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Effects of Aromatherapy on Test Anxiety and Performance in College Students

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EFFECTS OF AROMATHERAPY ON TEST ANXIETY AND PERFORMANCE IN COLLEGE STUDENTS

by

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Title	Effects of Aromatherapy on Test Anxiety and Performance in College Students
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ABSTRACT

Test anxiety is a complex, multidimensional construct composed of cognitive, affective, and behavioral components that have been shown to negatively affect test performance. Furthermore, test anxiety is a pervasive problem in modern society largely related to the evaluative nature of educational programs, therefore meriting study of its nature, causes, effects, and treatment. Aromatherapy is the skilled use of essential oils for physical and emotional well-being and has been used to increase relaxation, attention and memory. This study examined the effects of peppermint and rosemary aromatherapy essential oils and a control scent (apple) on self-reported test anxiety, emotionality and worry subscales of test anxiety, and their effect on test scores of first and second year college science students. Although test anxiety decreased from pre-test to post-test conditions, and test scores increased, no statistically significant changes were noted. No significant association was found between aromatherapy, test anxiety, and test scores.

CHAPTER I

INTRODUCTION

Background

Test performance has become increasingly important as the basis for entry or advancement in education (Spielberger & Vagg, 1995; Zeidner, 1998). Increased usage of test scores to evaluate educational attainments and programs, along with public pressure for higher levels of academic achievement, has created a more pressure-laden atmosphere in schools and university systems (Cizek & Burg, 2006; Hill & Wigfield, 1984). In addition, government involvement in education and the use of standardized testing as a measure of accountability in student achievement for public school education has increased the impact of evaluative assessment for students (Mulvenon, Stegman, & Ritter, 2005). Testing, therefore, is often a great source of stress and anxiety, and has led to the phenomenon of test anxiety becoming a pervasive contemporary problem.

Stress is a universal phenomenon: a biological and psychological response to a perceived threat first studied by Hans Selye in 1956 (Townsend, 2012). Anxiety is a complex phenomenon conceptualized as psychological and physical responses to a stressful condition. Test anxiety is a specific type of anxiety defined by Zeidner (1998) as a "set of phenomenological, physiological and behavioral responses that accompany

concern about possible negative consequences or failure on an exam or similar evaluative situation" (p. 17). Test anxiety has also been labeled anticipatory anxiety, situational anxiety, or evaluation anxiety. It is described as a complex, multidimensional construct comprised of a cluster of interacting components and reactions (Covington, 1992; Spielberger & Vagg, 1995). Research has shown that some individuals tend to have more test anxiety than others in evaluative situations, and that higher test anxiety is associated with lower test performance (Hembree, 1988; Wine, 1971, 1989). The prevalence of test anxiety among student populations has been estimated between 15 and 20 percent (Hill & Wigfield, 1984). More recently, Whitaker, Lowe, and Lee (2007) estimated test anxiety prevalence at 33 percent in the United States, making this an important area for study and intervention. If test anxiety can be ameliorated through some type of intervention, student success in higher learning situations may be enhanced.

Test anxiety, as a construct, was first identified and studied by Sarason and Mandler in 1952, when they discovered that students with low test anxiety performed better on intelligence tests than those with high test anxiety. Since its initial identification as a construct, test anxiety has been the focus of voluminous research and continues to be an area of interest in education and psychology because of its complex nature, its association with poorer test performance, and belief that reducing test anxiety is essential to allow students greater academic and vocational success (Hembree, 1988; Wine, 1971). Zeidner (1998) noted that: "Test anxiety may be among the sources of construct-irrelevant variance, introducing systematic differences in

individual characteristics that affect cognitive test performance, other than the ability or achievement tested" (p. 5). This statement indicates that test anxiety, because of its debilitating effects, could hinder students' ability to truly demonstrate knowledge and skill, despite actual ability, thus denying them success in higher education.

Cognitive, Affective, and Behavioral Components of Test Anxiety

The complexity of the construct is apparent in the numerous theories surrounding the nature of test anxiety, its development, assessment, and treatment. Researchers in the area of test anxiety agree it has three major components: cognitive, affective, and behavioral (Harris & Coy, 2003; Zeidner, 1998). As a cognitive construct, Sarason and Mandler (1952) were the first to postulate that the difference in test performance between students with low test anxiety and students with high test anxiety was related to learned psychological drives. Hullian learning theory (Hull, 1943) stated that those with low test anxiety are stimulated by a task-directed drive to complete a task and reduce the drive. Individuals with high test anxiety display learned anxiety drives that stimulate two opposite and incompatible behaviors: task-relevant efforts to finish a task in order to reduce anxiety about the task and task irrelevant responses such as feelings of fear of failure, inadequacy, helplessness, heightened somatic reactions, and withdrawal from testing situations that hinder successful task completion (Champion, 1962; Hull, 1943). This theory marked the beginning of the cognitive interference model of test anxiety.

Alpert and Haber (1960) expanded upon Mandler and Sarason's initial research proposing a bi-dimensional theory, and labeling task-relevant and task-

irrelevant drives as facilitating (AAT+) and debilitating (AAT-) anxieties, respectively. Facilitating anxiety (AAT+) is useful as a motivator during test taking. Debilitating anxiety (AAT-) interferes with a student's ability to attend to the task of test taking. Alpert and Haber developed the Anxiety Achievement Test with facilitating and debilitating subscales based on their research. Alpert and Haber's theory builds from classic psychological research that notes some stress or anxiety is necessary for survival.

Liebert and Morris (1967) proposed that debilitating anxiety was also a bi-dimensional phenomenon consisting of worry and emotionality. Worry has been defined as any cognitive expression of concern about performance or failure. Emotionality refers to autonomic reactions to a testing situation (e.g., increased heart rate, blood pressure, perspiration, and feelings of nervousness, nausea, or dizziness). Liebert and Morris developed two scales to measure the components of worry and emotionality. Several studies established that worry interfered with test performance, but that emotionality and performance were not related, except in those with a low worry component (Hembree, 1988; Morris & Liebert, 1969).

Wine completed a comprehensive review of test anxiety literature in 1971 and described test anxiety as an attentional cognitive deficit (i.e., those with high test anxiety being plagued by distracting, irrelevant, and negative thoughts that detracted from focusing on a testing situation). Wine's review, built on the determinations of Sarason and Mandler (1952), and Wine's description of an attentional (cognitive) deficit related to anxiety, has persisted as a relevant part of the test anxiety construct.

The affective (emotional) facet of test anxiety includes both the somatic (physical) symptoms of autonomic system arousal and more subjective manifestations of tension such as nervousness, muscle stiffness, dizziness, and nausea. Emotionality, as described by Liebert and Morris (1967), has been used to define a person's awareness, and interpretations, of these physiologic manifestations of anxiety. Although important in understanding the nature of test anxiety, affective or somatic responses to testing situations have not negatively influenced test performance (Hembree, 1988; Zeidner, 1998). Somatic effects of test anxiety may, however, contribute to the worry component of test anxiety and therefore cannot be discounted (Zeidner, 1998).

The affective aspect of test anxiety was further researched by Spielberger and Vagg (1995), who described differences in state anxiety and trait anxiety. State anxiety is a situational anxiety manifested as feelings of tension, apprehension, nervousness, worry, and physiologic arousal from activation of the autonomic nervous system during an examination. State anxiety varies in the testing situation, depending on a number of factors, such as perceived threat, general ability or aptitude, and individual differences in test anxiety as a personality trait. Trait anxiety is a relatively stable anxiety proneness of an individual and is different in every individual. It has also been described in the psychological literature as generalized anxiety disorder (Cassady, 2010). Spielberger (1980) noted that high trait anxiety individuals may perceive more threat from testing situations, and have a higher state anxiety during examinations, than low trait anxiety individuals. State anxiety increases emotionality

and worry and also contributes to depressed performance through cognitive interference (Hembree, 1988).

The behavioral facet of test anxiety has been described as deficits in a wide variety of academic skills. Highly test anxious students have difficulty encoding information, organizing information, and using metacognitive processes such as self-regulation and self-monitoring. This has been studied in relationship to inadequate study skills, procrastination, learned helplessness from previous failure, as well as lack of effective use of working memory (Zeidner, 1998, 2008). Working memory was postulated by Baddeley and Hitch (1974) and by Baddeley (2013) as a finite amount of brain function that can be delegated to a task. If working memory is taken up by distracting thoughts caused by anxiety, less memory is available for a given task. The concept of working memory dysfunction in test-anxious students feeds into the attentional-deficit theory of test anxiety proposed by Wine in 1971; therefore, in some instances the behavioral facet of test anxiety could be seen as inextricably linked to the cognitive facet of test anxiety.

Kirkland and Hollandsworth (1980) compared the effects of two methods for reducing test anxiety: behavioral anxiety reduction treatments and training in test-taking skills, and found that individuals tutored in test-taking skills exhibited less anxiety, and less attentional interference during testing, than the anxiety reduction treatment group. This observation led to the development of the Skills Deficit Model of test anxiety that suggests test anxiety involves information processing and memory problems and can be alleviated by study skills and test-taking strategy training

(Benjamin, McKeachie, Lin, & Holinger, 1981; Lee, 1999; Naveh-Benjamin, McKeachie, & Lin, 1987; Tobias, 1985). Tobias reviewed several studies in this area and concluded that the cognitive interference model and the skills deficit model were complementary, not mutually exclusive. Those with poorer study skills or a skills deficit were more likely to exhibit symptoms of cognitive interference (i.e., lack of concentration, interfering thoughts, and being easily distracted). Therefore, a skills deficit or the inability to organize and study efficiently may coincide with the inability to effectively concentrate. Hembree (1988) concluded from his meta-analysis of 562 test anxiety research studies that test anxiety is a behavioral construct, that emotionality triggers worry, and that worry affects test performance. He noted that study skills training alone did not significantly reduce test anxiety or result in increased test performance.

