyposmia could be the result of aging, concussion, brain tumor, birth, & toxic chemicals (Rosso, 2007). The common act of smoking is one of the highest contributors to avoidable olfactory impairment. An individual's ability to experience smell identification could have an adverse effect if that individual was a smoker (Doty, 1984). Although some smokers – even long-term – believe their sense of smell performs at normal or even heightened levels, damage from this habit can directly affect a person's ability to recognize and identify smells. A study showed that those who were current cigarette smokers were twice as likely to have an impaired sense of smell compared to non-smokers (Fackelmann, 1990). Studies have shown that the damage made to olfactory nerves could result in a lengthy recovery process. As an example, a five year smoker would have to go without a single cigarette for up to ten years before showing a somewhat normal sense of smell. This shows that even after smoke inhalation has ceased for years, the chemicals contained in cigarette smoke can damage the sense of smell from repeated

exposure (Fackelmann, 1990). Luckily for smokers, the possibility of regaining the original ability to smell is possible because the lifespan of olfactory neurons. Due to the body's natural intelligence to grow, olfactory neurons have a lifespan of 30-40 days, allowing for rapid redevelopment (Nef, 1998). Although this timeframe may seem rapid, smoke inhalation damages could mean a lengthy and extensive repair for an individual.

Finally, the last commonly known smell perception-related disease some individuals experience is parosmia. Parosmia is defined as having a distorted perception of smell (Gilbert, 2008). Individuals who suffer from this disease may experience smells differently than the average person may otherwise perceive. For example, a pleasant scent, like a rose, can smell as vulgar as garbage to a person with this disability, and vice-versa (Rosso, 2007). This particular impairment can be commonly confused with MCS, or Multiple Chemical Sensitivity. MCS occurs when people are extremely sensitive to chemicals – especially those in perfumes. These individuals have instant symptoms at the slightest whiff of these compounds but do not necessarily perceive them to be vulgar (Gilbert, 2008). Unfortunately, what many people do not realize is the cause of reaction is typically due to the alcohols and chemicals.

Why Smell is Important for Caregivers in the Emergency Department

The following section will discuss the importance of smells, both pleasant and unpleasant, for medical caregivers. It will review the instant effect smell has on an individual, and how adaptation occurs. This section

will also look at how caregivers use their sense of smell to help treat patients, and the issues that factor into how they perform their work.

Instantaneous Effect

In a healthcare setting, especially in a hospital Emergency Department, nurses and staff are constantly exposed to an assortment of smells - many which could be classified as "unpleasant". The reaction of smells can have a physiologic and psychological effect on those who experience it (Buckle, 2003). When a medical physician is responsible for caring for a patient under offensive conditions, they remain obligated to perform professionally and treat the patent with respect and with as much importance as another patient with non-emanating odors. Although some unpleasant odors could induce a negative emotion or physical reaction, such as gagging, it does not always mean it is harmful (Peng, 2009).

As mentioned earlier, every person experiences and reacts to smells differently. Some of these diverse reactions could be caused by mood, age, gender, and time of day – all which can play a part in creating sensitivity to some smells. As an example, Dr. Bryan Raudenbush from Wheeling Jesiut University performed a study to find the link between physical activity performance & smell. Eighteen males and 22 females who were all athletes and with a mean age of 20 years, performed a stress test on a treadmill. Every three minutes the incline on the machine would increase until a total of 15 minutes was performed. Each participant completed this study four separate times 48 hours apart from each other with the smell of jasmine, peppermint, dimethyl sulfide, and a 'control'. The smells used were chosen for

their ability to influence mood or performance, and were introduced through nasal tubes mixed with low flow oxygen. With each exercise, blood pressure, pulse, & oxygen consumption was measured and participants were asked the difficulty level of the exercise. Results indicated that participants found the task was easier and more slowly paced with peppermint, but no other differences were made with the other smells (Rosso, 2007). The findings from this study could be a stepping stone for positive olfaction stimuli in hospitals as it begins to show the mental effects an aroma has. By using an essential oil, such as peppermint, to make emergency staff believe the work they are producing is less than what it actually may be, caregivers may be better able to respond quicker and with a higher awareness of the surroundings.

William N. Denber, PhD and Joel S. Warm, PhD performed a 40 minute stressful task via the computer separating participants into either a room scented with peppermint or an unscented room. The study showed that the peppermint room had participants with more correct answers and whose performance levels did not decline. Although Dr. Denber and Dr. Warm had participants perform the task over a period of time to determine a cause and effect, they actually did not need the task to be so lengthy to determine a result. It is believed that the impact of aromas can be so instant that the thought of a particular smell can be just as powerful as the actual inhalation of it (Buckle, 2003). Similarly, even the idea of expecting a smell can induce odor perception, which, in the case of an emergency caregiver who may have the knowledge of their patient's illness prior to seeing them, triggers the brain to begin firing off signals about the sensation they are about the expect

(Gilbert, 2008). Therefore, a caregiver could potentially be affected by a negative odor even before physically experiencing it which may, in turn, prematurely affect their performance.

What happens when the smell experienced is unidentifiable? The scent could potentially be pleasant or revolting; however, caregivers could possibly react inadequately. Research has indicated that the central nervous system could experience widespread effects when it comes to smell, which has the ability to arouse memories, change moods, and also cause distraction (Raudenbush, Grayhem, Sears, & Wilson, 2009) (Smeets, Schifferstein, Boelema, & Lensvelt-Mulders, 2008). One example of this occurrence transpired during the pilot study where one participant noted that, although the aroma they had been exposed to was pleasant, they found themselves becoming distracted by it in an attempt to identify what the smell was rather than focus on the task at hand. This direct behavior response can be due to the sensation of smell which we, as humans, crave. Even in the case of perfumes, people drench themselves for the perception of a heightened sense of a particular essence even though it is not needed to survive (Rosso, 2007). The problem, in this case, is not whether the smell is pleasant or repulsive, but rather the level of distraction it produces. Even the most beautiful scents can cause an individual to become more focused on the aroma, and the connection as to what that smell is, as opposed to performing other tasks.

Finally, any smell, no matter if it is pleasant or appalling, has the ability to create lasting impressions on a person. An intense trauma associated with a smell can leave an indelible imprint on a person (Gilbert,

2008). Avery Gilbert notes an instance where a fire department paramedic was called to assist an injured mechanic who had been maimed when a tire exploded; the resulting effect was a badly damaged face. When mouth-to-mouth resuscitation was attempted, the paramedic had a difficult time locating the mouth and the victim died just after vomiting on the paramedic. For years the smell-linked trauma haunted him; when faced with a foul odor, he would experience a sudden nausea attack. Although this instance may have been extreme, the rule remains the same - that it only takes a single occurrence of physical distress for an odor to trigger an illness (Gilbert, 2008). In the case of an Emergency Department caregiver, it is important to know these trigger smells in the event a patient or family member enters in with this lingering smell. A single waft can cause more pandemonium in the department than necessary. However, there is an idea for a product that would cease specific molecules from triggering a sensation. According to Avery Gilbert, this "odor blocker" could make hospitals more pleasant to work in which would, in turn, make for happier patients (2008). But, until this time, other safe means must be taken into account.

Olfactory Adaptation

Another important note about how the human brain is affected by smell is its ability to adapt. Although it can be difficult for one person to identify a smell, "the olfactory system is always ready for the detection of novel odor molecules, but once they have been recognized, adaptation takes place and the odor signal is no longer perceived in a conscious manner" (Nef, 1998, p. 1). Take, for instance, the example of walking into a craft store.

Many times, as a person walks in, they are bombarded by a strong waft of smells. However, as the consumer begins to walk throughout the store, the scents of potpourri, artificial foliage, and markers start to drift away. This occurs because "the longer you are exposed to an odor, the more you adapt to it." (Gilbert, 2008, p. 85). An effect known as 'olfactory adaptation' occurs when an individual is exposed to a new odor for a long period of time and eventually the smell fades into the background (Gilbert, 2008). It is no longer new or novel, and the person "gets used to it". Although this particular adaptation would seem preferred in an unpleasant situation, this could be detrimental for emergency caregivers in patient evaluation.

Medical Treatment and Patient Evaluation

As discussed in a future section, nurses and caregivers use their sense of smell to help diagnose a patient. However, irrelevant of their occupation, people always evaluate others based on their odor (Rosso, 2007). Consider taking a stroll downtown one evening and accidentally bumping into someone who was 'homeless'. Logic would say that this person has done nothing necessarily wrong in society, and a simple apology from both parties would suffice. However, the olfactory nerves tend to fire off indicating an urgent need to leave the presence of this individual, typically with no exchange of words. According to George Simmel, the most intimate perception of another individual is smelling their body odor due to the fact "they penetrate in a gaseous form into our most sensory inner being" (Pink, 2009, pp. 17-18). One of the most repulsive sources of an odor in the Emergency Department doesn't always come from the odor emitted from a patient's skin; many

nurses gag at the emanation that comes from the bowels of a patient. During an observation at Banner Good Samaritan Medical Center, a foul odor wafted throughout the entire department – although it was not visibly apparent due to the casual workflow of the caregivers. When one nurse was asked what the odor was, they calmly replied "dirty feet" and carried on. However, when asked if the smell was unbearable, they chuckled and indicated that nothing was worse than the smell of a GI (Gastro Intestinal) bleed. In nearly every other response, it became apparent that the odors that were most offensive were ones that came from the bowels. Every person is aware of this smell, but little know why fecal odor is so potent. In 1984, researchers from Salt Lake City discovered that the key chemicals turned out to be sulfur-containing compounds such as dimethyl disulfide, dimethyl trisulfide, and methyl mercaptan (Gilbert, 2008).

It is known that a number of ailments a patient experiences can produce a foul odor; caregivers can sometimes use those emanations as clues to what the patient might be suffering from. Some examples include: yellow fever resembling the stench of a butcher shop, measles smelling like fresh plucked feathers, typhus mirroring the trace of mice, or nephritis smelling similar to ammonia. Other patient conditions, like the plague, can smell sweet and ironically similar to yellow apples; in addition, diabetes can simulate the scent of sugar (Ackerman, 1991). It is with these essences, along with the human body odor, that makes the most undeniable indoor source of odor: occupant-produced (Shusterman, 2010). Considering the aroma of some departments in a hospital where fresh plastic packaging takes precedence,

many would overlook the smell and carry on. However, it is when these odors of plastic wrappings and chemicals combine with occupant-produced smells that the unpleasant odors is created that many associate with a hospital setting. Although many would agree that their sense of smell can instantly trigger a memory, studies have shown that memory odors have the same level of effectiveness as other senses (Gilbert, 2008).

Finally, odors in the Emergency Departments may not be limited to patient medical issues. During a weekend course on aromatherapy and reflexology, the instructor commented that some hospitals, including Banner Desert Medical Center in Mesa, Arizona, use certain oils such as *Mentha piperita* (peppermint) to help women in labor induce their contractions. This method has been used to help mothers as the oil is believed to 'excite the muscles', making the delivery process easier for the mother. It is clear to see that olfactory sensations can greatly benefit caregivers in their line of work – whether by easing patients or helping to diagnose them. However, little is known about what affect this has on the caregiver and how they perform.

Common Caregiver Issues

Emergency Department caregivers could be considered some of the most dedicated professionals in their willingness to endure unmentionable circumstances and priorities. In 2011, Emergency Departments nationwide had 110 million visits, each unique in their own way (Mcginnis, 2006). With every one of those visits, caregivers must perform all of the tasks necessary in order to diagnose, treat, and comfort the patient. As reported by the Emergency Nurses Association (ENA), the typical Emergency Department

nurse carries out the following tasks: triage and prioritization, assessment, response evaluation, planning, analysis, nursing diagnosis, interventions implementation, preparedness of emergency operations, outcome identification, crisis intervention, and resuscitation and stabilization (Mcginnis, 2006).

With so much information to gather and maintain, it would seem that stress would be inevitable in the workplace. According to author Lynn Keegan, "the term 'stress' refers to a heightened physical or mental state produced by a change in the internal or external environment" (2003, p. 56). In a 2002 study done to compare the amount of stress between nurses in different departments, 37% of emergency Registered Nurses (RNs) reported feeling that they were under a great amount of stress that occurred daily, compared to 30% of other non-emergency RNs. In addition, where 3% of other RNs felt they have never been under a great amount of stress, none of the emergency RNs reported this perception indicating that stress was a daily occurrence in the Emergency Department at some level (Mcginnis, 2006). This, in turn, would mean that at any point in time, emergency caregivers could experience any of the 26 symptoms that are a result of prolonged stress including: tires easily, breathlessness, nervousness, chest pain, sighing, dizziness, faintness, apprehensiveness, headache, paresis, weakness, trembling, unsatisfactory breathing, insomnia, unhappiness, shakiness, continuous fatigue all the time, sweating, fear of death, smothering, syncope, nervous chill, urinary frequency, vomiting & diarrhea, anorexia, palpitations (Buckle, 2003).

Unfortunately, because of today's world of increasing technology, "society works & lives in stagnant structures" (Rosso, 2007, p. 29). In a healthcare setting, sanitation is paramount to prevent hospital acquired infections (HAI). Unfortunate cases where patients come into the hospital with one ailment, and leave with (or remain as an inpatient due to) easily contracted infections is a more common scene then healthcare officials would like to admit. The use of essential oils has shown to reduce the spread of bacteria when used topically, orally, and even when inhaled, which has the potential of reducing the number of hospital acquired infections. In addition to working in an enclosed environment, the staff can be more susceptible to odors, as well as, bacteria.

What is Aromatherapy?

Aromatherapy has been around for thousands of years, and has played a distant part in many different cultures through medicines and religious ceremonies. In today's society, 'aromatherapy' is considered to be the use of essential plant-based oils in a therapeutic practice (Tillett & Ames, 2010). Today, about 375-400 essential oils are made available to clinical and therapeutic aromatherapists, and many other are available for recreational use (Cristina, 2004). These clinical-grade oils have shown to have documented research on the effects of using them topically, orally, and through inhalation. An important note when using true essential oils: the Latin name is always given in addition to the common name. These names help to decipher what exactly is in the bottle and the types of plants used. When reading the names, the Latin name is always in italics with only the

first of the words capitalized. The first term is the genus name while the second is the species name. For example, the essential oil of peppermint is seen as: *Mentha piperita* (peppermint) (Buckle, 2003). It is with this type of classification and labeling that a person is able to identify true essential oils which would indicate the true effectiveness of that oil. It may come as a surprise that essential oils are one of the most resilient foreign substances our body accepts. In fact, not only is an essential oil absorbed into the body through topical application, but when aromatic molecules evaporate into the air, some are absorbed through the skin (Cristina, 2004). One study using the essential oil of rosemary measured the amount of α–pinene absorbed through inhalation to determine how effective breathing in an aroma was. The study found 60% of the α–pinene was absorbed through inhalation, and only 8% was exhaled back out while the remainder (32%) was emitted by urine (Buckle, 2003). Even the detection of some essential oils, such as lavender, can be noticed in the bloodstream within minutes of inhalation. This shows that even by the indirect method of breathing in, the effects of a true essential oil can be direct, pure, and abundant. Aromatherapy today works by a grouping of notes – twelve notes to be exact, which include a top, middle, and base. In the 19th century, chemist and perfumer Septimus Piesse developed this classification system to determine the aroma's evaporation rate. Aromas that evaporated quicker were placed in the top notes while the base notes were composed of aromas that lasted the longest. Other than an update in the early 1990s, perfumers still use this system today (Buckle, 2003). One of the most popular examples of this system being used is seen in

the novel turned film "Perfume: the Story of a Murderer" by German writer Patrick Süskind who introduces the main character as having the most incredible sense of smell and who will go at any length to create the ultimate perfume using the idea of smell notes. Unfortunately, with the term "aromatherapy" becoming ever more apparent in consumerism, there come many misunderstandings and misrepresentations. Many perfume industries love to take advantage of the market by using the term and labeling their products to reflect the natural properties of true essentials oil such as "Relaxing Vanilla" (Buckle, 2003).The most prominent fact is that the use of essential oils does not have to stop at inhalation but can include the use of topical and oral treatments to create a healing effect.

Why Aromatherapy? (How Aromas Affect Performance)

As mentioned earlier, true essential oils can affect a person even with the simple effort of unconscious breathing. However, as Jane Buckle, author of Clinical Aromatherapy, notes: "taking a normal breath is different than sniffing an essential oil" because of the potential healing properties that reside within these plant-based aromas (2003, p. 29). Lists of studies were included in her book to show how certain essential oils can affect individuals in key ways just by inhalation. For example, *Mentha piperita* (peppermint) exhibited an increase in psychological stimulation while *Lavandula angustifolia* (lavender) induced relaxation. An interesting note was made that both of these oils produced efficiency in proofreading even though their physical influences had drastically opposite outcomes (Buckle, 2003). Unfortunately for the science of aromatherapy, there is a shortage of

acceptance for introducing this homeopathic treatment into the patient care environment due to the inadequacy and scarcity of clinical research. Much of this absence is due to many scientists finding it difficult to perform randomized, blind trials when conducting research on essential oils; there is a temptation to use and compare multiple oils during the same trial (Tillett & Ames, 2010). Many people also ask the question: how ethical is it to be able to manipulate mood for individuals? Jane Buckle has since responded by asking the following questions: how many patients must sign a consent form to approve air fresheners, personal cleaning products (such as scented soap, aftershave, hair spray) worn by their caregivers, and cleaning fluids used in hospitals (such as Lysol) which may cause allergic reactions (2003)? For what has been tested and recorded, this section will review the positive persuasive influences, allergic reactions, and antibiotic and antimicrobial qualities of essential oils, followed by the effects each oil can evoke that have been used in this research.

Persuasive Positivity

As mentioned before, smell can play an integral part in how a person could react to a situation or another being. In fact, based on an ever-growing body of evidence, aroma and olfaction influences may be the result of a greater portion of human behavior based off of persuasive motivational factors. It is believed that mood & attitude alone can be improved by 40% with the presence of a pleasant odor (Rosso, 2007). This exorbitant amount of improvement can play a key role in job satisfaction for caregivers and may, in turn, improve performance as well as the quality of patient care. These

characteristics of essential oils are so critical to understand because of the nature of the oils. When a true essential oil is inhaled, ingested, or applied to the skin, they take a direct route to the nervous system and brain due to its fat-loving and lipophilic tendencies (Cristina, 2004). This makes understanding the oils and how they may affect a person imperative to not cause an undesired response. Although some studies have shown decreased work efficiency when exposed to sedative aromas, such as lavender, this only tends to be the case with certain individuals. For others, a calming aroma may increase the efficiency by reducing surrounding stressors (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005). Therefore, it is vital to have a solid understanding of how the oils not only affect a person physically, but emotionally.

Allergies

Unfortunately, with consumerism and marketing exploitation of the term 'aromatherapy', many people confuse the effects of essential oils with those of chemically - altered or - created flavors and perfumes. Synthetic or adulterated oils, such as perfumes or fragrances, are not the same as true essential oils and typically do not offer any therapeutic effects. In many cases, when an individual is allergic to an aroma, like lavender, they are reacting to a non-pure plant-extract causing chemical sensitivities and headaches (Butje, Repede, & Shattell, 2008).Therefore, although people can be, and are, allergic to some perfumes, they are not linked to aromatherapy or essential oils (Shusterman, 2010) (Rosso, 2007). In many cases, the user is suffering from MCS (Multiple Chemical Sensitivity) and not an allergic

reaction to an essential oil. This clarification is crucial in understanding the benefits and risks to using true essential oils as compared to non-plant-extracted based perfumes.

During a weekend course covering the use of aromatherapy in a clinical setting, the instructor recalled an instance that depicted the effect of essential oils compared to "fake" perfumes. As a certified clinical aromatherapist, they had a broad knowledge of essential oils and were aware of the positive effects each essential oil had. They recalled one session where a patient indicated that they were allergic to lavender and, although the therapist was aware of the concerns, they added a small amount of lavender to the blend to help with the symptoms the patient had come in for. The only comment the patient had made during the session was how pleasant the aroma was they were experiencing, and never showed any signs of an allergic reaction – even when the blend was applied to the skin. This example does not ultimately prove that essential oils are immune from causing any sort of reaction; in fact, author David Stewart P.h.D, D.N.M, believes that some essential oils could produce a slight response, but it may not necessarily be classified as an allergic reaction. He continues to say that while allergies tend to often be a lifelong and sometimes permanent reaction, any reaction to an essential oil would be temporary and may, in fact, be a positive and therapeutic process in healing and cleansing (2010). Therefore, even in the case that essential oils would cause an allergic reaction, the swiftness in the oil excretion could prohibit a long-term allergic effect.

Antibiotic

Using essential oils as an antibiotic may seem to be a story from a witchdoctor's tale, especially with today's heavy use of prescription drugs; however, it is a very plausible and holistic remedy. While an antibiotic or a prescriptive drug may attack to kill harmful bacteria, it may also destroy the good bacteria which may help with indispensable bodily activities, such as food digestion. Essential oils, however, are smart enough to attack the bad bacteria in the body while providing the good bacteria with nourishment. Most pharmaceuticals & antibiotics may seem to cure a sickness; however, because they make the body more acidic, they can stimulate the growth of other harmful organisms and fungi in the body. Some of these viruses and fungi, which a lab-made antibiotic is unable to attack, can be combatted by essential oils (Stewart, P.h.D., D.N.M., 2010). In considering how often emergency caregivers interact with contagious patients, it would seem that there would be a strong emphasis to prevent or reduce the possibility of a caregiver becoming ill themselves; their immune systems becomes weaker the more prescriptions they ingest. While mixing some prescription drugs is a serious hazard to a person's health, David Stewart notes that mixing essential oils into a hazardous condition is unheard of. Whereas one in seven patients at a hospital may experience complications due to adverse drug interaction, none would experience these similar complications when essential oils are used (2010). Unfortunately, many people do not always take the warning labels on their prescriptions seriously and thus serious injury or illness or even a fatality could be possible. What many people don't fully

understand is that artificial drugs do not 'fix' a problem. Prescriptions are designed and built in a laboratory to trick to body to allow for pain relief and ease discomfort which can cause future side effects (Stewart, P.h.D., D.N.M., 2010). Julian Whitaker, M.D., notes that over 10 million cases of negative reactions to over-the-counter medications are reported yearly where symptoms are noted to be more than just a headache or nausea. Between 60,000 and 140,000 people die every year due to negative reactions to medications prescribed by their doctors which is more than the number of deaths from the Vietnam War (Stewart, P.h.D., D.N.M., 2010). Unfortunately, in today's medical field, doctors are lectured that the only effective medications are those that have the potential for adverse negative side effects, and if the possibility of having a negative side effect is non-existent (as with essential oils) then the medication must not be effective (Stewart, P.h.D., D.N.M., 2010).

Antimicrobial

Beyond the realm of potential hazards that essential oils can play a part is the fantastic possibility that its benefits are currently highly underutilized. After all, it is not only patients in the Emergency Department who are at risk from airborne infections that spread throughout the department; staff is at risk as well (Shook, 1995). The extensive studies on the spread of airborne infections show that pathogens become aerosolized on small residual particles called a 'droplet nuclei', which are left behind when respiratory droplets dry. These "droplet nuclei are very light and can travel for long distances in air currents." (Shook, 1995, p. 266). This potential for a

swift and vast disbursement could mean the difference between a healthy hospital and a highly contagious one. During a review of the transmission of measles in U.S. health care settings, nearly 91% of staff who contracted the disease did so from patients; over the remaining 9% contracted the disease from other co-workers (Shook, 1995). Clearly, hospitals need to consider looking into more effective and beneficial ways to maintain a healthy atmosphere within their buildings. One of the problems that many designers and nursing staff are facing is the increase in drug-resistant bacteria. These bacteria are increasing their resistance through antibiotic therapy, causing a major problem of hospital acquired infections (HAI), and causing for stronger and more abundant amounts of medicines that need to be used (Khan, Zahin, Husain, & Ahmad, 2009). In addition, bacteria on surfaces and in the air are growing at speeds that current chemical products are unable to maintain. Through means of such behaviors, like antibiotic resistance and swarming, bacteria are seen as being highly interactive organisms with strong communications (Rumbaugh, 2009). A bacterium grows through communication called 'quorum sensing' which occurs when a pheromone is released (Brookfield, 1998). This pheromone signals the molecules around a single cell to determine how many bacteria are in the vicinity. Through this method, the bacteria population can then make a harmonized response (Rumbaugh, 2009).

Although, the current situation of bacteria rapidly outnumbering the odds of potential depletion may seem fictional, scientist are now better understanding how bacteria communicate, and how essential oils are

preventing that communication from happening. Essentials oils have been shown to have antibacterial properties based on in-vitro studies (Sanchez-Gonzalez, Chafer, Hernandez, Chiralt, & Gonzalez-Martinez, 2011). And many trials done between 1970 and 1990 focused on utilizing essential oils as antimicrobials. It is specifically the alcohols, phenols, ketones, aldehydes, phthalids, and ethers that help to make these oils antimicrobial (Tillett & Ames, 2010) (Serrano, et al., 2011). Studies have shown that several essential oils not only suppress bacterial growth but also block quorum sensing from becoming a regulated process (Szabó, et al., 2010). Without the ability to communicate, bacteria cannot develop in isolation and eventually die (Rumbaugh, 2009). "In varying degrees, all essential oils are antiseptic, kill bacteria and inhibit their growth and promote cellular rejuvenation when applied to the skin" (Cristina, 2004, p. 475). In essence, the use of essential oils can change the air quality of a room to be cleansed and disinfected, which may not only benefit the patients and their families, but also the staff working in these highly-contagious departments (Cristina, 2004). One of the most personal achievements essential oils can have on an individual is the rapid flux it can have on the body. Essential oils can be excreted from the body at a rapid speed, and micro-organisms are unable to develop resistance (Cristina, 2004). Because essential oils always vary slightly, bacteria are unable to develop immunity to them. Unlike prescription drugs and antibiotics, which contain the same exact measurement of chemicals every time, bacteria are more likely to be able to develop a resistance to the always-varying concentration of essential oils (Stewart, P.h.D., D.N.M., 2010). This

property can not only reduce the amount of high-dosage medication caregivers may need to take to ease pain, headaches, nausea, or stress, but may also help prevent foreign bacteria from invading their own immune systems.

Select Essential Oils and their Properties: *Mentha piperita* (Peppermint)

Peppermint is one of the most well-known of the hundreds of varieties of essential oils, both due to its memorable aroma and its characteristic traits. Remarkably, *Mentha piperita* (peppermint) oil is "unique in that it is the only essential oil to be licensed as a medicine . . ." (Tate, 1997, p. 546). In fact, among all of the essential oils that are readily available in a typical Emergency Department, *Mentha piperita* tends to be the most commonly accessible. This characteristic shows an acceptance in the medical field to allow for non-chemical-based products to be used as patient treatment. Past studies have indicated that peppermint can influence alertness, motivation, and task performance (Raudenbush, Grayhem, Sears, & Wilson, 2009). Based on research and centuries of use, peppermint is believed to counter sluggishness, shock, insomnia, mental fatigue, lack of focus, lethargy, and apathy; all states of being that can drastically affect performance in an emergency situation (Rosso, 2007). Performance has also been shown to increase when using peppermint for a sustained visual attention task (Moss, Hewitt, & Moss, 2008).

Studies have shown peppermint as having the ability to lower anxiety and fatigue (Raudenbush, Grayhem, Sears, & Wilson, 2009). These

characteristics could be vital for emergency caregivers to stay on task with patients – especially those who may prove to more difficult or more of a risk to themselves or others. A peppermint aroma has been studied and shown to have a more direct connection to an individual by increasing the level of stimulation (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005). One EEG study revealed that peppermint oil could not only lead to sustained attention, but also increase attention (Norrish, 2005). Exposure to peppermint oil can improve memory and cognition, increase arousal, and enhance cognitive assessment performance (Butje, Repede, & Shattell, 2008).

The essential oil of peppermint, like many other oils, is thought to be effective because of specific properties it has, such as anti-emetic, analgesic, and antispasmodic (Hines, Steels, Chang, & Gibbins, 2010). *Mentha x piperita* is used for antiseptic, headaches & migraines, flu and colds (Cristina, 2004). The treatment of nausea for caregivers can be beneficial when handling patients with not-so-pleasant odors or sights in an Emergency Department. One such essential oil that could be used is *Mentha x piperita* (peppermint) which has antispasmodic effects (Buckle, 2003). Peppermint can act as a febrifuge agent, a medication to reduce fever, which benefits the immune system (Lawless, 1995)

Select Essential Oils and their Properties: *Zingiber officinale* (Ginger)

In addition to peppermint reducing nausea, ginger *Zingiber officinale* can be used to reduce feelings of vomiting and gagging. In a study including 70 expectant mothers, the baseline vomiting and nausea significantly decreased in the group using ginger (Buckle, 2003). Although the typical

emergency caregiver may not experience these types of symptoms an expecting mother would, they may come across an instance, such as a foul odor, that may cause them to involuntarily react. Human immune function improvement and antimicrobial reduction in food-borne bacteria can be the result of using citrus oils such as ginger (Cristina, 2004). This environmentally friendly "germ fighter" can be an essential tool in future healthcare environments.

Select Essential Oils and their Properties: *Coffee Arabica* and Coffee Grounds

Nearly every person who works in an American Emergency Department is familiar with the smell of coffee. Most Americans cannot start their day without a cup, and a number of EDs cannot rid foul odors from their departments without it. Coffee beans can contain over 1,000 chemical compounds (with an additional 300 after brewing) which contain some antioxidants. Although there have not been any studies to show if the inhalation of these compounds are as beneficial as consuming them orally, studies have shown that some antioxidants in the aroma itself can stay effective for 30 days (Squires, 1997). And, as many drinkers would agree, the aroma of coffee can be used to lift moods (Gilbert, 2008). This sensation, if verified, could allow graveyard-shift caregivers to increase alertness and productivity. One common tool for coffee grounds currently in EDs is its perceived ability to absorb unpleasant odors from the surrounding areas. Although many people believe this to be true due the number of perfume companies who line their shelves with glasses of coffee beans to cancel the

previous inhalation in order to test the next, this theory has not yet been fully proven. In fact, Arabica coffee contains 27 aroma-impact molecules which would seem contradictory to the idea of neutralizing the air (Gilbert, 2008).

Select Essential Oils and their Properties: *Lavandula vera* (Lavender)

"There are over 40 different kinds of Lavender." (Cristina, 2004, p. 478). A single pound of the essential oil of lavender can take 150 pounds of the flower to produce (Cristina, 2004). Lavender can be used as a non-pharmacologic means to reduce stress (Tillett & Ames, 2010). Lavender has been reported to create a 'sense of euphoria' with reduced tension, anxiety, depression, and feelings of stress (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005). Lavender can lower blood pressure by decreasing sympathetic activity while increasing parasympathetic activity (McCaffrey, Thomas, & Kinzelman, 2009). Exposure to lavender oil can improve mood while decreasing anxiety (Butje, Repede, & Shattell, 2008).

In a study where a group of subjects were exposed to the aroma of lavender, a decrease in character count and calculating arithmetical equations were evident compared to participants exposed to another aroma or in the control group (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005). Although earlier studies may suggest that cognitive function is reduced due to the relaxing effects of lavender, more recent studies have indicated a benefit to sedative-type lavender aroma which may assist in reducing overstimulation by the subject's stressful work which may increase their overall performance (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005).

Mathematical computing speed has been shown to improve after exposure to lavender (Moss, Hewitt, & Moss, 2008). “An aroma that increases alertness may be expected to enhance cognitive performance, and one that increases calmness to impair it . . .” (Moss, Hewitt, & Moss, 2008, p. 73).

While exposed to visual and auditory stimulation while performing simple tasks. Participants who were exposed to lavender and showed to have a reduced performance in attention-required tasks. These tests showed that in intense conditions where mental activity is required to be at a high level, the aroma of lavender can decrease the stimulation level (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005). In a study done by Sakamoto, 36 healthy male students were asked to perform ‘work’ from 9:30a until 5:00p. These students were grouped into three categories: control group, jasmine group, and lavender group. During the course of the day, participants were given five work sessions which all took place on a computer for an hour at a time and focused on the ability for the participants to resist drowsiness and maintain high concentration. Between work sessions, participants were able to take a thirty minute recess and one half hour lunch break. Results of the study showed that each group had lowered concentration levels, however, the lavender group had significantly higher levels than the control group (Sakamoto, Minoura, Usui, Ishizuka, & Kanba, 2005).

Lavandula angustifolia can be used for an antiseptic, reduced blood pressure, soothing, antidepressant (Cristina, 2004). Lavender can also be used as an antiviral and bactericidal agent which can help with the immune system (Lawless, 1995)

Select Essential Oils and their Properties: *Citrus bergamia* (Bergamot)

Another citrus commonly used in aromatherapy is known as bergamot. Bergamot is used by aromatherapists to improve mood while reducing anxiety and stress (Butje, Repede, & Shattell, 2008). This reaction could assist caregivers in a high-intensive situation to stay calm and efficiently perform their duties. In addition to a positive response to inhaling, ". . . citrus oils are antimicrobial . . ." and can help to potentially reduce hospital acquired infections/illnesses (Cristina, 2004, p. 474).

Although bergamot does have phototoxic properties, which can make a person sensitive to sun or light, this is only the case if the oil is placed directly on the skin rather than providing exposure through inhalation or ingestion (Stewart, P.h.D., D.N.M., 2010). Bergamot can help the immune system by acting as bactericidal and antiviral agent (Lawless, 1995)

Conclusion

In this chapter, the topics discussed revealed the biological definition as to what is smell, why humans have the ability to smell, and how individuals are able to recognize and process each unique odor or aroma. The chapter continued on to distinguish why the topic of olfaction is important for caregivers - whether it be to help diagnose a patient or how it can affect their performance. Finally, the chapter concluded with what aromatherapy is, and research on the different types of essential oils used in both the pilot and formal study.

METHODOLOGY

Introduction

This chapter discusses the methodology regarding data collection and analysis from the pilot experiment, modifications made between the pilot study and the formal study, and the garnering approach for the formal experiment of this research. The topics that will be discussed include: the research questions, the methodology and methods used, the data tools used, and the safety concerns for both experiments. In addition, both studies will cover its theoretical framework, participant and location selection, procedures, and variables. Notable occurrences from the pilot study results will be explained, highlighting any unusual or unpredicted cause and effects. Lastly, this chapter will review modifications made for the formal study, which were in direct response to experiences and findings from the pilot experiment to more efficiently and effectively answer the research questions.

Research Questions

The objective of this study is to determine the effects of caregiver performance within a simulated Emergency Department environment relative to olfactory stimuli. This focus leads to the research questions in the following paragraphs.

1) What affect, if any, will an aroma have on performance? This question specifically correlates to the pilot study as it investigates the effects of aromas separately from other aromatic environments. The process for answering this question will utilize a series of different true essential oils, including *Mentha piperita* (peppermint), *Zingiber officinalis* (Ginger),

Lavandula vera (Lavender), *Citrus bergamia* (Bergamot), which will be diffused, as well as coffee grounds.

2) Will performance be affected by an unpleasant odor? With the variety, intensity, and frequency of odors in a typical Emergency Department, the answer to this question will prove to be a beneficial stepping stone to healthcare design and health research. Both the pilot and formal studies will seek to answer this question by exposing participants to a simulated common Emergency Department odor: "dirty feet".

3) Can, and in what ways does, an aroma following the presence of an odor affect caregiver performance? Because of the layout between studies, this question will be specifically geared towards the formal experiments, as each participant will be asked to experience all three environments: control, then odor, and then aroma. This question will seek to find a practical correlation between the first two questions, and what could be considered to be a more realistic real life scenario.

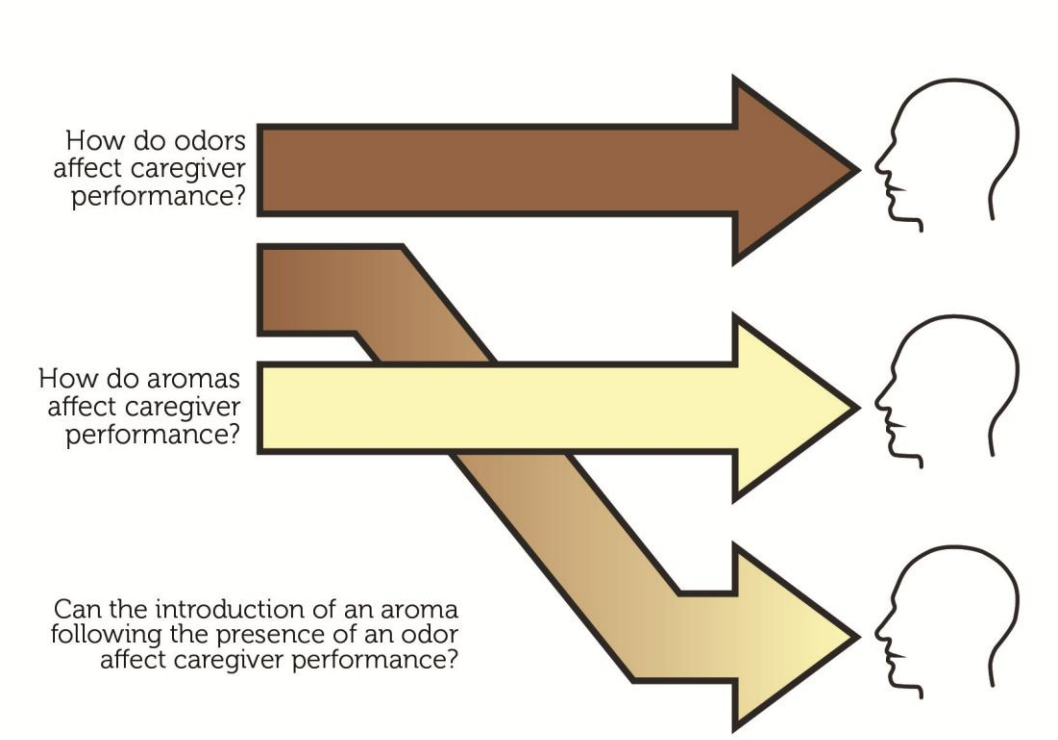


Figure 3: Visual representation of the research questions for this thesis.

Methodology

This research used mixed methods to gather and collect data. The most important piece was the physical experiments that took place during both the pilot study and the formal study, confirming attributes that reinforced or contradicted the hypothesis of this research. This information allowed the investigator to have a semi-controlled environment to test subjects exposed to a variety of aromatic stimulants to gather quantitative data from the subjects' heart-rate, skin temperature, and results from the web-based computerized tests. In addition, qualitative data was collected through study participants scaling their own emotional "states of being" during the experiments, and with their comments made during and following each session. A secondary qualitative method was also introduced: electronic

surveys were used to gather information from a broader range of Emergency Department caregivers across a number of different healthcare systems.

Methods Used

This section will discuss the variety of tools used to collect the data during both the pilot and formal studies, and the additional forms of data collection.

Heart-Rate Monitor

During both of the experiments, all participants were asked to wear a heart-rate monitor. Subjects were allowed to decline at any time; however, none chose to do so. The monitor was worn on one of the participants' fingers like a ring. The use of a heart-rate monitor helped the investigator to display acute stress and anxiety through pulse rates (McCaffrey, Thomas, & Kinzelman, 2009). Information from this device assisted in the data analysis phase to help quantitatively determine the physical stress subjects experienced during each test given. Had data from the heart-rate monitor not been collected in this manner, it is possible some discoveries by the investigator would have been missed.

In the pilot study, information from these heart-rate monitors were collected before and after each test type during the experiment causing measurements to be collected at different time intervals. Although, no data seems to be corrupted using this technique, one participant showed an extremely high pulse rate moments before finishing a test which dropped dramatically after its completion which would indicate a heightened level of stress shortly before the test ended followed by an instant calmness.

Modifications were made in the formal study. Data was collected at a consistent time interval of five minutes, allowing each session to last twenty minutes and the total study time to last about an hour and a half. This was done to assess two additional metrics: the physical and the psychological effects of constant movement in an attempt to simulate a typical emergency environment. The stress of continuous movement and tasks was encouraged to determine how a caregiver would react to stressful situations in varying aromatic environments.

Bio-Feedback Monitor

Similar to collecting heart-rate, a bio-feedback monitor was used in both experiments to collect the skin temperature of the participants. This piece of data is an important telling component of stress. An individual's skin temperature drops when a person is stressed; this is due to the movement of blood away from the limbs towards the heart, as if they were under attack. This primal technique has allowed humans to evolve in a way that, when injured, less blood would be lost from the extremities (Rosso, 2007). It also provides added blood flow, nourishment, and oxygen to the most vital organ responsible for life. Results from this device assisted in the investigator's ability to analyze and confirm that the participant was under duress.

Although both studies used a bio-feedback monitor, the tool used was modified in both use and form between experiments. In the pilot study, the monitor used was a wire which was attached to the participant's finger by a strip of Velcro and attached to a monitor, only seen by the investigator. This technique was useful in collecting its data; however, some participants felt

uncomfortable wearing the monitor during the entire study as they felt it restricted them from using that finger (typically the pinky) during their entire session. In some instances, subjects accidently pulled the wire off of their finger which the wire was quickly set back into place. This malfunction did not appear to affect the data collected. Similar to the heart-rate monitor for the pilot study, information from the bio-feedback monitor was collected in the period before and after each test the participant completed.

The bio-feedback monitor for the formal study was changed to better testing efficiency. It was updated to have information collected every five minutes and to have the participants wear the device throughout the entire study In addition, a secondary stand-alone bio-feedback device was set for the participants to be able to place their fingers on only at each five minute interval during which their temperature data was collected. Participants were, at this time interval, instructed to place two fingers on a metal plate for data to be collected. This then allowed the participants to move about freely throughout the experiment's space when not asked to collect this information, in between the five minute data collection interval. This modification reduced the subjects' level of distraction and frustration as well as decreased the likelihood of potential technical difficulties with the devices.

Smell Inhalation Through a Diffuser

Due to the wide variety of essential oils and the uniqueness these oils have on individuals, "it is difficult to conduct blinded, randomized clinical trials" (Tillett & Ames, 2010). During both the pilot and formal study, "aromatherapy" was used to introduce the participants to the pleasant

aromas. This technique can be administered three ways: topically, orally, and through inhalation (Buckle, 2003), with the latter being the most common and safest way to use essential oils (Cristina, 2004). Because "the most effective route for decreasing anxiety and slowing an over-active mind" is through inhalation, this study focuses on the olfactory response to smells, rather than through additional means, such as massage or reflexology (Butje, Repede, & Shattell, 2008, p. 50).

There are two types of inhalation: direct and indirect. Direct inhalation occurs when a participant has close contact with a direct source of an essential oil. Examples of this include: placing a cotton ball under a pillow case, breathing normally through a tissue, or elevating the head over a bowl of warm water containing a few drops of essential oil. Indirect inhalation uses a diffuser, or nebulizer, to disperse particles of an essential oil into the air and was used during the pleasant aromatic environments in both experiments (Buckle, 2003). This has shown to allow essential oils to be absorbed quickly and to appear in the bloodstream after only a few minutes, allowing it's user to achieve the full benefits of the oil without being directly exposed to the oil (Cristina, 2004). Because of the tasks set forth for the participants to complete during both experiments, indirect inhalation through a diffuser was used.

Test Descriptions

This section will discuss the different web-based computerized tasks used during both the pilot and the formal studies. All tests were performed off of an unlinked page of the investigator's personal website which was

active during each session. Both experiments had their own designated web link as some modifications were made between the studies.

Mood Mapping: This test allowed for participants to move a slider bar to the left or right to distinguish the amount of a particular emotion or "state of being" they felt at that moment. This test was crucial to incorporate at the beginning of each session to gather a baseline to compare to later in the session.

In the pilot study, this test was performed twice: once after the consent form was signed, and as part of the Beck Test in the final task. This technique provided a simple comparison between how participants felt prior to taking the tests and after taking the test.

The formal study was set up to allow this task to be taken a total of four times: 1) After the consent form was signed – this instance acted as a baseline determining the participants at-rest state 2) After the Control session was complete 3) After the Odor session was complete 4) After the Aroma session was complete. This provided a mental reaction that the investigator could determine related to each of the aromatic environments.

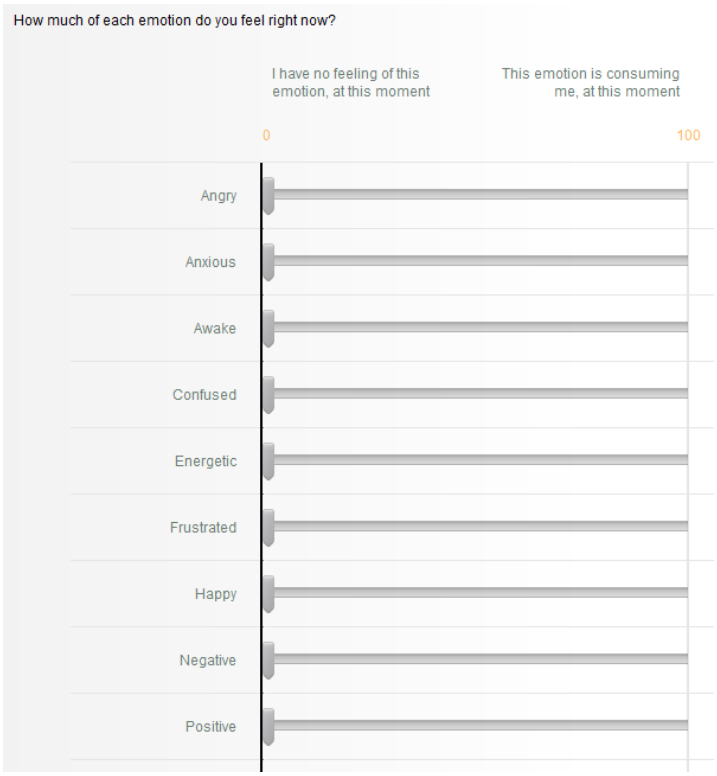


Figure 4: Mood Mapping web-based online tool screenshot used during the Pilot Study.

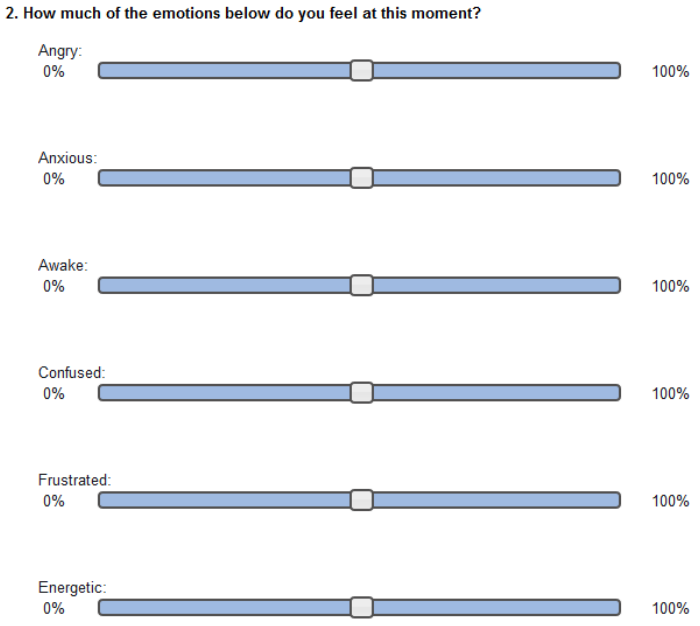


Figure 5: Mood Mapping web-based online tool screenshot used during the Formal Study. Platforms were shifted between studies which allowed for easier tracking.

Multi-Tasking: This test was performed three times per aromatic session for each participant. The purpose of this task was to produce a stressful situation filled with multiple stimuli seeking equal attention within a two-minute time period. This test was included into these studies to replicate the often hectic environment of a typical Emergency Department where caregivers must be aware of, and attending to, multiple patients, and complete various types of paperwork, assessments, tasks, and tests. Unlike all of the other web-based tasks, this test was not created by the investigator. Instead, an unknown designer created the program who was unable to be contacted for any modifications or credits.

In all attempts, the participants were able to start the test when they felt ready by clicking the start button. Subjects were then confronted with three simultaneous task themes: math, arrows, and color. The first was a simple math problem staying within basic arithmetic skills (addition, subtraction, multiplication, and division). In order to achieve points, participants only needed to enter the correct digits using either the row on top of a 'qwerty' keyboard or using the keyboard number pad (if available). The second task tested the participants' motor skills by requiring the up, down, left, and right arrow keys on the keyboard to be hit when their corresponding icon crossed either a dashed or solid line on the monitor. If the correct arrow was selected between the dashed lines, subjects received 10 points, whereas if the correct arrow was selected between the solid lines, subjects received 20 points. The third part of the test required more thought process as participants were instructed to select certain keys on the keyboard

to correlate with the background color of a section of the screen. Depending on whether subjects decided to use the 'qwerty' keyboard or number pad determined the key they would use for each of the three colors: red = "/" or "a", yellow = "*" or "s", blue = "-" or "d". If the correct key was selected, the background of that section turned green; if incorrect, it turned black. All three multi-tasking tests appeared on the monitor screen, and were to be performed, at the same time.

During the pilot study, participants were instructed to attempt the Multi-tasking test three times, or rounds. At the start of the first round, the participants were advised to perform the task as best as they could without the assistance of the investigator. This provided a blind attempt testing the dexterity and comprehension of participants. Even if a participant appeared frustrated and asked for help, the investigator refused to relay helpful information, maintaining a high stress level for the subject. This led to one participant refusing to attempt the task due to no clear instructions. Before the second round, participants were allowed to review the help menu, set by the task's creator, but no verbal instructions were given by the investigator. Before the final round, the investigator was able to reveal hints about the test, including one that would prevent the subject from imputing information depending on the type of keyboard the computer they were using had.

In the formal study, participants performed the task only once during each aromatic session they experienced. In addition, prior to collecting any data and following the signed consent form, subjects were invited to participate in a practice run of the test. This allowed all participants to have

an equal knowledge of how to correctly perform the task prior to collecting any data. Caregivers in this test had to be conscious of their simulated patient at all times, and once this test was started they did not have the ability to pause and return to it following the care of the patient's needs.

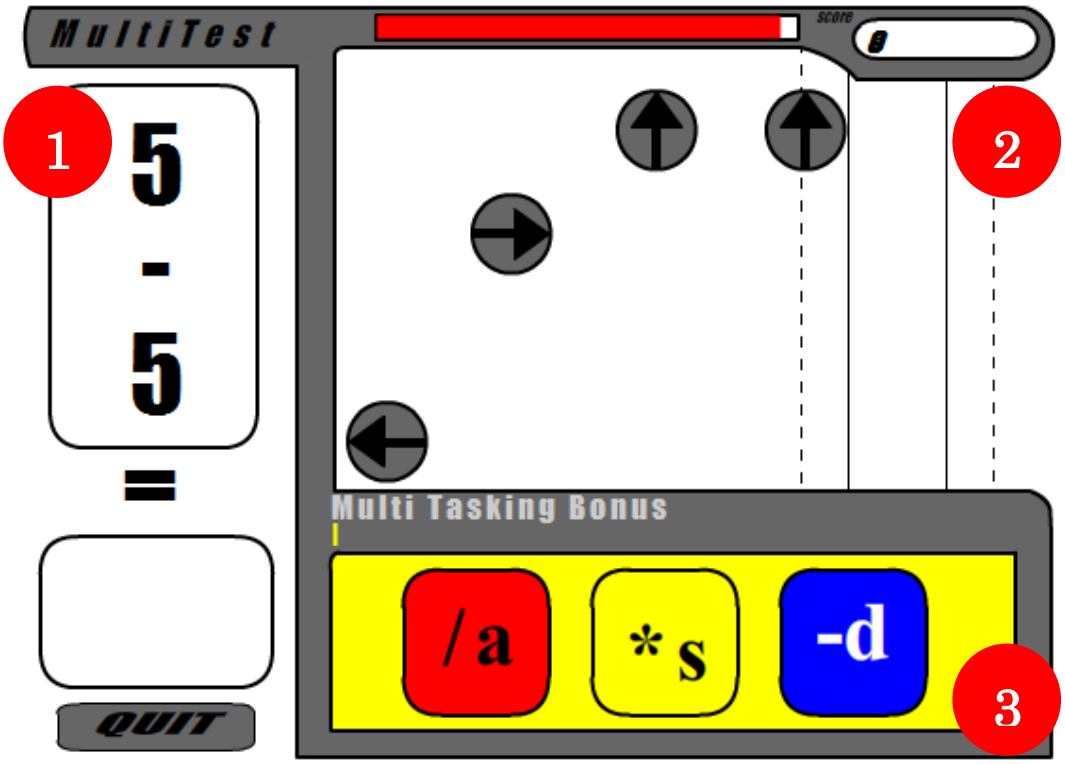


Figure 6: Screenshot of the Multi-tasking Test. 1) Math portion 2) Arrow portion 3) Color portion.

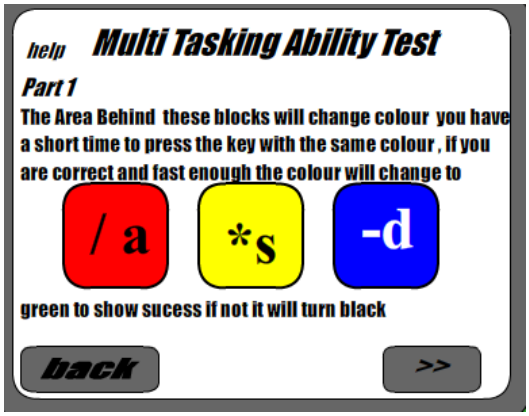


Figure 7: Screenshot of the help menu only shown to participants during the Pilot Study prior to starting the second round.

Medical Terms and Knowledge: This test was initially geared towards the medical students in the early stages of the pilot study where it remained even after the IRB modification. However, as mentioned later in this chapter, this test was removed during the formal study. The goal of this task sought to determine if olfactory stimuli affected an individual's knowledge on the memory center of the brain – important for diagnosing a patient. Subjects were instructed to click and drag a term that appeared on the screen and move it to the correct location on the diagram of the human body. All terms used were based on body regions (i.e. femur, bicep, etc.) rather than distinct parts.

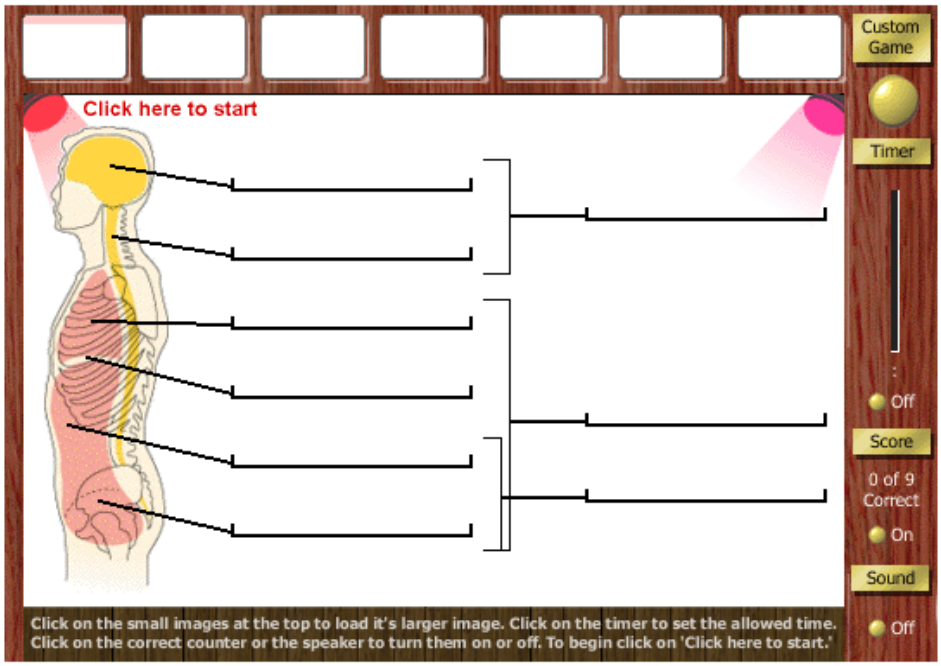


Figure 8: Screenshot of the Medical Test platform used only during the Pilot Study.

Stroop Test: The Stroop Test is designed to test the reaction time of a task – an important component for emergency caregivers dealing with ailing patients. This test contained 16 words – all words of a common color – which

were written in an ink color that did not always match the color word description. Participants were instructed to choose the best answer to decipher either what the color of the word was (the color of ink the word was written in) or what was the word's color (the word written text). This test was randomized so the order of the words came up differently for each participant. The pilot study only utilized this task once during the one-hour session; however, participants in the formal study completed this task three times – once during each olfactory environment – and all questions were randomized.

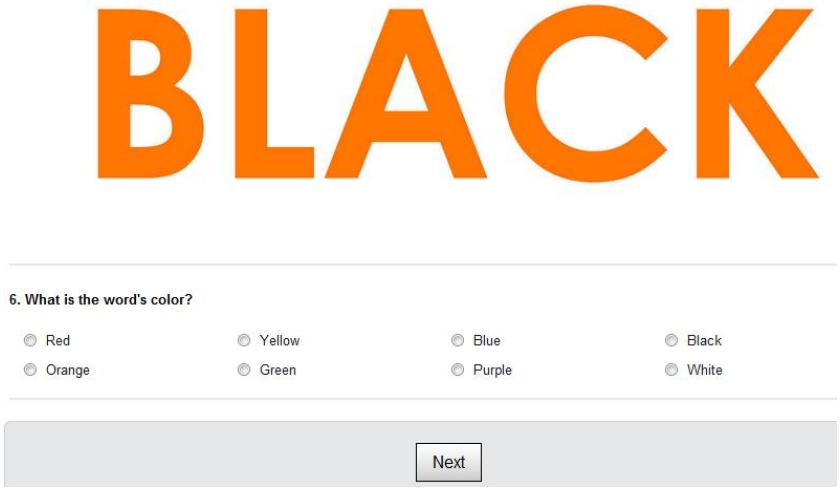


Figure 9. Screenshot of one page used during the Stroop Test for both studies.

Memory: This task provided participants with five objects which they were instructed to remember for later questions. The objects were: orange, car, dog, book, and tree. From a list of words, participants had to determine which ones listed were or were not listed in the original list. Between these questions, participants were asked a series of random questions, from what the current year was to simple math problems.

Unlike the pilot study, where subjects only experienced the memory test once, the formal study required participants to take the Memory Test three times. However, in order to not provide subjects with the same test all three times, three tests were created that built from each other.

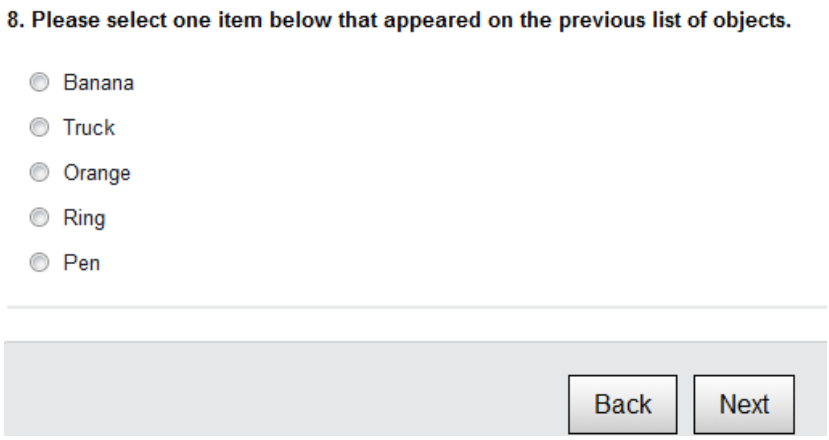


Figure 10: Screen shot of one of the questions asked during the Memory Test. The Pilot Study utilized this type of question once, while participants in the formal study experienced this type of question three times.

Beck Test: This test acted as a follow-up to the Mood Mapping test in the pilot study by once again asking the participants how much of each emotion or "state of being" they felt at the moment of testing. This time, however, participants were asked questions taken from the Beck Anxiety Test which measures the levels of anxiety a person experiences.

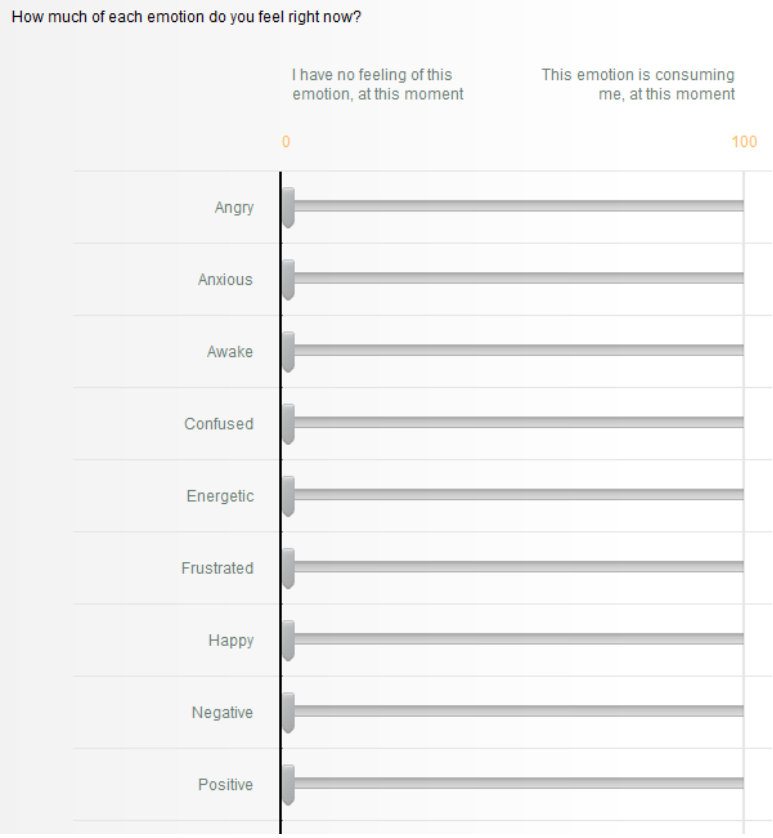


Figure 11: Screen shot of the Beck Test used only during the Pilot Study. The first initial questions were similar to the questions asked during the Mood Mapping Test.

Online Survey

The online survey was only used during the Formal Study, although it did not affect any results from the study. The online survey was composed of a series of questions for emergency caregivers who were unable to participate in the experimental part of the formal study. Emails were sent to Emergency Directors in multiple healthcare systems for a broader range of information that could be collected, and included a link to this online survey. Questions asked included basic information about the survey taker, as well as their impressions of smells within their department and how these smells may or may not affect them and their performance.

Safety Considerations

Similar to any other type of prescription, essential oils are not to be used carelessly. Even though they are a more naturalistic approach, it is important to note that a strong knowledge about the properties of the essential oils used should be considered with respect to their concentration and potency. It is crucial to use these oils with respect (Cristina, 2004). Although rare, essential oils do have the potential to cause allergies, pregnancy issues, and even some reactions.

Allergies

Although there are very few records to indicate any severe allergies to true essential oils, one study has revealed that out of 1147 participants in a patch test using Lamiacea, or a type of lavender oil, six individuals (0.05% of the participants) were noted having a positive reaction (Buckle, 2003). During the course of both experiments in this study, if any participants noted having an allergy - especially to an essential oil, flavor, or fragrance similar to the oils used in the study - they were placed in a group that did not contain the potential allergic aroma, and had the option to withdrawal from the study.

Pregnancy

The subject of using essential oils during pregnancy is a contradictory topic; many aromatherapists warn that the use of a number of specific oils during the first trimester could cause issues for the infant later in life (Buckle, 2003). However, evidence of harm to mothers or fetuses from essential oils has not been fully studied due to the fear of potential risks

(Tillett & Ames, 2010). But many argue that there are some benefits to using aromatherapy appropriately during pregnancy, with monitoring performed by a certified aromatherapist, including a lack of adverse effects, ease of control, fast action of the oils, and the therapy's simplicity (Tillett & Ames, 2010).In addition, some aromatherapists also encourage the use of some essential oils to help with labor. In the Labor and Delivery Department at Banner Desert Medical Center in Mesa, Arizona, some expectant mothers are given the option to use *Mentha piperita* (peppermint) to help start the contraction process.

In a study that included 8,058 women in labor using an essential oil, only 1% experienced an unpleasant response to the particular oils that were being used, although the unpleasant response was not noted in the study (Tillett & Ames, 2010). During pregnancy, a woman has a heightened sensitivity to smell which requires a certified aromatherapist to make necessary adjustments to lower the oil doses (Tillett & Ames, 2010). Based on the findings of this study and the history of essential oils being used as bath essences, scented soaps, and perfumes for hundreds of years by thousands of expectant mothers without any repercussions - the extreme threat of using true essential oils during pregnancy is not critical (Buckle, 2003)..

Due to safety precautions of this research study, no pregnant women - or potentially pregnant women - participated in either the pilot or formal studies. All participants were asked during the sign-up process and prior to starting the experiments if they were, or could be, pregnant; none indicated they were, or potentially could be.

Reactions

It is a respectable concern that the inhalation of essential oils could cause a reaction to any person – especially those who may have allergies. According to Jane Buckle, there is a possibility of a toxic reaction occurring with these oils if a person was confined in a high-temperature, non-ventilated room with the constant diffusion of the oil. However, this scenario would be less similar to a reaction to the essential oil than it would be to the suffocation of the individual (2003).

One important factor to note about some essential oils, such as *Citrus bergamia* (bergamot) which was used during the formal study, is that they could potentially be photosensitizing. This can cause the skin to react to sunlight creating a type of sunburn on an individual (Cristina, 2004).

All participants were made aware of these safety concerns prior to beginning the studies and through the informed consent. Although, no participants declined, all had the option to withdraw at any time without consequences from the experiments.

Pilot Study

Theoretical Framework

The goal of the pilot study was initially sought to determine if smells could affect the performance of individuals currently enrolled in the nursing program at Arizona State University. However, after only a very few potential nursing studies participants came forward from the college, the IRB was modified to allow any person without a Registered Nursing license to participate. As seen in the conceptual framework below, participants were

grouped into a single individual aromatic environment while performing web-based computerized tests. During this time, a heart-rate and bio-feedback monitor was used to collect quantitative data, and help find correlations between test results and subject commentary. These individuals were randomly selected a smell based on the day and time they signed up for using a web-based sign-up tool. Aromatic environments had been pre-determined and potentially modified to ensure even environmental distribution.

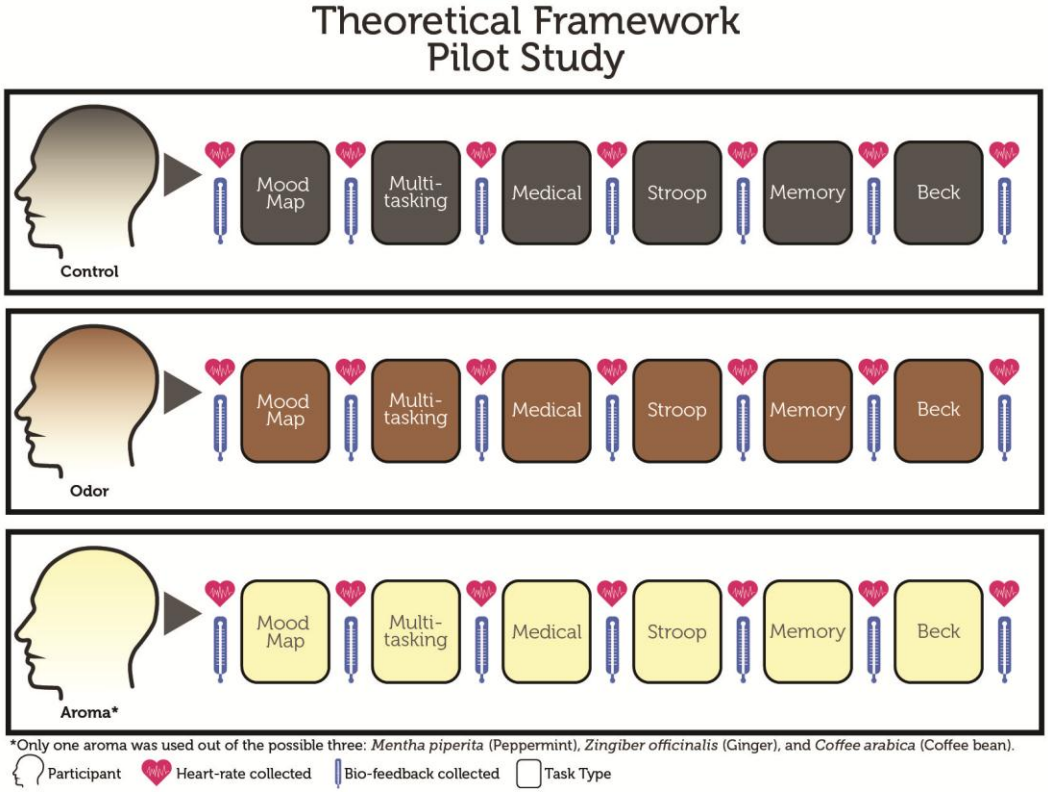


Figure 12: Diagram of the Theoretical Framework for the Pilot Study. All participants were involved in physical data collection (bio-feedback and heart-rate monitor), but varied regarding which aromatic environment they experienced.

Participant Selection Criteria

Following the approval from the IRB to modify participant selection, subjects were eligible to partake in the study if they were between the ages of 18 years and 65 years. Employment or schooling was not a requirement.

Therefore, although the initial pilot study allowed only nursing majors to participate, the revised study welcomed any persons with the exception of Registered Nurses. This study recruited 18 participants (6 males, and 12 females); however, two males never attended their scheduled time resulting in 16 total participants. In addition, the initial study set-up allowed for up to three individuals to participate at a single time. Only one instance included two subjects at once; none included three, which proved to be a more difficult task for the investigator than expected.

Location Selection Criteria

The location of each session took place on an Arizona State University campus; Tempe, Downtown, and West were used. This selection allowed for students to easily access the location, and provided non-students with a landmark location. The Downtown Campus was used for proximity to downtown offices for non-students who wished to participate. For the majority of the testing session, only 1 room from each campus was used to reduce participant confusion. None of the rooms allowed for temperature control.

Figure 13: Image of the Tempe campus classroom used during the Pilot Study.

Recruiting Process

The recruiting process for the pilot study became a challenge in finding willing participants. Initially, flyers were posted at the Downtown Campus to attract nursing majors prior to the IRB modification; when there appeared to be a lack of respondents; the modification of allowing anyone without a RN license provided a greater opportunity for potential respondents.

More flyers were hung on the Downtown and Tempe Campuses, and personal emails went out to friends and family providing a link to the study sign-up page. Personal emails to Professors, Asst. Professors, & Lecturers of the College of Nursing and Health Innovation and the Design School were also sent. However, due to a spelling mistake stating participants were needed from the School, instead of the College, of Nursing and Health Innovation, some respondents refused to forward the information to their students.

Lastly, word of mouth and personal website promotion was used as an indirect source of recruitment. This technique proved to be the most effective and resulted in recruiting the most willing participants.

Smell Descriptions

This section will discuss the different aromatic environments used in the pilot study and the initial hypotheses. Each participant was exposed to only one smell during the course of their session which was pre-determined prior to the participants signing up. The following will review the smell used,

how it was introduced to the participant, and the resulting statement of the outcome.

Control: The control group had no intentional smells associated with, nor introduced into, the study. Prior to the participants entering the room, an ionizer was used for at least thirty minutes to "clean" the air, eliminating as many outside contaminate as possible. This group provided for a baseline to see how participants would perform without any intentional olfactory stimuli. The initial hypothesis of this session assumed an average response to the tests with the possibility of showing some slight signs of stress due to performing the different tasks.

Mentha piperita (Peppermint): This smell group used a diffuser to allow the essential oil to distribute evenly into the air. As mentioned earlier, many studies have been done with this essential oil that showed its remarkable ability to energize individuals, combat fatigue, act as an antiseptic, and support self-confidence.

Based on previous research declaring these positive effects, the initial hypothesis deemed this essential oil would out-perform all of the other aromatic environments due to its high praise in olfaction research. Participants were assumed to show a significant reduction in heart-rate and an increase in their bio-feedback readings, indicating a lower stress level, while maintaining high scores on the web-based computer tests.

Zingiber officinalis (Ginger): This smell group was introduced into the study as a possible oil to consider for the formal study due to its property to relieve nausea for caregivers who may experience revolting smells or sights

in an Emergency Department. Although participants in the pilot study were not exposed to any of these foul sights or smells, nor had experienced these due to their education or employment, it was important to see how this aroma could potentially play a role in affecting the individual's performance. This oil was initially tested for the purpose of determining if a potential nausea-reducer has a positive or negative effect while performing simple tasks. Few studies have shown the aroma of ginger to be a source for increased productivity.

Coffee arabica (Coffee): This smell group was a modified control group, and was included to determine the effects of coffee aroma used as a current remedy. Although, there is no known clinical research highlighting the effects of this aroma, many hospitals around the nation, including the Emergency Department at Banner Good Samaritan Medical Center in Phoenix, AZ, use coffee grounds as a way to "absorb" odors that may present themselves in their Emergency Departments. However, although the notion of using coffee grounds has also not been tested to prove its ability to rid odors, hospital housekeeping favors the possibility of it as an easy air deodorizer.

During the pilot study, the initial extraction of the coffee was intended to be introduced into the air through a diffuser similar to the other essential oils. However, after testing this method, the oil was so thick it had clogged the small openings of the nebulizer, preventing any aromas from diffusing. As a modification to the introduction of the coffee aroma during the pilot study, three drops of the oil were placed on a cotton ball which was then positioned

directly behind the subject's computer screen without the subject's knowledge.

Initial hypothesis for this aroma assumed that there would be very little to no difference compared to the data collected from the control group. Based on personal experience during an observation at Banner Good Samaritan Medical Center's Emergency Department, a housekeeping employee walked around the entire department with coffee grounds following an incident where a strong odor quickly became present. The grounds were placed at the Nurse Station but the odor continued to waft through the department for over an hour until the observation ended. In addition, research into this oil consistently showed its main use was dedicated to enhancing the olfactory experiences through soaps and lotions rather than presenting any natural healing properties that are known in the other oils used in this study.

Methylindole (Odor): This odor was a critical part of the study as it was sought to determine if an odor can cause a negative effect on the participants' performance. The crystalized chemical, that resembled the smell of dirty feet, hoped to find a decrease in reaction time and task performance due to the olfaction distraction that may occur. The initial hypothesis of this odor assumed scores from the web-based computerized tests would be lower than the other environments due to a lack of concentration. In addition, it was assumed there would be a decrease in the skin temperature, with a raised heart-rate, displaying physical signs of stress caused by the frustration in accurately performing the tasks.

Procedure

As the participants signed up to participant in the study, they were asked a series of questions such as their age, gender, if they were (or could be) pregnant, if they had allergies, and if they felt comfortable working on a computer. Although, none of the female participants expressed being pregnant, or the possibility of being pregnant, precautions were made prior to the start of the study to ensure that those who may be pregnant would not be placed in the *Mentha piperita* (peppermint) group. Participants were then able to choose the best day and time they would be willing to attend from an online sign-up that. Out of the original eighteen participants who signed up, two of the original male participants did not show, and one participant changed the day and time from their original sign-up resulting in participation in a different aromatic environment.

The smells that were to be used were pre-determined prior to when the participants signed up to ensure a random selection; however, some modifications were made to provide a more even distribution between the use of smells. As a result, two females and one male were in the control group, two females were in the coffee group, three females were in the ginger group, two females and one male were in the peppermint group, and three females and two males were in the odor group.

Thirty minutes prior to a participant arriving, an ionizer was started to "clean the air" as set-up and preparation was made for the experiment. When participants entered the classroom, they were asked to sign a consent form, and the investigator explained the process of the study without

acknowledging if smells were to be used. During that session, participants were also asked if they felt comfortable with video recording to collect any data or comments; none refused. Lastly, the investigator helped the participants attach the heart-rate and bio-feedback monitors while explaining their purposes and the process of the session.

Figure 14: Typical set-up for data collection during the Pilot Study. A video recorder was set and used after approval by the participant for post-data collection review by the investigator. All of the materials and monitors needed by the participant were set up in their station prior to their arrival and the investigator was set up close by to collect the information.

As participants were instructed to perform the first test - Mood Mapping test - the investigator collected the consent form, filed it, and turned on the diffuser for the aroma sessions without the participants' knowledge. However, because of the bulk and strong odor from the Methylindole, participants were allowed to finish the Mood Mapping test prior to exposing the odor and were fully aware of an environmental factor during the course of the study.

Before and after each computer test, information from the heart-rate monitor and bio-feedback monitor was collected and documented using a Google Document Spreadsheet. Any tests that contained scores that

displayed on the screen, such as the multi-tasking and medical test, were also collected at this time due to the inability to retrieve scores once the screen had closed. All other scores were collected following the sessions which had used the online survey tool, SurveyGizmo.

To conclude the session, participants were asked a series of follow-up questions including: if they noticed any smells; if a smell was apparent, did they know what the smells was; if they liked it; and what they thought the smell was.

Variables

Although the pilot study was carefully planned out, there were a few variables that came in to play when collecting data, from the location selection to equipment operational difficulties.

When potential participants signed up to participate, they were given the options of a day, time, and the choice of Arizona State University campus to attend. The diversity of room and building locations created multiple room layouts between the aromatic environments, which lead to potentially uneven smell distribution and the inability to control the room temperature. Because of this anomaly, the findings for the bio-feedback monitor had to be slightly modified during data analyzing due to the varying ten degrees Fahrenheit between rooms. Although this difference may seem small, there is a possibility of causing a flux in skin temperatures that could potentially provide inaccurate data when looking at subject stress levels.

Another variable that had come in to play with respect to the aromatic environment was that the coffee essential oil attempted had a different

viscosity than originally determined. This caused the oil to clog the small nozzles in the nebulizer, prohibiting the diffuser to function correctly and not allowing the aroma to diffuse. A modification was made to use a cotton ball with three drops of the essential oil placed discreetly behind the subject's computer screen. This process was done during the timeframe that diffusion would have occurred - while participants were completing the Mood Mapping Test. It was important that, although this aromatic grouping could no longer utilize a diffuser, the aroma continued to be introduced via indirect inhalation. Data collection did not seem to be corrupted by this change as all participants in this grouping noticed the smell.

Lastly, due to renting laptops through the University for participants to use, there was a variety of different systems and keyboard layouts used. This caused a huge difficulty in accurate readings on the multi-tasking test due to the inability to work correctly on keyboards that lacked the additional number keypad extension. Without this additional keypad, the participant lacked the ability to do one of the three parts. Because the color matching section utilized the number pad to select correct colors displayed, it failed to work entirely if the machine was not equipped with this feature. Even selecting keys from the keyboard, which would otherwise work, failed to do so. Attempts were made to instruct participants to use an external keyboard which did not contain the extra number pad; however, that technique did not provide positive results either. Because of the inconsistencies from this test, depending on the laptop the participants used, results from part three – color – were discarded from the pilot study.

Pilot Study Findings

The following section will review the findings from the pilot study based on stress levels measured, test answers, and participant commentary. Fluctuations from the heart-rate and bio-feedback monitors will be discussed and examined between each of the five different environments. The averages of each group were investigated next to each other to determine which showed the highest and lowest stress levels. Following the stress results, each task was analyzed, once again, between groups and comparing groups. Finally, this section will highlight any considerable participant commentary and reactions.

Stress Levels

Stress levels were calculated through data gathered from the heart-rate and bio-feedback monitors. All participants' data was then averaged based on their aromatic groups, with the exception of one participant whose information gathered from the monitors was miscalculated during the study and the information from the monitors was discarded. In addition to collecting body heat information (participant temperature), average room temperature was recorded due to the inability to adjust the thermostat. After studying the data, it was noted that the room temperatures per session varied by a few degrees Fahrenheit and showed a maximum difference of 10 degrees Fahrenheit between the different groups. To ensure accurate data between groups, all room temperatures were adjusted to be 77 degrees Fahrenheit, shifting bio-feedback temperatures accordingly. This allowed for

a baseline room temperature to accurately compare the results from the participant's skin temperature.

Control: Because this group was utilized as a baseline for the results in this experiment, it provided a concrete view of how much variability was to be expected throughout the session. In addition, hypotheses could then be made to determine how or why an aromatic environment shifted from the control.

The results of this session showed a gradual increase in skin temperature throughout the progression of the session, starting from about 92 degrees Fahrenheit to about 102 degrees. As an increase in body temperature is an indicator of decreased stress, this would lead to the assumption that, as the tests progressed, the subjects became less stressed. During the test, a minor dip in temperature revealed there was a moment of increased stress following the completion of the third Multi-Tasking Test. Additionally, there was a fluctuation in skin temperatures between the start and end of each test. Although, the overall change in skin temperature was gradual over the task's timeline, the results indicated a very small or no decrease in temperature at the start of the following test, suggesting that subjects tended to become more relaxed after completing the task.

In addition to the bio-feedback temperature slightly increasing over the course of the session, the average participant heart-rate slightly increased during the duration of the one-hour period, fluctuating between about 80 and 90 beats per minute (bpm) – a slight increase above the at-rest state. Similarly, the results gathered showed there was a repetitive effect to

the bpm prior to and following each individual test: bpm rose before the start of the task and dropped after the task ended, with a drastic drop to 71 bpm subsequent to completion of the Medical Test. Although, not as prevalent in the bio-feedback results, an additional drop in beats per minute (bpm) was observed following the completion of the Memory Test.

The graph below displays the results of the bio-feedback and heart-rate monitors averaged between all subjects who participated in this group. The left side indicates temperature in degrees Fahrenheit, starting from the room temperature of 77 degrees to 100 degrees. Information from the bio-feedback is indicated in the bars based on the average temperature of participants before and after each test.

The right of the graph displays beats per minute (bpm) recorded from the heart-rate monitors, ranging from 65 bpm to the maximum of 105 bpm (with a bpm of over 100 bpm indicating a rapid heartbeat). The results are shown as a line which overlaps the bio-feedback results to quickly reveal consistencies. Finally, the symbols above the graph are indicators as to whether an increased (arrow up) or decreased (arrow down) in temperature (top row) or heart-rate (bottom row) was noted as compared to the collection time prior to it. The most significant results would show the two arrows pointing in opposite directions, indicating unison between both skin temperature and heart-rate confirming a more positive assumption of how the participants were physically affected. If the arrows pointed away from each other, the subject showed physical signs of less stress; if the arrows pointed towards each other, the subject showed physical signs of more stress.

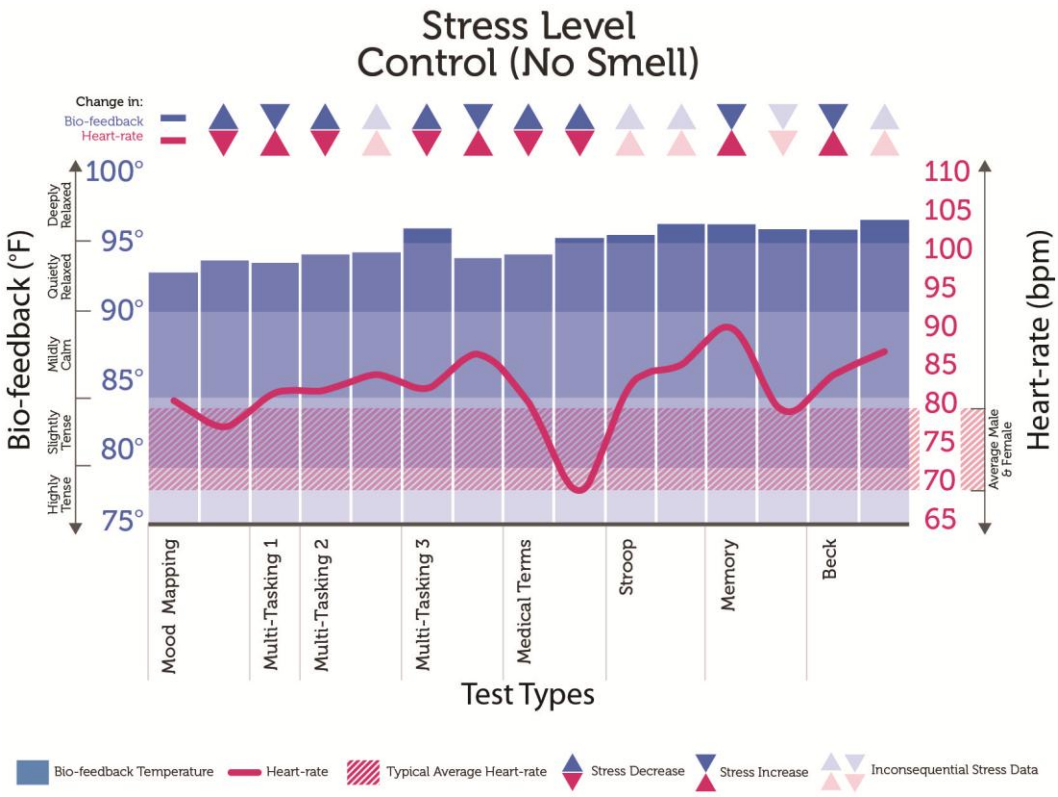


Figure 15: Stress level graph for the Control group during the Pilot Study.

Mentha piperita (Peppermint): The initial assumption for this group forecasted that information from the bio-feedback monitor would reveal high skin temperature indicating a reduced stress level. However, upon further inspection from the averaged results of this group, skin temperatures showed to be the second lowest compared to all of the other groups. Similar to the outcomes from the control group, the bio-feedback indicated a rise and fall before and after each test, with dramatic dips in temperature at the start of the first Multi-Tasking Test and Medical Terms Test (down to about 88 degrees Fahrenheit). Unlike the control group which had a total increase in skin temperature with a minor dip following the completion of the third Multi-Tasking Test, the peppermint group had an overarching wave-like

appearance in skin temperature over the course of the session, dropping and rising throughout.