Other factors studied relating to test anxiety have included individual differences such as: gender, age, socioeconomic status, parental influences, as well as personal characteristics. Increased levels of test anxiety are more common among female students, elementary to high school ages, those having lower socioeconomic status, and high parental expectation, as well as, personal characteristics such as trait anxiety, low self-concept, and external perceived control (Zeidner, 1998).

Research to Reduce Test Anxiety

Because of test anxiety's association with reduced test performance, a great deal of research has been conducted regarding its reduction. Previous studies have included cognitive therapies, behavioral therapies, cognitive-behavioral therapies, and

study skills training to combat the three identified facets of test anxiety: cognitive, affective, and behavioral.

Hembree (1988) reviewed the effects of various treatments on test anxiety and their related impact on test performance. Behavioral treatments most commonly used were systematic desensitization, relaxation training, modeling, covert positive reinforcement, extinction, and hypnosis. Systematic desensitization most effectively reduced test anxiety. Relaxation training used a variety of techniques, including cue-controlled relaxation (i.e., using a psychological trigger to induce relaxation), progressive relaxation training, and biofeedback. Relaxation was effective in reducing test anxiety, but proved ineffective in increasing test performance. Other behavioral techniques showed reduction in test anxiety as well.

Cognitive techniques tended to reduce the worry component of test anxiety. Group counseling was the example used in Hembree's (1988) meta-analysis and was found to be ineffective in reducing test anxiety. Cognitive-behavioral technique combinations included cognitive modification, attention training, insight therapy, anxiety management training, and stress inoculation. These techniques appeared to be the most effective in reducing both emotionality and worry components of test anxiety, and were deemed effective in increasing test performance. However, study skills training without cognitive or behavioral interventions proved to be ineffective in decreasing test anxiety and increasing test performance (Hembree, 1988; Zeidner, 1998).

Conceptual Model for Test Anxiety

The literature on test anxiety makes it clear that the concept is complex and multidimensional. Spielberger and Vagg (1995) edited a compendium on the topic of test anxiety and proposed a comprehensive model of the construct called the Transactional Process Model, which incorporated cognitive interference (worry/emotionality), study skills deficits, test taking skills deficits, information processing deficits, and individual differences. They proposed that it was the interaction of many variables that elicited a negative testing response (See Figure 1).

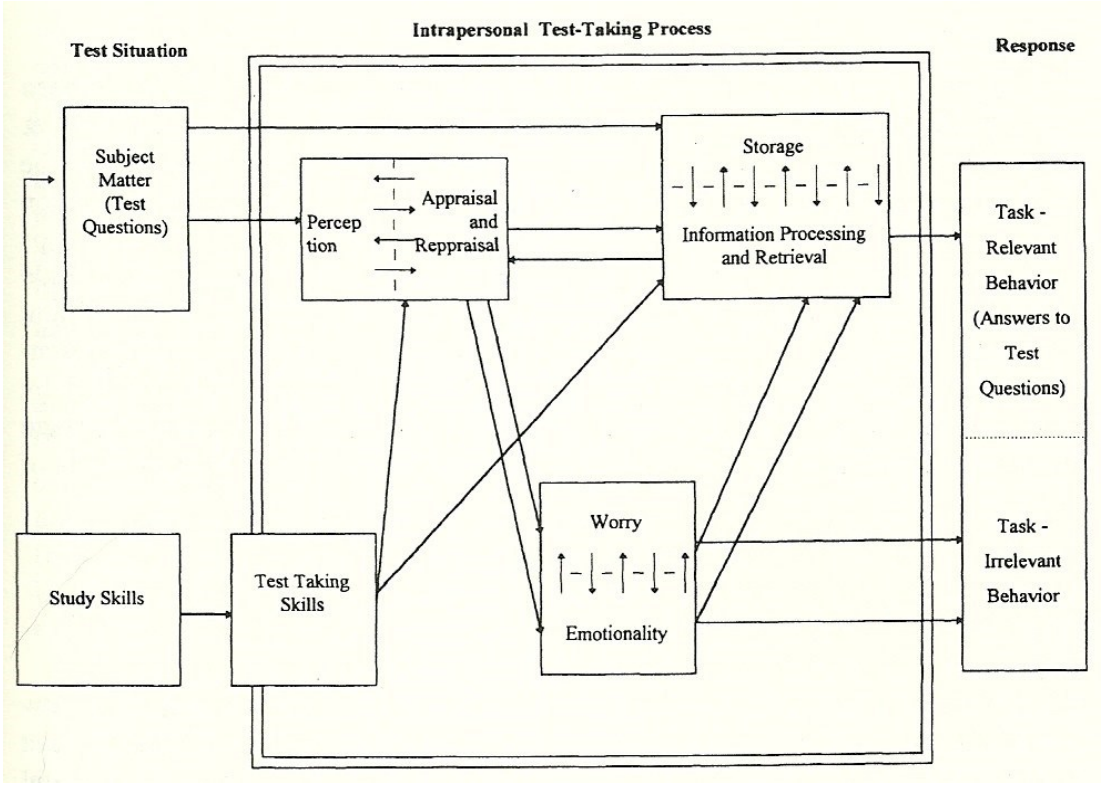

Figure 1. Spielberger and Vagg's Transactional Process Model of Test Anxiety. Reproduced from "Test Anxiety: A Transactional Process Model," by C. D. Spielberger and P. R. Vagg, 1995, in C. D. Spielberger and P. R. Vagg (Eds.), *Test Anxiety: Theory, Assessment, and Treatment*, p. 12. Copyright 1995 by Taylor & Francis.

Cognitive interference through worry and emotionality has been well established as contributing to test anxiety and reduced test performance (Hembree, 1988; Wine, 1971; Zeidner, 1998). The Transactional Process Model has served as a conceptual framework to identify key components of test anxiety in this research study. This framework allowed the researcher to propose a novel intervention that might affect two key components of test anxiety, and have an impact on test performance. The current study employed aromatherapy as an intervention to decrease worry and emotionality and to increase focus and attention, thereby disrupting two key components contributing to test anxiety and decreased test performance.

Aromatherapy

Aromatherapy is defined as the skilled and controlled use of plant essential oils for physical and emotional health and well-being (Cooksley, 2002). Plants have been used medicinally for thousands of years. Essential oils are volatile oily substances derived from roots, leaves, flowers, needles, seeds, or bark of certain aromatic plants. The essential oil of a plant is said to be the life force energy or "soul" of a plant; therefore, an essential oil imparts more than just chemical constituents that have therapeutic properties, but also works synergistically in the body for positive health changes (Schnaubelt, 1999; Tisserand, 1992).

Essential oils are remarkably diverse and complex molecular structures, consisting mainly of monoterpenes, sesquiterpenes, and phenylpropanes. The constituents of essential oils may explain their therapeutic properties, which can be stimulant, mucolytic, calmative, antispasmodic, expectorant, anti-inflammatory,

antiseptic, antiviral, and antimicrobial. Because essential oils are used as they are found in nature, rather than being synthesized in a laboratory, the various constituents work synergistically and uniquely in the body of an individual. For this reason, several essential oils, especially those that have effects on the nervous system and psyche, are also said to be "adaptogenic" or balancing, working either as stimulant or relaxant as needed by the body (Schnaubelt, 1995; Tisserand, 1992; Valnet, 1990; Worwood, 1991).

Aromatherapy, as the name suggests, involves the sense of smell and the olfactory system. Buck and Axel (1991) found that the human olfactory system is able to distinguish 10,000 distinct odors. Their work in olfaction has helped unlock the mysteries of this complex sense. Buck (2004) found that there are 1000 gene receptors in the olfactory bulb of the brain that encode the chemical signals of scents into unique pathways to the limbic system. The limbic system (or primitive brain) integrates the scent signals and directs them to different parts of the brain simultaneously, which can have an effect on the endocrine and immune systems as well as the hypothalamus, the center for homeostasis in the body. These responses can occur even before the scent is registered and interpreted in the higher centers of the brain. The limbic system and amygdala are associated with the expression of emotion and memory. Scent memory has been well studied and is reported to be very powerful. Scents can trigger strong emotion associated with painful or pleasant memories. Scent is also used to stimulate function in brain-injured persons (Battaglia, 2003; Buckle, 2001; Pert, 1997).

Aromatherapy and Performance

There has not been much published in the area of research on aromatherapy and test anxiety. Lee, Wu, Tsang, Leung, and Cheung (2011) completed a systematic review of the literature from 1990-2010 on the anxiolytic effects of aromatherapy and found only 16 articles that met their criteria for randomized control trials. They found that most of the studies indicated positive effects of aromatherapy on anxiety, and no adverse effects were reported. They cautioned, however, that there was a great deal of diversity in the nature of the anxiety studied, subjects included, interventions (aromatherapy oils) employed and evaluation techniques; therefore, results could not be conclusive or generalizable. These authors noted that more controlled study into the effects of aromatherapy are needed, but that since there were no adverse reactions to aromatherapy, it could be seen as a strategy for anxiety control.

Certain essential oils are said to have a direct effect on the nervous system (Battaglia, 2003). Peppermint *(Mentha piperita)* has been most studied in this area and has been labeled a central nervous system (CNS) stimulant. A CNS stimulant affects the central nervous system by way of the amygdala and limbic system (primitive areas of the brain) to increase alertness and concentration. Umezo, Sakata, and Ito (2001) studied the effects of constituents of peppermint oil on mice and found that intravenous and intraperitoneal administration significantly increased ambulation, demonstrating a physiologic and perhaps psychologic effect of this oil.

Ho and Spence (2005) found that tactile performance was facilitated in the presence of peppermint odor. Unfortunately, a synthetic peppermint odor was used for

the study instead of essential oil of peppermint *(Mentha piperita);* therefore the study cannot be used to provide evidence of essential oil of peppermint and increased cognitive performance.

The effect of peppermint *(Mentha piperita)* and cinnamon *(Cinnamomum ceylanicum)* odors on simulated driving alertness, mood, and workload was studied by Raudenbush, Grayhem, Sears, and Wilson (2009). Raudenbush et al. found that both peppermint and cinnamon increased alertness, decreased frustration, and increased perception of a shorter testing duration during simulated driving experiences. Peppermint was also found to decrease fatigue and anxiety in this situation.

In 2003, Barker et al. found that ambient presence of peppermint oil increased typing speed, and accuracy as well as alphabetization of items. In another study, peppermint was found to positively affect cognitive performance and mood during a computerized cognitive drug research assessment battery in 144 subjects (Moss, Hewitt, Moss, & Wesnes, 2008).

Peppermint *(Mentha piperita)* has also been studied in relation to sleep. Norrish and Dwyer (2005) found that inhaling peppermint odor significantly decreased daytime sleepiness. Goel and Lao (2006) found that peppermint was reported by different subjects as both stimulating and sedating when inhaled before bedtime, but was not associated with poorer sleep. Men reported more alertness the morning following inhaling peppermint at bedtime, but women experienced an increase in non-rapid-eye-movement (NREM) sleep. Overall, studies have found

peppermint to be stimulating and useful in increasing alertness, cognitive function, and task performance and in decreasing anxiety and fatigue.

Rosemary (*Rosmarinus officinalis)* has had less study related to the nervous system and usually has been studied as a blend or along with another essential oil. Diego et al. (1998) found lavender and rosemary had a positive effect on mood, EEG patterns of alertness, and math computation.

In 2007, Atsumi and Tonosaki studied physiological effects of lavender and rosemary and found that these essential oils increase free radical scavenging and decrease cortisol levels in saliva. These measures suggest that lavender and rosemary decrease the stress response and protect the body from harmful effects of oxidation.

Moss, Cook, Wesnes, and Duckett (2003) studied the effects of rosemary and lavender on cognition and mood in healthy adults. This study found that lavender significantly decreased memory performance, attention, and reaction time (whereas, rosemary enhanced the quality of memory while increasing response time). Both lavender and rosemary positively affected mood.

In terms of anxiety and test performance, another study found ylang ylang reduced anxiety during digit span tests, but test performance was depressed (Cheng, Chang, Kida, & Monteath, 2003). McCaffrey, Thomas, and Kinzelman (2009) studied the effects of lavender and rosemary on test-taking anxiety in graduate nursing students and found that both of these essential oils lowered test anxiety scores. Participants in this study also made positive comments about the use of aromatherapy while taking tests, but no information was provided regarding test performance.

Statement of the Problem and Significance of the Study

The incidence of test anxiety is widespread (Cizek & Burg, 2006; Hill & Wigfield, 1984). Zeidner (1998) stated that test anxiety is frequently associated with unfavorable outcomes such as poor cognitive performance, scholastic underachievement, psychological distress, and ill health. Wine (1971) urged researchers to find ways to reduce test anxiety in order to positively affect test performance in high test-anxious individuals. Research has shown a clear association between test anxiety and lower test performance; therefore, it is imperative that test anxiety be confronted and reduced (Hembree, 1988). Although a great deal of research has been conducted on test anxiety treatments, few studies have been performed regarding the effects of essential oils or aromatherapy on test anxiety and test performance. Since the essential oils of peppermint *(Mentha piperita)* and rosemary *(Rosmarinus officinalis)* have shown efficacy in increasing attention and cognition, as well as promoting memory and task performance; they may be useful in treating cognitive interference and information processing problems associated with test anxiety (Moss et al., 2003; Moss et al., 2008). Aromatherapy has also shown effectiveness in balancing emotionality (a significant component of test anxiety). Aromatherapy, if effective, would provide a simple, inexpensive intervention for decreasing test anxiety and, hopefully, counteract its negative effects on test performance.

Purpose of the Study and Research Questions

The purpose of this study was to determine the effect of aromatherapy – specifically, the use of essential oils of peppermint (*Mentha piperita)* and rosemary (*Rosemary officinalis)* on test anxiety and test performance among college students.

Specific research questions that guided the study were:

1. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported total test anxiety score?
2. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported worry and emotionality?
3. Does inhaling the essential oils of peppermint or rosemary before and during testing increase test performance in college students?

Definitions

Aromatherapy – the skilled and controlled use of plant essential oils for physical and emotional health and well-being (Cooksley, 2002).

Essential Oil – volatile oily substance derived from the roots, leaves, flowers, needles, seeds, or bark of certain aromatic plants (Battaglia, 2003).

Test Anxiety – a complex, multidimensional construct, comprised of cognitive, affective, and behavioral facets in response to an evaluative situation. The cognitive component of test anxiety can include worry, inattention, distraction, and negative self-talk. Affective symptoms of test anxiety stress include nausea, headaches, and

muscle tension. Behavioral components of test anxiety include disorganization, lack of adequate study skills, avoidance, and procrastination (Zeidner, 1998).

Study Delimitations

1. The generalizability of study findings is limited because the sample chosen consisted of freshman and sophomore college students attending basic science classes, and would be considered small.
2. Since essential oils are natural substances that may react differently from one individual to another, results may not be consistent within the sample.

Organization of the Chapters

In the first chapter, the nature of test anxiety, impact on education, and major areas of research into the construct were introduced to provide insight into the significance of the problem and the need for further study. The Transactional Process Model for Test Anxiety (Spielberger & Vagg, 1995) served as a theoretical framework for development of the study. Aromatherapy was proposed as a potential tool to decrease test anxiety by decreasing cognitive interference, emotionality, and worry. Research questions, delimitations, and definitions were provided to help the reader understand the direction of this study.

The second chapter provides a review of salient literature regarding the nature of test anxiety and research concerning test anxiety. The nature of aromatherapy as a tool to decrease anxiety, increase cognitive function, and augment attention is also discussed. In the third chapter, the methodology utilized in the study is provided and

includes a description of the sample, data collection, and data analysis procedures. Findings of the study are presented in the fourth chapter. The fifth chapter includes discussion of findings, relationship of the findings to salient literature, and recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study was to determine the effect of aromatherapy, specifically the essential oils of peppermint (*Mentha piperita)* and rosemary (*Rosemary officinalis),* on test anxiety and test performance among college students. In this chapter, literature related to the nature of test anxiety and its effect on test performance will be reviewed. Aromatherapy and research related to the use of aromatherapy for increasing memory and cognitive performance will also be presented.

Test performance is important for success in education (Cizek & Burg, 2006; Spielberger & Vagg, 1995; Zeidner, 1998). Test anxiety is a multi-faceted phenomenon with cognitive, affective, and behavioral components and is associated with lower test performance. Specifically, the facets of cognitive interference, worry, and emotionality have been shown to increase test anxiety and negatively affect performance (Hembree, 1988; Wine, 1971, 1989; Zeidner, 1998).

Aromatherapy is the use of essential oils to affect the primitive brain, the seat of emotion and memory (Pert, 1997). Certain essential oils have also been shown to affect cognitive functioning (Battaglia, 2003).

The Nature of Anxiety and Test Anxiety

Stress, anxiety, and coping are said to be universal human experiences (Zeidner, 1998). Stress causes a physiologic response in the body necessary for survival. In perceived threatening situations, sympathetic nervous system (SNS) and autonomic nervous system (ANS) stimulation cause increased release of epinephrine, norepinephrine, serotonin, and cortisol. These reactions result in increased heart rate, blood pressure, sweating, gastric acid secretion, and shunting of blood away from the gastrointestinal system and kidneys to more vital organs: the brain and heart. Known as the "flight or fight" response, first described by Hans Selye in 1956 and revised in 1976, this physiologic response allows persons to successfully adapt to a perceived threat. Continued stress, however, can be destructive, as the body gets to a point of exhaustion (Townsend, 2012). Chronic physiologic stress has recently been linked to chronic diseases such as hypertension, heart disease, obesity, rheumatoid arthritis, and cancer. It is, therefore, a phenomenon that warrants study and research of methods to reduce it (Smeltzer, Bare, Hinkle, & Cheever, 2010).

Anxiety

Anxiety is the major psychological response to stress and is also associated with chronic disease. A variety of thoughts, feelings, and behaviors are associated with this response pattern. Anxiety has been categorized along a continuum from mild anxiety to panic anxiety. Mild anxiety includes such perceptions and behaviors as increased awareness and alertness, increased learning capacity, restlessness, irritability, and increased motivation. It has been seen as a positive attribute

contributing to motivation, productivity, and success (Townsend, 2012). Zeidner (2008) noted that mild anxiety is adaptive and necessary for survival.

Panic anxiety, on the extreme opposite end of the continuum, is characterized by: inability to focus; misperceptions of the environment as threatening; inability to learn or concentrate; tremors, sleep disturbances, sweating, hyperactivity, incoordination, palpitations, and delusions. Panic anxiety can severely impair a person's ability to function (Townsend, 2012). From this information, it is apparent that stress and anxiety evoke both physical and mental responses that can be advantageous for success and survival, or in extremes, detrimental to both.