The heart-rate average for the peppermint group showed an overall gradual decrease in beats per minute indicating stress reduction. However, when comparing the heart-rate results from the control group to the peppermint group, there seems to be a number of inaccuracies. Whereas the control group dropped after completing the Mood Mapping Test by only 3 bpms, the peppermint group had a drop of almost 20 bpms - nearly twice the amount in the largest drop from the control group.

When confronted by the graphs from the peppermint group, it would appear that there was little to no improvement when using this essential oil compared to no smells. Other than during the time participants performed the Mood Mapping Test, all of the readings from the peppermint's bio-feedback remained lower than the control's, and remained at or slightly lower than the beats per minute (bpm) as compared to the control group. To sum up the comprehensive view of the essential oil of peppermint, there appears to be no significant positive benefit to diffusing this aroma based on the conditions set forth by this experiment.

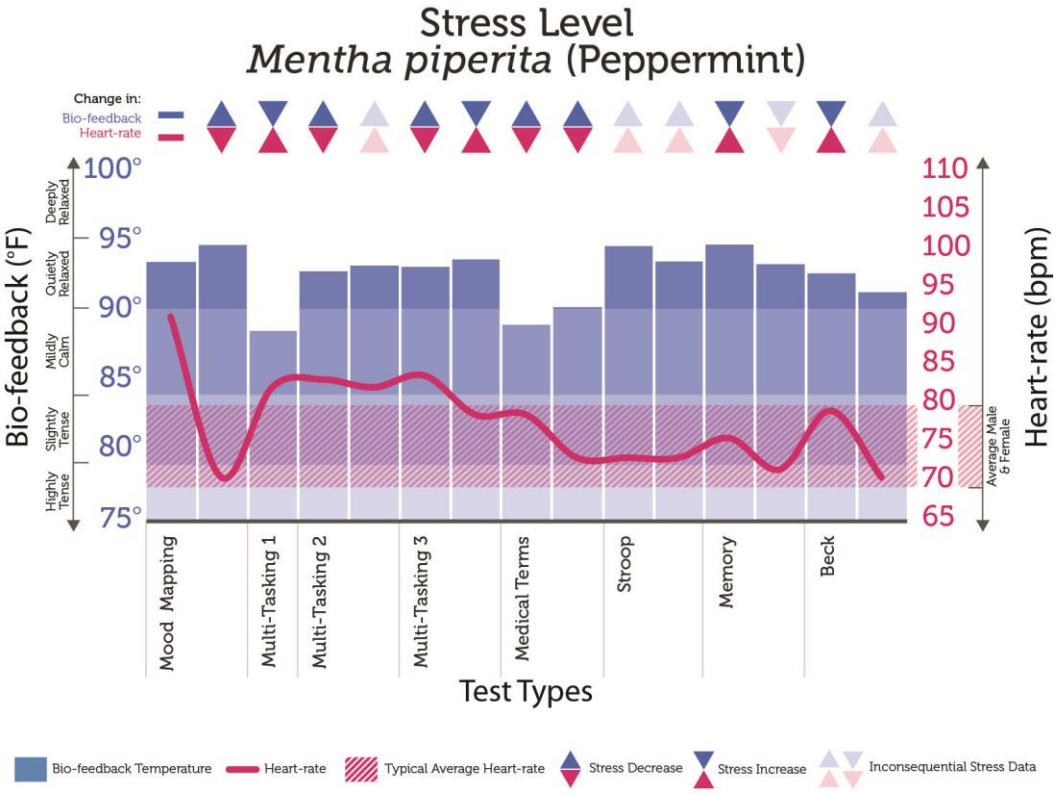


Figure 16: Stress levels graph for the Peppermint group during the Pilot Study.

Zingiber officinalis (Ginger): As stated earlier, the ginger group was included into the pilot study to test and determine if it would be a reliable option for the formal study experiment. When looking at the information from the bio-feedback, this group showed the overall highest skin temperature not only across the board, but this group also showed the most consistent increase in temperature signaling an extremely relaxed state for the participants in that group who never had their skin temperatures recorded below 94.5 degrees Fahrenheit. Much like the control and peppermint groups, ginger group showed skin temperatures dipping and rising before and after each test taken; but unlike the other two groups, the ginger group showed the changes more prevalently than any other group.

Unlike any of the other aromatic groups, the ginger environment showed a heart-rate slightly decreasing over the course of the session with a jump to the highest heart-rate recorded of 106 bpm. Although this was the highest heart-rate over all of the aromatic environments, averaging between 85-106 bpm, two of the three individuals in this group had a spike of 100 bpm or more. The final conclusions of this group prove to be unexpectedly positive. Although, the initial hypothesis for this group assumed little to no difference between it and the control group, it had outshined all of the others in having the least stressed participants based on the results from both the bio-feedback and heart-rate monitors.

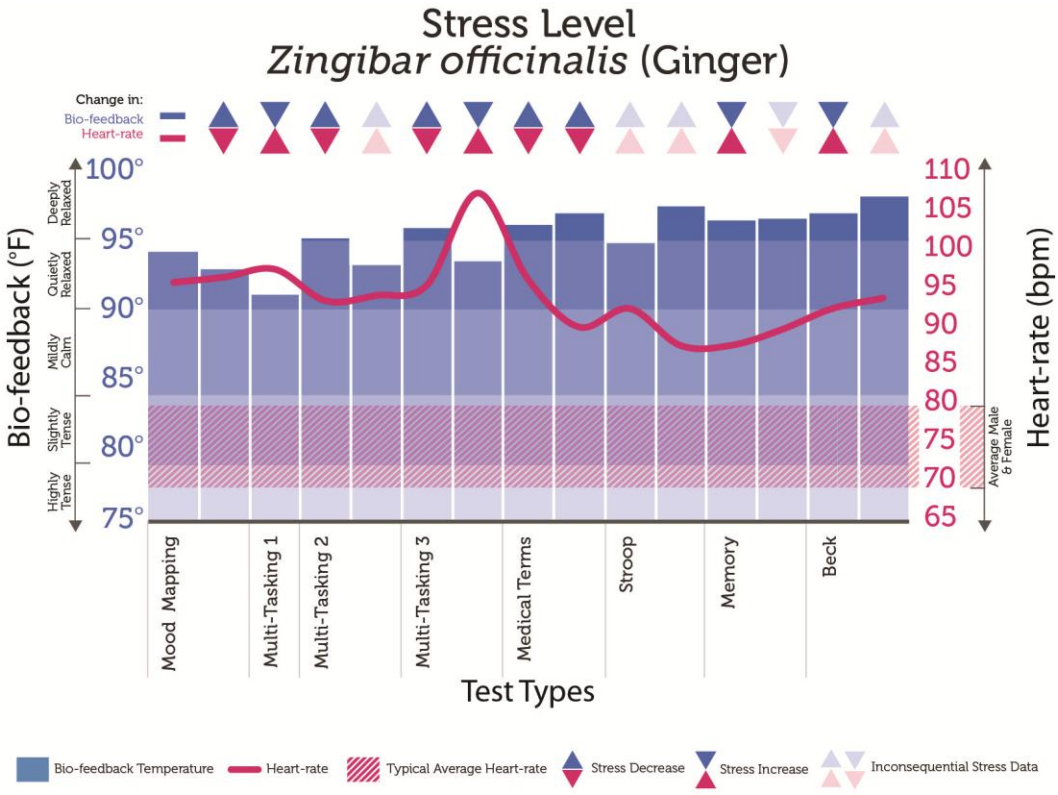


Figure 17: Stress levels graph for the Ginger group during the Pilot Study.

Coffee Arabica (Coffee): The aroma of coffee proved to be an unexpected setback in the hypothesis of this smell. Throughout the entire

study, the average skin temperature was only 88 degrees Fahrenheit – never reaching more than 91 degrees – indicating that the participants were slightly more stressed than the rest of the aromatic groupings. Unlike the control group, the graph for the bio-feedback temperatures recorded show a scattered rise and fall in temperature rather than a continuous increase. As a result, these temperature readings appear to not move at all indicating a constant state for the participants throughout the session.

This group was the only aromatic environment that had a similar fluctuation in heart-rate as compared to the control group. However, the coffee aroma showed to have a higher average in beats per minute, suggesting more stress than the control group with no smells. As a result to the findings from the bio-feedback and heart-rate monitors from this group, it would appear that out of all of the other groups, the coffee aroma group showed signs of having the most stressed participants. Although heart-rate alone did not indicate the group having the most stress, the addition of the bio-feedback, which does show the group as having a drastic reduction in skin temperature, concluded this group to have more stress than originally predicted.

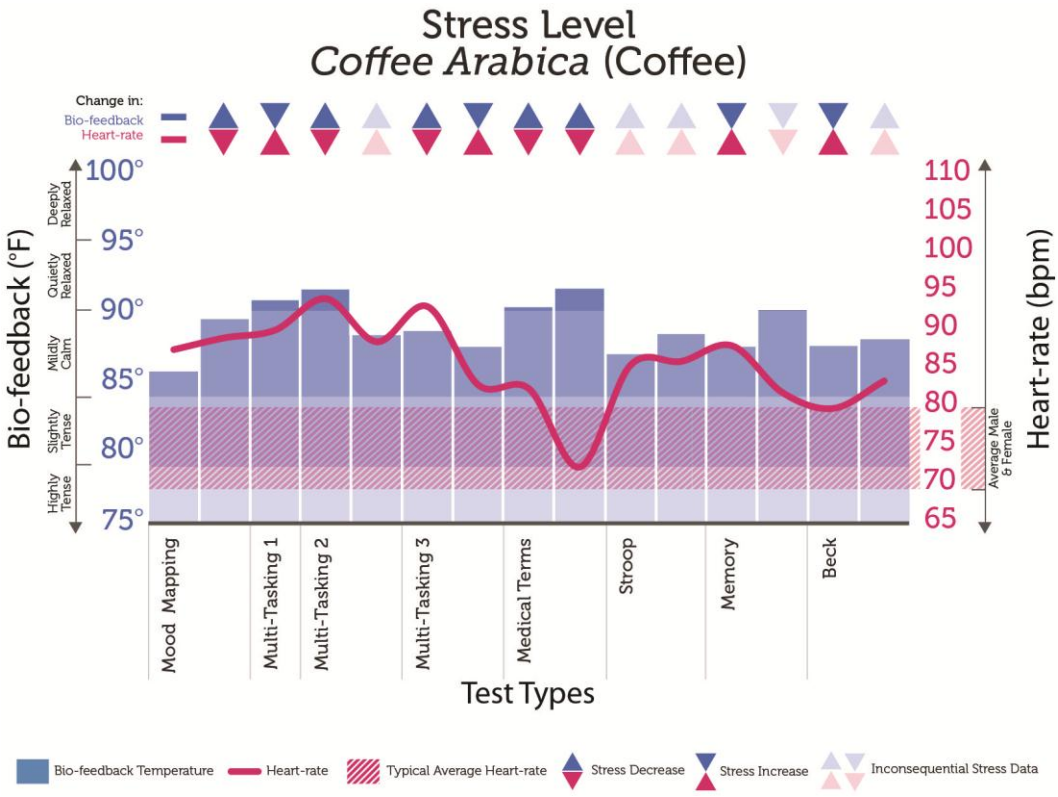


Figure 18: Stress levels graph for the Coffee group during the Pilot Study.

Methylindole (Odor): The odor used in this study had hoped to find significant results in the increase in stress levels due to the distraction of the stench. However, based on the bio-feedback and heart-rate readings, this assumption has been declared 'unconfirmed'. When looking at the temperature readings for participants in this group, the lowest recorded skin temperature was 91.8 degrees Fahrenheit, indicating this group was relatively calm while performing their tasks. However, similar to the peppermint and coffee aromas, there was no consistent increase or decrease in temperatures over the course of the session, but rather a wave-like movement that rose and dipped.

The bio-feedback results for this group reveal that the odor did not negatively affect the participants' stress levels, and the heart-rate monitor recorded the odor group having lower heart-rate readings throughout the session. The only indicator of stress was a jump following the completion of the Memory test to 92 bpm. In addition, when comparing all of the averaged heart-rates for all of the other groups to those collected for the odor (methylindole), the odor showed some instance of having opposite effects than the other groups. Therefore, rather than decreasing their bpm, participants in this group would show a rise. Between both the bio-feedback and heart-rate monitor findings, it would appear that this group showed having a slightly increased level of stress than the other groups but slightly mimicked the ginger group.

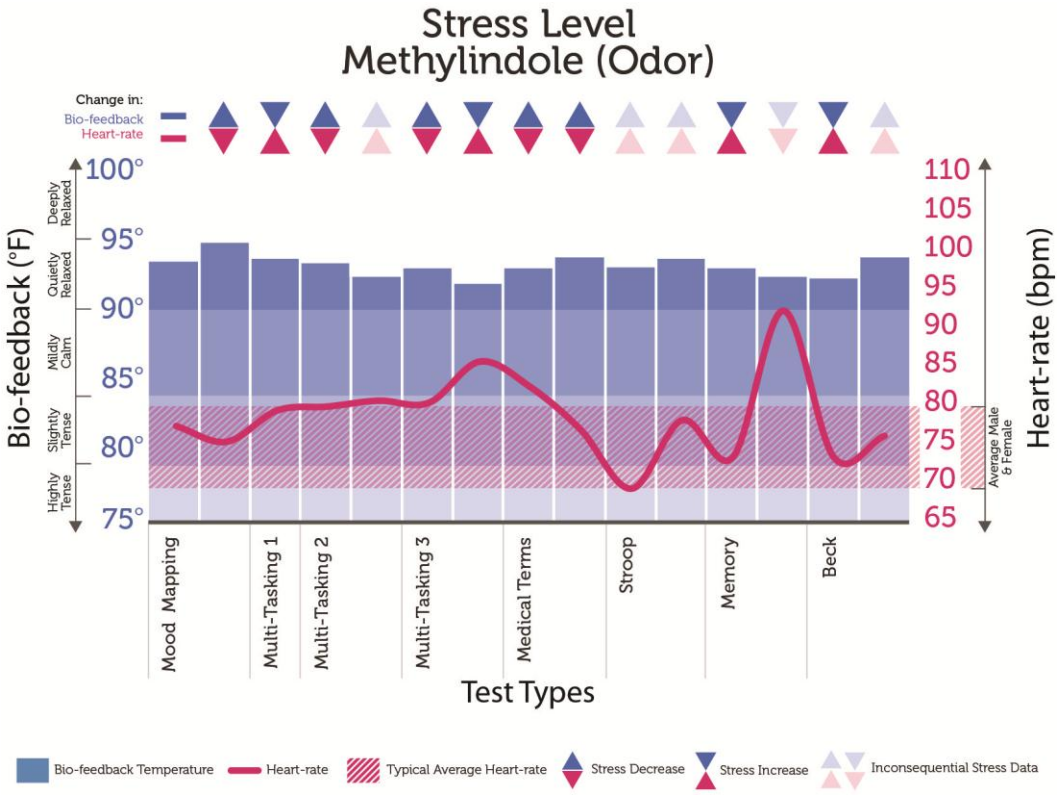


Figure 19: Stress levels graph for the Odor group during the Pilot Study.

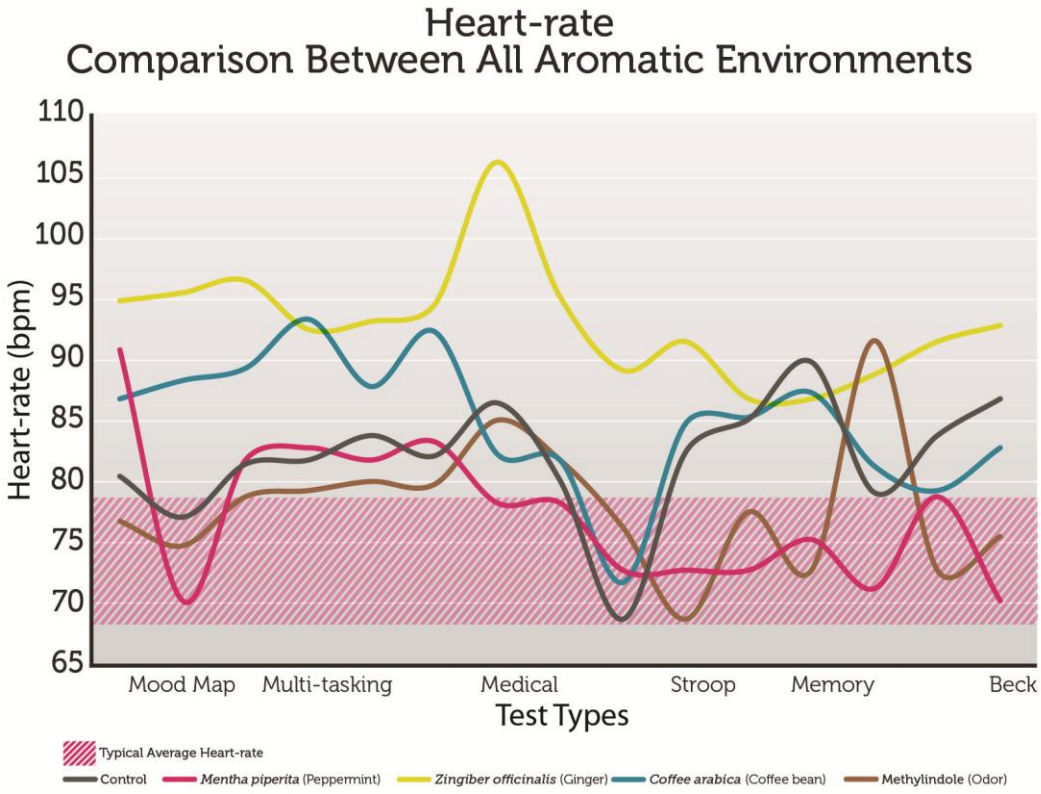


Figure 20: Heart rates between each aromatic environment groupings during the Pilot Study.

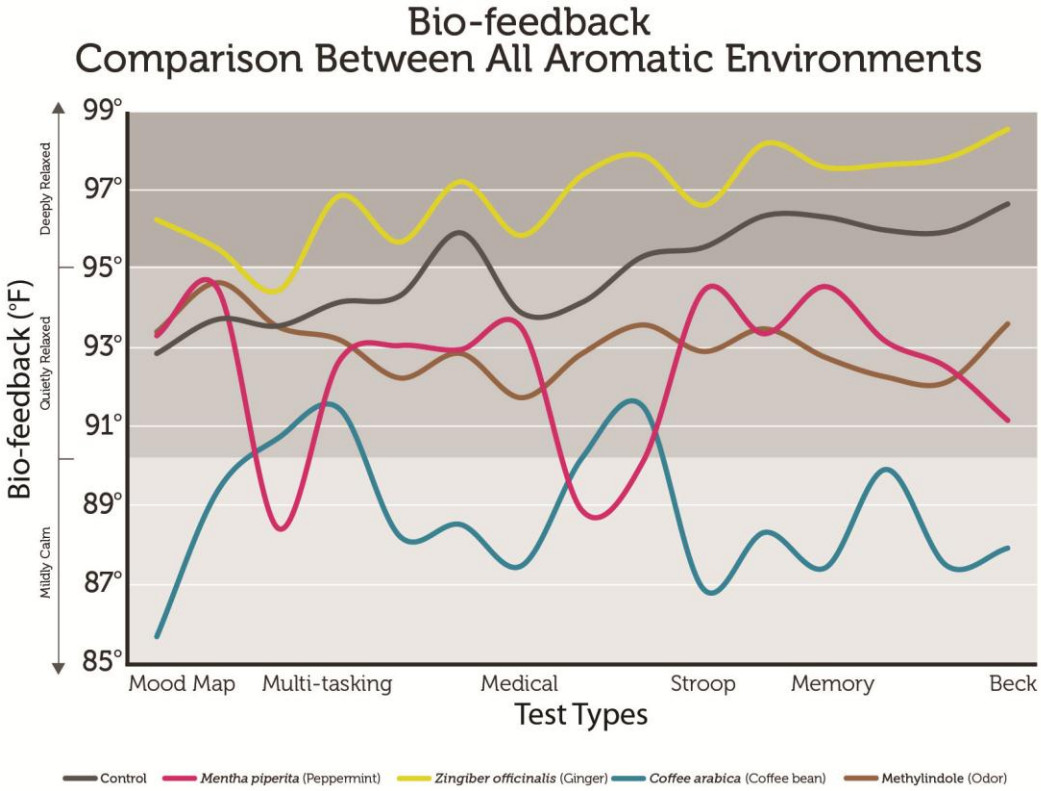


Figure 21: Bio-feedback between each aromatic environment groupings during the Pilot Study.

Conclusion: In conclusion, comparing all of the results from the heart-rate and bio-feedback monitors, each aromatic environment appeared to create their own stress level. Based on the findings between these two monitors, it would seem that the Ginger group was the least stressed, followed by the Control group. Although these findings were not predicted, they did show to have a positive outcome. The remaining smells show unexpected results from the odor group (which did not vary significantly from the control group), the peppermint group (which showed to have higher levels of stress than originally anticipated), and the coffee group (which showed having the most amount of stress).

Multi-Tasking Between Aromatic Environments

This section will discuss the analysis from the average participants' scores within each aromatic grouping for the multi-tasking test. Each group will discuss the results from all three attempts at the task: from the participant having no help allowing the participant to read instructions prior to the task, to the participant being provided with verbal direction. The groups will then be reviewed with respect to the progression of performance between the three attempts while comparing stress levels indicated previously. Finally, this section will compare the results of the three attempts between the different aromatic groups to determine if the smell could have affected their performance.

Control: As a baseline group, it was initially assumed that the results of the Multi-Tasking test taken three times would show a consistent increase in accuracy over the course of the task. Although there was an increase in

total points achieved over the three instances, the group showed a minimal increase from the first to second attempt (514%), relative to other aromatic environments, and a substantial increase from the second to the third attempt (540%). This may be a result relative to the participants had only a slight knowledge about how to perform the task, but once they were verbally given instructions, they had a greater knowledge regarding the goal of the task. One of the most notable facts about the results from this group was its consistent low-averaging score, maintaining total points well below any other group in the first two attempts and an overall score marked as the lowest (542 total points) making the improvements in total points over time appear high. Although having the lowest total points in the first two attempts, the control group had the third highest score relative to percentage of improvements over the course of all three ventures.

Mentha piperita (Peppermint): The peppermint group started the exercise with the highest number of points averaged (265); however, it only showed a 14% increase between the first and second attempts followed by an 85% increase between the second and third attempts. This group did, however, have the second highest total points score of 1128. As the second best performing group, the results from the peppermint environment aligns with the hypothesis and research findings indicating subjects having a heightened awareness.

Zingiber officinalis (Ginger): This group out-performed the other aromatic environments by a staggering percentage of improvement. Although, the ginger group started off averaging the third highest points for

the first attempt (203), the group increased in improvement between the first and second attempts by an increase of 150% followed by a 66% increase in the second to third attempts, as well as averaging the highest total points (1553). Based on the findings from the averaged points collected, this group was the only group to show a consistent rate of increase over the course of this task. The group outperformed all of the others in both total points and improvement percentage, making it the most productive on this task.

Coffee arabica (Coffee): It was assumed early on that the coffee group would show similar results in tasks compared to the control group. However, this group showed the worst decline in performance between the first and second attempts (-32%) but had the highest increase between the second and third attempts (195%). Unfortunately, the total improvement from the first attempt to the final attempt was only 101%. Because of this dramatic fluctuation in points, this group averaged having the median total number of points (813). Because of the poor total number of points only reaching 40, and the dramatic decrease in improvement, this group, along with the dirty feet, came last in terms of performance.

Methylindole (Odor): Based on the results from this task, the Methylindole did not cause participants to perform worse than those in the control group during the first two attempts. However, it did show the one of the weakest amounts of improvement throughout the three rounds: -1% between the first and second, and 77% between the second and third. This group also concluded having the lowest score in the final attempt, but the second to lowest in total points with 597, only 10% higher than the total score

from the control group. This group, like the coffee, came in last for its poor total points and their weak improvement percentage.

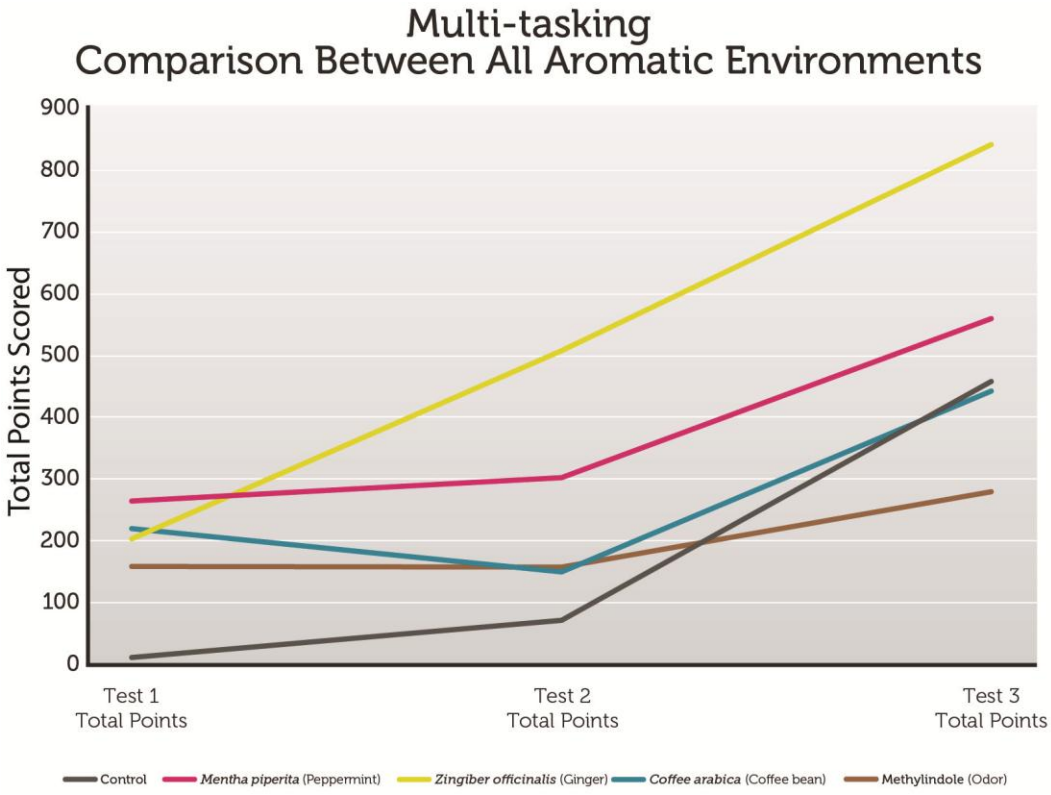


Figure 22: Multi-tasking results between all aromatic environmental groupings over the course of the three attempts.

Stroop Test

This segment will review the outcomes of the environments when conducting the Stroop Test. The following will discuss the total correct, the shift from the control group, and an overall analysis of the results.

Control: The baseline group for this task proved to show a successful attempt at performance. The overall averaged score for control group participants successfully answered 69% of the questions correctly. This placed the group as the second lowest scoring group.

Mentha piperita (Peppermint): The results from this group showed an 18% increase from the control group, averaging 81% of the questions asked as answered correctly. The high results show affirmation to the research of peppermint's ability to increase performance, and placed it as the second highest score.

Zingiber officinalis (Ginger): Once again, the ginger group out-performed all other aromatic environments, averaging 85% of the questions answered correctly on this task. This increase was 24% higher than the total results from the control group, and was the only group that included two individuals who received 100% correct on their attempt at the task. In comparison to the other groups, the ginger group once again out-performed, making it the most productive for this task with the highest number of correct answers.

Coffee arabica (Coffee): Although initially assumed to be a secondary control group, the results from this task showed a 42% decrease in correct answers compared to the control group, answering only 40% of the questions correctly. Unfortunately, six of the 16 questions had none of the participants in the group answer correctly.

Methylindole (Odor): Although, this group did not perform the worst between the different aromatic environments, it did only have a 2% difference between its total score (70% answered correctly) and the score from the control group. This gave the group a small lead ahead of the control group, but no significant improvement.

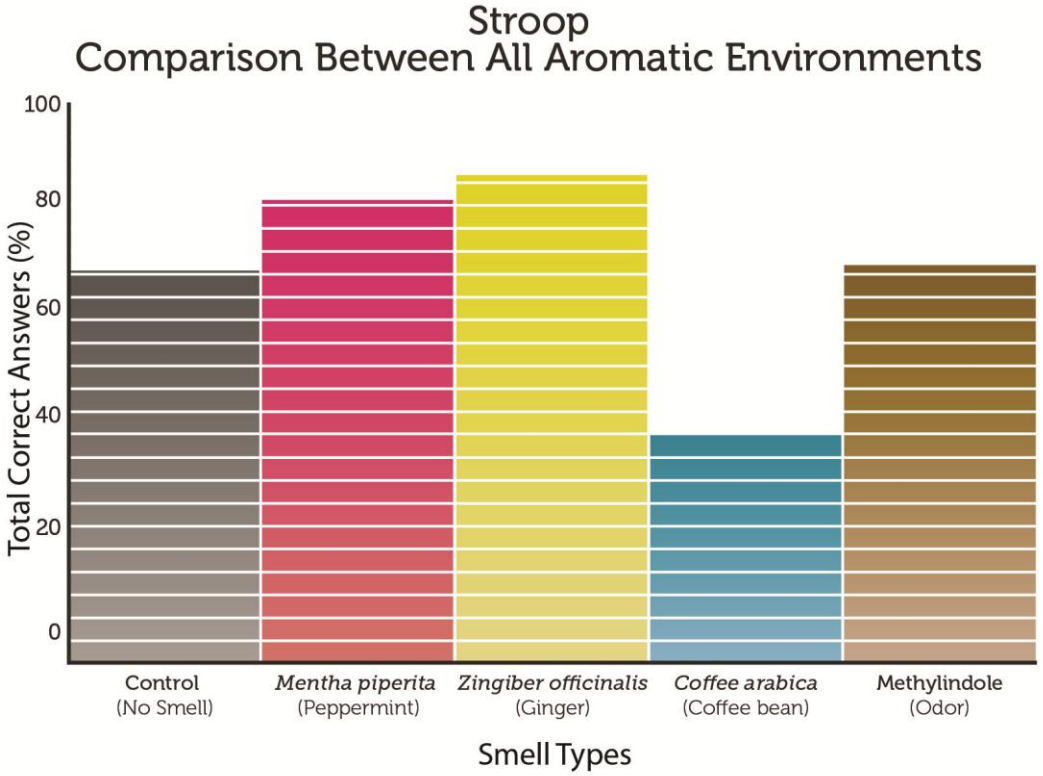


Figure 23: Results from the Stroop Test between all aromatic environmental groupings.

Medical Test

This section will discuss the results of the Medical Test between each of the olfactory stimulations. None of the participants were licensed in the medical field nor had any official medical training. The following will review the total number of correct answers, the average amount of time each group took to complete the task, and an overall assumption to the findings.

Control: Results from this group seemed to have a respectable outcome compared to the fact that none of the subjects who participated had previous knowledge of advanced medical schooling. Out of nine possible correct answers, this group answered an average of three questions correctly within 1:24 minutes. Unfortunately, based on the total number correct and

the time it took to complete the task, this group was one of the weaker performing groups on this task.

Mentha piperita (Peppermint): As the second lowest scoring group, answering about 4.5 questions correctly, this group took the longest amount of time to perform this task, clocking in at two minutes and ten seconds (2:10 minutes). This group was the worst in performance as it took the longest – this group took 54% more time to attain only 50% more correct answers as compared to the control group.

Zingiber officinalis (Ginger): This group showed having the second highest number of correct answers (4.67) on this task while averaging a similar length of time as the control (1:23 minutes). Although, it was not the highest scoring group regarding number of correct answers, there was a 56% increase in the number of correct answers attained in a 1% reduction in time taken to complete as compared to the control group.

Coffee arabica (Coffee): The results from this group showed an extremely unexpected result. Whereas other tasks indicated the coffee group to perform at baseline or worse, this task showed the coffee group not only having the highest number of correct answers (5) but also showing the least amount of time to complete the task (0:58 minutes) – the fastest compared to the other aromatic environments. In comparison to the control group, the coffee aroma showed having a 67% increase in correct answers with a 31% decrease in completion time.

Methylindole (Odor). The results from the odor group seemed to run in line with the results from the control and ginger group. The correct number of

answers reached 4.6 and the time to complete was clocked in at just over the minute and a half mark (1:30 minutes). Unfortunately, when compared to the control group, even though there was a 53% increase in correct answers, this group took 8% longer in completing the task, making it the median in performance for this task.

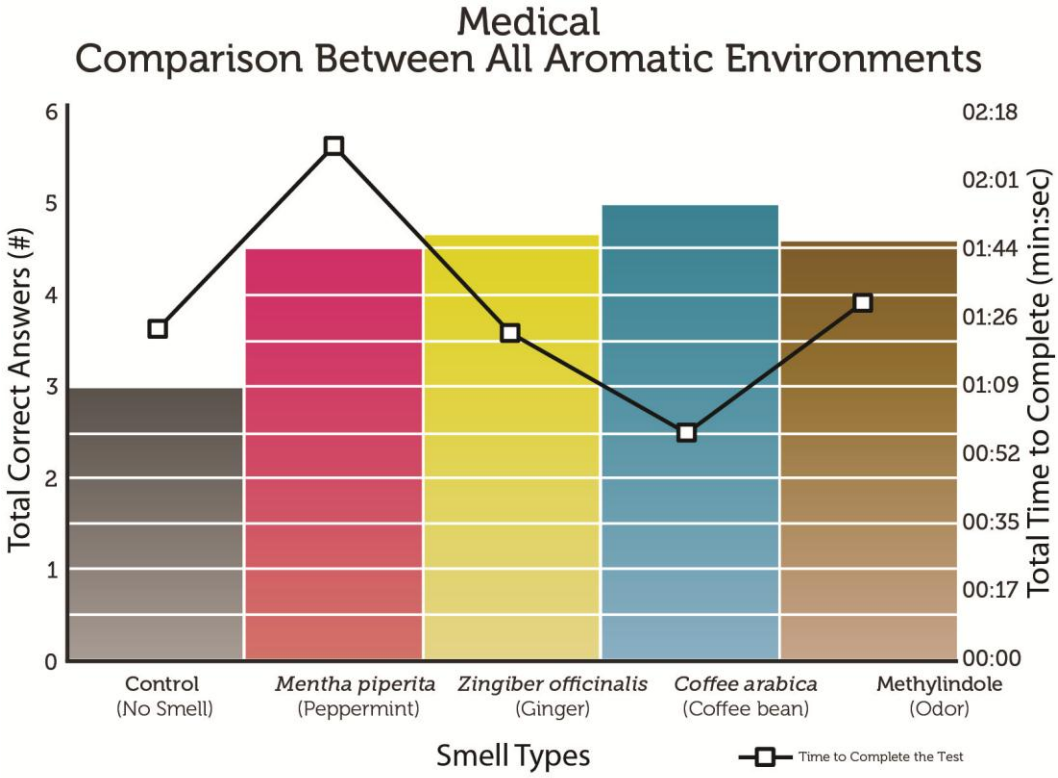


Figure 24: Results from the Medical Test between all aromatic environmental groupings.

Memory Test

The following segment will review the results of the Memory Test between each aromatic environment. The section will discuss correct answers, and overall assumption from the results.

Control: Based on the results, both the coffee and control group came out with the exact percentage (78%) of correct answers, which was lower than

the results from the other smells. Unfortunately, these groups were the worst in performance for this task.

Mentha piperita (Peppermint): This group had a slight increase of 3% over the control group, with 80% correct answers recorded, and the median among scores from the other groups.

Zingiber officinalis (Ginger): Having a 95% accuracy on this task, this group outperformed all others significantly and showed a 22% increase over the total correct in the control group. This group was also the only group to have two individuals score 100% correct on the task, making it the highest performing group for this task.

Coffee arabica (Coffee): With the lowest score, along with the control group at 78% accuracy, this group came in having no improvement. This group and the control show having the worst performance in the task.

Methylindole (Odor). The dirty feet group showed its participants reaching the second-highest in accuracy (81%), just 1% higher than the Peppermint group and 4% higher than the control group.

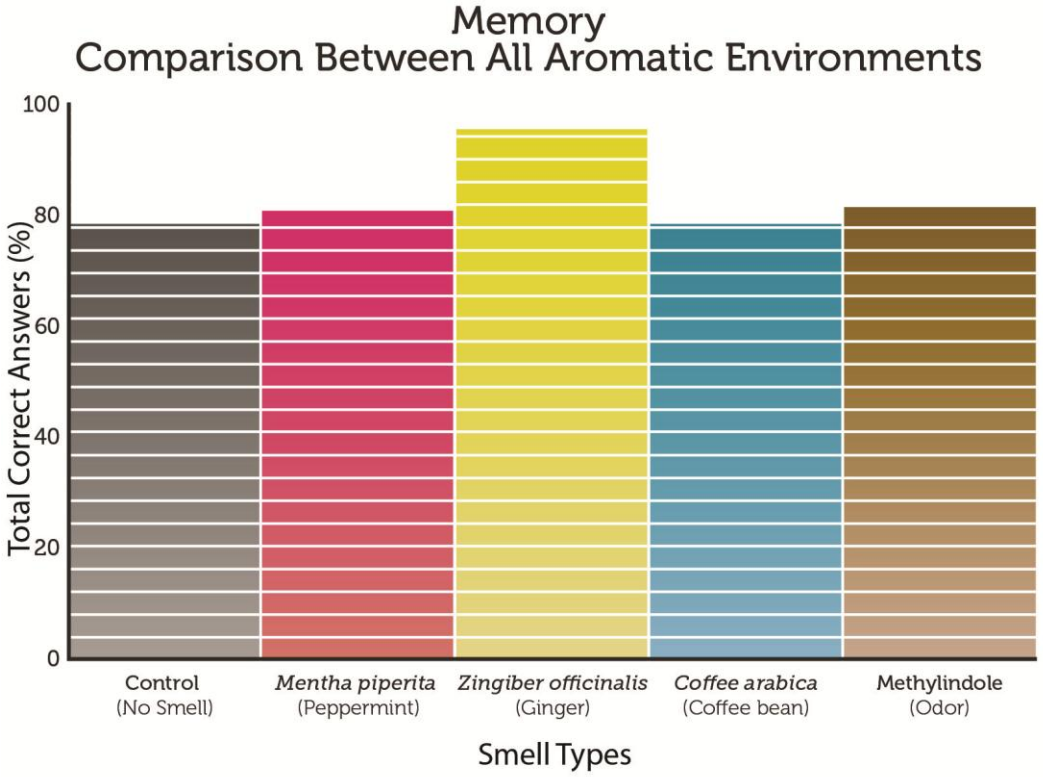


Figure 25: Results from the Memory Test between all aromatic environmental groupings.

Mood Mapping

This section was the most difficult but beneficial task to analyze. It reviewed the responses made by participants as they answered the Mood Mapping and Beck Test. All aromatic environments will review changes made between the five positive emotional states of being, and the eight negative states, plus indicators of anxiety from the Beck Test.

Control: The results from this test showed a remarkable fluctuation in the emotions, or state of beings, each participant had from the start to completion of this experiment. The results from the control showed a somewhat predictable outcome for the participants' reactions. Anxiety was slightly apparent at the start of the study (score = 4) compared to none at all at the end indicating some uncertainty by the participants (score = 0).

Relaxation decreased (27%) while energy increased (26%) following the end of the study, which corresponds to results from the bio feedback and heart-rate. In addition, confusion and frustration slightly increased by 6% and 2%, respectively, possibly due to scores seen by the participant. Although, information from the Beck Test did not provide significant results, some entries did have unique responses from the previous tasks. For instance, 14% of participants reported "feeling hot" which was the highest state of being for this group.

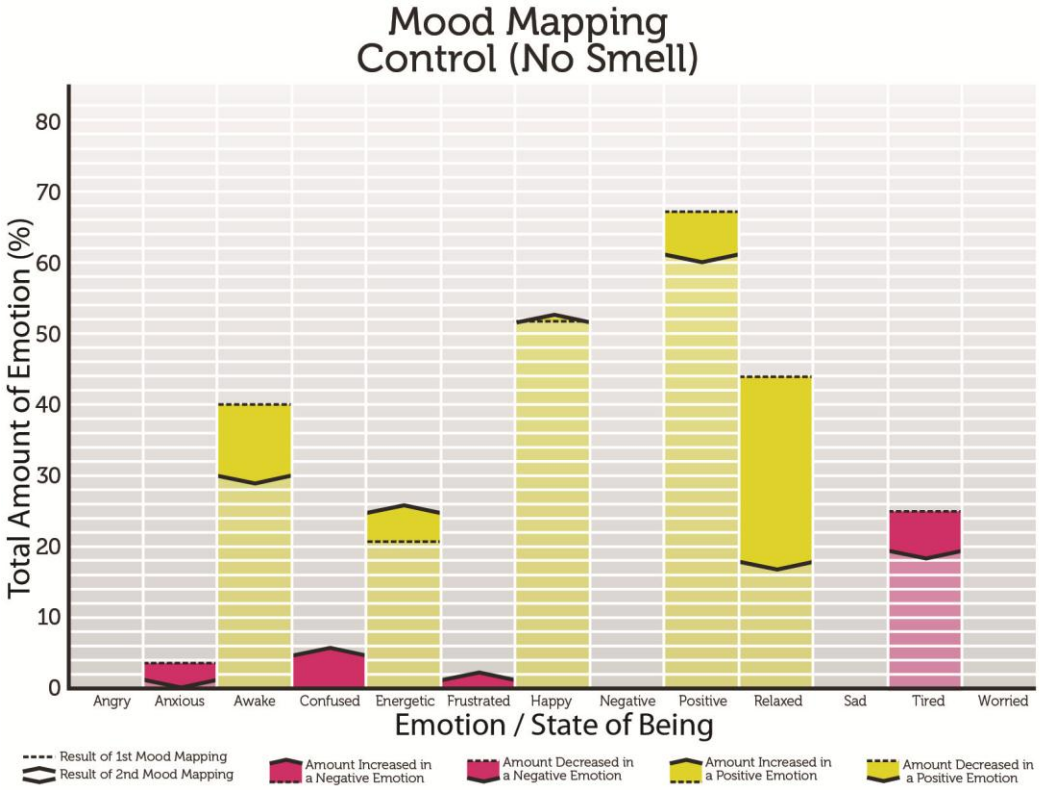


Figure 26: Mood mapping graph depicting the results from the control group.

Mentha piperita (Peppermint): This group produced some mixed results based on past research studies. Although there was a successful increase in the positivity of participants' (27%; 31% higher than the control group) following the end of the session, the amount of increased relaxation

(10%; 200% higher than the control) and reduced alertness (-16%; 79% higher than the control group) and energy (-2%; 32% higher than the control group) contradicts peppermint's known ability to make an individual more alert and excite their muscles. As a benefit to this aroma, the negative emotion had little to no feelings other than a slight 1% reduction in confusion. In addition, any indicators made from the Beck Test remained under 3 points.