Test Anxiety

Anxiety and stress that is not directly related to physical survival has become much more prevalent in modern society. Zeidner (1998) noted that the 20th century has been designated the "age of anxiety" (p. 3), and that anxiety related to evaluation or testing has been a factor in education in the United States since the beginning of the 20th century, largely related to the impact that testing has on the lives of people in our society for entry and progression in higher education. This form of anxiety has been termed test anxiety. Test anxiety is a subset of the broader psychological construct of anxiety that is evoked specifically by evaluative situations. It was referred to by Zeidner (1998) as "the set of cognitive, affective, and behavioral reactions that accompany concern over possible negative consequences contingent upon performance in a test or evaluative situation" (p. 25).

The cognitive aspect of test anxiety centers on a phenomenon known as cognitive interference, where distracting thoughts, not related to the task at hand, and an inability to stay focused hinder performance and learning (Wine, 1971). Affective aspects of test anxiety include physiological responses or autonomic stimulation related to perceived threat and manifest as increased sweating, nausea, and muscle tension. The behavioral dimension of test anxiety involves procrastination and poor study skills, which may contribute to poor test performance, but also may be symptoms of a cognitive interference problem, related to limited cognitive capacity, problems with encoding and retrieval of information, and learned helplessness from past failure (Alpert & Haber, 1960; Covington, 1992; Benjamin et al., 1981).

DeBlassie (1972) noted that test anxiety is a near universal experience in this country, because of the test-giving and test-conscious culture. Test anxiety has increased in recent years related to competition for entry and promotion in higher education. Related to this are the "No Child Left Behind" laws enacted at the beginning of the 1980s regarding elementary education and federal education funds. These laws have put great pressure on schools and children to meet strict standardized testing benchmarks and also have created a climate of anxiety that persists into higher education (Cizek & Burg, 2006; Hill & Wigfield, 1984; Mulvenon et al., 2005). Estimates of the prevalence of test anxiety in the United States range from 15-40%, making it a concern among educators (Cassady, 2010).

Test Anxiety and Performance

There has been great interest in the phenomenon of test anxiety and its effects on student performance and achievement since the 1950s. Test anxiety was formally introduced as a construct by Mandler and Sarason in 1952, through their study of the relationship of the anxiety response to learning and performance. Mandler and Sarason surveyed a group of 154 college students regarding their subjective experiences and attitudes about testing situations; students were placed in groups identified as low or high anxiety; next, several performance intelligence tests were administered. After the first performance test, participants were either told they did well, did not do well, or were told nothing (neutral group). Subsequent tests were then administered. High anxiety tended to improve performance; however, information of success or failure also had an impact on performance by depressing performance in high anxiety participants and improving performance for the low anxiety group. This study demonstrated from the beginning that test anxiety impacted performance, but the relationship between anxiety and performance was complex. It proposed that there was a relationship between expectation of test performance, anxiety, and actual performance.

Mandler and Sarason (1952) utilized Hullian learning theory (Hull, 1943) to describe two types of drive states present in testing situations: learned task drives that stimulate the participant to complete the task (motivating) and a learned anxiety drive which interferes with task completion. The anxiety drive consists of two facets; one that is positive and drives the person to complete the task to reduce anxiety related to

the task, and the other that is debilitating and interferes with task completion. Debilitating drives include: feelings of helplessness, heightened somatic reactions, anticipation of punishment, or loss of status.

In Mandler and Sarason's (1952) study, 154 students in an introductory psychology course at Yale University were given an anxiety questionnaire that asked questions regarding somatic symptoms of stress such as accelerated heart rate and increased perspiration. The instrument also asked about worry, uneasiness, and attitudes about tests. With the results of this questionnaire, researchers grouped the subjects along an anxiety continuum from low to high. Subjects were then given a number of intelligence tests. After this phase, subjects were placed into one of three experimental groups (i.e., those who were told that they had done well on the intelligence tests, those who were told they had done poorly on the intelligence tests, or those who were told nothing about the scores on the intelligence tests). An additional test was then administered to the subjects. The researchers noted that there was increased variability in performance on subsequent tests in the high anxiety group; for some subjects, performance improved, and for some, performance decreased; causing the researchers to conclude that anxiety can be both motivating and debilitating. Information that they had done poorly on previous intelligence tests depressed performance among those with high anxiety. The researchers believed that this could be attributed to a learned failure response in those with high anxiety. They also noted that anxiety responses were self-centered, rather than task centered. Those

with previous anxiety reactions related to evaluative situations and were more likely to demonstrate anxiety behaviors in subsequent situations.

Alpert and Haber (1960) provided more evidence that test anxiety was different from general anxiety and affected test performance, building on the findings of Mandler and Sarason. Alpert and Haber administered several anxiety scales to freshmen at Stanford University, and then related scores to the Scholastic Aptitude Test and student grade point average. They concluded that test anxiety scales measure something different than general anxiety scales, and were better predictors of academic performance; therefore, test anxiety was confirmed as a specific type of anxiety. Test anxiety was found to be unrelated to aptitude; rather, poor past test performance was found to increase anxiety in subsequent evaluative situations and resulted in poorer performance.

Another interesting aspect of the Alpert and Haber (1960) study was the development of facilitating and debilitating anxiety scales. They developed two scales, tested them for reliability and validity, and found that by measuring both debilitating and facilitating anxiety, grade point average could be more reliably predicted than by just using debilitating anxiety alone. Debilitating anxiety (AAT-) was found to be associated with more task-irrelevant behaviors than facilitating anxiety (AAT+). This supported Selye's supposition, that stress could be compartmentalized into "eustress" that is motivating toward action and "distress" that is detrimental to the organism (Lazarus, 2006). Ball (1995) noted that the relationship between test anxiety and test performance may be curvilinear, based on the Yerkes-Dodson (1908) theory (i.e.,

increasing test anxiety may enhance test performance up to a certain point after which greater test anxiety serves to lower performance).

Further defining the test anxiety construct, Liebert and Morris (1967) were able to isolate emotionality and worry as two distinct facets of debilitating test anxiety. Working with Mandler and Sarason's (1952) Test Anxiety Questionnaire, they hypothesized that two components of test anxiety (worry and emotionality) would have different effects on expectancy of test performance in actual college testing situations. Fifty-four students in an undergraduate psychology class at Vanderbilt University were divided into groups based on high, medium, and low expectancy of performance on tests based on personal report, and given the Mandler and Sarason "Test Anxiety Questionnaire" before an exam. Worry, defined as a cognitive self-doubt about ability to do well on a test, was significantly associated with poorer test performance expectancy. Emotionality was defined as autonomic arousal or affective symptoms such as nausea, sweating and headache, and had no relationship to test performance expectancy.

At the time of the Liebert and Morris (1967) study, most other research on test anxiety had used intelligence tests, or other standardized tests. Liebert and Morris stated that evaluative threat may have been a greater factor in their study (which involved an actual testing situation) than other studies at that time, and therefore, may have produced more anxiety in students than standardized tests with little related real-world consequence. Liebert and Morris also proposed that this relationship of worry and expectancy of test performance could negatively influence actual test

performance. Researchers have since concluded that worry is more detrimental to test performance and academic achievement than emotionality (Hembree, 1988; Kim, 1994; Liebert & Morris, 1967; Morris & Liebert, 1970). Kieffer (2009) studied worry and emotionality both in studying and testing situations and found that worry was detrimental to student performance in studying for tests as well as in test performance. Study worry, as the author called it, impeded motivation to study and ability to study.

Related to the idea of perceived evaluative threat affecting performance, Folkman (1984) discussed the relationship between personal control, stress, coping, and adaptation in terms of the relationship between a person and their environment. A response to a stressful situation or event is dependent upon a person's perception of the severity of a threat and perceived resources available to cope with the threat. Evaluative threat contribution to test anxiety and performance was further supported by the work of Eysenck (1982), who hypothesized that anxious individuals perceive more threat in evaluative situations, and Hancock (2001), who found a significant negative relationship between students with test anxiety, high perceived-evaluative threat, and student achievement. Cassady (2004) also concluded that evaluative threat contributed to increased test anxiety and poor test performance. In Cassady's study, high levels of cognitive test anxiety led to deficient performance, and evaluative threat increased the effect.

Spielberger and Vagg (1995) made another important distinction in the understanding of test anxiety: that of state and trait anxiety. The concept of state anxiety was based on the work of Lazarus and Folkman (1984). Lazarus and Folkman

spoke of stress as an interaction between a person and an environment (where the environment is seen as threatening). State anxiety was defined as an emotional state related to a perceived threatening or stressful situation. Trait anxiety referred to a relatively stable individual trait, as that of being anxiety prone. Testing was noted as a stressor, which produced an anxiety state consisting of traditional psychological responses: feelings of tension, apprehension, nervousness, and worry as well as physiological arousal of the sympathetic nervous system (including nausea, heart palpitations, and increased sweating). Understanding that test anxiety was a state prompted by an evaluative situation was an important revelation that all persons, not just those prone to anxiety, were subject to. However, Spielberger and Vagg noted that those individuals with higher trait anxiety had more of the debilitating effects (rather than motivating effects) of test anxiety than those individuals with lower trait anxiety.

Test Anxiety and Cognitive Interference

The first meta-analysis to interpret available research data on test anxiety was performed in 1971, and again in 1989, by Wine. She summarized major themes in the understanding of the phenomenon and noted that there was abundant evidence that the test-anxious person was more self-preoccupied and self-deprecatory than the not so test-anxious person, and that these thoughts were precipitated by an evaluative or testing event. This summary provided evidence of a negative relationship between worry and test performance. As other researchers had done, Wine turned to the theory of drives to support her suppositions. She noted that the literature indicated that low test-anxious persons were able to focus more completely on the task at hand to

complete it and had an internal positive drive; high-test anxious individuals were plagued with interfering thoughts and worry regarding the testing condition and their performance and could not direct adequate attention to completing the task at hand.

Wine (1971) was the first to describe test anxiety as a consequence of cognitive interference (i.e., that the experience of test anxiety caused increased task-irrelevant thoughts which were detrimental to focus, attention, and performance). Cognitive interference refers to thoughts that intrude unbidden into one's mind during exams, but have no functional value in solving the cognitive task at hand. Wine's model also includes an attentional deficit or high distractibility component, where persons are unable to focus exclusively on the task at hand, and are distracted by various environmental cues. Deffenbacher (1978) reported that highly stressed individuals spent only 60% of their available time on task with about 40% of the time spent on non-task related cognitive activities.

Since Wine's (1971) initial meta-analysis, the role of cognitive interference or attentional deficit in test anxiety has been well established in the literature (Cassady, 2004; Hembree, 1988; Tyron, 1980; Zeidner, 1998). Cognition and test anxiety have recently been studied by Keogh, Bond, French, Richards, and Davis (2004). These researchers found that anxious individuals are prone to distraction from threat-related material in testing situations. First-year psychology students were grouped as having high or low test anxiety determined by worry scores on a test anxiety scale, and then given a computerized test with distracters on the screen. Students with higher worry scores had no significant decreases in accuracy of the test, but did have a significant

susceptibility to threatening distracters, and poorer performance time. Non-threatening distracters did not appear to affect performance. As the level of worry increased, exam performance time decreased. Keogh et al. concluded that both worry and cognitive susceptibility to distraction were independent predictors of examination performance. This study supports the work of McKeachie (1984) that noted a non-threatening testing environment decreased test anxiety.

Wong (2008) studied cognitive effects of test anxiety through what she described as the cognitive triad: dysfunctional attitudes, automatic thoughts, and irrational beliefs. Dysfunctional attitudes are core beliefs that consist of a negative view of self, the world, and a misinterpretation of external stimuli, such as "I'm never going to pass this test" (p. 180). Automatic thoughts are distorted negative thoughts that arise involuntarily in the stream of thinking. Irrational beliefs are unreasonable evaluative beliefs that are not based on logic and can produce negative emotional and behavioral problems, such as "One must be perfectly competent, adequate, and achieving to consider oneself worthwhile." (p. 180). Wong found that the cognitive triad as a whole, rather than separate parts of the triad, was a significant predictor of debilitating test anxiety.

Test Anxiety and Behavior

Researchers have explored the behavioral aspect of test anxiety known as the skills deficit model (Kirkland & Hollandsworth, 1980; Tobias, 1985). This model describes the concept of test anxiety as a result, rather than a cause, of poor test performance. Researchers asserted that poor study skills lead to poor test performance

and result in a negative feedback loop that perpetuates negative study behaviors, poor test performance, and increased anxiety. Deficits have appeared in a wide variety of academic skills. Students with high test anxiety have had difficulty understanding, organizing, and retrieving information, and have had difficulty using metacognitive processes such as self-regulation and self-monitoring (Zeidner, 1998).

Kirkland and Hollandsworth (1980) compared anxiety reduction treatments and training in test-taking skills and found that those tutored in test-taking skills exhibited less anxiety and attentional interference during testing than the anxiety reduction treatment group. This observation suggested that test anxiety involved information processing and memory problems that could be alleviated by test-taking strategy training.

Baddeley and Hitch (1974) conceptualized that the human information processing system has a limited cognitive capacity. Both attention and memory work with the same pool of resources that must be shared when performing concurrent tasks. Eysenck (1982) and Tobias (1980) noted that anxiety negatively affected performance related to this limited cognitive capacity. They explained that working memory would be torn between effective processing and ineffective worry or irrelevant thoughts. Persons with high-test anxiety must attend to two tasks during test-taking, that of coping with the task at hand or taking the test and the cognitive interference as well.

Tobias (1985, 1990) reviewed several studies in the areas of interference, defective skills, and cognitive capacity and found that students with higher anxiety and

poorer study skills had more problems acquiring and encoding information. He concluded that the cognitive interference model and the skills deficit model of test anxiety were complementary, not mutually exclusive. Those with poorer study skills or skills deficit were more likely to exhibit symptoms of cognitive interference (i.e., lack of concentration, interfering thoughts, and distraction). Therefore, skills deficit (or the inability to organize and study efficiently) coincides with the inability to effectively concentrate, and may be related to limited cognitive capacity, or limited information processing ability. More recently, Mowbray (2012) conducted a review of the literature regarding working memory, attentional control, study skills, and test anxiety and concurred with the conclusions of Tobias.

McKeachie (1984) and his colleagues completed a series of research studies in the area of skills deficits, test anxiety, information processing, and cognitive capacity. In a review of these studies, McKeachie detailed their (his and his associates) journey of exploration into the relationship of test anxiety and performance. A 1955 study by McKeachie, Pollie, and Speisman yielded the following results: the ability to channel tension or anxiety through writing comments about feelings and explanations of answers in a testing situation increased test scores, perhaps by allowing students to think more deeply about the subject matter and remember more material, or allowing students a cathartic release of negative emotion to reduce tension and return to more productive thinking. McKeachie continued to look at test anxiety from various perspectives (including ability, study habits, and achievement).

Lin and McKeachie (1970) found that students with high test anxiety were lower in scholastic aptitude and reported poorer study habits. They believed that anxiety resulted in less effective processing of information and use of more primitive study practices, such as rote memorization. Benjamin et al. (1981) discovered that students with high test anxiety had difficulty both in encoding and organizing information, because of more superficial study methods and difficulty recalling information in testing situations related to increased worry. In 1987, Naveh-Benjamin et al. added support to this, by identifying those who had poor study skills and those who had good study skills and distinguishing performance differences in the two groups. Those with good study skills and high anxiety performed better on tests than those with high anxiety and poor study skills; however, those with high anxiety and good study skills still had academic achievement issues, believed to be related to worry and decreased information retrieval ability.

More evidence of the "working memory capacity theory," the ability to maintain or process talk-relevant information and inhibit task-irrelevant information, and its relationship to test anxiety and learning, came from a study by Tse and Pu in 2012. Tse and Pu found the interaction of low working memory capacity scores, together with high test anxiety scores, significantly decreased repeated-measure test scores in students when asked to recall English translation of Swahili words. Tse and Pu concluded that re-testing is a better learning tool for those with low working memory capacity and high test anxiety than re-study of the material, because re-testing as an acquisition tool increased the number of retrieval cues encoded by students with

each subsequent test experience, and allowed them to perform better on delayed recall testing.

Test Anxiety and Emotionality

A final aspect of test anxiety, known as emotionality, is the affective physiological response to evaluative stress that manifests itself in the symptoms of nausea, increased sweating, headache, and muscle tension. These symptoms can also result in an inability to concentrate and focus on material (either while studying or taking tests) related to an individual's preoccupation with their physiological symptoms. Wine (1971) proposed that this preoccupation could contribute to inattention and off-task thoughts and behaviors. Deffenbacher and Suinn (1988) described a more elemental or neurophysiologic explanation, related to the autonomic nervous system response of fear that one experiences in threatening testing situations. Deffenbacher and Suinn suggested the use of systematic desensitization to reduce the affective component of test anxiety. Nonetheless, most research has found that emotional responses to testing situations, although substantial at the beginning of an exam, soon subside and do not significantly affect performance. Furthermore, systematic desensitization or relaxation alone, although effective in ameliorating the emotional aspects of test anxiety, was not effective in increasing test performance (Hembree, 1988; Zeidner, 1998).

Test Anxiety and Academic Achievement

Conclusive evidence that there is a detrimental relationship among test anxiety, test performance, and academic achievement exists (Seipp, 1991). Hembree (1988)

conducted a meta-analysis of 562 North American studies from 1952-1986 to integrate information on causes, effects, and treatments of test anxiety. He noted that study skills training alone did not significantly reduce test anxiety and result in increased test performance. Hembree demonstrated that test anxiety correlated negatively with a wide variety of achievement measures such as IQ and aptitude tests, laboratory memory, problem solving tasks, and grade point average. Hembree's meta-analysis also found that worry was consistently associated with distractibility and lower test performance.

Chapell et al. (2005) investigated the relationship between test anxiety and academic performance in a large cohort of 4,000 undergraduate and 1,414 graduate students and found a small, but significant, inverse relationship between test anxiety and grade point average (GPA) in both groups. Chapell et al. also noted that female undergraduate and graduate students had significantly higher test anxiety and higher GPAs than male undergraduate and graduate students. Another study of the negative relationship between test anxiety and performance was conducted by Rana and Mahmood in 2010, which discovered a significant negative relationship between test anxiety scores and students' achievement scores among 414 Pakistan university students.

In an effort to more fully understand test anxiety and performance, differences among individuals have been studied to note whether or not other factors contributed to increased test anxiety and decreased test performance. Zeidner (1998) summarized these factors and noted that increased levels of test anxiety were more commonly

found among students who: were female, elementary to high school age, of lower socioeconomic status, reporting high parental expectations, and having personal characteristics such as trait anxiety, low self-concept, and perceived external control.

Interventions for Test Anxiety

Researchers have focused on interventions related to the various aspects of test anxiety, believing that reducing any aspect of the test anxiety construct may reduce its impact on performance. Strategies for reducing test anxiety have encompassed systematic desensitization or relaxation methods, to decrease the affective or physiological response to test anxiety; cognitive therapies with a focus on positive self-talk, to combat the cognitive interference portion of test anxiety; and programs to enhance study skills and test-taking skills, to combat the skills deficit (behavioral) facet of test anxiety. A combination of relaxation, cognitive coping, and study skills seemed to be the most effective of these approaches (Hembree, 1988; Spielberger & Vagg, 1995; Zeidner, 1998).