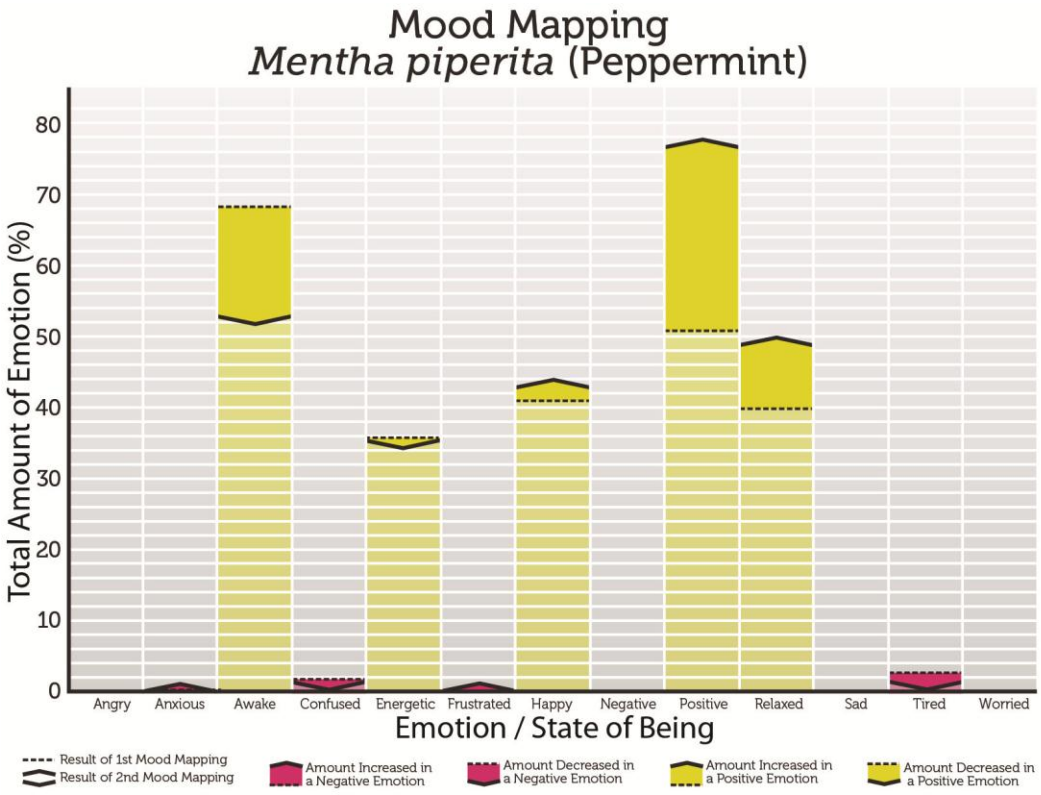


Figure 27: Mood mapping graph depicting the results from the *Mentha piperita* (Peppermint) group.

Zingiber officinalis (Ginger): This group also showed an unusual reaction from the start of the session to the end. Although, alertness (10%; 182% increase from the control group), energy (11%; 132% increase from the control group) , happiness (9%; 41% increase from the control group), positivity (2%; 19% increase from the control group) increased at the end of

the session, and the feeling of being tired decreased (-8%; 13% decrease from the control group), an unprecedented increase in anxiety (8%; 800% from the control group), confusion (16%; 271% increase from the control group), and frustration (28%; 1114% increase from the control group) was noted by the participants. Interestingly enough, the Beck Test revealed participants noting that they were "unable to relax" (17%; 478% increase from the control group) however, their results from the Mood Mapping section reviled only a 3% drop (200% more than control) at the end of the session in relaxation than from the beginning. Participants also indicated they felt their heart pounding (20%) and felt nervous (18%) - numbers higher than any recorded for the Beck test section.

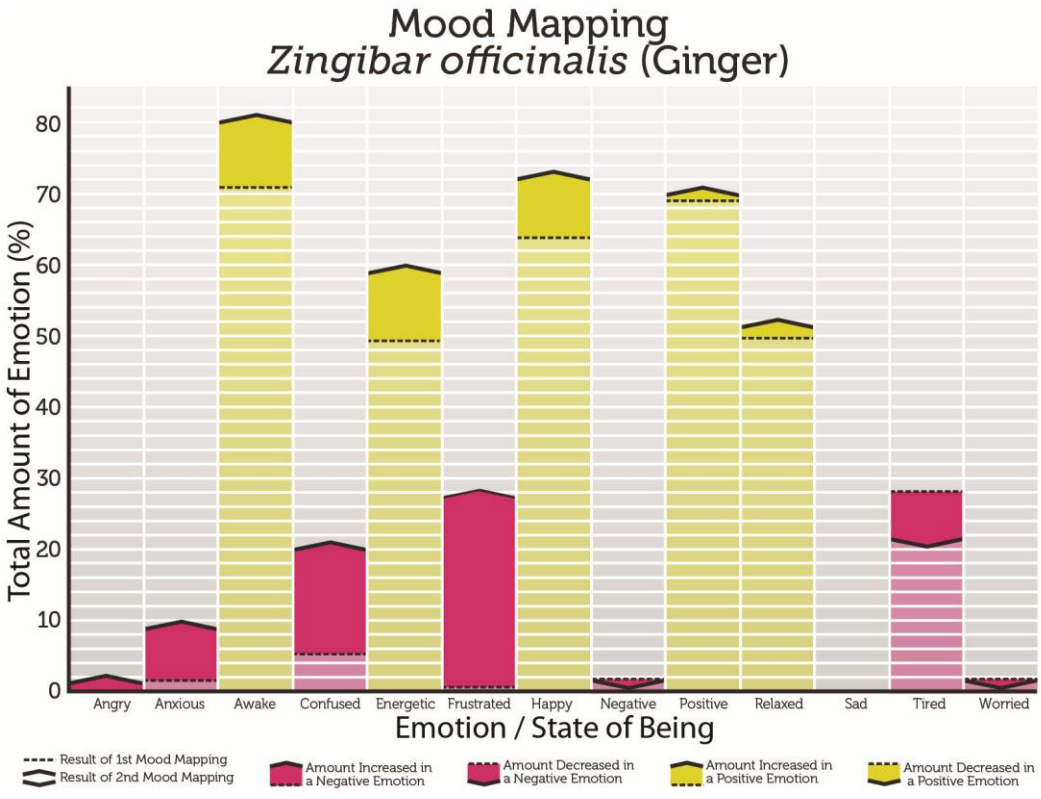


Figure 28: Mood mapping graph depicting the results from the *Zingiber officinalis* (Ginger) group.

Coffee arabica (Coffee): This group seemed to have the worst outcomes than any other aromatic environment. All of the positive emotions such as awake (-14%; 57% more than the control group), energetic (-11%; 29% less than the control group), happiness (-18%; 43% less than the control group), positivity (-1%; 93% less than the control group), and relaxed (-23%; 67% less than the control group) had strikingly lower scores following the completion of the session as compared to the start. In conjunction, negative emotions such as anger (3%; 300% more than the control group), confusion (24%; 315% more than the control group), frustration (6%; 136% more than the control group), negativity (1%), and tiredness (5%, but 72% lower than the control group) all increased following the session's completion. These results seem to compare evenly with results from the web-based computerized tasks. Looking at the negative emotions, the coffee group showed having an increase in confusion (23%; 315% more than the control group) and only a few indicators from the Beck Test, such as Numbness or Tingling (1), Feeling hot (2), Heart pounding (3), and Nervousness (4).

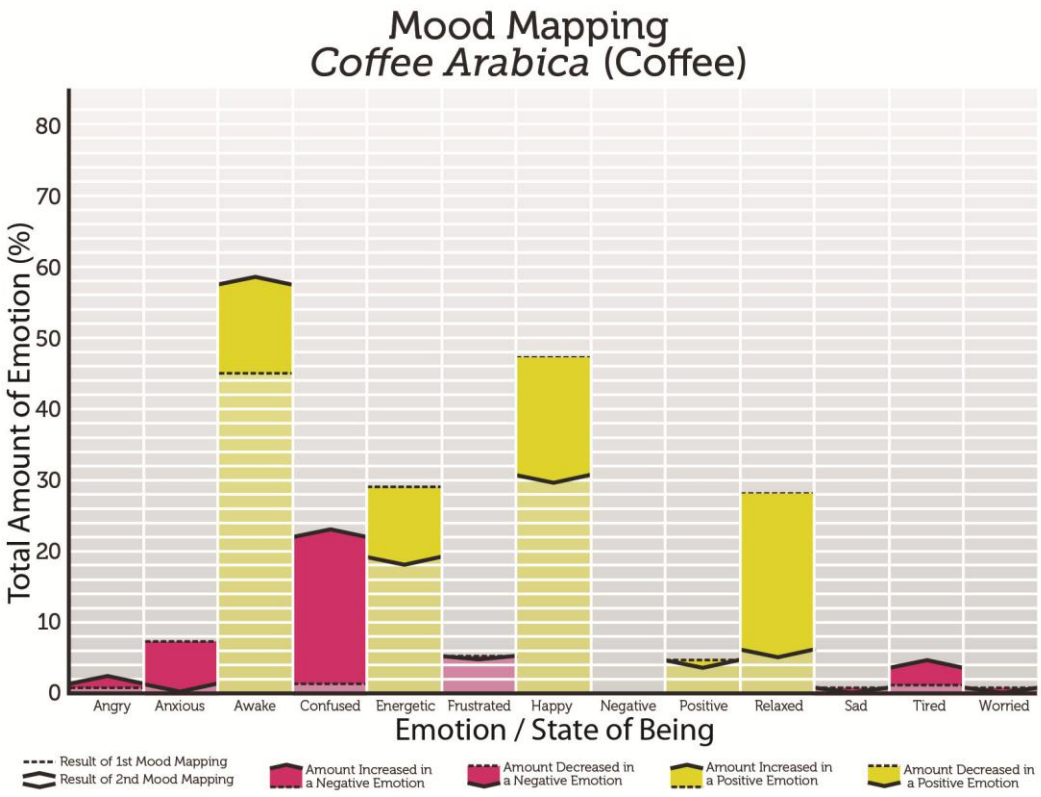


Figure 29: Mood mapping graph depicting the results from the *Coffee arabica* (Coffee) group.

Methylindole (Odor): This group had an unusual reaction in that, although there were increase in negative emotions, like anger (21%; 11% higher than the start and 2100% more than the control), anxiety (22%; 9% higher than the start and 2200% more than the control), confusion (16%; 189% more than the control), frustration (38%; 5% higher from the start and 1520% more than the control), and negativity (19%; 7% higher from the start and 1900% more than the control), this group did show reduced tiredness (21%; 4% lower than the start), and increased awareness (76%; 18% more than the start) and energy (41%; 12% higher than the start and 161% higher than the control). The Beck Test revealed the highest indicators of anxiety through Numbness or Tingling (3%; 160% higher than the control), Feeling hot (40%; 183% higher than the control), Unable to relax (11%; 280% higher

than the control), Fear of worst happening (3%), Dizzy or lightheaded (17%; 5060% higher than the control), Heart pounding (16%), Nervous (18%; 790% higher than the control), Hands trembling (1%), Difficulty in breathing (9%), and Face flushed (12%; 815% higher than the control).

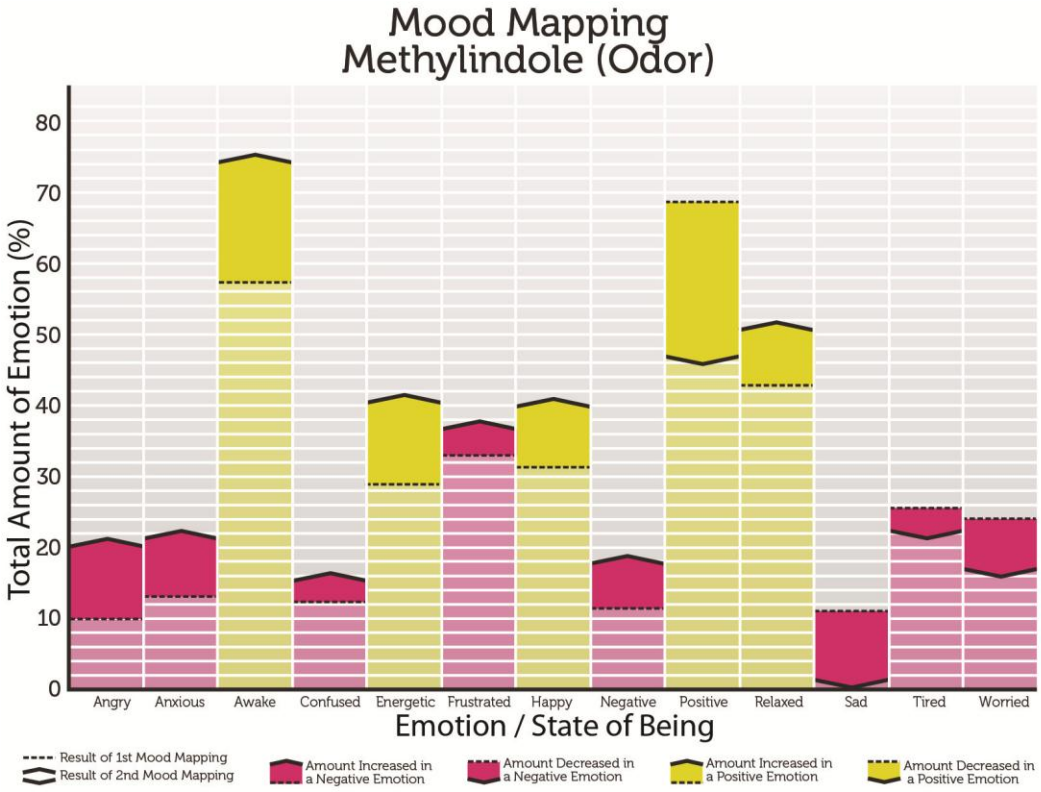
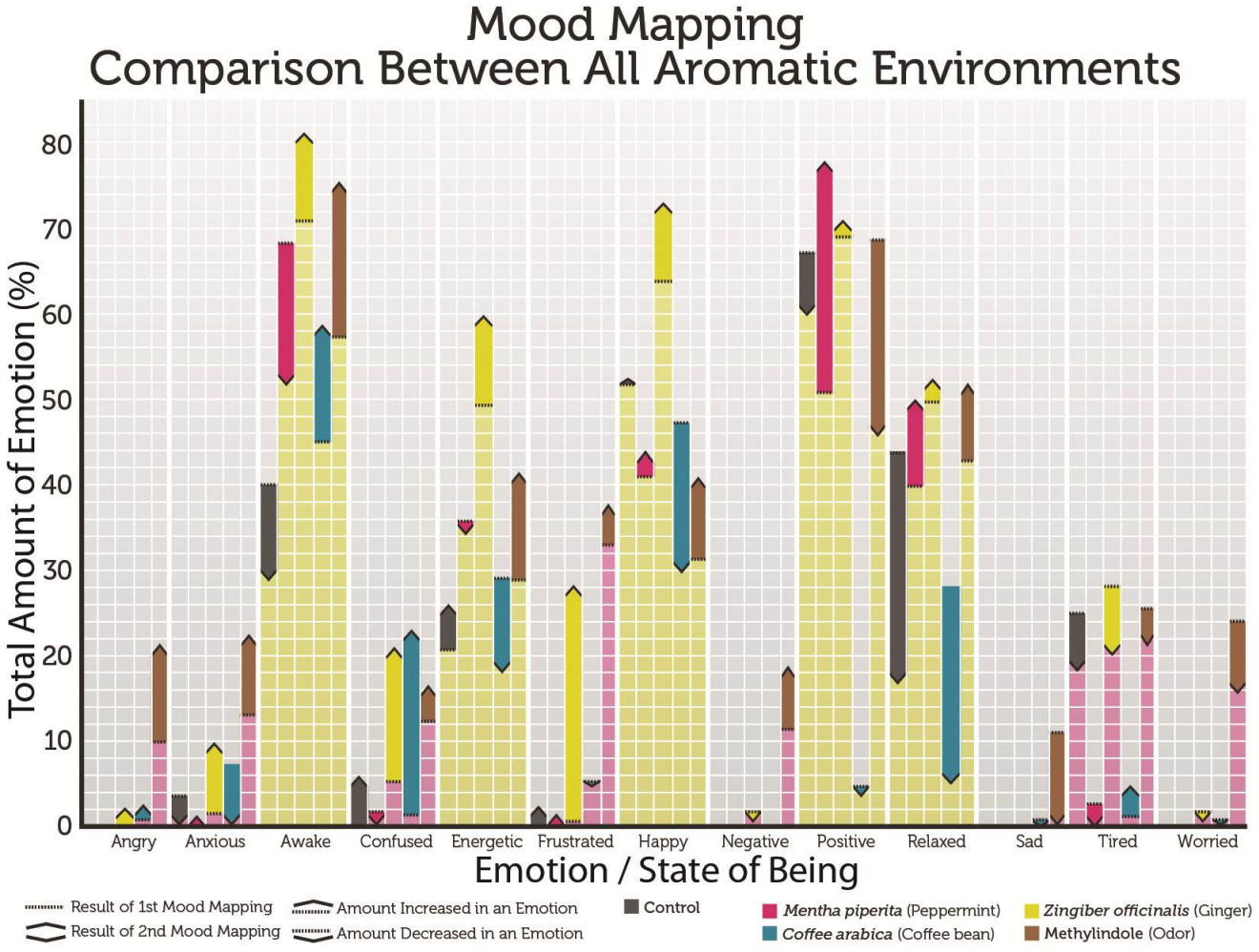


Figure 30: Mood mapping graph depicting the results from the Methylindole (odor) group.

Figure 31: Mood mapping graph depicting all aromatic environments.



Smell Identification and Participant Commentary

Individuals in the Peppermint group did not notice a smell immediately; however, once they were made aware that an aroma was being used, all said they recognized peppermint and that they would be able to spend 8-12 hours a day with that level of peppermint present. In most cases, the participants in the study guessed the aroma correctly, with the exception of *Zingiber officinalis* (Ginger). With ginger, the participants likened the smell to a lemon-scented cleaning product, and all were surprised it was ginger but noted they felt more positive with the aroma. One participant in the ginger group mentioned that they had not eaten all day, but said their stomach was not hurting like it typically would. Another participant, after the first attempt of the Multi-tasking test was completed, commented on the room smelling good.

Modifications to the Final Study Based on Pilot Study Findings

More aggressive recruitment process. Because the location of the formal study took place in the Banner Good Samaritan SimET, and the goal of this research was to determine how caregivers react to olfactory stimuli, the recruitment process was made stricter on its potential subjects. Emergency Department nurses were asked to participate, rather than continue using an open field of employment. In addition, potential subjects were asked to sign up for a given time slot to ensure only a single participant was involved in the study at a given time. Finally, emails were directly sent to Registered Nurses within the Banner Health System to ensure these professionals were recruited.

Additional Bio-feedback device: In addition to using the bio-feedback monitor from the pilot study which was able to indicate the exact temperature of the participant's fingertip, a secondary device was used to collect the physical stress. The bio-feedback scale is a device that participants are able to rest two fingers on a metal plate and a needle sways left or right indicating an elevated or reduced amount of stress. Prior to the study starting, the participant was asked to place their fingers on the pad to set the device at 0 – this provided an initial baseline, or 'at-rest' reading. Information was then collected multiple times during each aromatic environment designating an increased stress (positive number 1.0 to 20.0) or decrease in stress (negative number -1.0 to -20.0).

Updating tests. Although, all of the tasks the participants performed during the pilot study showed exceptional findings, it was required that participants in the formal study were employed as a Registered Nurse who has worked six months or more in the Emergency Department. This would assume that they already had a well-rounded knowledge of medicine, omitting the Medical Test from the formal.

The introduction at the start of each session was also modified as well by exposing the participant to all of the possible pleasant smells for them to select their "most preferred". This would help determine if, in fact, the participant initially enjoyed the aroma they experienced and if the effects of a pleasant aroma the subject experienced had an effect on their performance even if they did not list it as their "most preferred". This particular modification was included to create a real-world experience, setting an

atmosphere that a nurse may be exposed in which they may or may not find the aroma used to be pleasant.

Finally, the largest modification from the pilot study to the formal study was the process of how each session was run for the subject participants. Rather than asking participants to spend 30 minutes to an hour in a session with a single olfactory stimulus, the formal study requested subjects to experience all three aromatic environments with full knowledge of their presence. Each session began by allowing the participant to do a trial run of the Multi-Tasking test for a basic knowledge of how the program worked. Following introductions, each session separated into the three aromatic groups while performing four tasks (Mood Mapping, Memory Test, Stroop Test, and Multi-Tasking Test). Although, subjects were aware that they would experience a control, a pleasant aroma, and an unpleasant odor, they were not informed of which pleasant aroma they were assigned.

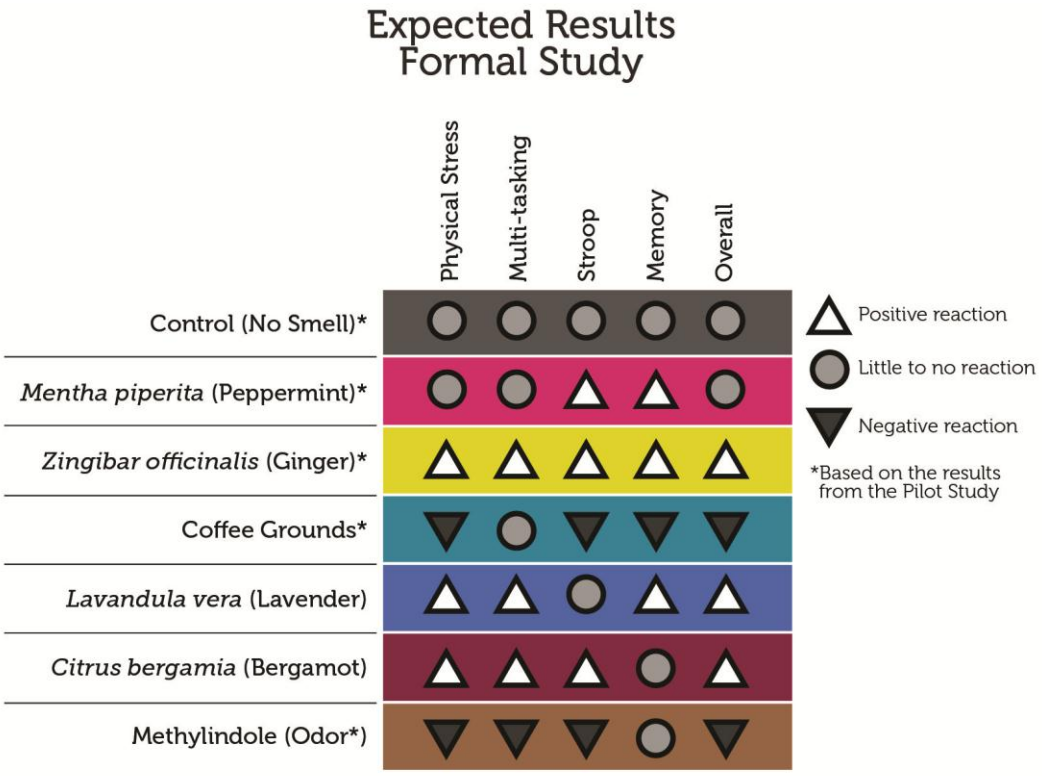


Figure 32: Expected results of the Formal Study based on results from the Pilot Study and additional research.

Final Study

Theoretical Framework

Below is a diagram indicating the theoretical framework for the formal study. Unlike the framework for the pilot study, the smells listed were exposed based on the colors shown. In addition, an electronic survey was sent out to different Healthcare Systems for a better understanding of smells in an Emergency Department. Although it was part of this study, the online survey was not associated with the experimental side.

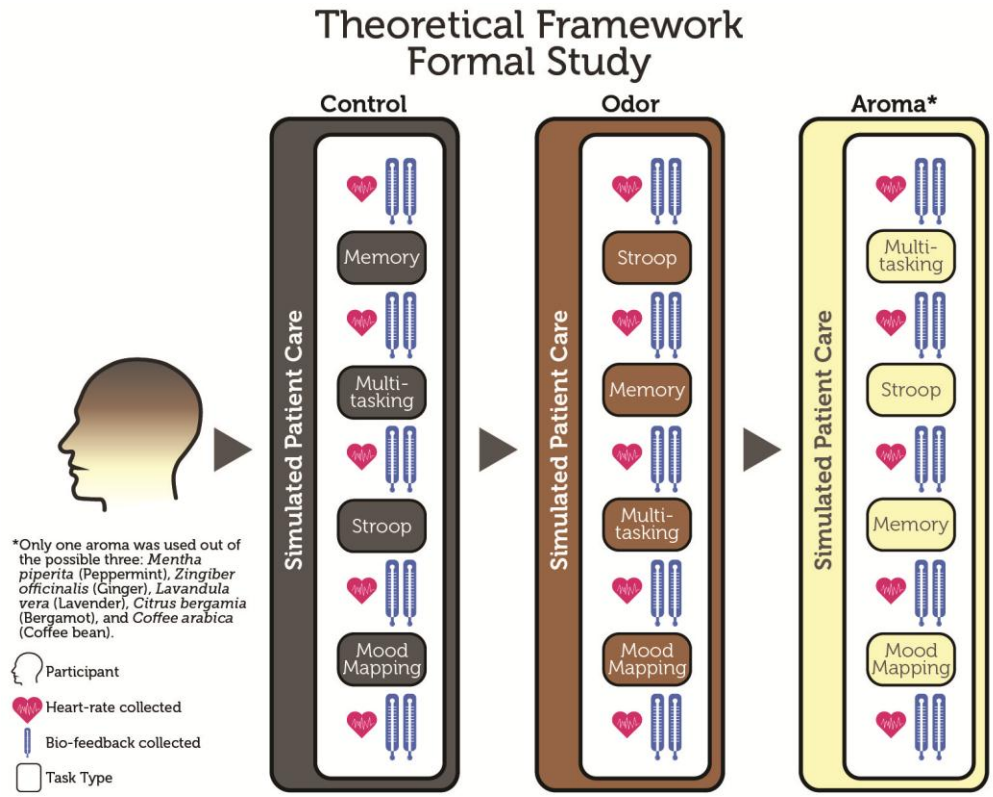


Figure 33: Theoretical framework of the Formal Study.

Participant Selection Criteria

Due to the study's focus on how caregivers, or nurses, are affected by pleasant or unpleasant smells, it was important to recruit participants who had nursing skills. It was crucial to see how participants reacted to the smells during tasks, especially during their interaction with the simulated patients. The inclusion criteria for participants included: an age range from 18 years to 65 years, were Registered Nurses who have worked in a typical Emergency Department environment for a minimum of 6 months, and who worked within the Banner Health System who wished to volunteer to take part in this study. Potential participants who were excluded from the study

included individuals who were or may be pregnant, individuals under the age of 18 years, and individuals over 65 years of age.

Location Selection Criteria

Although the most ideal location for monitoring the effects of nurses exposed to smells in an Emergency Department would have been an active Emergency Department, this experiment took a precautionary approach due to the possibility that the smells could cause a negative effect to the participants, and in turn, potentially their patients.

As a means to reduce the possibility of staff error affecting an actual human patient, the study took place in the SimET, a simulation center for new nurse training, located in the basement level of the Banner Good Samaritan Medical Center in Phoenix, Arizona.

Recruiting Process

Recruitment occurred via emails sent by the Director of Emergency and Trauma at Banner Good Samaritan Medical Center and publicity on the investigator's personal website (www.cotb.me/thesis). Any persons who met the inclusion criteria listed above were encouraged to participate. These players were then asked to fill out an online form where they provided background information to determine their eligibility to participate in the study, as well as other valuable information that may affect their reaction (such as if they were smokers).

A maximum of 60 individuals were screened for enrollment for this study, while the maximum number of subjects that could enroll was 45, giving a 95% confidence interval. Participants were screened through an

online application form where those who were ineligible were notified immediately.

Mannequin Programing

During the study, only one type of mannequin was used for all participants, and was pre-programmed to simulate a healthy patient. Prior to tests starting, Sim techs from the SimET Center helped to program the mannequin and helped to record voices and sounds, such as vomiting, which would be typical for a patient. When the session started, the investigator was able to select key phrases or noises that emanated from the mannequin. In addition to pre-recorded noises and responses, the mannequin was also technically equipped to allow for the investigator to provide responses directly through a microphone.

Participant Codes

Participant codes were used as a tool to ensure participant confidentiality during the course of the session. Codes were created by using a number system: the first number indicated the participant's gender (1 = Female; 2 = Male) and the second two digits represented the time slot during which the volunteer chose to participate in the study. For instance, if a female nurse decided to sign up for the very first time slot, her participant code would read: 101. If a male nurse decided to sign up for the following time slot, his code would read: 202. This technique allowed the investigator to easily and quickly gather and analyze the information from each participant. The possibility of error was also reduced as each time slot was numbered specifically.

Smell Descriptions

Control: The control group was once again used as a baseline to compare the findings between the other aromatic environments. No smells were intentionally introduced into the simulated emergency space during this time to ensure a natural 'neutral' atmosphere.

Mentha piperita (Peppermint): This group was once again used based on the reports from past research studies indicating this essential oil to be optimal for increasing alertness and reducing fatigue. Although the results from the pilot study did not indicate such significantly positive outcomes, the formal study sought to determine the effects this aroma had on caregivers while they cared for a simulated patient. Once again, the essential oil was introduced into the environment through diffusion. It is hypothesized that the results from the formal study will share similar results from the pilot study, and conclude the unnecessary need for this essential oil to be used in a typical Emergency Department.

Zingiber officinalis (Ginger): Because of its outstanding and unpredicted results from the pilot study, this aroma was once again utilized in the formal study in an attempt to recreate the positive reaction from this citrus aroma found in the pilot study. Just like in the pilot study, this essential oil was diffused into the air. The hypothesis for this aroma predicted similar results, possibly referencing the smell to the lemon-scented aroma of the cleaning products.

Coffee Grounds: As a necessary modification from the pilot study, the formal study presented the aroma of coffee beans in a similar fashion than is

currently used in many typical Emergency Departments: coffee grounds. These grounds were placed discretely near the computer where participants were performing their web-based computerized tasks, instead of near the simulated patient, to replicate similar layouts in the ED. The results from this group were assumed to show a more positive reaction compared to the results from the pilot study; however, the results were also conversely predicted to show negative results due to the aroma's association in the Emergency Department as a foul odor.

Lavandula angustifolia (Lavender): As one of the most favored aromas in today's society, this essential oil was selected due to its "miracle properties" and recognizability. Like the other essential oils used in this study, the lavender aroma used a diffuser to evenly disperse the smell throughout the space. It is assumed that this aroma will have the greatest number of individuals selecting this as their "most-pleasant" aroma at the start of the sessions. In addition, because so many people find this aroma to be pleasant, it was hypothesized that this group would show the most prominent increase in productivity based on test scores and positivity from the Mood Mapping Test due to its familiarity which, in turn, would lead to a reduction in participants' physical stress.

Citrus bergamia (Bergamot): As an additional citrus aroma, bergamot was introduced due to its de-stressing properties. It was also introduced to determine if the aroma of citrus would have similar results to the ginger group from the pilot study. The essential oil for this study used diffusion to introduce the aroma. Although pleasant and uplifting, this group is

hypothesized to have a slightly reduced positive effect compared to the ginger group due to its unrecognizable aroma which may distract participants.

Methylindole (Odor: Once again, this odor is used in the formal study to replicate the stench of dirty feet. During this experiment, the jar of Methylindole will be taken out of the box prior to the start of the study and placed near the participant's computer. Although the pilot study revealed some slight negative responses to the odor, it is assumed that this smell may have participants react closer to the control group due to the nurse's constant exposure to foul odors.

Procedure

The duration of the study lasted between June 29, 2012 and November 8, 2012. Each session lasted no more than 1.5 hours (or just shy of 1/6 of a typical 12 hour shift) for each participant. Following each session, data analyzing began immediately and continued for one month following the completion of the study.

There was no deception in this experiment. Participants were informed of participating in three different aromatic environments which included an odor and an aroma. Prior to the start of testing, participants were allowed to choose their pleasant aroma of choice to determine their "most-pleasant" aroma. Each session began with an introduction to the study and the opportunity to sign the consent form, which all participants were given a copy of. Following the participant signing the forms, they performed a short test (Mood Mapping) which allowed participants to place how they felt, emotionally, on scales. Once this initial test was completed, information was

gathered from heart-rate and bio-feedback monitors every five minutes starting after the completion of the first test, Mood Mapping. This was initial data was used as a cross-reference, or baseline, to how the participants performed; any comments that are made during and after the sessions were also recorded. Participants were asked to begin taking care of their simulated patients – mannequins - and the aromatic diffusion process finally began.

The smell diffused was determined by the section, or group, of the session that the subject participated in. All participants took part in a control session, an odor session (which contained the same odors amongst all participants), and an aroma session (which had been predetermined prior to the recruitment process). During the study, each participant completed all computerized tasks and attended to their simulated patients. The environment attempted to simulate a highly stressful atmosphere by interrupting the caregivers from their patients every five minutes to collect bio-feedback and heart-rate information, as well as requiring the caregivers to simultaneously perform computer tasks, complete a high score from a virtual IV, as well as continue to care for their simulated patient.

Each test consisted of a series of tasks considered common for a caregiver in a typical Emergency Department, including, but not limited to: patient interaction and care, administering medication to patients, and simple computerized tasks/tests which this study included: the Stroop Test, Memory Test, and a Multi-tasking Test. A participant repeated the series of tasks and participated in patient (simulated) care for the two olfactory environments that followed; see appendix for a timeline of each grouping.

Finally, a short follow-up interview was conducted. End of study interviews took place immediately after each session of the study, and was set up semi-structured. This allowed participants to openly express, and be able to better describe, how they felt about performing each task, if they noticed any smells, how they liked – or disliked - the smells, and if they felt the smell in the room allowed or prevented them from performing their best.

Confidentiality of data. Confidentiality of records identifying subjects has been maintained. Individuals who may have access to data information include the following: Carina Clark (co-Investigator), Jose Bernardi (Principle Investigator), Richard Watts (co-Investigator), and the SimET at Banner Good Samaritan Medical Center.

Participant codes were used during data collection to protect patient confidentiality, while a Master List was kept in a secure location in a locked cabinet within a locked room on the ASU Tempe campus. Once the data had been collected and analyzed, any identifiers (ex. Participant's name, position, hospital of employment) were emitted prior to publication. Coding was used to identify participants between each types of data collection, such as surveys, interviews, and the study.

Master list. Identifiers were removed from the data at the full completion of the study prior to graduation. A Master List was used as a way to accurately analyze data between the different participants. The Master List was stored in a locked cabinet in the locked room CDN66 on the ASU Tempe Campus, which only one investigator had access to.

Variables

Due to the nature of this experiment, it is possible that, because participants knew they would be experiencing three different smells, the demand-characteristic effect took place. This effect is an occurrence where participants attempt to act as a "good subject" by interpreting what the study is attempting to find, and by then acting in a way they feel would meet the best requirements the researcher is looking for (Tate, 1997).

IRB Approval

ASU IRB approval was given in October 2011, and modified to reflect exact verbiage of changes to meet Banner Health's IRB approval. In November 2012, this study received IRB approval from Banner Health.

Conclusion

This chapter discussed the essence of this study by reviewing the research questions, methodology, methods used, and safety considerations for the study. It then explained further details of the pilot study, including the theoretical framework, participant and location selection, recruitment process, data collection, procedures, and variables. Due to the strong influence the pilot study had on the modifications made to improve the formal study, the chapter then introduced the findings from each task that participants were asked to perform, followed by what modifications were made between study experiments. Finally, the chapter then looked into the details of the formal study including mannequin programing, participant codes, master list, smell descriptions, confidentiality of the participants, and

approval. To conclude, this chapter highlighted the IRB approval for the formal study from both the University's IRB and the Banner Health IRB.

DATA ANALYSIS AND RESULTS

Introduction

This chapter will review the project analysis for this thesis. Participant information, such as age, gender, if they suffer from any allergies – especially to fragrances - and their selective choice in pleasant aroma will be discussed. Afterwards, the chapter will synthesize outcomes for each of the different aromatic environments from both the physical monitors and web-based computer tasks. Findings will then be summed up with final comments and participant interactions from the sessions.

Participant Info (Age, Gender, Allergies, Etc.)

This study allowed for up to 45 participants to take part. While only fifteen individuals signed up for the study, only eight actively attended and participated. Four individuals who signed up did not schedule a day & time to attend the study and did not schedule after an attempt was made to contact them. Three individuals signed up for a day and time, but did not show up at their scheduled study time, nor did they reschedule even after being contacted by the investigator. For the eight individuals who did fully participate, five were females with an average age of 41 years; three were males with an average age of 39.67 years. The average age of all of the participants was 40.33 years. Only one of the participants currently was, or had been a smoker, and indicated that they had smoked for over 30 years. None of the females who participated in the study were pregnant, or thought to be. None of the participants indicated they had any allergies to any of the aromas used during the study.

All of the participants in this study had worked in the Emergency Department (ED) for six months or more. The average work period in the Emergency Department was 2.56 years, but the average period was 8.07 years working in the medical field. The maximum number of years worked in an Emergency Department was 16 years. All but one participant currently worked in an Emergency Department, with one of the participants currently focusing in a pediatric ED. The participant who did not currently work in the Emergency Department, but had in the past, was working in Internal Medicine at the time of the study. In total, six Registered Nurses, one Emergency Department tech, and one Emergency Department physician participated in this study.

Participants Choice in "Pleasant Smell"

Although the type of pleasant aroma used during the study was predetermined to ensure even data collection, all participants were briefly exposed to each of the five different essential oils to calculate which oil was their preferred. Because participant size was small, analysis was not done to compare if the oil chosen by the participant matched the oil used in the study, nor if the aromas affected them in a more positive manner than those who chose an oil different than the one used in the study. Based on the information collected, half (4) of the participants chose the aroma of peppermint as their most preferred; only one of these participants experienced *Mentha piperita* (Peppermint) during the study. The only aroma that was not chosen as a preferred aroma by any of the participants was the coffee grounds; it is to be noted that the one participant who was randomly

chosen to experience this aroma during their session noted greatly disliking the essence after this portion of the study.

Stress Levels

Prior to the start of the study, each participant was asked to perform the actions necessary to collect their heart-rate and bio-feedback information to act as the baseline by placing their fingers on the stand-alone bio-feedback device and allow for the investigator to record information from the secondary bio-feedback monitor and heart-rate monitor. This data reflected the participants at a state of rest. The baseline information allowed the investigator to study the differences between physical reactions when exposed to an aromatic environment and the physical state of the participant at this resting state (baseline). This knowledge was different than the control information, as the control session had participants performing all of the additional tasks required by the study while the participants' physical data was being collected.

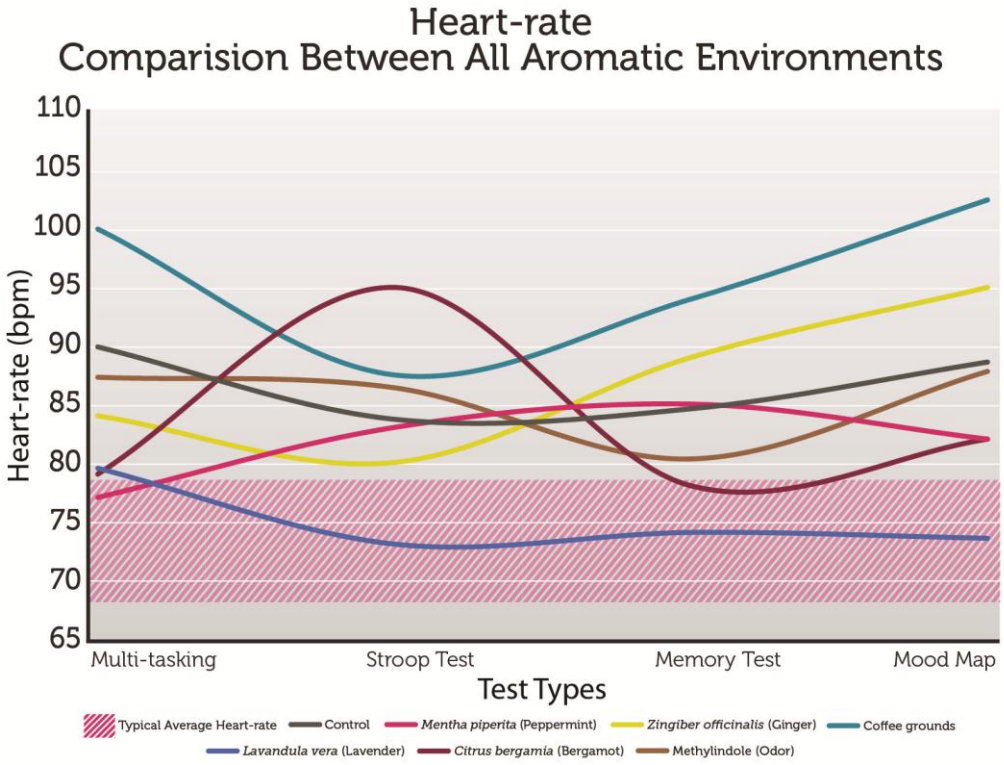


Figure 34: Heart rates between each aromatic environment groupings during the Formal Study.

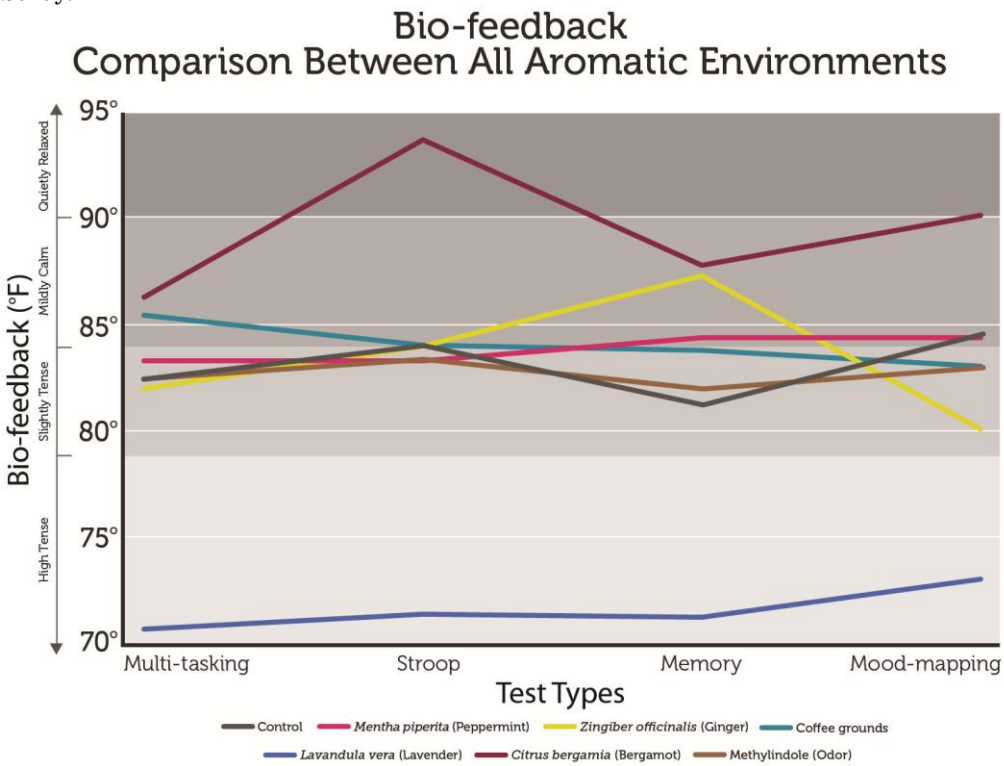


Figure 35: Bio-feedback between each aromatic environment groupings during the Formal Study.