Hembree (1988) reviewed the effects of various treatments for test anxiety, and their related impacts on test performance. Cognitive, behavioral, combined cognitive-behavioral, and study skills training techniques were used. Cognitive techniques, such as group counseling to reduce negative thoughts and negative self-talk, tended to reduce the worry component of test anxiety, but were found to be less effective than other techniques. Behavioral techniques most commonly used to reduce test anxiety were systematic desensitization, relaxation training, modeling, covert positive reinforcement, extinction, and hypnosis. Systematic desensitization most effectively

reduced test anxiety. Relaxation also effectively reduced test anxiety, but proved ineffective in increasing test performance.

Cognitive-behavioral technique combinations included cognitive modification, attention training, insight therapy, anxiety management training, and stress inoculation. These techniques appeared to be the most effective in reducing both emotionality and worry components of test anxiety, and were deemed effective in increasing test performance. In addition, study skills training without cognitive or behavioral interventions proved to be ineffective in decreasing test anxiety and increasing test performance (Hembree, 1988).

Several authors have suggested that a set of interventions might be more beneficial in combatting test anxiety than one strategy. Poorman (2009) noted that practicing nurses often exhibit increased test anxiety when faced with continuing education and certification pressure. Poorman provided a practical list of strategies for these nurses, based on different aspects of test anxiety, to decrease test and performance anxiety while taking certification examinations. Her list included relaxation for the emotional symptoms, earplugs for high distractibility, cognitive restructuring for negative thoughts and information processing problems, and education on highlighting important points while studying for study skills problems. No data were provided regarding the efficacy of this list of strategies. In another example, Salend (2011) outlined several practical strategies to help students cope with test anxiety. This approach focused on the importance of identifying students with high test anxiety and of manipulating tests and the testing environment in order to

make it less threatening. Strategies such as practice testing, untimed tests, clear directions, collaborative testing, and computerized testing were suggested to decrease evaluative threat. For those with high distractibility, testing in a separate room was also suggested.

It is clear from the literature that test anxiety continues to be of concern at all levels of education, and that it is a phenomenon that may keep otherwise capable students from achieving education success. Distractibility, negative thoughts, and difficulty with information processing appear to be major contributors to test anxiety and decreased test performance. Many interventions have been suggested and studied, but no single strategy appears to be universal. It is plausible that an intervention that enhanced focus, concentration, and memory (and encouraged relaxation) might allow for more productive study and better recall during testing. Because an examination of the literature led this researcher to believe that aromatherapy (using essential oils) might provide such an intervention and assail both cognitive and affective aspects of test anxiety, it became important to define and examine all of its related facets.

Aromatherapy

Aromatherapy is defined as the skilled and controlled use of plant essential oils for physical and emotional health and well-being (Cooksley, 2002). Plants have been used medicinally for thousands of years in almost every culture and geographical area of the world (Buckle, 2003; Tisserand, 1992). Even today, the pharmaceutical industry depends on the botanical world for active ingredients. Common examples of this include the drug digoxin, obtained from the foxglove plant, which is used in

treatment of heart failure; and deadly nightshade or belladonna which produces both scopolamine (an anticholinergic used for motion sickness), and atropine (a powerful cardiac stimulant; Grieve, 1971).

Essential oils are volatile oily substances derived from the roots, leaves, flowers, needles, seeds, or bark of certain aromatic plants used in aromatherapy. The essential oil of the plant is said to be the life force energy or "soul" of the plant, therefore imparting more than just a chemical constituent that has therapeutic properties, but also working synergistically in the body for positive health changes (Schnaubelt, 1999; Tisserand, 1992).

Essential oils are remarkably diverse and complex molecular structures, that are purported to have varied therapeutic properties (stimulant, mucolytic, calmative, antispasmodic, expectorant, anti-inflammatory, antiseptic, antiviral, and antimicrobial). Because essential oils are natural substances, rather than being synthesized in a laboratory, the various constituents in essential oils may work synergistically and uniquely in the body of each individual. For this reason, several essential oils, especially those that have effects on the nervous system and psyche, are said to be "adaptogenic" or balancing, working either as stimulant or relaxant as needed by the body (Schnaubelt, 1995; Tisserand, 1992; Valnet, 1990; Worwood, 1991).

Aromatherapy, as the name suggests, involves the sense of smell and the olfactory system. Buck and Axel (1991) in their Nobel Prize winning work in olfaction found that the human olfactory system is able to distinguish 10,000 distinct

odors. Their work in olfaction has helped to unlock the mysteries of this complex sense. Buck (2004) also discovered 1000 gene receptors in the olfactory bulb of the brain that encode chemical signals of scents into unique pathways of the brain's limbic system. The limbic system or primitive brain integrates scent signals and directs them to different parts of the brain simultaneously; this can have an effect on the endocrine and immune systems, as well as the hypothalamus, the center for homeostasis in the body. Olfactory stimulation causes immediate physiological changes in blood pressure, muscle tension, pupil size, blink magnitude, skin temperature, skin blood flow, electro-dermal activity, heart rate, brain wave patterns, and sleep/arousal states (Kuroda et al., 2005). Inhaled odors activate the release of neurotransmitters (e.g., serotonin, endorphins, and norepinephrine) in the hypothalamus and pituitary. These odors also modulate neuroreceptors in the immune system, altering mood, reducing anxiety, and interrupting the stress response (d'Angelo, 2002). These responses can occur even before the scent is registered and interpreted in the higher centers of the brain.

The limbic system, that includes the hippocampus and amygdala, is also associated with memory and the expression of emotion. Scent memory has been well studied and is reported to be very powerful. Scents can trigger strong emotion associated with painful or pleasant memories. Scent is also used to stimulate function in brain-injured persons (Battaglia, 2003; Buckle, 2001).

Aromatherapy and Learning

Smell has been linked to enhanced learning and memory. As infants, we encounter and learn about the world through smell and touch before any other sense. This learning is powerful and permanent. Aromas are carried through the olfactory system in humans to the limbic system of the brain (i.e., hippocampus and amygdala) where they are processed before reaching the higher centers of the brain. The hippocampus is where the memory of smell is triggered, and is associated with the formation and retrieval of explicit memories (e.g., semantic memory, associated with retrieval of concepts and facts; episodic memory, associated with recollection of events, and spatial memory, concerned with recognition). The amygdala is thought to play a pivotal role in processing emotion and in the formation of emotional memory; it also governs emotional response. Specific aromatherapy oils, that act on the limbic system or primitive brain and are thought to enhance memory and decrease emotional anxiety, may enhance a person's ability to concentrate and focus and may also decrease feelings of anxiety and stress in the person (Buckle, 2003; Herz, 2005; Herz, 2009). In this manner, aromatherapy might serve to combat test anxiety, and therefore, increase test performance.

Aromatherapy and Anxiety

Since aromatherapy works in the primitive brain affecting emotion, and many essential oils are known to have a calming effect on the emotions, certain essential oils have the potential to lessen anxiety. Lee et al. (2011) completed a systematic review of the literature from 1990-2010 on the anxiolytic effects of aromatherapy and found 16

articles that met their criteria for randomized control trials. All of the articles examined the effects of aromatherapy on secondary anxiety symptoms or state anxiety caused by an external factor. Only one of the studies dealt specifically with test anxiety. The researchers found that most of the studies indicated a positive effect of aromatherapy to control anxiety and reported no adverse effects related to aromatherapy. They cautioned, however, that among the articles examined there was a great deal of diversity in terms of the nature of the anxiety studied, subjects included, interventions employed (e.g., inhalation, massage, foot bath), and evaluation techniques; therefore, results should not be considered conclusive or generalizable. These authors noted that much more controlled study into the effects of aromatherapy on anxiety are needed; nonetheless, since no adverse reactions to aromatherapy have been found, it may be seen as a safe strategy to be considered for anxiety control. The studies that were reviewed used a variety of essential oils, including rose, jasmine, chamomile, eucalyptus, lemon, mandarin, clary, sage, frankincense, lavender, peppermint, rosemary, bergamot, cedar wood, neroli, and orange.

More studies on aromatherapy and anxiety have included lavender either alone or in a blend with other oils, than any other essential oil. Lavender is consistently associated with decreased anxiety, but is also often associated with decreased attentionality and task performance; therefore, it may not be suitable for use as a strategy to decrease test anxiety and increase test performance (Cooke, 2008; Cooke & Ernst, 2000; Moss, Cook, Wesnes, & Duckett, 2003).

Several oils have been studied in relationship to attention, cognition, and anxiety. Takeda, Tsujita, Mitsuharu, Takemura, and Oku (2008) found that aromatherapy massage body treatment (with a blend of orange, lavender, and marjoram) provided a stronger and more continuous relief from fatigue, especially fatigue of mental origin after a stressful stimulus (computerized test), than massage with just carrier oil in a group of 13 healthy volunteers. Kutlu, Yilmas, and Cecen (2008) studied the effects of lavender inhalation during testing on 50 students with a control group of 45 students in nursing. The study group's mean anxiety score was significantly lower than that of the control group.

Aromatherapy, Attention, and Memory

Based on research evidence, aromatherapists believe that certain essential oils have a direct effect on the central nervous system (Battaglia, 2003). Peppermint *(Mentha piperita)* has been most studied in this area as a central nervous system (CNS) stimulant. A CNS stimulant affects the central nervous system by way of the amygdala and limbic system to increase alertness and concentration. Peppermint could potentially be used to enhance test performance in test anxious students by increasing alertness and concentration.

Barker et al. (2003) studied the effects of inhaled peppermint odor on clerical task performance. Twenty-six participants completed two sessions, where they were asked to recreate patterns of colors and tones on a game pad, type a nonsensical letter group presented to them on a screen, and alphabetize a set of flash cards. During one session, peppermint odor was presented, and in the other, no odor was present. Gross

and net typing speed, as well as accuracy, improved in the presence of peppermint odor. Alphabetization of items also significantly improved in the presence of peppermint; however, no significant improvement was found in memorization.

Ho and Spence (2005) found that tactile performance was facilitated in the presence of peppermint odor. Sixteen healthy adults aged 18-25 (eight male and eight female) were asked to identify numbers on a screen among distractors as well as to identify the application of a vibrotactile sensation on their body, with and without the presence of peppermint odor. Visual performance was unaffected by odor, but tactile performance increased in the presence of peppermint odor. Unfortunately, a synthetic peppermint odor was used for the study, instead of essential oil of peppermint *(Mentha piperita)*; therefore, the study cannot be used to definitively provide evidence of essential oil of peppermint and increased performance.

The effect of peppermint *(Mentha piperita)* and cinnamon *(Cinnamomum ceylanicum)* odor on simulated driving alertness, mood, and workload was studied by Raudenbush et al. (2009). Twenty-five healthy subjects completed workload analysis and profile mood states questionnaires; next, they participated in three 1 hour long driving simulations, while inhaling either cinnamon or peppermint essential oil through a nasal cannula connected to an oxygen concentrator. The researchers found that both peppermint and cinnamon increased alertness, decreased frustration, and increased perception of a shorter testing duration during the simulated driving experiences. Peppermint was also found to decrease fatigue and anxiety in this situation. In another study, peppermint was found to positively affect cognitive

performance and mood during a computerized cognitive drug research assessment battery (Moss et al., 2008).

Peppermint has also been studied in relation to sleep. Norrish and Dwyer (2005) noted that inhaling peppermint odor significantly decreased daytime sleepiness in conditions that would induce sleepiness, as tested by a questionnaire and pupillary changes. Twenty healthy adults were subjected to an 11 minute relaxing recording in a darkened room, both with peppermint odor present and without peppermint odor present. Significant statistical results indicated that peppermint was efficacious in maintaining alertness.

Goel and Lao (2006) found that peppermint was reported by different subjects as both stimulating and sedating when inhaled before bedtime, but was not associated with poorer sleep. Twenty one healthy subjects (11 women and 10 men) participated in a study where they were exposed to peppermint oil at bedtime. Subjects were asked to complete a sleepiness scale, report their perception of the intensity of the peppermint odor, and report on their sleep experience. Men reported more alertness the morning following inhaling peppermint at bedtime, but women experienced an increase in non-rapid-eye-movement (NREM) sleep. Those who rated peppermint as stimulating and intense had more total sleep and more slow-wave sleep than the control group. Overall, studies have found peppermint to be stimulating and useful in increasing alertness, cognitive function, and task performance and in decreasing anxiety and fatigue.

Rosemary (*Rosmarinus officinalis)* is an herb that has been associated with improving memory since ancient times. Mummies were found with rosemary-scented wrappings, apparently indicating an association with remembering the dead (Hamilton, 2000). Ophelia, in Shakespeare's *Hamlet* Act IV Scene V stated: "there's rosemary, that's for remembrance; pray love, remember; and there's pansies, that's for thoughts" (The Literature Network, 2000). Although rosemary has undergone less study related to the nervous system and usually has more often been studied as a blend with another essential oils, it has been associated with increased memory performance.

One study that found a positive effect of aromatherapy on mood, EEG patterns of alertness, and math computation was completed by Diego et al. (1998). This study used both lavender *(Lavandula angustifolia)* and rosemary. Under the influence of lavender, subjects' EEG patterns showed increased beta power, suggesting increased drowsiness. They had less depressed mood, and reported feeling more relaxed. This group performed math computations faster and with more accuracy than the group exposed to rosemary. With rosemary, the subjects' EEG patterns suggested increased alertness. They had lower anxiety scores and reported feeling more relaxed and alert, but were only faster, not more accurate, at math computations.

Atsumi and Tonosaki (2007) studied physiological effects of lavender and rosemary on 22 healthy adults and found that these essential oils increase free radical scavenging and decrease cortisol levels in saliva of the research subjects. These measures suggest that lavender and rosemary decrease the stress response and protect the body from the harmful effects of oxidation.

Moss et al. (2003) also studied the effects of rosemary and lavender on cognition and mood in healthy adults. This study found that lavender significantly decreased memory performance, attention, and reaction time; whereas, rosemary enhanced the quality of memory, while increasing response time. Both lavender and rosemary positively affected mood.

Aromatherapy and Test Anxiety

There has not been much research published specifically in the area of aromatherapy and test anxiety; however, Cheng et al. (2003) found ylang ylang reduced anxiety during digit span tests, but performance was depressed. Kutlu et al. (2008) studied the effects of lavender on test anxiety in nursing graduate students and found a significant decrease in anxiety; but, changes in test performance were not measured. McCaffrey et al. (2009) studied the effects of lavender and rosemary on test-taking anxiety in graduate nursing students and found that both of these essential oils lowered test anxiety scores. Participants in this study also made positive comments about the use of aromatherapy while taking tests; nonetheless, no information was provided regarding test performance.

Summary

Test anxiety continues to be a pervasive issue in education that negatively affects student performance. As yet, there are not proven universal strategies to lessen test anxiety and increase test performance in highly test-anxious students; therefore, continued research into such strategies is important. Aromatherapy may prove to be such a strategy. This literature review has provided information on the nature of test

anxiety, research related to this construct, and evidence that the aromatherapy scents of peppermint and rosemary may impact the cognitive and affective facets of test anxiety by decreasing physiological anxiety symptoms, helping students focus, and by increasing memory performance. These essential oils also have the potential to impact the worry and emotionality facets of test anxiety identified by Liebert and Morris (1967), by decreasing test anxiety and increasing test performance.

CHAPTER III

METHODOLOGY

Test anxiety among college students is a pervasive problem in education. The literature is rife with evidence that test anxiety negatively affects student performance and success. Although a great deal of research has been done concerning interventions to reduce test anxiety and its negative effects on test performance, no single definitive strategy has yet been found to do so. The purpose of this study was to determine the effects of aromatherapy, specifically, the essential oils of peppermint (*Mentha piperita)* and rosemary (*Rosemary officinalis*), on test anxiety and test performance among college students. The researcher conjectured that because aromatherapy affects attention and emotion, it may be useful in reducing test anxiety, and in increasing test performance. In this chapter, the research design is discussed; and a descriptive overview of the sample, instrument, data collection procedure, and data analysis are presented.

Research Design

This study was a pre/post-test, experimental design, utilizing survey data to assess the effects of aromatherapy on test anxiety and performance in college students. Two treatment groups and a control group were surveyed in both pre-treatment and post-treatment situations to gather data regarding test anxiety and the subscales of

emotionality and worry. Test scores of the participants were also obtained before and after treatment.

Research questions that guided this study were:

1. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported total test anxiety score?
2. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self–reported worry and emotionality?
3. Does inhaling the essential oils of peppermint or rosemary before and during testing increase test performance in college students?

Sample

A convenience sample of first and second year college students enrolled in basic science classes at a small private Midwestern university during the fall semester of 2011 were invited to participate in the study. The recruitment consisted of all students (approximately 300) attending these classes. This was done in order optimize treatment group numbers for study.

Characteristics of the Sample

Students were informed that they were being asked to participate in a study of test attitudes and the use of essential oils (aromatherapy) as a study aid. Inclusion and exclusion criteria, potential risks and benefits, participant's role in the study, and the right not to participate were verbally addressed during a personal visit to the science

classes, and an informed consent letter detailing this information was distributed (see Appendix A). In order to protect participants from any potential harm related to the use of aromatherapy, certain exclusion criteria were identified. Exclusion criteria consisted of: those with plant allergies, those with known high blood pressure, or those who were pregnant. Students were asked to exclude themselves from the study if they met any of the exclusion criteria.

One hundred-twenty students originally consented to participate. Because of student attrition in the science classes, and student absences during classes where data collection occurred, a total of 75 participants completed all components of the study.

Instrument

The Test Anxiety Inventory (TAI) developed by Spielberger (1980) was used to collect data on perceived test anxiety. The TAI test form is one page, includes a separate page with directions for completion, and consists of twenty items for participants to choose answers from a four-item likert scale (i.e., 1 = *Almost Never*, 2 = *Sometimes*, 3 = *Often*, and 4 = *Almost Always*). Examples of the types of questions asked on the inventory are: "I feel confident and relaxed while taking tests," and "Thoughts of doing poorly interfere with my concentration on tests." Participants were asked to report how frequently they experience specific symptoms of anxiety before, during, and after examinations.

This scale was chosen for use in this study because it has been used extensively in test anxiety research, includes both worry and emotionality elements of test anxiety, and is free from gender, cultural, or socioeconomic bias. Reliability and

validity of this instrument have also been established by its author. A test-retest reliability coefficient of the TAI total scale is .80. The alpha coefficients for the TAI subscales of worry and emotionality are $\alpha = .88$ and .90 respectively, indicating satisfactory internal consistency of the scale and subscales. Validity has been established by correlating the TAI with six other anxiety measures. Correlation coefficients were $r = .82$ for males and $r = .83$ for females (Putwain, 2008a Spielberger, 1980).

The TAI is a self-reporting psychometric scale developed to measure individual differences in test anxiety as a situation-specific phenomenon (Putwain, 2007). Putwain noted the practicality of using a self-report survey for researching test anxiety, as it is mainly a subjective phenomenon. Although somatic symptoms such as nausea, headaches, and muscle tension can be associated with test anxiety, they are not universally present in everyone and may attenuate with continued testing situations. The "feeling" of being anxious, however, can be easily and consistently self-reported. The TAI also includes subscales to assess worry and emotionality as major components of test anxiety.