Control

The initial baseline reading was taken just after the informed consent was signed and prior to starting any tasks; this reflected the participant at an "at rest" state. Results from the control grouping showed an average control heart rate reading of 87 bpm (beats per minute) (1.70% less than the baseline), ranging between a minimum of 70 bpm and a maximum of 117 bpm. The average biofeedback reading was 83.05 degrees during the control, 1.11% higher than the baseline reading (82.14), and a 2 on the scale (where the baseline was set to read as 0) from the average participants' reading. The minimum bio-feedback reading during the control session was 71.4 while the maximum was 93.0. One individual showed a spike from 80 bpm to 117 bpm, and an elevated biofeedback scale of 19 between the Memory test and the Multi-Tasking test.

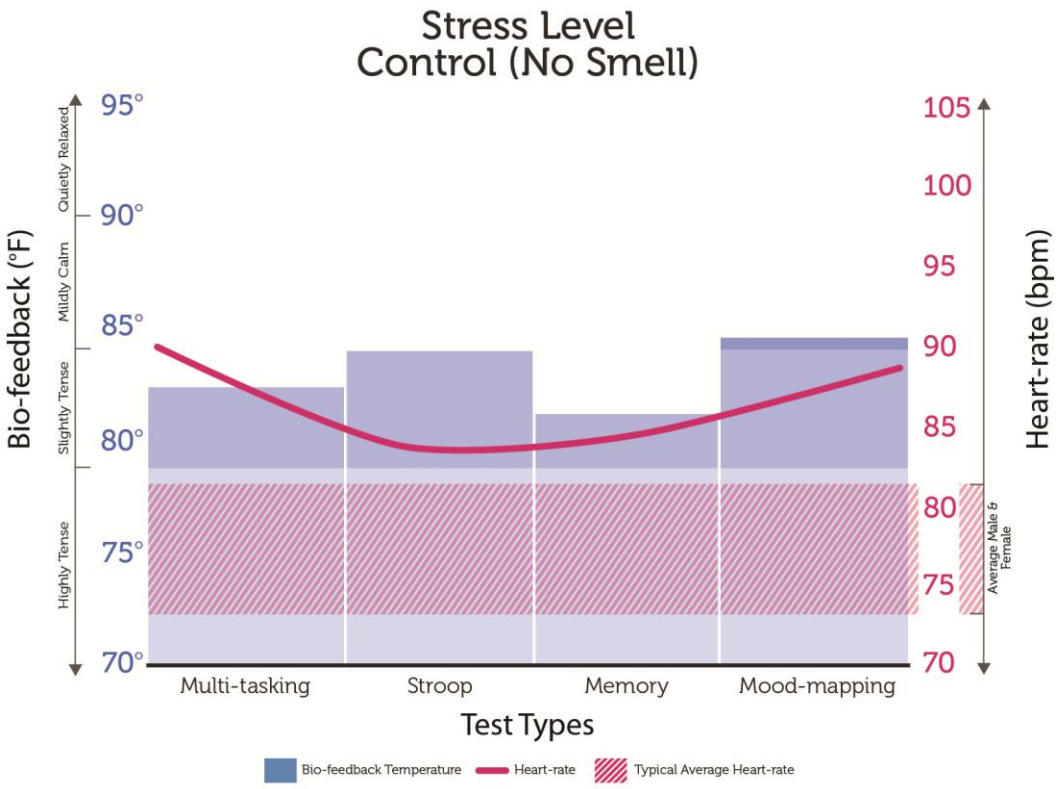


Figure 36: Stress Levels graph for the Control group during the Formal Study.

Methylindol (Dirty Feet)

The odor grouping showed having a range for the baseline heart rate reading between 71 and 123, with an average of 85 bpm (-3.12% as compared to the baseline reading). The average skin temperature for the odor grouping was 82.69 degrees Fahrenheit (or a -1 on the scale), with a minimum of 70.9 degrees Fahrenheit (and -20.0 on the scale) and a maximum of 94.5 degrees Fahrenheit (and 20.0 on the scale). For one individual during the coffee grounds session, this heart-rate jumped between 103, to 84, to 101, to 81 bmp; this physical reaction of swaying from high stress to low stress to high stress back to low stress was also noticeable in the data collected from the biofeedback monitor which recorded a skin temperature of 85.1 (20 on the scale), then 82.9 (14), then 83.8 (16), then 80.1 (18) degrees Fahrenheit.

Besides this particular individual, the overall stress level of participants during the odor grouping appeared to have no effect to a slightly reduced effect on the stress of the participant. Heart rate numbers revealed this grouping had the fourth-highest bpm, while skin temperatures showed the odor group having the second lowest range in temperatures.

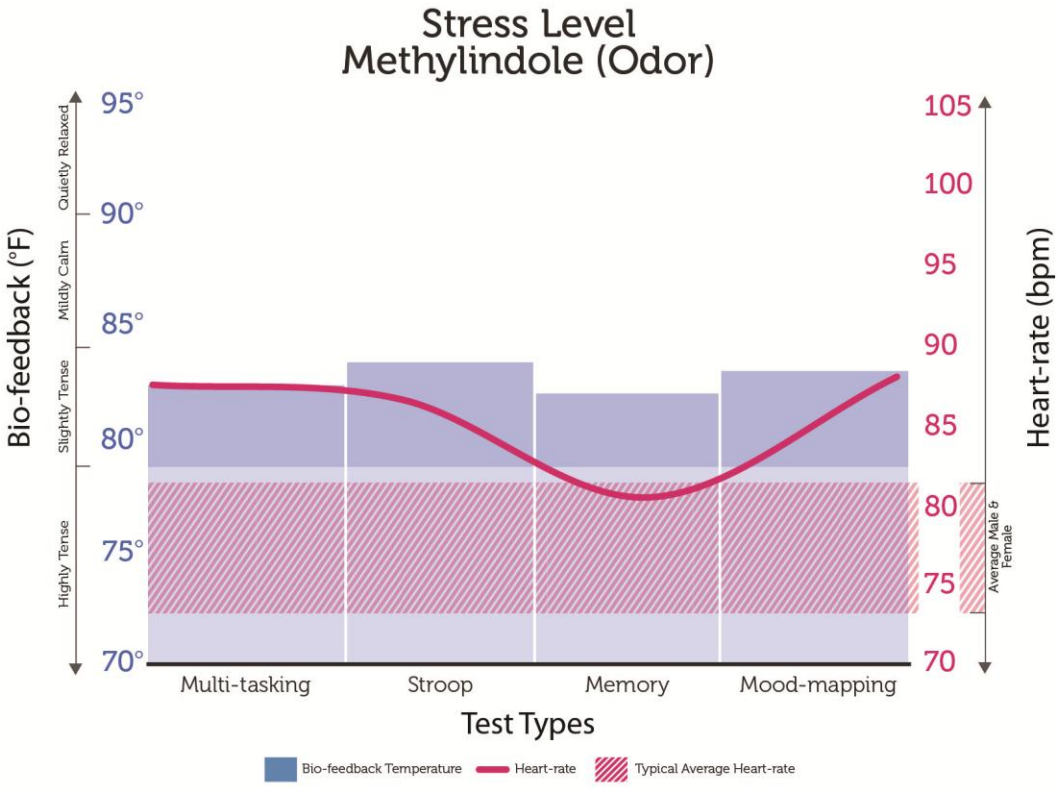


Figure 37: Stress Levels graph for the Odor group during the Formal Study.

Aromas

***Mentha piperita* (Peppermint)**. The average heart rate reading was 81.8 bpm, 7.31% lower than the baseline, and 10.32% lower than the odor group. The average skin temperature during this session was 83.85 degrees Fahrenheit (+4 on the scale), 2.08% higher than the baseline and 0.96% higher than the control group. The reduction in bpm and the increase in bio-

feedback numbers indicate that participants in this group showed their stress reduced.

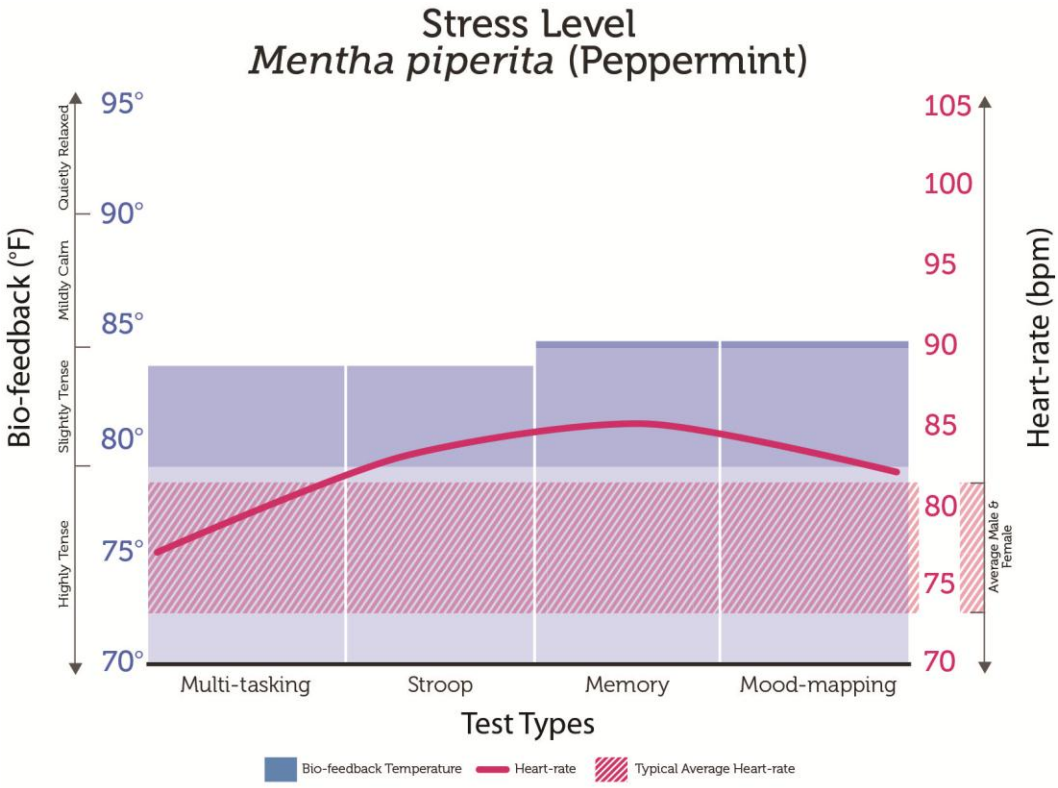


Figure 38: Stress Levels graph for the *Mentha piperita* (Peppermint) group during the Formal Study.

***Zingibar officinalis* (Ginger)**. This group showed an average bpm of 87, which was lower than the baseline (-1.36%) and the control group (-3.11%) but slightly elevated from the odor group (1.81%). The biofeedback thermometer showed the average skin temperature for the ginger group was 83.35 degrees Fahrenheit, which had increased from the baseline (1.47%), the control group (0.36%), and the odor group (0.80%). In addition, the scaled biofeedback monitor showed an average of -19 (negative), indicating a considerable reduction in stress levels, and a large reduction from the control group (1249.15%) and the odor group (1733.33%). With the reduction in heart

rate beats per minute and the slight increase in skin temperature, but decrease from the biofeedback scale, this group shows a significant correlation between physical stress and the aroma used based on the data collected from the physical reactions.

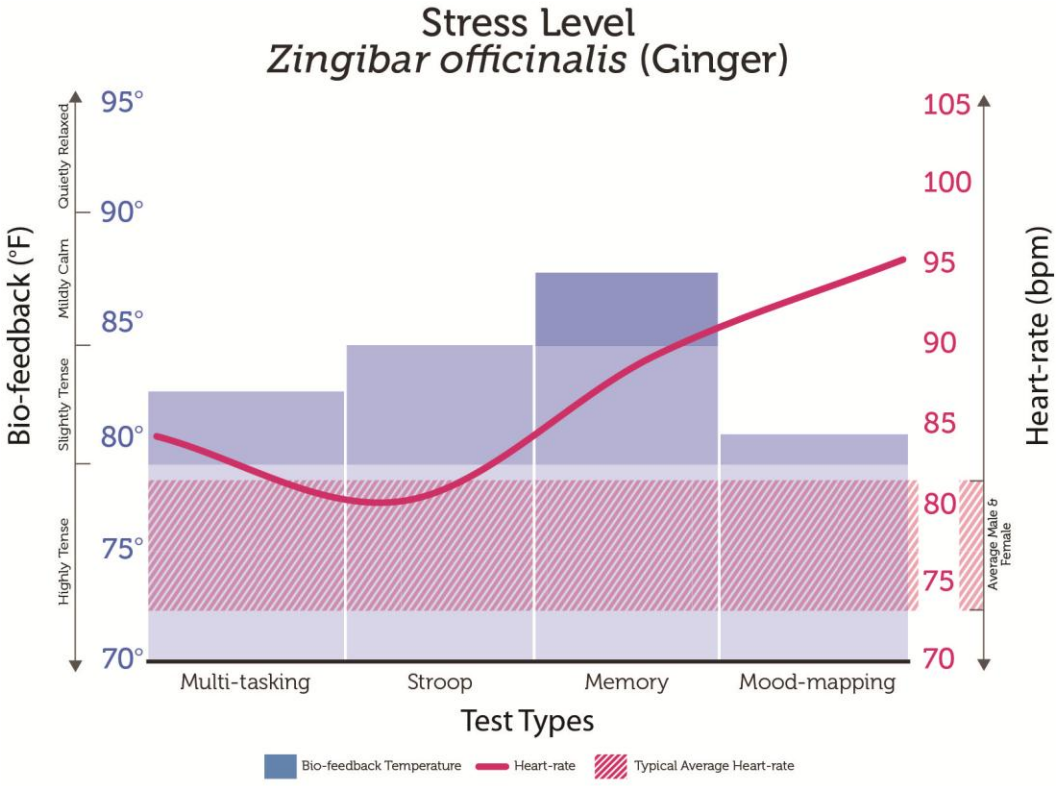


Figure 39: Stress levels for the *Zingibar officinalis* (Ginger) group during the Formal Study.

Coffee grounds. The coffee grounds group showed an average heart rate of 96 bpm – the highest among all of the aromatic environments. This heart-rate showed an increase from the baseline (8.84%), the control group (13.90%), and the odor group (12.35%) by large amounts. Additionally, the average skin temperature was 84.09 degrees Fahrenheit, a 2.37% increase from the baseline, a 1.25% increase from the control group, and a 1.69% increase from the odor group. Likewise, the biofeedback scale indicated an average score of 13, with a 676.12% increase from the control group and

1338.10% increase from the odor. These numbers state that there was a significant increase in stress due to the elevated heart rate and biofeedback scale. Although the average skin temperature did not decline, indicating more stress, the increase from baseline, control and odor was so minimal; it did not show any positive effects. Overall, the coffee grounds group showed the second worse reaction by producing physical stress on the participants.

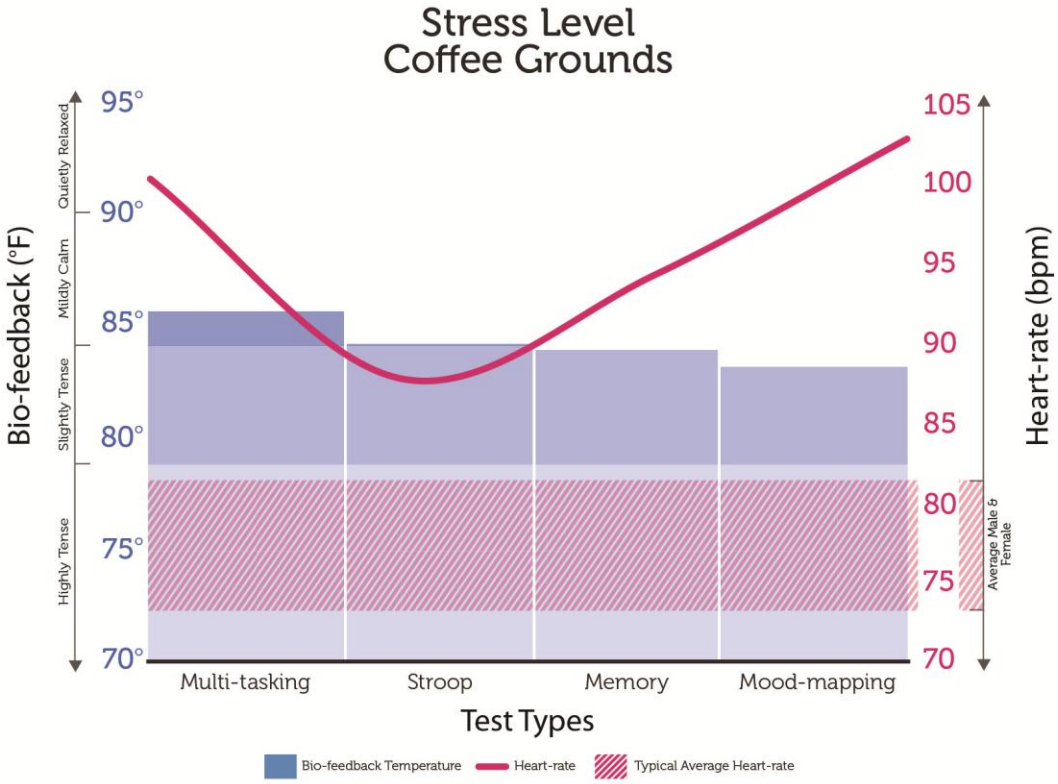


Figure 40: Stress levels for the coffee grounds group during the Formal Study.

***Lavandula vera* (Lavender)**. The average heart rate reading was 75 bpm – the lowest recorded between all groupings – and indicated a reduction in bpm from the baseline (-14.97%), the control group (-12.34%), and the odor group (-12.23%). The average reading for the lavender group read between 71 and 81 bpm. Although, the lavender group showed the best response through a reduced heart rate, the opposite occurred during the biofeedback

collection. The average biofeedback reading was 75.9 degrees – the lowest average among all groups - and showed a decline from the baseline (-12.83%), the control group (-13.79%), and the odor group (-13.41%) with similar results for the biofeedback scale (-935.82% from the control, -1233.33% from the odor). Even though this group showed some reduction in skin temperatures, the overall averages for the heart rate and biofeedback scales were in relatively great condition. Based on the information collected from all of the aromatic environments, the Lavender group showed having the most positive physical reaction.

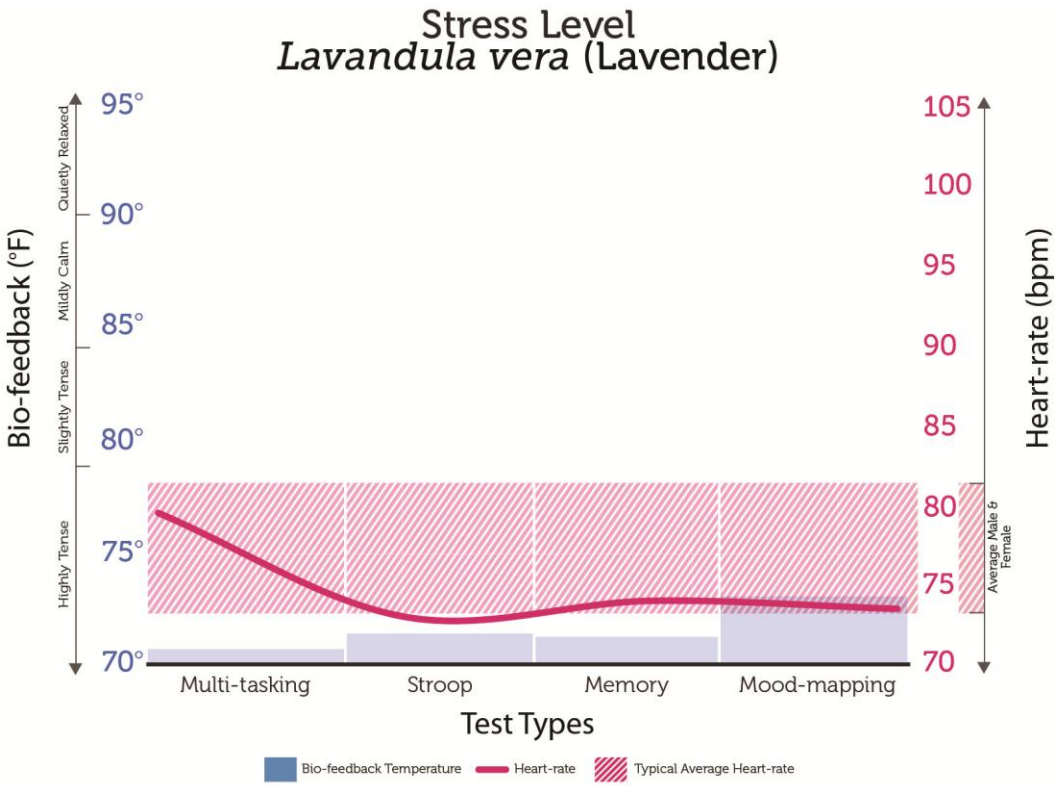


Figure 41: Stress levels for the *Lavandula vera* (Lavender) group during the Formal Study.

***Citrus bergamia* (Bergamot)**. The average heart rate reading was 84 bpm - 5.33% lower than the baseline, 4.67% higher than the control group, and 2.28 lower from the odor group. The average group reading was between

74 and 95 bpm, with the absence of one recording during the multi-tasking test due to technical difficulties. The average biofeedback reading was 89.49 degrees Fahrenheit, an increase from the baseline (8.95%), the control group (7.75%), and the odor group (8.22%). The biofeedback scale averaged out at 14.25, an increase from the control group (750.75%), and the odor group (1457.14%).

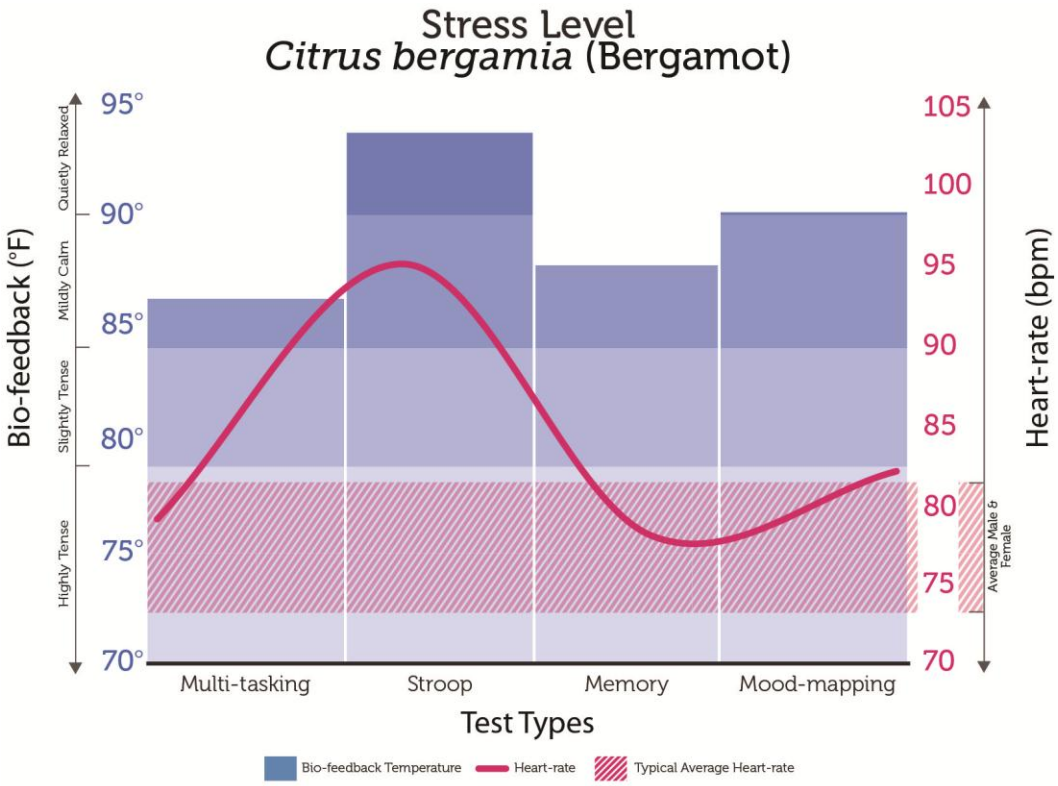


Figure 42: Stress levels for the *Citrus bergamia* (Bergamot) group during the Formal Study.

Multi-tasking between aromatic environments

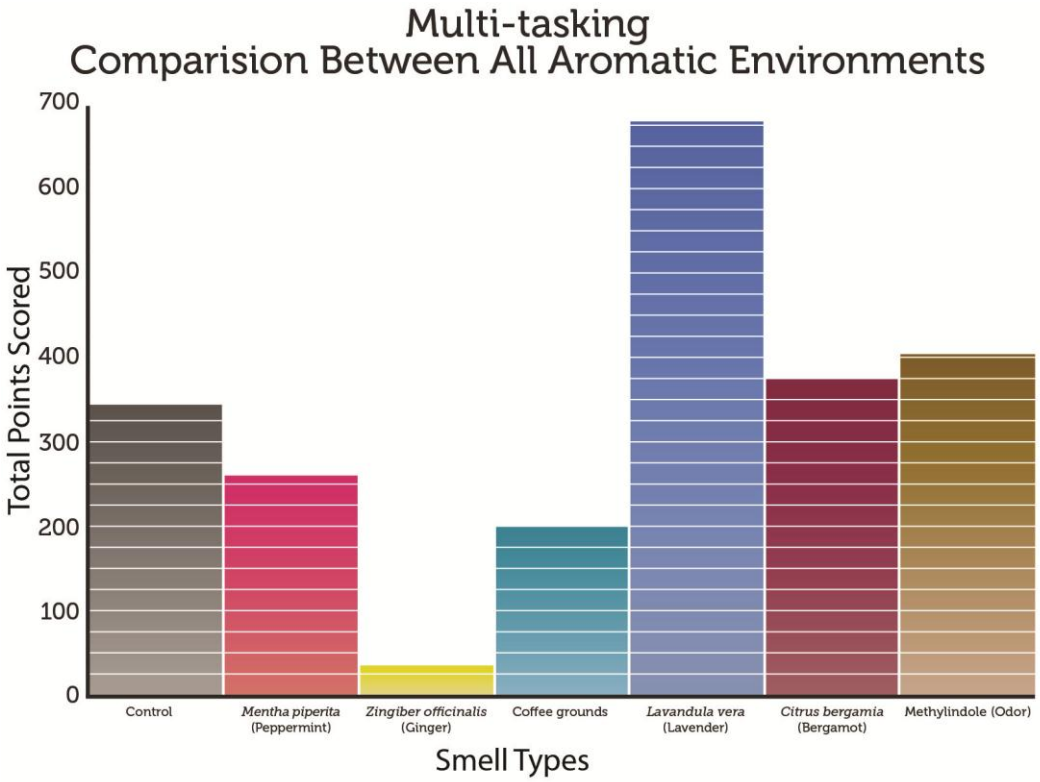


Figure 43: Total scores for the Multi-tasking test between each aromatic environment groupings during the Formal Study.

Control

The control group was the first officially-recorded attempt made by the participants following a trial run after the informed consents were signed. This group showed having an average total score of 334 points with 105 in math, 135 in arrow, and an average of 3 in color. The control group ended up having the fourth highest score among all other aromatic environments.

Methylindol (Dirty Feet)

The average total points for the odor group was 404, with 131 in math (25.36% higher than the control group), 213 in arrow (58.36% higher than the control group), and 18 in color (506.67% higher than in the control group).

Overall, there was a positive increase in accuracy during the odor group, resulting in the second highest score between all aromatic environments.

Aromas

***Mentha piperita* (Peppermint)**. The average total points for the peppermint group was 260 (35.64% lower than the odor group and 24.40% lower from the control group). The average score for math was 120 (-8.4% from the odor group and +14.83% from the control group), arrow was 95 (-55.4% from the odor group and -29.37% from the control group), and color was 45 points (+147.25% from the odor group and +1400% from the control group).

***Zingibar officinalis* (Ginger)**. The average total points for the ginger group was 35 – the lowest total score out of all of the aromatic environments (91.34% lower than the odor and 89.82% lower than the control). The average math score was -5 (-103.82% from the odor group and -104.78% from the control group), the average arrow score was 35 (-83.57% from the odor group and -73.98% from the control group), and the average color score was 5 (-72.53% from the odor group and +66.67% from the control group).

Coffee grounds. This group had an average total score of 200 points (-50.50% compared to the odor group; -41.84% compared to the control group) separated by 25 points in math (-80.92% from the odor group and -76.08% from the control group), 145 in arrow (-31.92% in the odor group; +7.81% in the control group), and 30 in color (+64.84% from the odor group and +900% from the control group).

***Lavandula vera* (Lavender)**. The average number of total points earned in the Lavender group was 680, scoring 45 in math, 82.5 in the arrows, and 55 in the color section. The average points showed an increase from the odor session of about 68.32% and an increase from the control session of 97.73% increase from the control. This group showed the highest total score among all other aromatic environments.

***Citrus bergamia* (Bergamot)**. This group showed an average number of points earned at 375. This broke down to achieving 175 in math, 20 in the arrows, and 15 in the color section. The average points showed a decrease from the odor session of about -7.18% and an increase from the control session of 9.04%.

Stroop Test

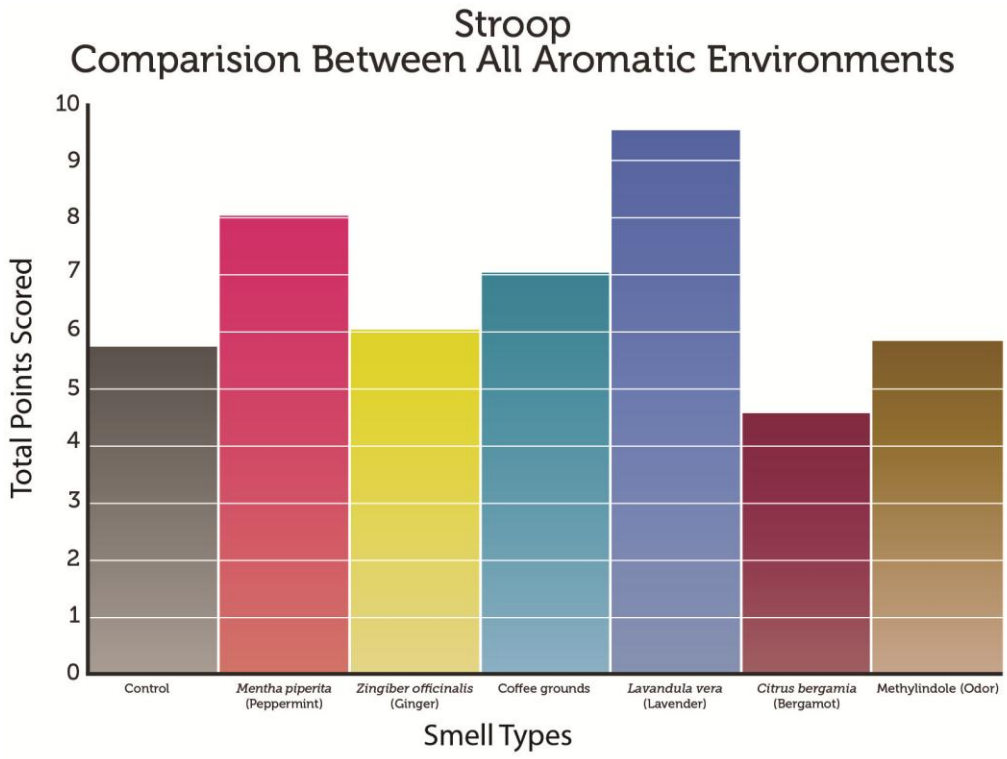


Figure 44: Total scores for the Stroop test between each aromatic environment groupings during the Formal Study.

Control

This group had the second lowest score, just over bergamot, with a total score of 6 out of 10. The peppermint group had the highest positive variance (Δ-4) between the control and the aroma, from 4 to 8. One individual in the bergamot group had a negative variance between the control and the aroma of 8 to 3. Another bergamot participant had the lowest positive variance (Δ4) from the control to the odor of 4 to 8. No control went below 4 correct responses, while the maximum was 8. The average number of correct answers for this group was 6.

Methylindol (Dirty Feet).

The average correct number of answers for this group was 6, with a minimum of 3 correct and a maximum of 8 correctly answered questions. The lavender, coffee grounds and peppermint groups all showed a slight improvement over the control group.

Aromas

***Mentha piperita* (Peppermint)**. The average correct number of answers for this group was an 8 - a 37.93% increase in the number of correct answers from the odor group, and a 40.35% increase from the control group. This group showed a steady increase throughout the study, increasing from a score of 4 to 5 (+25.00%) to 8 (+60.00%). A steady increase could have resulted from the participants' increasing familiarity with the task; however, the heightened increase between results between the odor and aroma sessions could reflect peppermint's perceived ability to increase productivity and awareness.

Zingibar officinalis (Ginger). The ginger group showed an average of 6 correct answers (3.45% higher than the odor group and 5.26% higher than the control group) and had a jagged reaction between the different aromatic environments. The control group for this test had the highest score (8) which then decreased drastically to 5 (-37.50%). There was then an increase of 20.00% (6) by the aroma group over the control group. This group best illustrated the original hypothesis for this study and particular session by showing a decrease in performance during the odor session, attributed to this producing a possible distraction and/or discomfort, followed by an increase in numbers during the aroma session. However, the difference between the control and aroma group did not show a positive increase, which would have been consistent with the results from the Pilot Study.

Coffee grounds. The coffee grounds group had an average score of 7, which was 20.69% higher than the odor group and 22.81% higher than the control group. Unlike some other aromas, this session progressed with number of correct answers increasing from 5 to 6 (+20%), to 7 (+16.67%).

Lavandula vera (Lavender). The average score for the lavender group was 9.5. This was a 63.79% increase from the odor session, and a 66.67% increase from the control group. This consistent increase could be the result of a progressive better understanding from the participant after each time tried, as well as the inherent benefits of inhaling the essential oil.

Citrus bergamia (Bergamot). The Bergamot group showed an average score on the Stroop Test of 4.5. The score was a 22.41% decrease from the odor session and a 21.05% decrease from the control group.

Memory Test

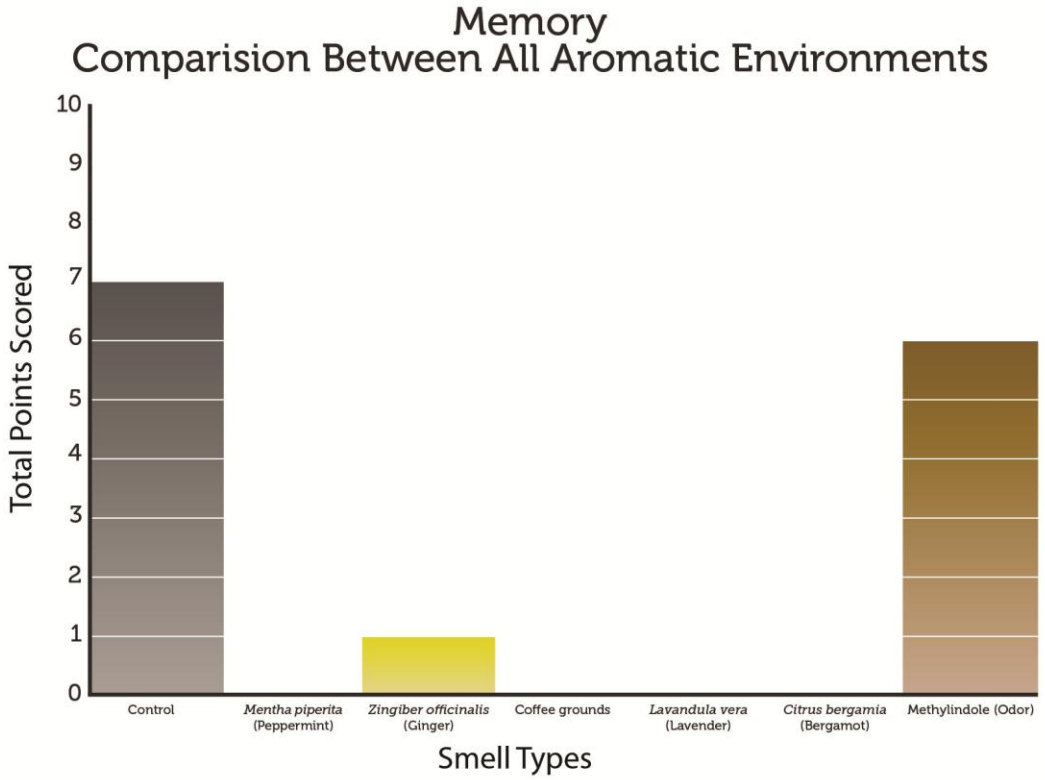


Figure 45: Memory results from the Formal Study

Control

The control group showed having the highest number of correct answers (7 out of 10 possible) on the memory test than of any other grouping.

Methylindol (Dirty Feet)

The odor group showed having the second highest number of correct answers (6). Although a reduction in correct answers was expected due to the amount of time between first and second attempts, the small reduction (-16.42%) was unpredictable in the number of correct answers.

Aromas

Only the ginger group showed a score higher than zero for this task. These results may not directly indicate that all essential oils are ineffective

for memory tasks, regardless of the results. Causal effects of these results may be due to the time frame participants participated in this task. For instance, this was the first task during the control session, but the second to the last task during the aroma session, allowing for a 50 minute time gap. Only the ginger group managed to achieve a positive score (1) which was an 82.14% decrease from the odor group and 85.07% decrease from the control group. All of the other aromas received a 0 score.

Mood Mapping

Control

The control group was used as a tool to determine a controlled – non-aromatic - state of being for the participants. Assumptions would conclude that all aromas would produce a more positive emotional state, the odor would have a negative reaction, and the control should fit squarely in the middle. Results from this study revealed that the control group was the second highest in producing positive emotions (78.2), 5.03% less than the baseline, compared to all other aromatic environments. This particular reaction could be the result of reduced confusion and anxiety from performing all of the tasks. For the negative emotions, the control group landed in the middle of the pack with an average of -23.575, 39.09% lower than the baseline reading. Overall, the control group achieved a Mood Mapping score of 54.63, the second highest most positive score and 16.46% higher than the baseline reading.

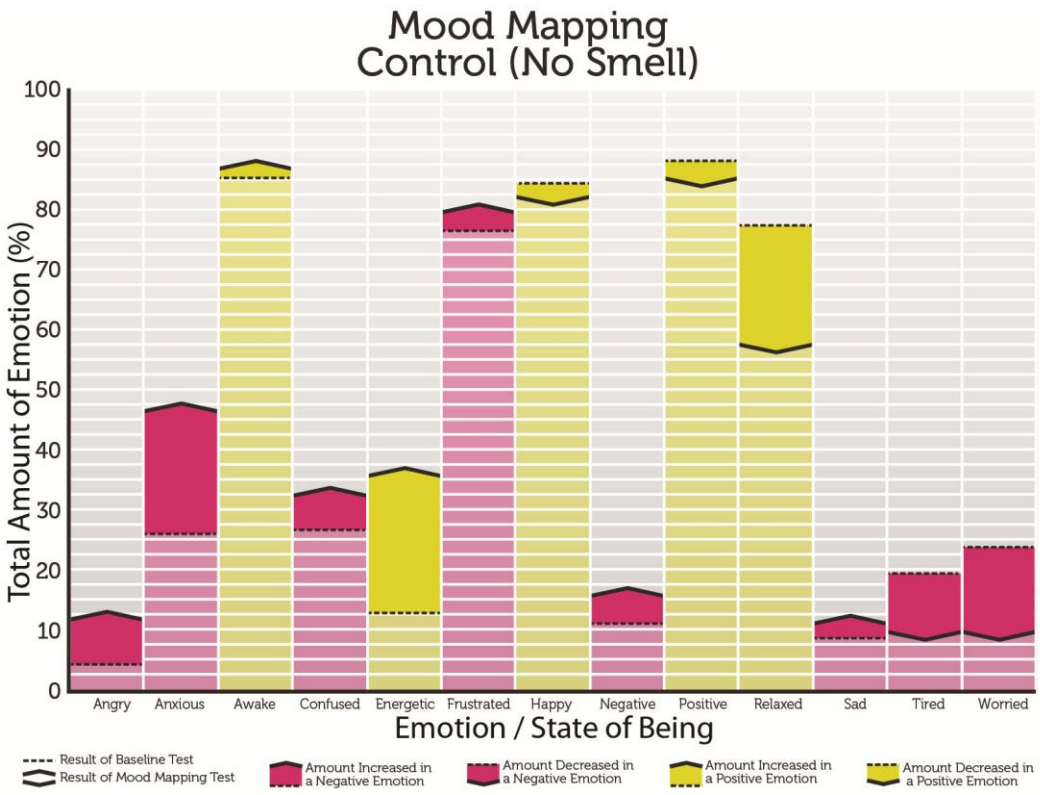


Figure 46: Recordings of states of beings for the control group during the Formal Study.

Methylindol (Dirty Feet)

The odor group was assumed to show some of the lowest positive scores and one of the – if not the most – lowest scores for the negative states of being, resulting in an overall negative emotional state. However, results from the Mood Mapping test revealed that the odor may have had a slight effect on the emotional state of participants as the positive emotions, such as awake (86), energetic (77), happy (73), positive (76), and relaxed (63), averaged to be a total positive score of 74.94, only 8.99% less than the baseline. On the other hand, the negative emotions, such as anger (-24), anxiety (-39), confusion (-35), frustration (-45), negativity (-29), sadness (-19), tiredness (-33), and worrisome (-28), averaged to be -31.3 (84.66% less than the baseline reading) totaling an overall emotional score of 43.64 – the third

lowest emotional state compared to all other aromatic environments – and 33.26% lower than the baseline. All of these scores indicate that, although not producing the worst emotional state, the odor did slightly negatively affect the states of beings for the participants.

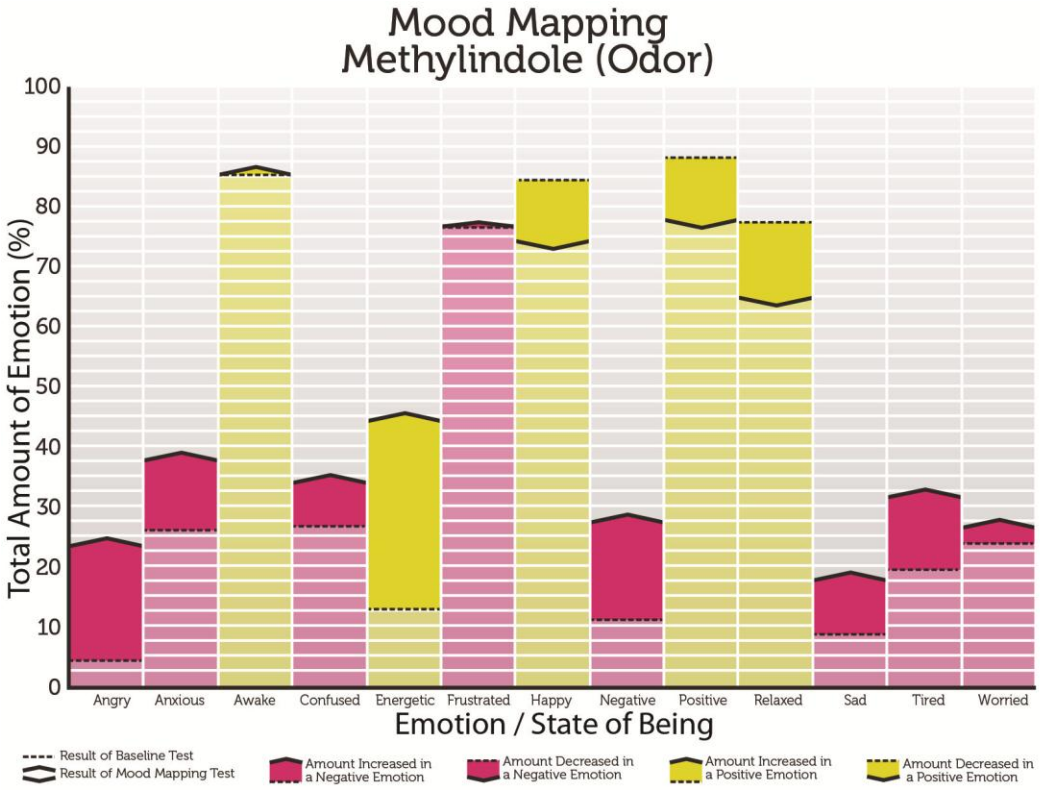


Figure 47: Recordings of states of beings for the odor group during the Formal Study.

Aromas

Mentha piperita **(Peppermint)**. The peppermint group showed having the most positive emotional reaction (94.6), and was the only aroma to achieve a positive variance from the baseline of +14.89%. Positive states included awake (99), energetic (94), happy (97), positive (94), and relaxed (89). It also produced the second lowest negative reactions (-19.74), only 16.52% lower than the baseline. These negative emotions included angry (-5), anxious (-75, and 56.58% more than the next highest group), confused (-9),

frustrated (-33), negative (-7), sad (-5), tired (-12), and worried (-12). Overall, the peppermint group was the most positive group with an overall Mood Mapping rating of 74.85. Once again, peppermint produced the only aromatic environment to receive a Mood Mapping score higher than the baseline (+14.47%).

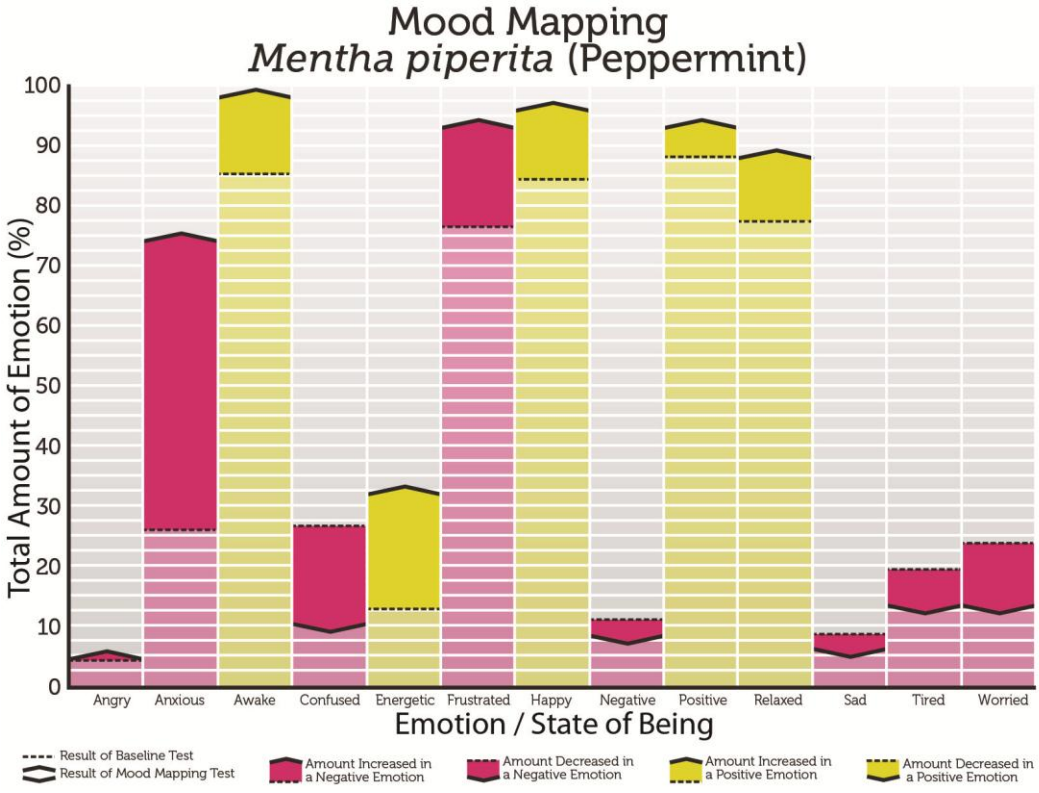


Figure 48: Recordings of states of beings for the *Mentha piperita* (Peppermint) group during the Formal Study.

***Zingibar officinalis* (Ginger)**. The ginger group had the third lowest positive reaction (71.40), with a 13.29% decrease from the baseline reading. Positive emotions included: awake (78), energetic (70), happy (67), positive (80), and relaxed (62). This group achieved a score of -17.25 for negative emotional states – the highest among any other aromatic environments, and 1.77% lower than the baseline reading, indicating that the participants who

experienced ginger felt slightly less negative emotions than when they initially started the study. Scores recorded for the negative emotions included: angry (-11), anxious (-20), confused (-22), frustrated (-33), negative (-13), sad (-11), tired (-10), and worried (-18). Overall, the ginger group scored a Mood Mapping rating of +54.15 which was only 17.19% lower than the baseline. Although this group was not significantly negatively impacted emotionally, results did seem to be slightly lower than what may have been expected based on the results from the Pilot Study.

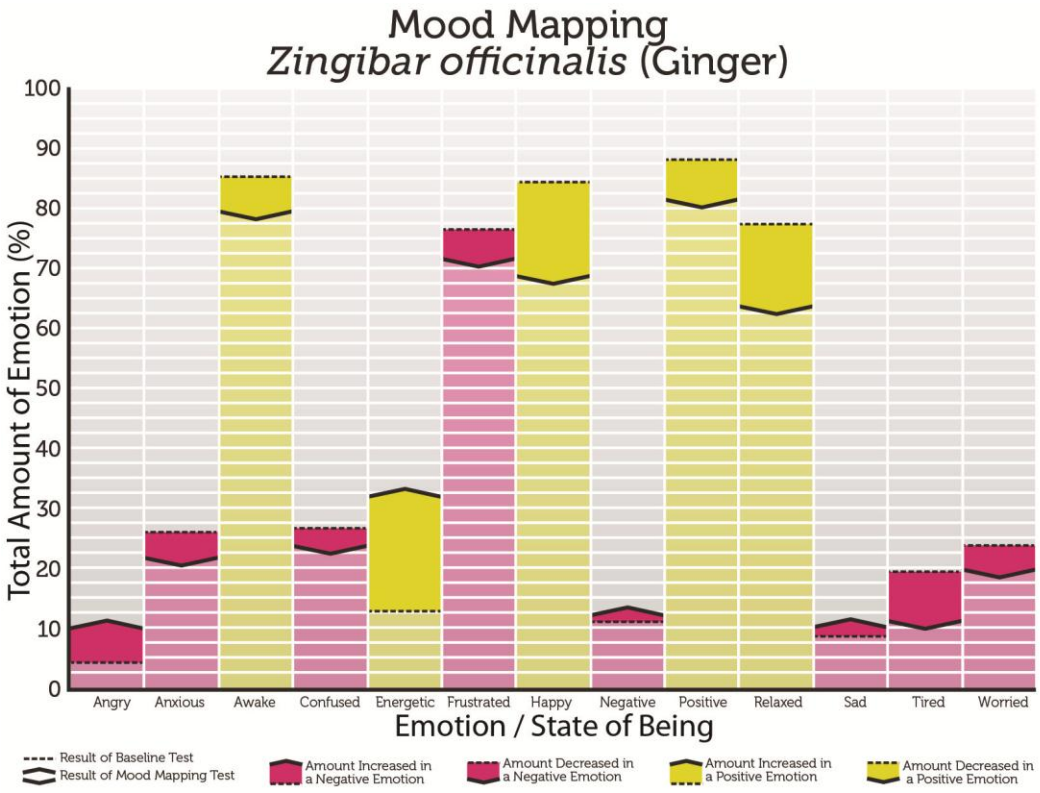


Figure 49: Recordings of states of beings for the *Zingibar officinalis* (Ginger) group during the Formal Study.

Coffee grounds. The coffee ground group had the second lowest positive reaction (60.10) behind bergamot, with a 27.01% reduction from the baseline. Each of the positive states of beings were recorded at or near the

lowest, which included awake (52), energetic (60), happy (66), positive (66), and relaxed (58). Although no significant research for this study indicated that a positive emotional state was concurrent with the aroma of freshly ground coffee beans, results did show that participants of this group noted having the lowest score for being awake (26 points) which was 33.97% lower than the next lowest score. Similarly, this group reported experiencing the worst amount of negative emotions (-37.56%), 121.61% lower than the baseline reading. These emotions consisted of: anxious (-47), confused (-34), frustrated (-35), and negative (-33) with the lowest scores reported for angry (-43), sad (-42), tired (-37), and worried (-30). Overall, the coffee grounds group reported the lowest emotional state of being compared to all other aromatic environments with a Mood Mapping score of only 22.54 (65.53% lower than the baseline).

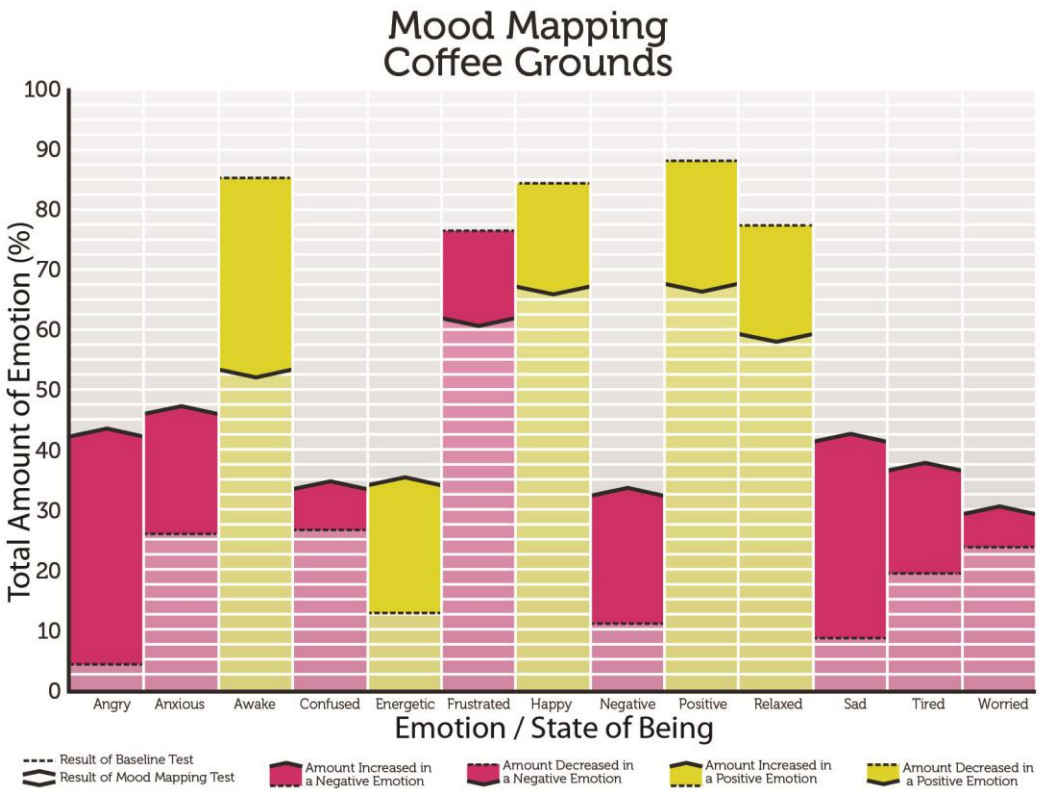


Figure 50: Recordings of states of beings for the coffee grounds group during the Formal Study.

***Lavandula vera* (Lavender)**. This group showed having a median average of positive emotional states (+75.10; -8.79% from the baseline). All positive states were in a medium to high range in comparison to other aromatic environments including: awake (78, which was the second lowest score), energetic (79), happy (75), positive (77), and relaxed (68). Many of the positive scores, such as the awake and energetic, were slightly reduced most likely in conjunction with lavender's researched ability to relax an individual. This also rang true with lavender having the second highest relaxed score, after peppermint. The lavender group also showed having the third lowest negative emotive response (-27.94), 64.82% lower than the baseline, and included angry (-25), anxious (-33), confused (-33), frustrated (-30), negative (-25), sad (-25), tired (-25), and worried (-29). Overall, the lavender group

scored a 47.16 on their Mood Mapping, which was 27.88% lower than the baseline.

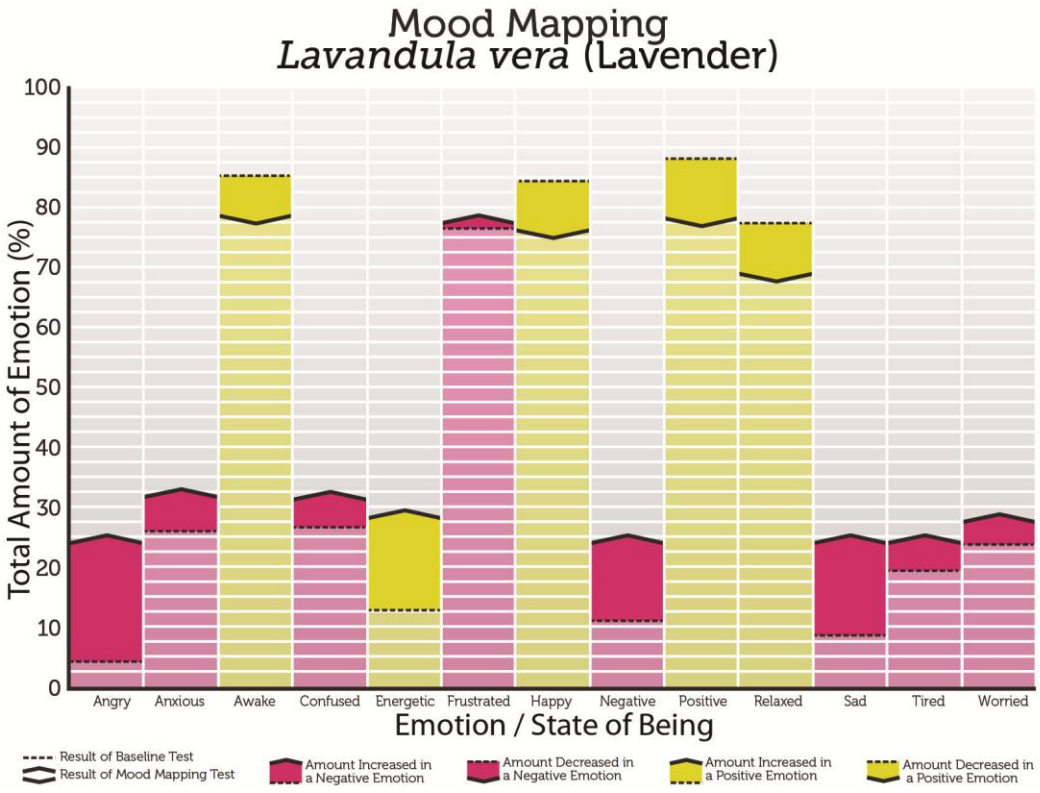


Figure 51: Recordings of states of beings for the *Lavandula vera* (Lavender) group during the Formal Study.

***Citrus bergamia* (Bergamot)**. This group had a positive score of 59.70, 27.5% lower than the baseline, and the lowest positive score among all of the aromatic environments. Positive states of being included: awake (90), energetic (62), happy (63), positive (46), and relaxed (39). Happy, positive, and relaxed all averaged the lowest scoring positive emotional state. The bergamot group showed both the highest and lowest scores for the negative emotions, including: anger (-2, the highest recoded), anxiety (-1, the highest recorded), confusion (-57, the lowest recorded), frustration (-58, the lowest recorded), negativity (-42, the lowest recorded), sadness (-3, the highest

recorded), tiredness (-25), and worrisome (-14). Overall, this group achieved a Mood Mapping score of 34.64, 47.03% lower than the baseline.

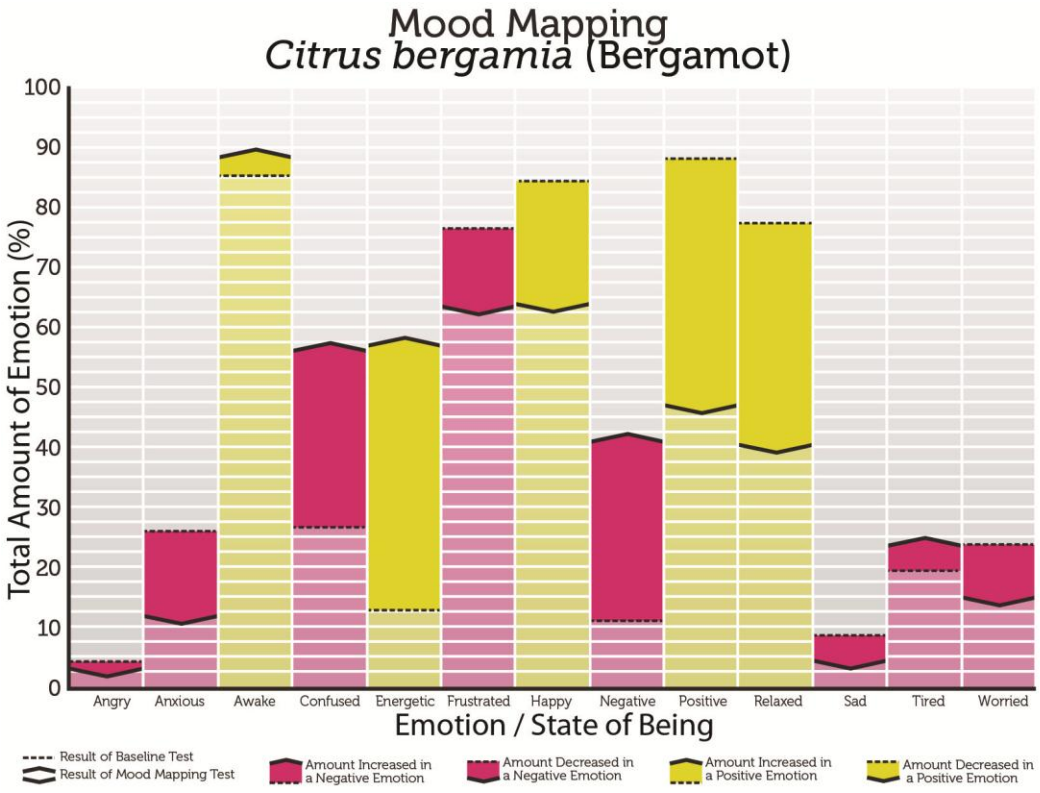
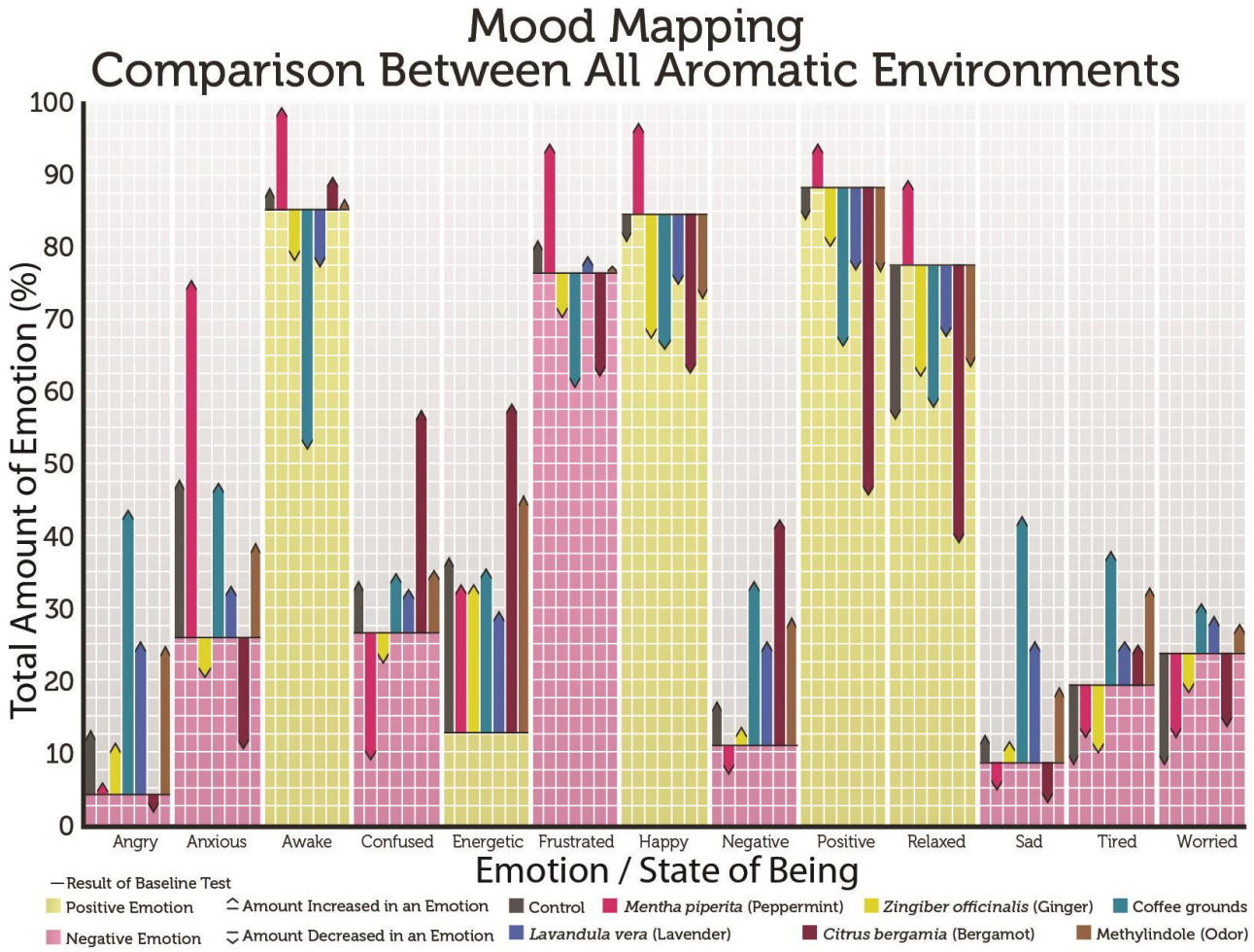


Figure 52: Recordings of states of beings for the *Citrus bergamia* (Bergamot) group during the Formal Study.

Figure 53: Full Mood Mapping graph depicting all aromatic environments against the baseline.



Electronic Survey

Thirty-four individuals, including of 26 females and 7, males participated in the survey. The average age of participants was measured at 35.12 years, with a minimum age of 24 and a maximum of age of 60 years. Most of the participants (29 individuals) were a part of the Catholic Healthcare West System and all of those individuals were from St. Joseph's Hospital and Medical Center in Phoenix, AZ. Three participants were from the Banner Health System and worked at Banner Desert Medical Center in Mesa, AZ, Cardon Children's Medical Center in Mesa, AZ, or Banner Del E. Webb Medical Center in Sun City West, AZ. The average years of healthcare experience was 10.09 years with a minimum of 2 years and maximum of 31 years. The average number of years worked in an Emergency Department was 7.10 years with a minimum of 1 year and a maximum of 28 years. Thirteen of the thirty-four participants indicated they had some sort of allergies. Most of the allergies that were identified were pollens (6) and grasses (5). Others included animal fur (3), dust mites (3), mold (2), latex (3), floral (1), and perfumes (1).

A majority of the participants (29 individuals) noted that they regularly noticed smells at the hospital they currently work at while five indicated that smells were not regularly noted. The top six smells that were identified as those that might be found within the hospital they previously or currently work at included: dirty feet (70.09%), body odor (66.85%), alcohol – the beverage (64.03%), feces (63.09%), Gastro Intestinal (GI) bleed (56.18%), and vomit (55.56%).

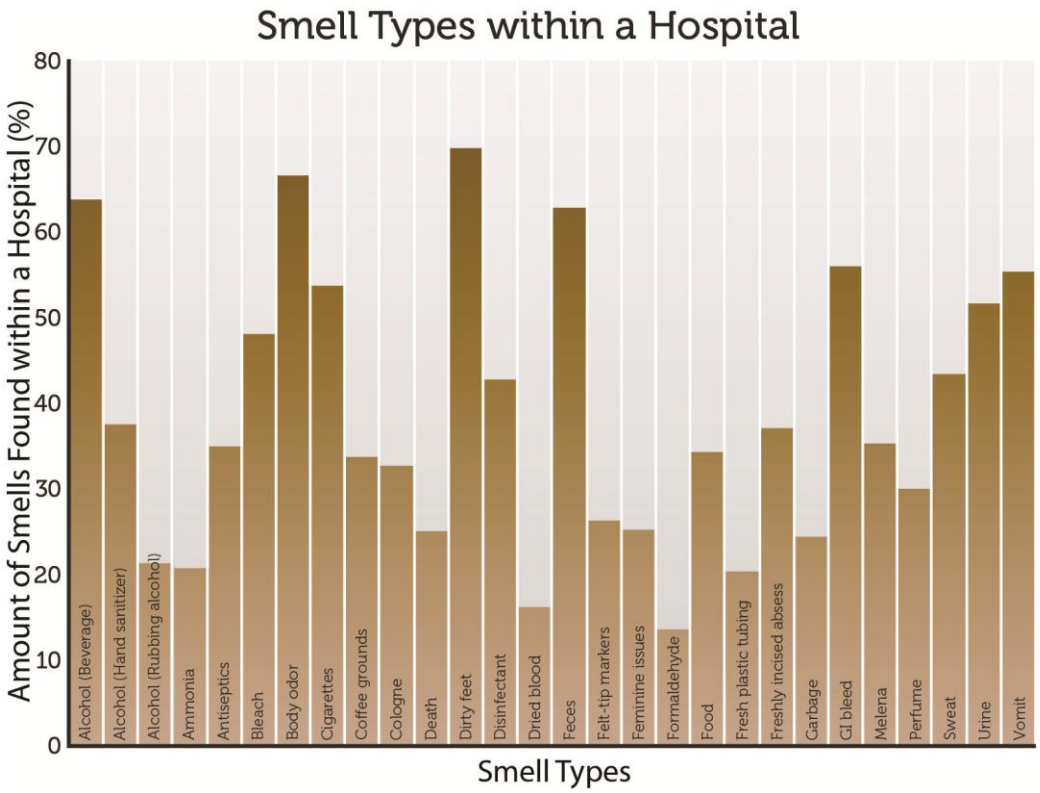


Figure 54: Smell types within a hospital setting and the amount caregivers perceive there to be.

When asked if the current hospital of employment uses coffee grounds to combat smells, the majority (21 individuals) indicated they were not familiar with the strategy being used, seven individuals indicated it was a used strategy, however, they were aware of it, and the remaining six individuals indicated it was used, but were not sure on how frequent. Participants believed the use of coffee grounds did not adequately affect the removal of odors (3.86 out of 10); the highest effectiveness indicated was 6 out of 10. When asked if the essential oil of peppermint was used at their current place of employment to rid odors, most respondents said it was used sometimes (16 individuals). 9 said the essential oil was used all the time while 4 said it was used rarely. Five individuals indicated it was not used nor

were they familiar with this strategy. When asked if an essential oil other than peppermint was used, only 4 individuals indicated a 'yes' answer (2: yes all the time; 2 yes sometimes) while 3 indicated it was not used but they were aware of the strategy. All other respondents indicated they were not familiar with the strategy. When asked if an ionizer was used to rid odors, most respondents (19) said they were not aware of the strategy, and 5 said they were aware but it was not used. Eight individuals said it was sometimes used, but only 1 said it happened all the time and 1 said it was a rare occurrence.

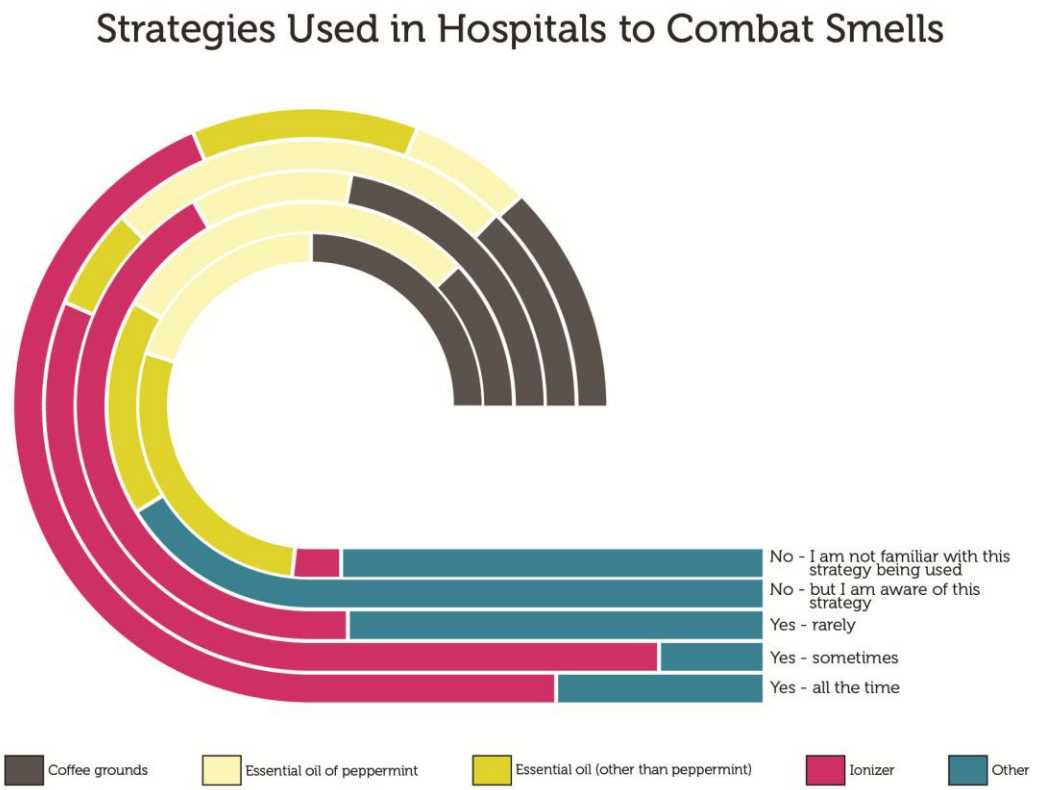


Figure 55: Strategies used in hospitals to combat smells based on the responses of caregivers.

In most cases, respondents indicated that the strategies were mostly being used as tools to rid of the department odors. In many cases, peppermint oil was used in various formats from hanging lodoform gauze in a patient's

doorway to rolling a piece of paper so it sits halfway out of a cap filled with peppermint oil.

When asked if the individual believed that smells have the ability to affect productivity, 85% (29) agreed. However, when asked if they had experienced a smell that affected their own ability to work, only 25 responded that they had experienced that, and of those, 92% (23) indicated it was a negative experience and 8% (2) indicated it was a neutral experience. Many of the respondents described the experiences they had – especially negative ones – in relation to not being able to rid an odor; they indicated that it permeated their own clothes and would linger for the rest of their shift. Many of the contributing factors as noted by the participants were of homeless individuals coming in with extensive body odor – especially during the Arizona summer , or those who were experiencing some sort of medical condition related to a skin infection (which smelled like "extended death"), or feces and GI bleeds. Many participants say they are affected mentally by the odors, but try not to have their facial expressions show as they hurry in and out of the patient area.

Conclusion

This chapter has covered the overall information collected from the Formal Study, from participant information to test outcomes. All tests and physical collection devices were detailed as to how there was improvement or a decline in performance between the control and odor sessions compared to the aroma sessions. In addition, this chapter also reviewed the information

collected from the electronic survey which was sent out to a number of different hospitals among varying healthcare systems.

CONCLUSION AND RECOMMENDATIONS

Introduction

The following chapter will culminate the information related to this thesis. Limitations to the Formal Study will be discussed, as well as a summary of information will be provided, as it relates to this thesis as a whole. The chapter will then review the implications for future research and close with a final conclusion.

Summary

As part of the overall physical scores, test scores, and mental scores, each smell was reviewed and their results from each test were given a ranking between one and seven (1 being the worst score, and 7 being the best score) depending on how well that smell did compared to the others; this allowed for a better representation in how each group did rather than compare the scores themselves as some scores varied widely. Those numbers were then added together to find the overall sum of rankings based on the aromatic environment.

Overall the physical performance of the different aromatic environments was semi-surprising. Results from the study indicated that, just as in the Pilot Study, the coffee grounds aroma had the lowest physical performance readings and highest stress readings. Although, at this time, it is unclear if this reaction is due because of the aroma itself or if caregivers associated the smell with negative memories of the Emergency Department – further studies will need to be performed focusing primarily on this scent to determine its effects.

The citrus essential oils (bergamot and ginger) also had an unforeseen result regarding its physical reaction due in part because the Pilot Study revealed such a reduction in stress using ginger – leading to the hypothesis of citrus aromas being beneficial. Unfortunately, the Formal Study revealed only a mid to slightly above average reduction in physical stress.

What is unsurprising to see in the physical stress results is the high outcome for the lavender and peppermint groups. Although the lavender group had the lowest skin temperature recorded during the study, the results from the stand-alone bio-feedback monitor and heart-rate monitor showed having the least amount of stress.

Physical Scores

	Heart Rate	Skin Temp	Bio-Feedback	Sum of Ranking
Lavandula vera (Lavender)	75	71.6	-14	14
Mentha piperita (Peppermint)	81.75	83.85	4	14
Citrus bergamia (Bergamot)	83.5	89.49	14	13
Zingibar officinalis (Ginger)	87	83.35	-19	13
Methylindole (Odor)	85.45	82.69	-1	11
Control	86.7	83.05	2	10
Coffee Grounds	96	84.09	13	9

Most Relaxed — Least Relaxed

Table 1: Table of the overall physical ranking scores and the measurements associated with it

Similar to the physical results, lavender showed having the best test performance just above the odor group. It is once again assumed that because

of the relaxing properties of lavender, participants were able to take their time to correctly answer questions.

The odor grouping had an unpredicted result of having the second best scores behind lavender. Even though more research may need to be considered prior to attempting a conclusion, it is assumed that the odor may not have negatively affected the participants for three potential reasons: 1) the odor was set next to the mannequin during the time of the study instead of near the computer where all of the aromas had been placed, possibly relieving stress or tension during the collection of test scores and physical measurements and/or 2) the odor was not "revolting" enough for the participants to fully notice, and/or 3) since the caregivers may have become used to experiencing unpleasant smells from working in an Emergency Department, they were not negatively affected by the odor.

In contrast to results from the Pilot Study, the ginger group had the lowest test scores – even less than those in the coffee ground group. Although, no conclusive remarks can be made, it is possible that ginger and bergamot were the two most confused aromas – ones where participants were unable to identify the scent – and it is possible that, although pleasant, may have caused a distraction in the inability for participants to determine what they smelled.

Mental Scores

	Stroop	Memory	Multi-tasking	Sum of Ranking
Lavandula vera (Lavender)	9.5	0	680	15
Methylindole (Odor)	5.8	5.6	404	12
Control	5.7	6.7	343.90	10
Mentha piperita (Peppermint)	8	0	260	10
Coffee Grounds	7	0	200	8
Citrus bergamia (Bergamot)	4.5	0	375	7
Zingibar officinalis (Ginger)	6	1	35	7

Most Correct — Least Correct

Table 2: Overall test ranking and the tests that were included

Mood mapping showcased a remarkable view into the thoughts of the participants for each aromatic environment. Information from each group was calculated by averaging out the positive and negative scores, and adding them together. The resulting number listed the average state of positivity the participant felt based on how high the number was. In the end, the peppermint group showed having the highest Mood Mapping score - feeling the most positive. Surprisingly, the odor group indicated having the second highest level of positivity, which could be the result of the participants themselves or the potential ability for caregivers to simply "tune-out" to odor.

However, what is shocking to see, is that both citrus aromas ranked near the bottom of the Mood Mapping scores. These results could indicate that participants may perform better with the knowledge of what they are exposed to, and/or the average caregiver may feel more negative or depressed

when exposed to citrus essential oils. In addition, the coffee grounds group showed having the second lowest Mood Mapping score slightly above the ginger group. This ranking indicates that participants from this group felt less positive emotions than other aromatic environments.

Emotional Scores	Mood Mapping
Mentha piperita (Peppermint)	114
Methylindole (Odor)	106
Lavandula vera (Lavender)	103
Control	102
Citrus bergamia (Bergamot)	98
Coffee Grounds	87
Zingibar officinalis (Ginger)	86

Most Positive — Least Positive

Table 3: Mood mapping ranking among aromatic groupings

Overall scores were taken from the physical performances, test scores, and emotional positivity. Each aromatic environment was then listed from best (7 points) to lowest (1 point) and all of the points were added together to find the overall result between each smell. Below is the list of aromatic environments and how they ranked based on all of the information collected throughout the study.

Based on the final results, the two essential oils most common in current research compared to the others used in this study (lavender and peppermint) proved to be the most affective in enhancing caregiver

performance based on the physical, emotional, and accuracy of tasks. In addition to showing one of the highest performance rankings, *Mentha piperita* (peppermint) resulted in having four of the eight respondents choose the aroma as their favorite at the beginning of the study, although only one of these participants eventually experienced the aroma during the study.

What appears to be surprising is that the second best aromatic environment used, following lavender and peppermint, is 'odor'. In considering the amount of potentially foul odors that emanate in the Emergency Department, the average person may initially assume that it negatively affects the performance of the caregivers working within those environments; however, it appears that just the opposite is occurring. It is possible that because Emergency Department caregivers are constantly introduced to foul odors – even those worse than the one used during this study – they develop a tolerance to un-pleasantries or learn to cope with, or ignore, the odor, in order to be able to perform their duties.

On the other hand, it appears that the tool caregivers use during these odorous instances in some Emergency Departments (coffee grounds) is negatively affecting the performance of these individuals. This aroma could potentially be due to its overuse and association to adverse instances in emergency settings which, in turn, is causing a performance reduction.

Overall Scores	Final Score
Lavandula vera (Lavender)	15
Mentha piperita (Peppermint)	15
Methylindole (Odor)	13
Control	9
Citrus bergamia (Bergamot)	8
Zingibar officinalis (Ginger)	6
Coffee Grounds	5

Table 4: Final overall ranking for each aromatic environment tallying results from the overall stress, overall test, and mood mapping rankings

Limitations

Because the contract for the Formal Study was between Arizona State University and Banner Health, only Banner Health employees were eligible to participate in the study. Do to this limitation, the investigator was unable to reach out to other healthcare systems unless an additional IRB process took place at that system's facility or at a third-party location. Although results from the study were not affected by this limitation, it did reduce the potential number of active participants.

In conjunction with the above limitation, the variety of caregiver types (Registered Nurses, Technicians, Physicians, etc.) was unevenly distributed due to the small sample size of this study. Although, the majority of the

participants were Registered Nurses, different caregiver types interact with the patient or potential odor uniquely.

Implications for Future Research

This section will discuss the potential implications for future research based on the information gathered from this thesis.

The first potential opportunity to further review is the possibility of comparing liked aromas with those used during the study. Do to the number of active participants in the Formal Study, some information, which the investigator would have liked to have analyzed deeper, was unachievable. At the beginning of each session, participants were allowed the opportunity to waft the five different pleasant aromas, and were asked to determine which of the five they found most enjoyable. Had more participants contributed to the data collection, information could potentially determine if a favorite aroma affected the individual more so than not using the favorite aroma during the tasks. For instance, if one participant named the smell of peppermint as their favorite among the five given to them, and received that same aroma during the study, would the effects of that aroma cause a higher reaction than if that person had chosen lavender as their preferred scent but were exposed to peppermint during the study? This research could further question performance and how smell affect caregivers in an emergency setting by determining if a single pleasant smell would affect every staff person at the same degree, or if caregivers would be more effective at managing their tasks by using choice aromas on their own persons.

The second potential opportunity for advanced research is to further, more intensely, how current smells are affecting caregivers in typical Emergency Departments. Based on the findings from both the pilot study and the formal study, the average participant performed at a higher stress level and made more mistakes when the smell of coffee grounds was present than any other odor or aroma. The concern lies in the idea that many Emergency Departments use this technique of exposing coffee grounds as a way to absorb foul odors in the department; however, they are unaware of the negative effects it is causing for the staff.

Closing

This thesis looked at how the average person and the typical Emergency Department caregiver are affected by olfactory stimuli – both pleasant and unpleasant. Based on initial research and findings from the pilot study, the hypothesis assumed that the aroma of coffee grounds would show to not only be ineffective in performance enhancement, but reduce the physical stress levels of participants. However, after findings from the pilot study revealed an astonishing performance from the ginger group, the hypothesis assumed citrus essential oils may be the foundation to this positive result. Unfortunately results from the formal study did not mimic the pilot study results in the way of concluding the effectiveness of citrus oils. Final conclusions indicate that there is a vast amount of research that stills needs to be considered in looking at the environmental conditions caregivers are placed in. Although it is easy to quickly assume a foul odor would bring upon negative reactions and increased stress, it is important to note who the

actors are and what factors they are currently dealing with. By looking further into, and potentially solving, this question of how caregivers are affected by olfactory stimuli, designers and medical staff are better able to cater to the needs of their clients - whether that is the patient or the person caring for them.

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APPENDIX A

Pilot Study IRB Form

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jose Bernardi AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/27/2011
Committee Action:	**Amendment to Approved Protocol**
Approval Date:	04/27/2011
Review Type:	Expedited F12
IRB Protocol #:	1102006092
Study Title:	Olfactory Effects on Productivity
Expiration Date:	03/17/2012

The amendment to the above-referenced protocol has been APPROVED following Expedited Review by the Institutional Review Board. This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

Pilot Study IRB Modification

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jose Bernardi AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/27/2011
Committee Action:	**Amendment to Approved Protocol**
Approval Date:	04/27/2011
Review Type:	Expedited F12
IRB Protocol #:	1102006092
Study Title:	Olfactory Effects on Productivity
Expiration Date:	03/17/2012

The amendment to the above-referenced protocol has been APPROVED following Expedited Review by the Institutional Review Board. This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX C

Pilot Study Continuing Review Form

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jose Bernardi AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	03/16/2012
Committee Action:	**Renewal**
Renewal Date:	03/16/2012
Review Type:	Expedited F7
IRB Protocol #:	1102006092
Study Title:	Olfactory Effects on Productivity
Expiration Date:	03/16/2013

The above-referenced protocol was given renewed approval following Expedited Review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX D

Pilot Study Smell Description Sheet

Smell Variation Procedures:

Participants will be asked not to use any fragrances 24 hours prior to attending their scheduled time. These fragrances include, but are not limited to:

- Perfume/cologne
- Fragranced soaps, shampoos, conditioners
- Fragranced deodorants

Participants will also be asked not to consume any food products that may leave an aroma prior to their scheduled time.

Participants will also be asked if they understand and are comfortable with using a laptop to complete some of the tests. These laptops will be rented from ASU.

Participants will be placed in their group at random (with assigned codes instead of names) unless the following apply:

- Any participant that is pregnant or may be pregnant will not be placed in the Essential Oil of Peppermint (*Mentha piperita*) group.
- Any participant who expresses concern for allergies will be placed accordingly.

Smell	Purpose of smell	Introduction of smell
1. Can the use of positive aromas influence caregiver productivity?		
Coffee (*Coffee Arabica*) [ca-w/m-xx]	Coffee grounds are currently used in Good Samaritan Emergency Department to relieve the area of odors.	Diffuser
Peppermint (*Mentha piperita*) mp-w/m-xx]	Migraine relief, nausea relief, cold and flu, to improve concentration and memory, travel sickness.	Diffuser
Ginger (*Zingiber officinale*) [zo-w/m-xx]	Nausea, hangovers, travel and sea sickness, colds and flu, congestion, coughs, sinusitis, sore throat.	Diffuser
The room will be filled with one of the positive aromas listed above 30 minutes prior to the investigation. The introduction of these smells will be through means of a diffuser for the essential oils. Participants will then be given a number of tasks to simulate common tasks within a typical emergency department. (see agenda for a list for tasks and their descriptions) Participants will be monitored by means of changes through a bio-feedback monitor, heart rate monitor, and facial expressions and commentary through a small camcorder and microphone.		

Smell	Purpose of smell	Introduction of smell
2. Does the use of negative odors influence caregiver productivity?		
Feet [tf-w/m-xx]	One extremely noticeable odor of an ED is the stench of a transient's dirty feet. Many caregivers strive to make sure shoes remain on at all times, however, once the odor is released, it is difficult to get rid of and quickly spreads throughout the department.	Premier Specialties has been contacted to find a safe, synthetic representation of one or all of these odors to use for these tests. *If a single smell/odor is created from IFF, the code will be: [al-w/m-xx]
Feces [bm-w/m-xx]	Although many caregivers claim to not be affect by the smell of feces after a period of time, it is a common smell that is introduced into the Emergency Department.	
Ammonia [ha-w/m-xx]	Because of the hospital setting, ammonia is a common smell and vital for this test to have a "medical-type" smell involved in the process.	
GI bleed [gb-w/m-xx]	Through interviews and conversations with Emergency Department and Intensive Care Unit nurses, a gastrointestinal bleed is the one smell that most nurses have a hard time dealing with. Many fight the urge to gag causing more focus on the stench itself than the patient.	
The room will be filled with all of the negative odors listed above 30 minutes prior to the investigation. Participants will then be given a number of tasks to simulate common tasks within a typical emergency department. (see agenda for a list for tasks and their descriptions) Participants will be monitored by means of changes through a bio-feedback monitor, heart rate monitor, and facial expressions and commentary through a small camcorder and microphone.		

Smell	Purpose of smell	Introduction of smell
3. Control Group		
No smells will be introduced to this group. Diffusers may be set up as a distraction. Participants will then be given a number of tasks to simulate common tasks within a typical emergency department. (see agenda for a list for tasks and their descriptions) Participants will be monitored by means of changes through a bio-feedback monitor, heart rate monitor, and facial expressions and commentary through a small camcorder and microphone. The code for individuals is: [cg-w/m-xx-year-mo-da]		

	10a-11a	11a-12p
April 8	**Ginger** **(*Zingiber officinale*)** [zo-w/m-xx-year-mo-da]	**Ginger** **(*Zingiber officinale*)** [zo-w/m-xx-year-mo-da]
April 15	**Control Group** [cg-w/m-xx-year-mo-da]	**Dirty Feet** [tf-w/m-xx-year-mo-da]
April 22	**Peppermint** **(*Mentha piperita*)** [mp-w/m-xx-year-mo-da]	**Peppermint** **(*Mentha piperita*)** mp-w/m-xx-year-mo-da]
April 29	**Control Group** [cg-w/m-xx-year-mo-da]	**Dirty Feet** [tf-w/m-xx-year-mo-da]
May 6	**Coffee** **(*Coffee Arabica*)** [ca-w/m-xx-year-mo-da]	**Coffee** **(*Coffee Arabica*)** [ca-w/m-xx-year-mo-da]
May13	**Control Group** [cg-w/m-xx-year-mo-da]	**Dirty Feet** [tf-w/m-xx-year-mo-da]

APPENDIX E

Pilot Study Recruitment Poster

Participate
IN
RESEARCH
A study is being performed this semester to determine if odors and aromas can effect an individual's performance.
If you are in the School of Nursing and Health Initiatives, and are interested in participating, please sign up at: cotb.me/thesis/pilot
Participate here: cotb.me/thesis/pilot

APPENDIX F

Pilot Study Recruitment Script

Greetings!

I am a graduate student in the Design in Heath and Healing Environment program in the college of Design at Arizona State University.

I am conducting a research study to determine if odors and aromas can affect the performance of caregivers (nurses) within an Emergency Department.

I am recruiting individuals (both male and female and ages 18-65) to determine how these smells effect performance with basic tasks which will take approximately one hour. Individuals may be exposed to pleasant smells or unpleasant smells during this period of time. These tests will have flexible scheduling which you may be able to select on the online application.

Your participation in this study is voluntary but greatly appreciated. All participants, except for those who are, or may be pregnant, are strongly encouraged to participate. If you have any questions concerning the research, please contact me at cclark7@asu.edu

For further information and a quick application/questionnaire to participate in this study, please visit:

cotb.me/thesis/pilot

Your participation is greatly appreciated!

Sincerely,

Carina Clark
cclark7@asu.edu

APPENDIX G

Pilot Study Cover Letter

COVER LETTER
Olfactory Effect on Productivity

2/19/11

Dear Participant:

I am a graduate student under the direction of Professor Jose Bernardi in the College of Design at Arizona State University.

I am conducting a research study to determine if smells have any effect of the productivity of an individual, in particular, the nurses in an Emergency Department. I am inviting your participation, which will involve a two hour study where you may or may not be exposed to different smells while performing simple tasks.

Your participation in this study is voluntary. You can skip questions if you wish. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. However, you must be 18 years or older to participate in the study.

Participation in the study will benefit future studies to be performed in a typical healthcare setting as well as a possible, natural tool for Emergency Department nurses to use during stressful moments. There are no foreseeable risks or discomforts to your participation; however, you are free to opt out of the study at any time.

Your responses will be anonymous and your name will not be used at any stage of the study; instead, you will be given a code that will only be used for data collection. The results of this study may be used in reports, presentations, or publications but your name will not be known, and your assigned code number will not be given to protect your confidentiality.

If you have any questions concerning the research study, please contact the research team at: cclark7@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Filling out the questionnaire will be considered your consent to participate.

Please access the questionnaire here:

Sincerely,

Carina Clark
cclark7@asu.edu

APPENDIX H

Pilot Study Participants Application Questions

Pilot study application questions

PARTICIPANT INFORMATION

- Email
- Phone (optional)
- Age range
- Gender
    - Female/ are you pregnant?
- Do you have any allergies?
    - Y/ Do you have allergies to perfumes?
    - Y/ Do you have allergies to any smells (Ex. Floral)?
    - Y/ What other allergies do you have that you feel is important and relevant to this topic?

ADDITIONAL INFORMATION

- Are you willing to not use any of the following products from the list below within 24 hours of your scheduled test time?
    - Perfume
    - Cologne
    - Scented bath soap
    - Scented shampoos and/conditioners
    - Scented deodorants
    - Scented cosmetics (including lip balm)

The following questions will not affect your ability to participate in this study. This is only for the facilitators use and preparation.

- Are you familiar with computers?
- Do you feel comfortable doing tasks on computers?
- Would you be willing to participate in this study using mostly a computer?
    - N/ would you be filling to participate in this study without needing to use a computer?

APPENDIX I

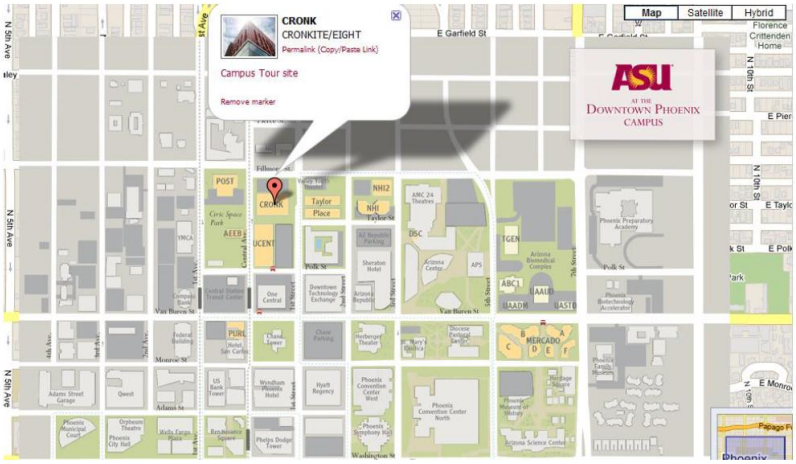
Pilot Study Participant Confirmation Email

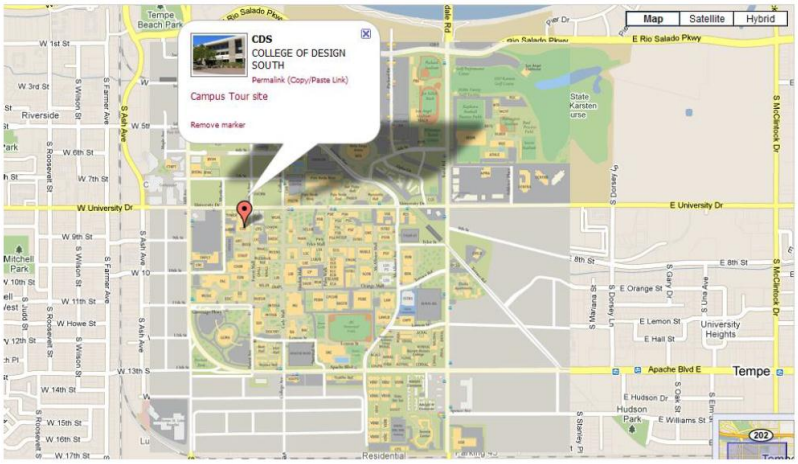
Greetings!

I would like to thank you for your interest in participating in my study on Productivity.

I show that you have chosen to participate on:

Day starting at **10:00a / 10:45a / 11:30a**
That day, the study will take place on the **Downtown Campus** / **Tempe Campus** / **West Campus** in room **#**





Again, thank you for your volunteered participation in this study!
If you could please pass on this link to your peers for their participation, it would be greatly appreciated!
cotb.me/thesis/pilot

I will send out a reminder email closer to the date of your requested participation.
Please let me know if you have any questions and I will be happy to answer them!

APPENDIX J

Pilot Study Room Reservation

EVENT CONFIRMATION

Customer	The Design School

Joni Escobedo

, ,
(480)965-8726

Account Number :
Billing Reference:

Reservation	20110516-037
Event Type :	Dissertation & Thesis Defense
From :	6/3/2011 8:50 AM
To :	6/30/2011 1:10 PM
Event Status :	**Scheduled**
Est. Attendance :	5

If your event takes place in a room that requires Zone Keys, you will need to make arrangements to get keys prior to your event. Please see the "General Info" section of https://astra.oasis.asu.edu/astraweb for a list of classrooms that require Zone Keys.

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Friday, June 03rd, 2011 9:00 AM to 1:00 PM in CRONK, 124			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Tuesday, June 07th, 2011 9:00 AM to 1:00 PM in CRONK, 124			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Wednesday, June 15th, 2011 9:00 AM to 1:00 PM in CRONK, 124			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Thursday, June 30th, 2011 9:00 AM to 1:00 PM in CRONK, 124			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

EVENT CONFIRMATION

Customer	The Design School

Joni Escobedo

, ,
(480)965-8726

Account Number :
Billing Reference:

Reservation	20110516-023
Event Type :	Dissertation & Thesis Defense
From :	6/8/2011 8:50 AM
To :	7/1/2011 1:10 PM
Event Status :	**Scheduled**
Est. Attendance :	5

If your event takes place in a room that requires Zone Keys, you will need to make arrangements to get keys prior to your event. Please see the "General Info" section of https://astra.oasis.asu.edu/astraweb for a list of classrooms that require Zone Keys.

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Wednesday, June 08th, 2011 9:00 AM to 1:00 PM in CDS, 141			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Wednesday, June 22nd, 2011 9:00 AM to 1:00 PM in CDS, 141			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Thursday, June 23rd, 2011 9:00 AM to 1:00 PM in CDS, 141			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Friday, July 01st, 2011 9:00 AM to 1:00 PM in CDS, 141			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

EVENT CONFIRMATION

Customer	The Design School
Joni Escobedo	
, ,	
(480)965-8726	
Account Number :	
Billing Reference:	

Reservation	20110509-022
Event Type :	Dissertation & Thesis Defense
From :	6/2/2011 8:50 AM
To :	6/29/2011 1:10 PM
Event Status :	**Scheduled**
Est. Attendance :	5

If your event takes place in a room that requires Zone Keys, you will need to make arrangements to get keys prior to your event. Please see the "General Info" section of https://astra.oasis.asu.edu/astraweb for a list of classrooms that require Zone Keys.

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Thursday, June 02nd, 2011 9:00 AM to 1:00 PM in CLCC, 102			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Friday, June 03rd, 2011 9:00 AM to 1:00 PM in CLCC, 102			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Tuesday, June 14th, 2011 9:00 AM to 1:00 PM in CLCC, 102			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

Meetings	Quantity	Unit Cost	Total Cost
MSD Research Study - Wednesday, June 29th, 2011 9:00 AM to 1:00 PM in CLCC, 102			
Room reserved for : 8:50 AM to 1:10 PM			
Room Charge	1	0.00	0.00
Notes :			
Room Setup Notes :			
Room Teardown Notes :			
Resource Category :			

APPENDIX K

Pilot Study Student Equipment Authorization

Validation Date	Media Staff	Time

Shaded areas for Media Services staff use only.

ASU MAIN

Media Services
Student Authorization for Equipment Use

Student Name	ASU ID #	Date
Carina Clark	[redacted]	3/15/2011

Address	Phone Number
[redacted]	[redacted]
	Studio (if applicable)

Failure to return equipment on time will result in the revocation of borrowing privledges.
In addition, ASU-DPS may be called on to assist in equipment recovery.

Student Signature	
Carina Clark	

I confirm that the above named student is currently enrolled in my class this semester.
I will also take responsibility for the equipment.

Instructor Name	Department	Date
Joe Sandy	INT : Design	03-15-11
Instructor Signature	**Phone Number**	
Jose Bernardi	480 965 9140	

studentAuthorization.pdf, last updated 6/12/00

APPENDIX L

Pilot Study Informed Consent

CONSENT FORM
OLFATORY EFFECTS ON PRODUCTIVITY

INTRODUCTION
The purposes of this form are to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

RESEARCHERS
Professor Jose Bernardi, from the Interior Design Program in the College of Design, and Carina Clark, a graduate student in the Design in Health and Healing Environment program through the College of Design has invited your participation in a research study.

STUDY PURPOSE
The purpose of the research is to determine if and how effective smells are to the productivity of individuals, in particular, nurses in an emergency department.

DESCRIPTION OF RESEARCH STUDY
If you decide to participate, then you will join a study involving research to determine if smells affect an individual's performance positively or negatively. Participants will be semi-randomized into different groups in order to accommodate even distribution of age and gender. A video recorder will record any comments that may contribute to the study (ie. the type of environment, if there is a smell that is noticed, etc.) as well as monitor any facial expressions that may be caused due to the smells in the room. These recordings will only be used for data collection and will not be published or presented at any future conferences. At any point in the study, an individual is able to withdraw or skip questions asked.

If you say YES, then your participation will last for one hour, which you will be able to select the time and location during the online application. You will be asked to perform simple tasks with or without the influence of a smell which will be evenly dispersed into the room. In addition, you will be asked to wear a small heart rate monitor (in the form of a ring) and a bio-feedback monitor which will help determine stress levels during each task. As a willing participant, you have the option to opt out of wearing these devices at any time.

RISKS
There are no known risks from taking part in this study, but in any research, there is some possibility that you may be subject to risks that have not yet been identified.

It is encouraged that pregnant women do not participate in this study.

BENEFITS
Although there may be no direct benefits to you, the possible benefits of your participation in the research are to determine how to increase the productivity of nurses and caregivers in a healthcare setting.

CONFIDENTIALITY
All information obtained in this study is strictly confidential. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records Carina Clark will never ask for the names of any participants, instead, codes will be given in order to collect data. Once data is collected during the study, and it has been analyzed, all records of these codes will be

destroyed. In addition, all video recordings will be destroyed once data has been collected and within 30 days after graduation (tentative date is May 2012).

WITHDRAWAL PRIVILEGE

Participation in this study is completely voluntary. It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time. Your decision will not affect your relationship with Arizona State University or otherwise cause a loss of benefits to which you might otherwise be entitled. In addition, nonparticipation or withdrawal from the study will not affect grades. Lastly, if you choose to withdraw once the study has taken place, you have the option to choose if any recordings collected can be used or not. If you allow for the researcher to continue using the data collected, these will be destroyed at the time of the remaining recordings; otherwise, they will be destroyed immediately.

COSTS AND PAYMENTS

There is no payment for your participation in the study.

VOLUNTARY CONSENT

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Carina Clark at cclark7@asu.edu or by phone at 623.640.8851.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given (offered) to you.

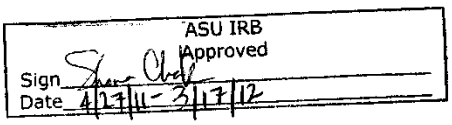
Your signature below indicates that you consent to participate in the above study.

Subject's Signature	Printed Name	Date

INVESTIGATOR'S STATEMENT

"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided (offered) the subject/participant a copy of this signed consent document."

Signature of Investigator_____ Date_____



APPENDIX M

Pilot Study Beck Anxiety Inventory

Beck Anxiety Inventory

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

	Not At All	Mildly but it didn't bother me much.	Moderately - it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding/racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky / unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint / lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot/cold sweats	0	1	2	3
Column Sum				

Scoring - Sum each column. Then sum the column totals to achieve a grand score. Write that score here .

Interpretation

A grand sum between **0 – 21** indicates very low anxiety. That is usually a good thing. However, it is possible that you might be unrealistic in either your assessment which would be denial or that you have learned to "mask" the symptoms commonly associated with anxiety. Too little "anxiety" could indicate that you are detached from yourself, others, or your environment.

A grand sum between **22 – 35** indicates moderate anxiety. Your body is trying to tell you something. Look for patterns as to when and why you experience the symptoms described above. For example, if it occurs prior to public speaking and your job requires a lot of presentations you may want to find ways to calm yourself before speaking or let others do some of the presentations. You may have some conflict issues that need to be resolved. Clearly, it is not "panic" time but you want to find ways to manage the stress you feel.

A grand sum that **exceeds 36** is a potential cause for concern. Again, look for patterns or times when you tend to feel the symptoms you have circled. Persistent and high anxiety is not a sign of personal weakness or failure. It is, however, something that needs to be proactively treated or there could be significant impacts to you mentally and physically. You may want to consult a counselor if the feelings persist.

APPENDIX N

Pilot Study Focus Group Questions

Focus group questions
Questions after each study

- How was this experience for you?
- Have you experienced any difficulties performing these tasks?
- Did you notice any environmental influences?
- Do you believe these influences affected your performance in these tasks?
- How do you believe it affected your performance?

As you may be aware based on the name of the study, that I am looking into if and how performance can be affected by odors and aromas.

- Did you notice any smells?
- What did you smell?
- Did you like the smell?
- What do you believe you smelled?
- Did the smell bring any memories once you recognized it?
- Do you think the smell made this experience more pleasant/difficult
- Do you feel you would be able to spend a work day (8-12) hours with this smell lingering?
- Would you prefer another smell than the one currently being used? What would you prefer?
- Do you think that a simple smell, like the one experienced today, could influence a nurse in an ED? Why?

APPENDIX O

Formal Study Research Team Conflict of Interest

Banner Health

FINANCIAL DISCLOSURE / CONFLICT OF INTEREST FORM

Title of Study: Researching how the Olfactory Stimuli Affect Caregiver Performance in an Emergency Department
Principal Investigator: Jose Bernardi

This form is to be completed and submitted by each Clinical Investigator involved in the study to provide written certification attesting to the absence of financial interests and arrangements described in *21 CFR Section 54.4, paragraph (a) (3).* (Clinical Investigators include the principal investigator and each sub-investigator who will be directly involved in the treatment or evaluation of research subjects. The term also includes the spouse and each dependent child of a Clinical Investigator)

As part of my arrangement with the sponsor of the study I have already provided this information on FDA Form 3454, 3455 or equivalent. **SUBMIT A COPY OF THAT FORM TO RESEARCH ADMINISTRATION IN LIEU OF THIS FORM.**		
If you have not already attested to the absence of financial interests or arrangements, please answer all of the following questions. If any are answered Yes, please provide detailed response. An affirmative answer of any of these following does not automatically hinder the proposed research. The IRB, in their role of human subject protection, shall use this information to determine if a significant real of perceived conflict of interest is present and to what safeguards, if any and to what extent will be required to move forward with research as proposed.		
Any financial arrangement entered into between the sponsor of the study and the clinical investigator involved in the conduct of a clinical trial, whereby the value of the compensation to the clinical investigator for conducting the study could be influenced by the outcome of the study. **Explanation**:	☐Yes	☒No
Any significant payment of other sorts from the sponsor of the study, such as a grant to fund ongoing research, compensation in the form of equipment, retainer for ongoing consultation, or honoraria. **Explanation**:	☐Yes	☒No
Any proprietary interest in the tested product held by any clinical investigator in the study. **Explanation**:	☐Yes	☒No
Any significant equity interest in the sponsor of the study held by any clinical investigator involved in any clinical study. **Explanation**:	☐Yes	☒No
Any steps taken to minimize the potential for bias resulting from any of the disclosed arrangements, interests or payments. **Explanation**:	☐Yes	☒No

By my signature below, I certify that the information provided above and in attachments to this certification is accurate and complete as to myself, my spouse and dependent children, and that I am unaware of any other fact or circumstance that would constitute a conflict of interest in connection with my participation in this clinical study.

Jose Bernardi, 07-26-11

Investigator Print Name | Investigator Signature | Date

Banner Health

FINANCIAL DISCLOSURE / CONFLICT OF INTEREST FORM

Title of Study: Researching how the Olfactory Stimuli Affect Caregiver Performance in an Emergency Department
Principal Investigator: Jose Bernardi

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Any proprietary interest in the tested product held by any clinical investigator in the study. **Explanation**:	☐Yes	☒No
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Any steps taken to minimize the potential for bias resulting from any of the disclosed arrangements, interests or payments. **Explanation**:	☐Yes	☒No

By my signature below, I certify that the information provided above and in attachments to this certification is accurate and complete as to myself, my spouse and dependent children, and that I am unaware of any other fact or circumstance that would constitute a conflict of interest in connection with my participation in this clinical study.

Carina Clark /  7/25/2011

Investigator Print Name | Investigator Signature | Date

Banner Health

FINANCIAL DISCLOSURE / CONFLICT OF INTEREST FORM

Title of Study: Researching how the Olfactory Stimuli Affect Caregiver Performance in an Emergency Department
Principal Investigator: Jose Bernardi

This form is to be completed and submitted by each Clinical Investigator involved in the study to provide written certification attesting to the absence of financial interests and arrangements described in *21 CFR Section 54.4, paragraph (a) (3)*. (Clinical Investigators include the principal investigator and each sub-investigator who will be directly involved in the treatment or evaluation of research subjects. The term also includes the spouse and each dependent child of a Clinical Investigator)

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Any significant equity interest in the sponsor of the study held by any clinical investigator involved in any clinical study. **Explanation:**	☐Yes	☒No
Any steps taken to minimize the potential for bias resulting from any of the disclosed arrangements, interests or payments. **Explanation:**	☐Yes	☒No

By my signature below, I certify that the information provided above and in attachments to this certification is accurate and complete as to myself, my spouse and dependent children, and that I am unaware of any other fact or circumstance that would constitute a conflict of interest in connection with my participation in this clinical study.

Rachel Rosso / Rachel Rosso — 1.18.11

Investigator Print Name | Investigator Signature | Date

Banner Health

FINANCIAL DISCLOSURE / CONFLICT OF INTEREST FORM

Title of Study: Researching how the Olfactory Stimuli Affect Caregiver Performance in an Emergency Department
Principal Investigator: Jose Bernardi

This form is to be completed and submitted by each Clinical Investigator involved in the study to provide written certification attesting to the absence of financial interests and arrangements described in *21 CFR Section 54.4, paragraph (a) (3)*. (Clinical Investigators include the principal investigator and each sub-investigator who will be directly involved in the treatment or evaluation of research subjects. The term also includes the spouse and each dependent child of a Clinical Investigator)

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Any steps taken to minimize the potential for bias resulting from any of the disclosed arrangements, interests or payments. **Explanation**:	☐Yes	☒No

By my signature below, I certify that the information provided above and in attachments to this certification is accurate and complete as to myself, my spouse and dependent children, and that I am unaware of any other fact or circumstance that would constitute a conflict of interest in connection with my participation in this clinical study.

John Richard Watts / John Richard Watts — 7/25/2011

Investigator Print Name | Investigator Signature | Date

APPENDIX P

Formal Study Proposal

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department

Carina Clark

Health and Healing Environment MSD Candidate

Arizona State University

Contents

DEFINITIONS

Aroma: during this proposal, the term "aroma" will be used to define the positive effecting, or pleasant, smells used based on the participant's perceptions of five different essential oil options.

Odor: during this proposal, the term "odor" will be used to define the unpleasant, or negative effecting smell, used which is based on the perception of the investigator.

Smell: throughout the proposal, the term "smell" will be used to define both odors and aromas without the positive of negative effects of the prior terms. This term will be used as an overarching representation of odors and aromas.

Performance: this proposal seeks to define the understanding of caregiver performance as the positive output of the individual including, but not limited to, reduced errors, quick response time, and the positive physical and emotional experience of the caregivers.

RESEARCH OBJECTIVES

- The objective of this study is to see if the hectic environment of a simulated emergency department plus the added olfactory stimuli from odors and aromas can enhance or reduce the impact of caregiver (nursing staff) performance in a simulated environment.
- The objectives of this project include:
    - See if the introduction of an odor plays a role in causing or influencing caregivers to perform at a heightened or reduced efficiency and performance. The odor will be diffused into the air.
    - See if the introduction of an aroma can increase or decrease caregiver efficiency, and performance within the Emergency Department. This includes the introduction of the aroma through diffusion into the air.
    - See if the introduction of an aroma during the presence of an odor can allow for the caregiver to perform more or less efficiently. This includes the introduction of the odor and aroma through diffusion into the air.

SUBJECT RECRUITMENT

- **Inclusion Criteria**
    - Registered Nurses who have worked in a typical Emergency Department environment for a minimum of 6 months.
    - Registered Nurses within the Banner System who wish to volunteer to take part in this study.
    - Registered Nurses between the ages 18 and 65 years.
- **Exclusion Criteria**
    - Individuals who are or may be pregnant.
    - Individuals under the age of 18 years.
    - Individuals over 65 years of age.
- Recruitment will occur via emails and publicity on the investigator's personal website (www.cotb.me/thesis). Any individuals who meet the inclusion criteria listed above are encouraged to participate.
- These participants will be asked to fill out an online form where they will be asked background information and determine if they are eligible to participate in the study.
- A maximum of 45 subjects will be encouraged to participate in the study given a 95% confidence interval.

METHOD AND PROCEDURES

- **Procedure:**
    - Each two-hour session will be conducted in the Simulation Lab (SimET) and will start by welcoming the participants to the study and providing a brief introduction to the tasks they will be doing. After the consent form has been signed by the participant, the first task will have each individual rank the emotions they feel at that moment prior to any smells being diffused (Mood Mapping Test). Once finished, heart-rate and bio-feedback information will be gathered, and continue for every 5 minutes creating constant movement for the participants. They will be asked to begin taking care of their simulated patients (manikins) and the diffusion process will begin.

- The smell diffused will be randomized based on the session that the participant will be participating in. All Participants will take part in a control session, an odor session (which will contain the same odors between all participants), and an aroma session (which will be chosen from 5 essential oils).

- During the study, each participant will have completed all web-based computerized tasks and assisted their simulated patients (manikins). The environment will attempt to simulate a stressful atmosphere by interrupting the caregivers from their simulated patients every five minutes to collect bio-feedback and heart-rate information as well as performing web-based computer tasks.

- To conclude, participants will be asked to answer a few one-on-one interview questions relating to how difficult this process was, and if they believed the smells affected their performance positively or negatively.

- See **Appendix A** for a timeline of events for each two-hour session.

- **Location:** Banner Good Samaritan Medical Center; SimET in Phoenix, AZ

- **Timeline:**

  - The Duration of the Study will last over a 3 month period starting from the tentative date of November 2011 and will contain 45 sessions. Willing participants will only need to volunteer for one session.

  - Each session will last two hours (or 1/6 of a typical 12 hour shift) for each participant.

  - Following each two-hour session, data analyzing will begin immediately and continue by the tentative date of February 2012. (See data collection below).

- **Screening Log:**

  - A maximum 60 individuals will be screened for enrollment for this study, while the maximum number of subjects that are planned to be enrolled is 45.

  - Participants will be screened through an online survey (application form) where those who are ineligible will be notified immediately.

- **Deception**: There will be no deception in this study. Participants will be informed of participating in 3 different aromatic environments including an odor and aroma.

- **Data Collection:** Data that will be collected include the following:

- Observations will be made during the course of the study and recorded through a digital video recorder.

- End of study interviews will take place immediately after each session of the study and will be semi-structured. This will allow participants to openly express and be able to better describe how they felt about performing each task, if they noticed any smells, how they liked – or disliked the smells, and if they felt the smell in the room allowed or prevented them from performing their best.

- Information gathered from heart-rate monitors, and bio-feedback monitors will be collected every five minutes starting from after the completion of the first test (Mood Mapping) and will be used as a cross reference to how the participants are performing, and any comments that are made during and after the sessions.

- **Procedures**:

  - Prior to the start of testing, participants will be asked to choose their pleasant aroma of choice.

  - Each test will begin with an introduction to the study, the ability to sign the consent form (which they will be able to have a copy of) and a video release form. Following the participant signing the forms, they will perform a short web-based test (Mood Mapping) which will allow participants to place how they feel, emotionally, on scales.

  - Each test will consist of a series of tasks, common for a typical emergency department including, but not limited to, patient interaction and care, administering medication to patients, as well as simple web-based computerized tests including the Stroop Test, Memory Test, and a Multi-tasking Test.

BENEFITS

There may or may not be any benefit to the participant. The possible benefits of participation in this research are to determine if there is a difference in performance based on the introduction of offensive, pleasant, or no odor.

Benefits to the Banner Health System may include additional information about the effects of smells, odors, and aromas on performance of health care workers (nurses).

POTENTIAL RISKS TO SUBJECTS

The following risks may be possible due to the introduction of odors as well as some aromas.

- Feeling ill / nausea
- Headache
- Dizziness

However, if a participant feels ill or unable to complete the study, they will be able to withdraw from the study at any time without consequences.

INFORMED CONSENT

- An informed consent will be available for viewing at the time of the participant's application to the study. In addition, a hard copy will be provided for the participant at the time of the study as well as a signed copy for the investigator's records.

- A participant will also be given the option to choose to sign a photo release waiver for any video recordings that may take place during the study; however, no recordings will be used in future publications or presentations. If a participant chooses not to sign the waiver, no recordings will take place during the study and all observations will be made and recorded on site. Recordings will be destroyed following the completion of the study.

CONFIDENTIALITY OF DATA

- Effort will be made to protect the confidentiality of records identifying subjects.

- Individuals who may have access to data information include the following:

    - Jose Bernardi (PI; committee chair)
    - Carina Clark (co-PI)
    - Richard Watts (co-PI)
    - Karen Josey (co-PI)
    - Banner Good Samaritan SimET

- Participant codes will be used during data collection to protect patient confidentiality while a master list will be kept in a secure location in a locked cabinet, within a locked room on the ASU Tempe campus. Once the data has been collected and analyzed, any identifiers (ex. Name, position, hospital of employment) will be separated prior to publication.

- Coding will be used to identify participants between each types of data collection (surveys, interviews, and the study).

- Following the completion of this study, the master list and all video recordings will be destroyed.

- **Master list:**
    - Identifiers will be removed from the data at the full completion of the study.
    - A Master List will be used as a way to accurately analyze data between the different participants, or if a single participant chooses to become involved with the different types of data collection (electronic survey, one-on-one interview, or the physical study). Efforts will be made to minimalize the risk to this master list. Only the investigator will have access to the master list, however, data – with identifiers removed – may be viewed by other members of the research team.
    - The master list will be stored in a locked cabinet in the locked room CDN66 on the ASU Tempe Campus which only the investigator has access to.
    - The master list will be destroyed at the end of data analysis and prior to graduation.
    - Data will be retained until the graduation date.
    - Data will be disposed by shredding any hard documents, deleting any electronic copies, and destroying all video recordings.
- **Consent forms**: will be stored with the master list in a locked cabinet, in the locked room CDN66 on the ASU Tempe Campus.

APPENDIX

Data collected may be used for thesis and defense as well as any publications and/or presentations that may be associated with the thesis.

Appendix A: Timeframe

Set-up	
Participant Welcome	00:00-00:10
00:00-00:02	Study Description & Consent form signed
00:02-00:06	Participant Multi-tasking practice run
00:06-00:09	Participant Mood Mapping
00:09-00:10	Participant pleasant aroma choice
Session: Control	00:10-00:30
00:10-00:30	Patient care
0:10:00	Memory Test
0:15:00	Multi-tasking
0:20:00	Stroop
0:25:00	Mood Mapping
Session: Odor	00:30-00:50
00:30-00:50	Patient care
0:30:00	Stroop
0:35:00	Memory Test
0:40:00	Multi-tasking
0:45:00	Mood Mapping
Session: Aroma	00:50-01:20
00:50-01:20	Patient care
0:50:00	Multi-tasking
1:00:00	Stroop
1:10:00	Memory Test
1:15:00	Mood Mapping
Follow-up	01:20-01:30
01:20-01:30	Follow-up interview with participant

APPENDIX Q

Formal Study Banner Health and ASU Agreement

Contract Details

File Number	5300-02-32367	Materials Management	No	Entech Contract	No
Vendor Name	Arizona State University		Office for Research and Sponsored Projects Administration		
Street Address	P.O. Box 873503				
[cont]					
City	Tempe	State	AZ	Zip	85287
Phone		Fax		Country	
Tax ID		Entered By	bhs\saculver	Entered On	2/10/2012 10:13:18 AM

Dates & Status

Effective Date	Expiration Date	Briefed Date
5/16/2012	12/31/2020	5/21/2012
Contract Status	Executed	

Facilities
5300 - Banner Good Samaritan Medical Center

Legal Contacts
Riannan F Stichter

Requesters
Denise Drumm-Gurnee (Manager: Shaun Opie)
Ofelia M Martinez (Manager: Connie A Boker)
Gordon Schneider (Manager: Merriley R Sprague)

File Type & Subaccounts

File Type	02 Care Related Contracts
Subagreement Type	110 Research Agreem
SubAccounts	

Contract Coordinators
Culver, SallyA

Cost Centers

Payments

Contract Total	$0.00
Pay Schedule	
Payment Amount	
Additional Payment	No

Keywords
RESEARCH
BGSMC
BANNER GOOD SAMARITAN MEDICAL CENTER
ASU
ARIZONA STATE UNIVERSITY
KAREN JOSEY
RICHARD WATTS
CORINA CLARK
JOSE BERNARDI, MA
SIM CENTER
SimET CENTER
SIMULATION CENTER
IRB APPROVED
RESEARCHING HOW OLFACTORY STIMULI AFFECTS CAREGIVER PERFORMANCE IN AN EMERGENCY DEPARTMENT

Requirements

Cancellation	30 DAYS PRIOR WRITTEN NOTIFICATION
Insurance	Unknown
Auto Renewal	No
Exclusive Contract	No
Fortis	No
Compliance Education	No
Physician Ownership, Interest or Service	No
Excluded Provider Search Completed	Yes
Business Associate	No, because Protected Health Information not involved
Executed BAA Received On	
File Location	BHRI
Archived Retention #	
Archived Date	

Contract Information

Contract Description:

Research Agreement

Contract Cost Information:

Contract Notes:

5-11-12: OFS Hensing (SAC)
04-27-12: Transferred file to SC to complete execution. (RFS)
04-26-12: Email to Carina Clark with instructions on getting additional ASU signature and returning it to me for completion. (RFS)
04-26-12: Email from Carina Clark with questions. (RFS) with instructions on getting additional ASU signature and returning it to me for completion. (RFS)
04-24-12: Received partially executed RP from Bernardi. (RFS)
04-23-12: Call from Drumm-Gurnee. Provided update and next steps. (RFS)
04-23-12: Call from ASU PI. Provided background and next steps. (RFS)
04-23-12: Email to PI for ASU with draft RP and request that it be forwarded to legal team, as needed. (RFS)
04-12-12: Email to ASU with draft RP. (RFS)
04-12-12: Draft RP from RD. (RFS)
02-27-12: No SSA required since student & PI are being assumed by ASU. No BAA required because no PHI is involved. The study involves simulations with BH ED employees. (RFS)
2-10-12: Note to CMS: Please let me know if an SSA is req. for Student and Jose Bernardi as well as if a BAA is required. (SAC)

[C O N T R A C T]

5 **pages**

RESEARCH PLAN

This Research Plan shall be undertaken under the RESEARCH COLLABORATION AGREEMENT between **Banner Health** (including all its subsidiaries, "BANNER" or "BH") and the Arizona Board of Regents acting on behalf of **Arizona State University** ("UNIVERSITY" or "ASU"), which has the Effective Date of September 2, 2004. This Research Plan shall be effective as of the date of the last signature affixed to this Research Plan (the "Effective Date"), and shall continue until the End Date of the Project, listed below.

Research Project Title, Term & Investigators:

Full Title of the Project:	*Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department(Smell) Study*
BH Investigator(s):	Richard Watts, RN Karen Josey, RN, M.Ed.
BH Facility:	BGSMC Simulation Center
UNIVERSITY Investigator(s):	Jose Bernardi, M.A. Carina Clark (student)
Term of Project:	Start Date: Effective Date set forth above End Date: One year from date of signing
Catalog of Federal Domestic Assistance Number ("CFDA#"):	N/A
Prime Sponsor:	N/A
Sponsor Award#:	N/A
ASU Subaward#:	N/A

"N/A" shall mean not applicable for the purposes of this Research Plan.

A) STATEMENT OF WORK:

The statement of work should be concise but of sufficient detail to clearly and completely describe the work to be undertaken by the Party providing such work or the work provided by both Parties, as appropriate.

Statement of Work	The goal of this study is to see if the busy environment of a simulated emergency department plus the added olfactory stimuli from odors and aromas can enhance or reduce the impact of caregiver (nursing staff) performance in a simulated environment. This project has received

	IRB approval from both BH and ASU. Research participants are volunteers from the Emergency Department who will be consented to perform mock Emergency Department tasks in Simulation There are three primary objectives of this project: (1) to investigate if the introduction of an odor plays a role in causing or influencing caregivers to performance at a heightened or reduced efficiency and performance after diffusing an odor in the air; (2) to investigate if the introduction of an aroma can increase or decrease caregiver efficiency, and performance within the Emergency Department. This includes the introduction of the aroma through diffusion into the air; and (3) investigate if the introduction of an aroma during the presence of an odor can allow for the caregiver to perform more or less efficiently. This includes the introduction of the odor and aroma through diffusion into the air Research participants will perform mock tasks in three odor environments, each taking about 2 hours. Enrollment is anticipated to be around 45 people. The first session consists of participants choosing their favorite odor/scent followed by a short web-based test (Mood Mapping). The other tasks will consist of exposure to the odor, the mock code, followed by the Stroop/Memory Test and a Multi-tasking test.

Identification of study protocol ("Study Protocol")

Study Protocol	*Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department(Smell) Study* (IRB # 01-11-0058)

The above listed Study Protocol is, by reference, fully incorporated into and made part of this Research Plan.

B) RESOURCE PROVIDED:

The resources section should include a description of the following:

1. List of personnel of each of the UNIVERSITY and BH working on the project/study; identifying whether the personnel are working for the UNIVERSITY or BH.

BH personnel	Richard Watts, RN (BH ED employee)

	Karen Josey, RN, Med (BH Simulation employee)
UNIVERSITY personnel	Jose Bernardi, PI. Carina Clark (ASU student) Chair of Carina's committee

2. Briefly describe if any biological-items (including but not limited to: blood or tissue) which are being used or transferred for the study/project

Biological items	N/A

3. In the event the Intellectually Property and Commercialization terms of RESEARCH COLLABORATION AGREEMENT will not apply to this Research Plan describe the deviation/differences.

Deviation of IP & Commercialization Terms from Research Collaboration Agreement	N/A

C) MONETARY COMPENSATION:

This section C. applies where payment ($) is transferred between BH and ASU.

Transfer of Payment between the Parties:

N/A. IRB fees paid by Carina Clark

D) ADDRESS OF PAYOR & PAYEE

This section **D.** applies where payment is being transferred between BH and ASU. *Insert payor and payee contact person's name, phone number, e-mail address, fax number and compensation (payor or payee) related address.*

BH Contact Person:	N/A
ASU Contact Person:	N/A

E) CONTACT INFORMATION FOR CLINICAL / STUDY CORRESPONDENCE

This section **E.** applies to all studies/projects. *Insert clinical study-operational contact person's name, phone number, e-mail address, fax number and address.*

BH Contact Person	Denise Drumm-Gurnee, PhD, MSc Research Director 2145 W. Southern Avenue, Suite 373 Mesa, AZ 85202-4703 Phone 480-412-4868 Email: denise.drummgurnee@bannerhealth.com
ASU Contact Person	Dr. Jose Bernardi College of Design/ Arizona State University Tempe, AZ 85287-2105 Phone: 480-965-9140 Home Telephone: 480-705-8740 Email: Jose.bernardi@asu.edu

F) ADDITIONAL TERMS & CONDITIONS REQUIRED BY SPONSORING AGENCY/ORGANIZATION:
Where the terms and conditions of this section F. conflict with any terms and conditions of this Research Plan or the Research Collaboration Agreement the terms of this section F. shall control and govern.

N/A

G) ADDITIONAL TERMS & CONDITIONS
Where the terms and conditions of this section G. conflict with any terms and conditions of this Research Plan or the Research Collaboration Agreement the terms of this section G. shall control and govern.

N/A

H) "LEAD" PARTY (Lead Institution), with regard to intellectual property protection:

The "lead" Party (or Lead Institution) with regard to intellectual property protection shall be: *(see Article 9 of the Agreement for further explanation)*	UNIVERSITY

I) Election to have Institutional Review Board (IRB) Authorization (choose one):

X ASU and BH will have their separate IRBs review the Study (no IRB Authorization is occurring; ASU's IRB will review only for ASU; BH's IRB will review only for BH);

ASU's IRB shall be the reviewing IRB for both ASU and BH;

BH's IRB shall be the reviewing IRB for both ASU and BH.

Not applicable.

Note: operational personnel/investigators must notify the reviewing IRB where an election was made for such IRB to review for both ASU & BH. Each party will rely on the reviewing IRB for review and continuing oversight of the human subjects research protocol.

IN WITNESS WHEREOF, BH and ASU have caused this Research Plan to be executed by their duly authorized representatives. This Research Plan may be executed in one or more counterparts, each of which shall be deemed to be an original but all of which together shall constitute one and the same instrument. Facsimile signatures and signatures transmitted by email after having been scanned shall be accepted as originals for the purposes of this Research Plan.

BH:

By _____

Name: John Hensing, M.D.
Title: Executive V.P., Chief Medical Officer
Date: 5/16/12

ASU:

By _____

Name: Debra Barnes Murphy
Title: Director, Research Integrity & Assurance
Date: 05/01/2012

STATEMENT OF PRINCIPAL INVESTIGATOR

I have read the RESEARCH COLLABORATION AGREEMENT between Banner Health ("BANNER" or "BH") and the Arizona Board of Regents acting on behalf of Arizona State University ("UNIVERSITY" or "ASU"), which has the Effective Date of September 2, 2004 and I shall abide by the terms of the Research Collaboration Agreement and this Research Plan.

BH Principal Investigator

By: Richard Watts RJ
Print Name: RICHARD WATTS
Date: 05-03-2012

ASU Principal Investigator

By: Jose Bernard
Print Name: Jose Bernard
Date: 04-24-12

APPENDIX R

Formal Study Banner Health IRB Approval

Banner Health®

FWA #00002630
IORG #0004299

June 07, 2012

Jose Bernardi, MA
Attn: Carina Clark
P.O.Box 871605
Tempe, AZ 85287-1605

RE: **Project # 01-11-0058**
Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
iRIS Reference # 011981
IRB Expedited Review and Approval – Revision to Research Team

- **Removal of Team Member Jane Hoverson**
- **Addition of Team Members Donna-Linda Livergood, RN and Anthony Denison, RN**

Dear Dr. Bernardi:

This letter serves to notify you that the Revision to Research Team the above referenced study received expedited review and approval by Marc Lee, MD, Chair of the Banner Health Institutional Review Board (Phoenix Panel) on June 07, 2012. This expedited review was performed in accordance with 21CFR56.110(b) and 45CFR46.110(b). A copy of this letter will be placed in the study file.

Thank you for your continued participation in research at Banner Health. If you have any questions, please contact Cindy Soto, IRB Coordinator, at 480.256.3420.

Sincerely,

Signature applied by Marc Lee on 06/07/2012 05:16:00 PM MST

Marc Lee, MD
Chair, Banner Health IRB (Phoenix Panel)

ML/cs
cc: Study File
Research Director

APPENDIX S

Formal Study Arizona State University IRB Approval

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jose Bernardi AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/27/2011
Committee Action:	**Amendment to Approved Protocol**
Approval Date:	04/27/2011
Review Type:	Expedited F12
IRB Protocol #:	1102006092
Study Title:	Olfactory Effects on Productivity
Expiration Date:	03/17/2012

The amendment to the above-referenced protocol has been APPROVED following Expedited Review by the Institutional Review Board. This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX T

Formal Study Continuing Review Form

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Jose Bernardi AED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	10/15/2012
Committee Action:	**Renewal**
Renewal Date:	10/15/2012
Review Type:	Expedited F4 F7
IRB Protocol #:	1109006876
Study Title:	Researching How the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Expiration Date:	10/01/2013

The above-referenced protocol was given renewed approval following Expedited Review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX U

SimET Approval Letter

Banner Health.

1441 North 12th Street, Phoenix, AZ 85006
602-495-4000
BannerHealth.com

Karen Josey M.Ed, BSN,RN
Simulation Director
1111 E. McDowell Road, Phoenix, AZ 85006
602-839-3609/480-684-6109
Karen.Josey@bannerhealth.com

June 12, 2012

Carina Clark
5336 W Rose Garden Ln
Glendale, AZ 85308

Carina,

Thank you for submitting the research proposal *Researching How the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department*; IRB **Number 01-11-0058.** The proposal was reviewed by the Banner Simulation Research Committees on 3/1/2012. The committee approves support of this project and Simulation will provide simulation expertise, space, and scenario development.

I appreciate your enthusiasm in wanting to work with Simulation and Innovation.

Sincerely,

Karen Josey

Karen Josey
Banner Health Simulation Director

APPENDIX V

Formal Study SimET Room Reservation

Meeting Summary by Host

My Location: MULTI USE ROOMS
Time Difference: -7 hour(s)

From: Monday, June 25, 2012
To: Friday, December 28, 2012

Start & End Time (My Location)	Start & End Time (Actual Location)	Location	Meeting Room	Meeting Title	Booked by
Host Name:Carina					
Friday, June 29, 2012					
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	DEBRIEF 2	Smell study	bhs\ypreciado
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Tuesday, July 24, 2012					
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Wednesday, July 25, 2012					
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Thursday, July 26, 2012					
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado

12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Friday, July 27, 2012					
8:00 am - 5:00 pm	8:00 am - 5:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am - 5:00 pm	8:00 am - 5:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Monday, July 30, 2012					
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Tuesday, July 31, 2012					
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm - 4:30 pm	2:30 pm - 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Wednesday, August 01, 2012					
1:00 pm - 5:00 pm	1:00 pm - 5:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
1:00 pm - 5:00 pm	1:00 pm - 5:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Monday, August 06, 2012					
8:00 am - 5:00 pm	8:00 am - 5:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am - 5:00 pm	8:00 am - 5:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Wednesday, August 08, 2012					
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am - 11:00 am	9:00 am - 11:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm - 2:00 pm	12:00 pm - 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado

12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado

Tuesday, August 21, 2012

8:00 am – 1:00 pm	8:00 am – 1:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 1:00 pm	8:00 am – 1:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado

Thursday, August 23, 2012

9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado

Wednesday, August 29, 2012

9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado

Thursday, August 30, 2012

9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
12:00 pm – 2:00 pm	12:00 pm – 2:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
2:30 pm – 4:30 pm	2:30 pm – 4:30 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado

Thursday, September 20, 2012

9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
9:00 am – 1:00 am	9:00 am – 1:00 am	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado

Meeting Summary by Host

My Location: MULTI USE ROOMS
Time Difference: -7 hour(s)

From: uesday, September 11, 2012
To: Friday, November 30, 2012

Start & End Time (My Location)	Start & End Time (Actual Location)	Location	Meeting Room	Meeting Title	Booked by
Host Name:Carina					
Thursday, September 20, 2012					
8:00 am – 12:00 pm	8:00 am – 12:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell study	bhs\ypreciado
8:00 am – 12:00 pm	8:00 am – 12:00 pm	MULTI USE ROOMS	ICU ROOM	Smell study	bhs\ypreciado
Tuesday, October 16, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Wednesday, October 17, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Thursday, October 18, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Friday, October 19, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Tuesday, October 23, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Thursday, October 25, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado

Friday, October 26, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Thursday, November 08, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	DEBRIEF 1	Smell Study	bhs\ypreciado
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado
Monday, November 12, 2012					
8:00 am – 4:00 pm	8:00 am – 4:00 pm	MULTI USE ROOMS	ICU ROOM	Smell Study	bhs\ypreciado

APPENDIX W

Formal Study Email Recruitment Example

Greetings,

My name is Carina Clark and I am a graduate student at Arizona State University in the Design School studying Health and Healing Environments. I am currently doing a study to look at how odors and aromas affect the performance of caregivers in an Emergency Department and am seeking participants to help with my study.

During this 1+ hour study, you will be asked to perform a series of computer tasks while caring for a simulated patient in the Banner Good Samaritan SimET. Additionally, you will be exposed to three different aromatic environments: control, unpleasant, and pleasant.

If you are between the ages of 18-65 years, are a caregiver (Registered Nurse, Physician, Tech, etc.) who has worked in an Emergency Department for at least 6 months and is confident in caring for a patient and hand documenting, and are interested in participating in this study, please visit http://cotb.me/thesis/ for more information and a link to sign up. There are also incentives for your participation (details are on the website). If you have any questions, please don't hesitate to email me at: cclark7@asu.edu

Thank you for your time and consideration!

Carina Clark, LEED AP, EDAC
Arizona State University | Design for Healthcare & Healing Environment MSD Candidate
cclark7@asu.edu
cotb.me/thesis/

APPENDIX X

Formal Study Participant Application Questions

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department Study Participation Form

Welcome

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department

Banner Good Samaritan Medical Center - SimET

Your information

1. First Name *

2. Last Name *

3. Email address *
   Please provide one you actively check for your participation reminders

4. Age *

- Under 18
- 18
- 19
- 20
- 21
- 22

- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31
- 32
- 33
- 34
- 35
- 36
- 37
- 38
- 39
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- 42
- 43
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- 47
- 48
- 49
- 50
- 51
- 52
- 53
- 54
- 55
- 56
- 57
- 58
- 59
- 60
- 61
- 62
- 63
- 64
- 65
- Over 65

5. Gender *

- Male
- Female
- Prefer not to ans

6. Are you (or have you

- Yes
- No

7. How many years ha

- Less than 1 year
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years
- 19 years
- 20 years
- 21 years
- 22 years
- 23 years
- 24 years
- 25 years
- 26 years

- 27 years
- 28 years
- 29 years
- 30 years
- 31 years
- 32 years
- 33 years
- 34 years
- 35 years
- 36 years
- 37 years
- 38 years
- 39 years
- 40 years
- Over 40 years

Work history

8. What department you currently work in? *

9. How long have you been working in this department? *

- Under 6 months
- 6-12 months
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years
- 19 years
- 20 years
- 21 years
- 22 years
- 23 years
- 24 years
- 25 years
- 26 years
- 27 years
- 28 years
- 29 years
- 30 years
- 31 years
- 32 years

- 33 years
- 34 years
- 35 years
- 36 years
- 37 years
- 38 years
- 39 years
- 40 years
- 41 years
- 42 years
- 43 years
- 44 years
- 45 years
- Over 45 years

10. How long have you been a registered nurse? *

- Under 6 months
- 6-12 months
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years
- 19 years
- 20 years
- 21 years
- 22 years
- 23 years
- 24 years
- 25 years
- 26 years
- 27 years
- 28 years
- 29 years
- 30 years
- 31 years
- 32 years
- 33 years
- 34 years
- 35 years
- 36 years
- 37 years

- 38 years
- 39 years
- 40 years
- 41 years
- 42 years
- 43 years
- 44 years
- 45 years
- Over 45 years

11. What other departments have you worked in? *

Get ready to sign up

12. Thank you for your interest in participating in this study. The final step is to choose the day that works best with your schedule to participate. By choosing "I am ready to sign up" you will be redirected to another site where you will be able to choose from a list of days.

Thank you again! *

- I am ready to sign up

Thank You!

Thanks [question("value"), id="4"]

We appreciate you contacting us and we will be in touch soon.

APPENDIX Y

Formal Study Master List Example and Participant Codes

Participant Code	First Name	Last Name	Age	Smoker	Reg. nurse yrs.	Data Collection type	Participation day/time

Gender:

1 = Female

2 = Male

Participation number:

XX

Example code:

2 0 7

Female Female participant number

APPENDIX Z

Formal Study Smell Description Sheet

Control			
Smell	Introduction	Reason for Selection	Data Collection
None	None	Control for how nurses respond to tasks given without any positive or negative smells.	• Observations (video recorded if participant signed a video release form) • Data collected from heart rate monitor • Data collected from bio-feedback monitor • Comments, or reactions from participants • After study interviews
Positive (pleasant) Aroma			
Smell	Introduction	Reason for Selection	Data Collection
Peppermint *Mentha x piperita*	Diffuser	• Clears energy • Uplifts and stimulates to the mind to combat fatigue • Awakens, refreshes • Stimulates digestion of new ideas and creativity • Supports self confidence • **Antiseptic** - assists in fighting germs/infections (urinary, pulmonary) • **Antispasmodic** - relieves spasms and cramps • **More info** here	• Observations (video recorded if participant signed a video release form) • Data collected from heart rate monitor • Data collected from bio-feedback monitor • Comments, or reactions from participants • After study interviews
Lavender *Lavandula angustifolia*	Diffuser	• **Antidepressant** - can help to prevent and alleviate depression • Antiseptic - assists in fighting germs/infections • Antispasmodic - relieves spasms and cramps • Antiviral • Bactericidal - destructive to bacteria • Anti-infectious • Calms, soothes, nurtures • Encourages balances in all body systems • Reduces anxiety and fear • Helps calm and control panic attacks • More info here	

Bergamot *Citrus bergamia*	Diffuser	• Antidepressant - helps prevent and alleviate depression • Anti-inflammatory - alleviates inflammation, promotes cooling • Antispasmodic - relieves spasms and cramps • Antiviral- destructive to viruses • Relaxing, restorative, calming • Emotionally uplifting • Supports the release of repressed emotion • Helps reduce insomnia and anxiety • More info here	
Ginger *Zingiber officinale*	Diffuser	• Anti-inflammatory - alleviates inflammation • Antiseptic - assists in fighting germs/infections (urinary, pulmonary) • Antispasmodic - relieves spasms and cramps • Carminative/Tonic - settles digestion and may assist in preventing gas • Antiemetic - reduces incidence and severity of nausea or vomiting • More info here	
Coffee Bean	Coffee Grounds set in small cups around working area	• Current odor repellant of choice to many hospitals in the United States (in particular, Banner Good Samaritan Medical Center) Although, there is not a traditional effect of this aroma like the ones listed above, this will be used to see if there is any affect for participants.	
Negative (unpleasant) Odor			
Smell	Introduction	Reason for Selection	Data Collection
Methylindole	Open jar	• Critical part of the study to determine if an odor can cause a negative effect on the performance of a caregiver in the Emergency Department. • Used to determine if an odor can cause sluggishness and if an aroma can counteract the odor and assist caregivers to perform better.	• Observations (video recorded if participant signed a video release form) • Data collected from heart rate monitor • Data collected from bio-feedback monitor • Comments, or reactions from participants • After study interviews

APPENDIX AA

Formal Study Test Description Sheet

Title	Significance to study	How data will be analyzed
Mood Mapping *Initial emotional response*	Before entering the room, participants will be asked to complete their first questionnaire by considering how much of each emotion that they feel at that time. Questions asked will be rated and include: Angry, Anxious, Awake, Confused, Frustrated, Energetic, Happy, Negative, Positive, Relaxed, Sad, Tired, Worried Mood Mapping test link (same test for all 3 aromatic environments)	**Once completed, information from the bio-feedback monitor and heart rate monitor will be collected every five minutes.** Computer software will be used to collect the data and compare later results of analysis.
Computerized Multi-tasking	Participants will be asked to partake in a simple game of multitasking from the link below: http://karma.celardore.net/multi/ **Practice run:** Prior to performing any tests, participants will be able to run a practice run of this test to ensure an even knowledge during the 3 sessions. **Test:** Once the tests have started, participants will not be given any assistance to completing this test.	**During this time, information from the bio-feedback monitor and heart rate monitor will be collected every five minutes.** Computer software will be used to collect the data and compare later results of analysis. **Test:** Scores will be collected at the end from a combination of math, arrows, and color recognition
Stroop test	Participants will be shown 3 sets of a series of words (all color names) via their computers. **Set 1:** Participants will be asked to name the color of the word they see on the screen, while the text is written in black **Set 2:** Participants will be asked to name the color of the word that is written that they see on the screen, while the text is written in colors other than what the text says. **Set 3:** Participants will be asked to name the color of the word that they see on the screen –not the word itself, while the text is written in colors other than what the text says. Stroop test link (same test for all 3 aromatic environments with randomized questions)	**During this time, information from the bio-feedback monitor and heart rate monitor will be collected every five minutes.** Computer software will be used to collect the data and compare later results of analysis. The amount of time it takes to choose their answer as well as the accuracy of the answer will be recorded.
Memory	Each participant will be asked a series of questions with reference to topics covered in previous sessions. Memory test 1 link Memory test 2 link Memory test 3 link	**During this time, information from the bio-feedback monitor and heart rate monitor will be collected every five minutes.** Computer software will be used to collect the data and compare later results of analysis.

Smell Study - Memory 1

Remember these

1. Participant code *

Please remember these 5 objects.

- orange
- car
- dog
- book
- tree

2. The current year is

- 2009
- 2010
- 2011
- 2012
- 1969

3. You have $100 and you go to the store and buy a dozen apples for $3 and a tricycle for $20. How much did you spend?

- $16
- $17
- $23
- $24
- $29

4. You have $100 and you go to the store and buy a dozen apples for $3 and a tricycle for $20. How much do you have left?

- $97
- $87
- $77
- $75
- $67

5. 649 backwards is:

- 496
- 964
- 694
- 946
- 469

6. 8537 backward is:

- 3758
- 7358
- 5378
- 8753
- 7385
- 7583
- 3875
- 8573

7. 2645 backwards is:

- 5426
- 4652
- 5462
- 4562
- 4526
- 6425
- 2654
- 6254
- 5246
- 5624
- 6452
- 4265

Based on a list of words given at the beginning of this section, answer the questions below to the

best of your ability.

8. Please select one item below that appeared on the previous list of objects.

- Banana
- Truck
- Orange
- Ring
- Pen

9. Please select the object below that did NOT appear on the list you were given earlier.

- Tree
- Cat
- Dog
- Orange
- Book

10. Please select one object below that appeared on the list you were given earlier.

- Patio
- Apple
- Novel
- Car
- House

11. "Book" was one of the objects that appeared on the list you were given earlier.

- True
- False

Quiz Score

Smell Study - Memory 2

1. Participant code *

2. 593 backwards is:

- 539
- 935
- 359
- 395
- 953

3. 6529 backward is:

- 9562
- 9256
- 5692
- 6529
- 9526
- 9625
- 9265
- 5269

4. 60969 backwards is:

- 60699
- 69069
- 96906
- 96609
- 90696
- 69609
- 99066
- 90966
- 60699
- 90669

5. 7 x 9 =

- 48

- 36
- 64
- 56
- 63

Based on a list of words given at the beginning of this section, answer the questions below to the best of your ability.

---

6. Please select one object below that appeared on the list you were given earlier.

- Tree
- Apple
- Novel
- House
- Fish

---

7. "Cat" was one of the objects that appeared on the list you were given earlier.

- True
- False

---

8. Please select one item below that appeared on the previous list of objects.

- Truck
- Orange
- Pen
- Apple
- Van

Quiz Score

Smell Study - Memory 3

1. Participant code *

2. Take 1000 and add 40 to it. Now add another 1000. Now add 30. Add another 1000. Now add 20. Now add another 1000. Now add 10. What is the total?

- 5010
- 5000
- 4010
- 4100
- 5100
- 4000

New Page

3. Please select the object(s) below that appeared on the list you were given earlier.

- Patio
- Van
- Cat
- Dog
- Car
- Novel
- Book
- Boat

Quiz Score

APPENDIX AB

Formal Study - Study Log

PARTICIPANT CODE:	DATE:
AROMA OF CHOICE:	**AROMA USED:**

	INFORMED CONSENT SIGNED		MULTI-TASKING PRACTICE RUN
	INFORMED CONSENT COPY GIVEN TO PARTICIPANT		INITIAL MOOD MAPPING TEST

CONTROL

Monitor	
Heart Rate	Bio-Feedback

Memory

Monitor	
Heart Rate	Bio-Feedback

Multi-Tasking

Points	Math	Arrow	Color

Monitor	
Heart Rate	Bio-Feedback

Stroop

Monitor	
Heart Rate	Bio-Feedback

Mood Mapping + Comments

ODOR

Monitor	
Heart Rate	Bio-Feedback

Stroop

Monitor	
Heart Rate	Bio-Feedback

Memory

Monitor	
Heart Rate	Bio-Feedback

Multi-Tasking

Points	Math	Arrow	Color

Monitor	
Heart Rate	Bio-Feedback

Mood Mapping + Comments

AROMA

Monitor	
Heart Rate	Bio-Feedback

Multi-Tasking			
Points	Math	Arrow	Color

Monitor	
Heart Rate	Bio-Feedback

Stroop

Monitor	
Heart Rate	Bio-Feedback

Memory

Monitor	
Heart Rate	Bio-Feedback

Mood Mapping + Comments

COMMENTS	
How was the experience of volunteering for this study?	
Were there any difficulties in performing these tasks? ☐ Yes ☐ No	
What were they?	
Were any environmental influences noticed? ☐ Yes ☐ No	
Did they affect performance? ☐ Yes ☐ No How?	
Where any smells noticed? ☐ Yes ☐ No	Is it a pleasant smell? ☐ Yes ☐ No
What was smelled?	Why/why not?
Does the smell bring back any memories? ☐ Yes ☐ No What?	
Did the smells make this a more enjoyable experience? ☐ Yes ☐ No	
Could working 8-12 hours shifts with this smell be beneficial? ☐ Yes ☐ No	
Would performing these tasks be easier with a different smell? What?	

APPENDIX AC

Formal Study Timeframe

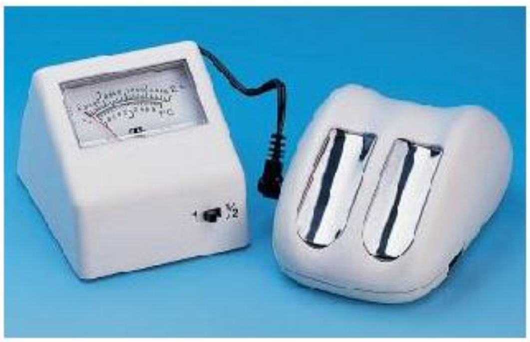
Set-up	
Participant Welcome	00:00-00:10
00:00-00:02	Study Description & Consent form signed
00:02-00:06	Participant Multi-tasking practice run
00:06-00:09	Participant Mood Mapping
00:09-00:10	Participant pleasant aroma choice
Session: Control	00:10-00:30
00:10-00:30	Patient care
0:10:00	Memory Test
0:15:00	Multi-tasking
0:20:00	Stroop
0:25:00	Mood Mapping
Session: Odor	00:30-00:50
00:30-00:50	Patient care
0:30:00	Stroop
0:35:00	Memory Test
0:40:00	Multi-tasking
0:45:00	Mood Mapping
Session: Aroma	00:50-01:20
00:50-01:20	Patient care
0:50:00	Multi-tasking
1:00:00	Stroop
1:10:00	Memory Test
1:15:00	Mood Mapping
Follow-up	01:20-01:30
01:20-01:30	Follow-up interview with participant

APPENDIX AD

Formal Study Data Collection Tools

Heart-rate Monitor is worn as a ring throughout the course of the study

Bio-feedback monitor will be used throughout to collect skin temperature data



Participant code	Session: Control													
	Monitor		Memory	Monitor		Multi-tasking				Monitor		Stroop	Monitor	
	HR	BF	correct	HR	BF	Points	Math	Arrow	Color	HR	BF	Correct	HR	BF
0														
0														
0														
0														
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Session: Odor													
Monitor		Stroop	Monitor		Memory	Monitor		Multi-tasking				Monitor	
HR	BF	Correct	HR	BF	correct	HR	BF	Points	Math	Arrow	Color	HR	BF

Session: Aroma													
Monitor		Multi-tasking				Monitor		Stroop	Monitor		Memory	Monitor	
HR	BF	Points	Math	Arrow	Color	HR	BF	Correct	HR	BF	correct	HR	BF

Session: Aroma													
Monitor		Multi-tasking				Monitor		Stroop	Monitor		Memory	Monitor	
HR	BF	Points	Math	Arrow	Color	HR	BF	Correct	HR	BF	correct	HR	BF

APPENDIX AE

Formal Study Electronic Survey

Page 1: Welcome

I am a graduate student in the Design in Heath and Healing Environment program in the college of Design at Arizona State University.

I am conducting a research study to determine if odors and aromas can affect the performance of caregivers (nurses) within an Emergency Department.

Your participation is greatly appreciated for this short survey which will help me to determine basic knowledge of smells within the hospital.

For more information on this study, please feel free to visit: cotb.me/thesis

Sincerely,

Carina Clark
cclark7@asu.edu

Page 2: Personal Information

1. Name (optional)* *[Fill in the blank]*
2. Email *[Fill in the blank]*
3. Gender* *[Radio button: Male, Female, Prefer not to answer]*
4. Age* *[Drop down: Under 18, 18-65, Over 65]*
5. Do you have allergies?* *[Radio button: Yes, No]*
    - → YES: What Allergies do you have? *[Check boxes: Floral, Perfume, Cologne, Grasses, Pollens, Animal hair, Dust mites, Mold, Latex, Other]*
        - → Please list what "other" allergies you have that relate to smells. *[Fill in the blank]*

Page 3: Employment background

6. Current Hospital System of Employment* *[Abrazo, Banner Health, Catholic Healthcare West, Scottsdale Healthcare, Other]*
    - → BANNER HEALTH: Please choose which Hospital you currently work at within the Banner Health System.
        - → Banner Baywood Medical Center; Mesa, AZ
        - → Banner Behavioral Health Hospital
        - → Banner Boswell Medical Center; Sun City, AZ

- → Banner Churchill Community Hospital; Fallon, NV
- → Banner Del E. Webb Medical Center; Sun City West, AZ
- → Banner Desert Medical Center; Mesa, AZ
- → Banner Estrella Medical Center; Phoenix, AZ
- → Banner Gateway Medical Center; Gilbert, AZ
- → Banner Good Samaritan Medical Center; Phoenix, AZ
- → Banner Heart; AZ
- → Banner Ironwood Medical Center; San Tan Valley, AZ
- → Banner Lassen Medical Center; Susanville, CA
- → Banner MD Anderson Cancer Center; Gilbert, AZ
- → Banner Thunderbird Medical Center; Glendale, AZ
- → Cardon Children's Medical Center; Mesa, AZ
- → Community Hospital; Torrington, WY
- → Page Hospital; Page, AZ
- → East Morgan County Hospital; Brush, CO
- → Fairbanks Memorial Hospital & Denali Center; Fairbanks, AK
- → McKee Medical Center
- → North Colorado Medical Center; Greeley, CO
- → Ogallala Community Hospital; Ogallala, NE
- → Platte County Memorial Hospital; Wheatland, WY
- → Sterling Regional MedCenter; Sterling, CO
- → Washakie Medical Center; Worland, WY

→ ABRAZO: Please choose which Hospital you currently work at within the Abrazo System.

- → Arizona Heart Hospital; Phoenix, AZ
- → Arizona Heart Institute; Phoenix, AZ
- → Arrowhead Hospital; Glendale, AZ
- → Maryvale Hospital; Phoenix, AZ
- → North Peoria Emergency Center; Peoria, AZ
- → Paradise Valley Hospital; Phoenix, AZ
- → Phoenix Baptist Hospital; Phoenix, AZ
- → West Valley Hospital; Goodyear, AZ

→ SCOTTSDALE HEALTHCARE: Please choose which Hospital you currently work at within the Scottsdale Healthcare System.

- → Scottsdale Healthcare Osborn Medical Center; Scottsdale, AZ
- → Scottsdale Healthcare Shea Medical Center; Scottsdale, AZ
- → Scottsdale Healthcare Thompson Peak Hospital; Scottsdale, AZ

→ CATHOLIC HEALTHCARE WEST: Please choose which Hospital you currently work at within the Catholic Healthcare West System.

- → Arroyo Grande Community Hospital; Arroyo Grande, CA
- → Bakersfield Memorial Hospital; Bakersfield, CA
- → Barrow Neurological Institute; Phoenix, AZ

- → California Hospital Medical Center; Los Angeles, CA
- → Chandler Regional Medical Center; Chandler, AZ
- → Community Hospital of San Bernardino; San Bernardino, CA
- → Dominican Hospital; Santa Cruz, CA
- → French Hospital Medical Center; San Luis Obispo, CA
- → Glendale Memorial Hospital and Health Center; Glendale, CA
- → Mark Twain St. Joseph's Hospital; San Andreas, CA
- → Marian Medical Center; Santa Maria, CA
- → Mercy General Hospital; Sacramento, CA
- → Mercy Gilbert Medical Center; Gilbert, AZ
- → Mercy Hospital of Folsom; Folsom, CA
- → Mercy Hospitals of Bakersfield; Bakersfield, CA
- → Mercy Medical Center Merced Community Campus; Merced, CA
- → Mercy Medical Center Merced Dominican Campus; Merced, CA
- → Mercy Medical Center Mt. Shasta; Mt. Shasta, CA
- → Mercy Medical Center Redding; Redding, CA
- → Mercy San Juan Medical Center; Carmichael, CA
- → Mercy Southwest Hospital; Bakersfield, CA
- → Methodist Hospital of Sacramento; Sacramento, CA
- → Northridge Hospital Medical Center; Northridge, CA
- → Oak Valley Hospital; Oakdale, CA
- → Saint Francis Memorial Hospital; San Francisco, CA
- → Saint Mary's Regional Medical Center Reno; Reno, NV
- → Sequoia Hospital; Redwood City, CA
- → Sierra Nevada Memorial Hospital; Grass Valley, CA
- → St. Bernardine Medical Center; San Bernardino, CA
- → St. Elizabeth Community Hospital; Red Bluff, CA
- → St. Joseph's Hospital and Medical Center; Phoenix, AZ
- → St. John's Pleasant Valley Hospital; Camarillo, CA
- → St. John's Regional Medical Center; Oxnard, CA
- → St. Joseph's Behavioral Health Center; Stockton, CA
- → St. Joseph's Medical Center; Stockton, CA
- → St. Mary Medical Center Long Beach; Long Beach, CA
- → St. Mary's Medical Center San Francisco; San Francisco, CA
- → St. Rose Dominican Hospitals - Rose de Lima Campus; Henderson, NV
- → St. Rose Dominican Hospitals - San Martín Campus; Las Vegas, NV
- → St. Rose Dominican Hospitals - Siena Campus; Henderson, NV
- → Woodland Healthcare; Woodland, CA

→ OTHER: Please list the hospital you work at.

7. Years of healthcare experience * *[Drop down: Less than 6 months, More than 6 months, 1-70+]*

8. Title/ Position *[Fill in the blank]*
9. Years worked in an Emergency Department (ED) * *[Drop down: Less than 6 months, More than 6 months, 1-70+]*

Page 4: Olfactory

10. Are smells regularly noticed at the hospital you currently work at? * *[Yes, No]*
11. Please rate some smells that might be found within the hospital you previously or currently work at. * *[Slider: all of the items listed below are given their own slider to move between "Not noticeable" and "Extremely intense"]*
    - → Alcohol (beverage)
    - → Alcohol (hand sanitizer)
    - → Alcohol (rubbing alcohol)
    - → Ammonia
    - → Antiseptics
    - → Bleach
    - → Body odor
    - → Cigarettes
    - → Coffee grounds
    - → Cologne
    - → "Death"
    - → Dirty feet
    - → Disinfectant
    - → Dried blood
    - → Feces
    - → Felt-tip markers
    - → Feminine issues
    - → Formaldehyde
    - → Food
    - → Fresh plastic tubing
    - → Freshly incised abscess
    - → Garbage
    - → GI Bleed
    - → Melena
    - → Perfume
    - → Sweat
    - → Urine
    - → Vomit
12. Are there any other smells you notice that are not listed? * *[Yes, No]*
    - → YES: Please list 1 of the smells below.
    - → YES: How potent/ strong is this smells?
    - → YES: If there is an additional smell not listed, please list 1 of the smells below.

13. Does the hospital you currently work at employ strategies to combat unpleasant smells? * *[Radio table: Header – Yes-all the time, Yes-sometimes, Yes-rarely, No-but I am aware of this strategy, No-I am not familiar with this strategy. Side axis – Coffee grounds, Essential oil of peppermint, Essential oil (other than peppermint), Ionizer, Other]*
    - → YES: How are these strategies being used?
    - → YES-COFFEE GROUNDS: How effective do you believe coffee grounds helps with unpleasant smells? *[Radio button: Very dissatisfied, dissatisfied, Somewhat dissatisfied, Somewhat satisfied, satisfied, Very satisfied]*
    - → YES-ESSENTIAL OIL OF PEPPERMINT: How effective do you believe the essential oil of peppermint helps with unpleasant smells? *[Radio button: Very dissatisfied, dissatisfied, Somewhat dissatisfied, Somewhat satisfied, satisfied, Very satisfied]*
    - → YES-IONIZER: How effective do you believe an ionizer helps with unpleasant smells? *[Radio button: Very dissatisfied, dissatisfied, Somewhat dissatisfied, Somewhat satisfied, satisfied, Very satisfied]*

Page 5: Olfactory & Productivity

14. Do you believe smells have the ability to affect a person's productivity? * (Positively or negatively) *[Yes, No]*
    - → NO: Please explain why you do not think so.
    - → YES: Have you ever experienced a smell affecting your ability to work? (Positively or negatively)
        - → YES: What type of experience did it give you?
        - → Please describe this experience. (Location, who you may have been with, how it impacted you, etc.)

Page 6: Thank you!

Thank you for taking this survey [question("value"), id="2"] , your answers are very important to this study.

For more information on this study, please feel free to browse for information at: cotb.me/thesis

Thank you again!

APPENDIX AF

Formal Study Email Recruitment Example

Greetings,

My name is Carina Clark and I am a graduate student at Arizona State University in the Design School studying Health and Healing Environments. I am currently doing a study to look at how odors and aromas affect the performance of caregivers in an Emergency Department and am seeking participants to help with my study.

During this 1+ hour study, you will be asked to perform a series of computer tasks while caring for a simulated patient in the Banner Good Samaritan SimET. Additionally, you will be exposed to three different aromatic environments: control, unpleasant, and pleasant.

If you are between the ages of 18-65 years, are a caregiver (Registered Nurse, Physician, Tech, etc.) who has worked in an Emergency Department for at least 6 months and is confident in caring for a patient and hand documenting, and are interested in participating in this study, please visit http://cotb.me/thesis/ for more information and a link to sign up. There are also incentives for your participation (details are on the website). If you have any questions, please don't hesitate to email me at: cclark7@asu.edu

Thank you for your time and consideration!

Carina Clark, LEED AP, EDAC
Arizona State University | Design for Healthcare & Healing Environment MSD Candidate
cclark7@asu.edu
cotb.me/thesis/

APPENDIX AG

Formal Study Informed Consent

Banner Health

Informed Consent to Participate in Research

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Banner Good Samaritan Medical Center - SimET
Carina Clark

INVITATION TO PARTICIPATE

You are being asked to take part in this study because, although odors are a commor occurrence within a typical Emergency Department, little research has been done to show i these foul odors affect the caregivers. In addition, much research has shown the benefits tc using aromatherapy to reduce stress, and increase alertness, but little has shown how essentia oils affect caregiver's during a typical nursing shift.

This is a Master's thesis research study. This research study includes only Registered Nurses who choose to take part. Please take your time to make your decision.

WHY IS THIS STUDY BEING DONE?

The purpose of this study is to determine if there is a correlation between how efficient nurses perform in a simulated Emergency Department environment with the influence of smells (both odors and aromas) and if the presence of aroma can counteract any negative effects from ar already present odor. This study will be conducted in the Simulation Lab (SimET) at Banner Good Samaritan Medical Center - not at the Emergency Department.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

This is a single-site study, about 45 people will take part in this study.

WHAT IS INVOLVED IN THIS STUDY?

If you choose to participate in this study, you will be exposed to three different aromatic environments while performing a series of tasks ranging from patient care to computerized tests. These environments include: no smell (control), unpleasant odor, and a pleasant aroma (which will be chosen from 5 different options). Patient care will be done through simulation using manikins in the Banner Good Samaritan SimET. Throughout the course of the study, the investigator will monitor your heart-rate as well as use a bio-feedback monitor to measure skin temperature. In addition, you will be able to choose whether or not you wish to be video recorded for study use and will be asked to sign a Photographs, Videos and Recordings Form if you agree. No recordings will be used for publications or presentations. Video recordings will be destroyed after the data are processed and the Master's thesis has been completed.

Subject initials: _____

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Banner Good Samaritan Medical Center - SimET
Carina Clark

HOW LONG WILL I BE ON THE STUDY?

There will be 3 different aromatic environments during the course of this study each ranging from 30 minutes to 45 minutes in length. The total estimated time involved in this study is 2 hours to include the introduction to the study, the study itself, and follow-up questions.

WHAT ARE THE RISKS?

The following risks may be possible due to the introduction of odors as well as some aromas.

- Feeling ill / Nausea
- Headache
- Dizziness

However, if a participant fells ill or unable to complete the study, they will be able to withdraw from the study at any time without consequences.

WHAT ARE THE REPRODUCTIVE RISKS?

You should not be pregnant while on this study. Please notify the Principal Investigator immediately if you think you are pregnant or may become pregnant. Women who are or may be pregnant will be disqualified from this study.

ARE THERE BENEFITS TO TAKING PART IN THIS STUDY?

If you agree to take part in this study, there may or may not be direct medical benefit to you. The possible benefits of your participation in the research are to determine how to increase the performance of nurses and caregivers in a healthcare setting through non-invasive measures. We hope the information learned from this study will benefit other caregivers with in the future.

WHAT OTHER OPTIONS ARE THERE?

Instead of being in this study, you have these options:

- Participate in an online survey
- Participate in an one-on-one interview
- Not participating in this study

WHAT ABOUT CONFIDENTIALITY?

Efforts will be made to keep your personal information private and confidential however we cannot guarantee absolute privacy and confidentiality.

Subject initials: _____

ASU IRB Approved
for Mark Roosa, IRB Chair
10/15/12 to 10/1/13

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Banner Good Samaritan Medical Center - SimET
Carina Clark

The biometric data and survey information collected during the course of this study may be disclosed if required by law and/or following completion of a separate authorization from you giving your permission to release select private health information (biometric data) to certain individuals associated with this research. The individuals associated with this study who will receive your private health information include:

- The research team:
  - Jose Bernardi (PI)
  - Carina Clark (co-PI)
  - Richard Watts (co-PI)
  - Karen Josey (co-PI)
- Research Administration, including the Banner Health Institutional Review Board
- The Department of Health and Human Services including but not limited to the Food and Drug Administration and the Office of Human Research Protections

WHAT ARE THE COSTS?
There is no cost for your participation in the study.

IS THERE COMPENSATION FOR PARTICIPATING?
There is no payment for your participation in the study.

WHAT HAPPENS IF I AM INJURED?
In the case of injury or illness resulting from this study, emergency medical treatment is available from Banner Good Samaritan Medical Center, but will be provided at the usual charge. No funds have been set aside to compensate you in the event of injury. You or your insurance company will be charged for continuing medical care and/or hospitalization.

This does not waive your rights in the event of negligence.

WHAT ARE MY RIGHTS AS A PARTICIPANT?
Taking part in this study is voluntary. You may choose not to take part or may leave the study at any time. Leaving the study will not result in any penalty or loss of benefits to which you are entitled.

Subject initials: _____

ASU IRB Approved
for Mark Roosa, IRB Chair
10/15/12 to 10/1/13

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Banner Good Samaritan Medical Center - SimET
Carina Clark

We will tell you about new information developed during the course of the study that may affect your health, welfare, or willingness to stay in this study.

CAN I BE REMOVED FROM THE STUDY?
For your safety, your participation may be terminated by the Principle Investigator at any time without your consent.

WHOM DO YOU CALL IF YOU HAVE QUESTIONS?
For questions about the study or a research-related injury, contact the researcher Carina Clark at (623) 640-8851

If you have any questions about your rights as a research participant, contact the Banner Health Human Subject Protection Administrator at Research Administration at (480) 412-3969, Monday through Friday, from 9AM to 5PM. This study has been approved by a panel of the Banner Health Institutional Review Board (IRB)

Intentionally left blank

Subject initials: _____

ASU IRB Approved
for Mark Roosa, IRB Chair
10/15/12 to 10/1/13

Banner Health

Informed Consent to Participate in Research

Researching how the Olfactory Stimuli Affects Caregiver Performance in an Emergency Department
Banner Good Samaritan Medical Center - SimET
Carina Clark

VOLUNTARY CONSENT TO PARTICPATE IN RESEARCH

You are voluntarily making a decision whether or not to participate in the research study described above. Your signature indicates that you have read the information provided above and have decided to participate in this research project. You will be given a copy of this consent form to keep.

SIGNATURES
I agree to take part in this study.

	Printed name	Signature	Date	Time
Subject:				
Legally Authorized representative or ☐ NA				
Person Obtaining Consent:				
Investigator:				

Subject initials: _____

ASU IRB Approved
for Mark Roosa, IRB Chair
10/15/12 to 10/1/13

APPENDIX AH

Formal Study Post Study Interview Topics

The questions below may or may not be asked in full to the participant.

- How was the experience of volunteering for this study?
- Were there any difficulties in performing these tasks?
    - What were they?
- Were any environmental influences noticed?
    - Did they affect performance? How?
- Where any smells noticed?
    - What was smelled?
    - Is it a pleasant smell? Why/why not?
    - Does the smell bring back any memories? What?
    - Did the smells make this a more enjoyable experience?
- Could working 8-12 hours shifts with this smell be beneficial?
- Would performing these tasks be easier with a different smell? What?