Permission to reproduce and use the scale was obtained from Mind Garden, Inc.® (Spielberger, 1980). The original forms were modified to delete name at the top of the second page of the form, include student identification number, and include age. Gender was already present on the form. No changes were made to the substantive portion of the survey; therefore, psychometric indices were not affected. Several yes/no and open-ended questions were added to the post-test TAI tool to gather

qualitative information about the student's perceptions of the aromatherapy scent used in the study (see Appendix B).

Permissions and Protection of Subjects

Permission to conduct the study was granted from the University of Mary Institutional Research Review Committee as well as the University of North Dakota Institutional Review Board (See Appendices C and D). Verbal permission to conduct the study in first and second-year science classes was granted by instructors. An example of an email from one of the instructors can be found in Appendix E. Students were verbally told of potential risks and benefits of the study and were given a copy of the signed consent form that outlined those potential risks and benefits. Students were also asked to exclude themselves from the study if they suffered from plant allergies, had known hypertension, or were pregnant, to protect them from any remote untoward effects of aromatherapy.

Anonymity and privacy of participants was maintained by altering identifying information at the top of the TAI instrument. Student name was replaced with student identification number. The directions page of the instrument included student name and identification number to allow the researcher to correctly identify participants' signed consent form and provide them with a copy. This first page was removed before data entry into the computer, and was not included on the second administration of the instrument (See Appendix B). The researcher also requested student test scores from instructors using only student identification numbers. Original

signed consent forms and Test Anxiety Inventory surveys were kept separate from each other in two locked boxes.

Data Collection Procedure

Test Anxiety Inventory (TAI) scores of participants were collected before and after treatment to establish baseline test anxiety scores and assess changes in test anxiety scores. Two sets of test scores were also collected to assess for any change in test performance related to aromatherapy treatment.

The researcher scheduled three visits to each science class. Instructors allowed the first 10 minutes of each class visit to be used to conduct study procedures. The first visit was scheduled at least one week before a test day (Test A). The second visit was one week before a subsequent test (Test B), and the third scheduled visit was on the day of the subsequent test (Test B).

During the first class visit, the researcher explained the nature of the study and invited students to participate. The researcher distributed consent forms and Test Anxiety Inventory (TAI) forms to the class, and verbally read the consent form to the students. Students were told that if they wanted to participate in the study, they should sign the consent form and complete the TAI. If they did not wish to participate, they should return blank forms. After ten minutes, all forms were collected. A copy of each student's signed consent form was mailed to them, at their school address, so that they could refer to it at any time during the study.

The first class visit where students were recruited for the study was scheduled one week prior to a planned examination (Test A), but after at least one class

examination had been taken by the students. This time frame was chosen to permit students to acclimate themselves to the class and the instructor's testing style. This procedure was followed so that the evaluative threat of testing would not be significantly higher for the students, as in a first test, where the teacher's testing style is unknown, or as in a higher weighted test, such as a final examination. An informal survey of course instructors revealed that a test length of fifty items was consistent over the semester in all classes. Report of instructors also indicated that no specific test over the semester was considered more difficult than any other by previous students; therefore test anxiety or evaluative threat might not be significantly affected by perceived test difficulty or test weight in the course.

The second class visit was scheduled one week prior to the next examination (Test B) to distribute personal essential oil inhalers to participants. The researcher prepared a sufficient number of inhalers with each scent (peppermint, rosemary, and a placebo scent of Yankee Candle Macintosh Apple® air freshener) to accommodate the number of students who signed consent forms. Essential oils used in the inhalers were obtained from Young Living Essential Oils®: a reputable company that provides only 100% Grade-A pure oils, to insure quality. Aromatherapy inhalers were sealed to prevent subjects from inadvertently touching the essential oil, so that the administration condition of the aromatherapy would be inhalation, not topical administration (see Figure 2).

Participants were systematically assigned to three treatment groups, based on the three treatment scents, to insure equal size groups at the beginning of the study. A

list of inhaler scents associated with student identification numbers was drafted by the researcher. The inhalers and written directions for use were placed in small plastic bags, labeled with the student's identification numbers, and placed on a table outside the classroom before class. An announcement that participants could pick up their

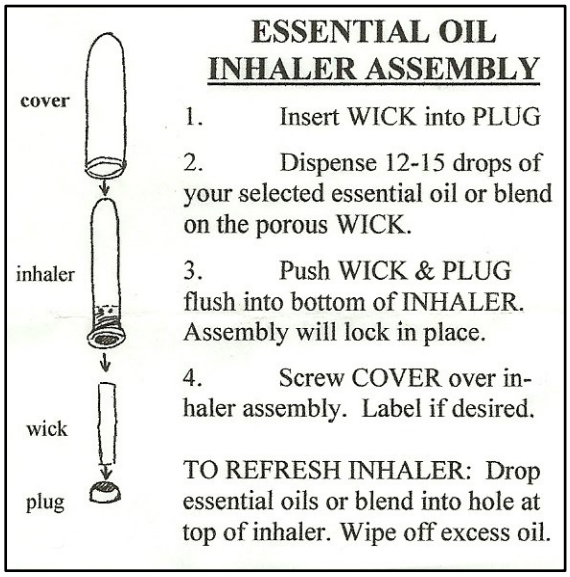

Figure 2. Essential Oil Inhaler. Reproduced with permission from unpublished data included with purchased inhalers from 100% Pure Essential Oils Online, P.O. Box 1220, Mechanicsburg, Pennsylvania, 17055-1220 (http://www.100pureessentialoils.com/; Appendix F)

assigned essential oil inhaler, by choosing the bag labeled with their identification number was made during the first 10 minutes of class. Students were allowed to exit the classroom and pick up the inhaler if they chose to do so. The directions instructed participants to use the inhaler by opening the device and waving it under their noses every 20 minutes, while they studied for the next test. Students were also encouraged to bring the inhaler and use it during the test.

The third class visit took place on the subsequent test day (Test B). Test Anxiety Inventories were again distributed to all students present, and study participants were asked to complete them before the test. If students were not participating in the study, they were asked to return the blank TAI. Forms were collected after 10 minutes.

Data Analysis

Data from completed surveys were entered into predictive analytics software, Statistical Package for the Social Sciences (SPSS®, Version 21.0) for analysis. Descriptive statistics were used to characterize the respondents (i.e., age range, science class, and gender). Association between treatment conditions (scent), emotionality, worry, and total test anxiety scores were analyzed.

Four mixed Analysis of Variance (ANOVA) were used to analyze associations among the three treatment conditions (inhaling peppermint, rosemary or apple scent), test anxiety scores (total test anxiety, worry and emotionality) and test performance scores, looking for changes in a repeated measures variable by three levels of a factor.

Information in this chapter has provided an overview of the methodological procedures used to direct the study. This discussion included a description of the research design, sample, instrument, data collection procedure, and data analysis procedure. In Chapter IV, the results of the data analysis will be presented.

CHAPTER IV

RESULTS

The purpose of this study was to determine the effects of aromatherapy – specifically, the essential oils of peppermint (*Mentha piperita*) and rosemary (*Rosemary officinalis*) – on test anxiety and test performance among college students. Found in this chapter are the research questions that guided the study, a description of the data analysis procedure used, a description of the sample, results of the analysis of test anxiety scores, results of the analysis of the effect of scent on anxiety and test scores, and qualitative responses.

Research Questions

Research questions that guided this study were:

1. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported total test anxiety score?
2. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported worry and emotionality?
3. Does inhaling the essential oils of peppermint or rosemary before and during testing increase test performance in college students?

Data Analysis Procedure

Surveys were analyzed manually for completeness and incomplete forms discarded. A total of 75 students were present during all three class periods in which the study was conducted, and completed all parts of the study. Data from completed surveys were entered into SPSS® (Version 21.0). In order to characterize the sample, student identification number, age, science class, gender, and like/dislike of the scent used during the study were entered into the study's dataset. The scent utilized by each participant was also entered into the dataset and labeled peppermint, rosemary, or apple.

Each item response for the Test Anxiety Inventory (TAI) was entered into SPSS® (Version 21.0) and total test anxiety scores, as well as worry and emotionality subscale scores, were calculated. TAI response scores for the research sample were analyzed for reliability, skewness, and kurtosis. Cronbach's alpha levels for the total Test Anxiety Inventory (TTAI) scale on the sample were: pretest, $\alpha = 0.94$, and posttest, $\alpha = 0.96$. Subscale alpha scores were: emotionality pretest, $\alpha = 0.92$, and posttest, $\alpha = 0.93$; worry pretest, $\alpha = 0.88$, and posttest, $\alpha = 0.92$, indicating good reliability for this scale on these participants (Creswell, 2005). Skewness scores ranged from -0.03 to 1.36, kurtosis ranged from -1.44 to 1.06, indicating a fairly normal distribution (Creswell, 2005).

Descriptive statistics were used to analyze age, gender, scent like/dislike, and science class distribution. Four mixed effects Analyses of Variance (ANOVA) were used to analyze associations among the three treatment conditions (inhaling

peppermint, rosemary, or apple scent), test anxiety scores (total test anxiety, worry, and emotionality), and test performance scores in order to answer the research questions.

Description of Sample

The study sample consisted of 75 participants. Twenty were male (27%) and 55 were female (73%). Age ranged from 18 to 28 years (see Figure 3). The majority of subjects were 18 (37%, *n* = 28) or 19 (39%, *n* = 29) years of age.

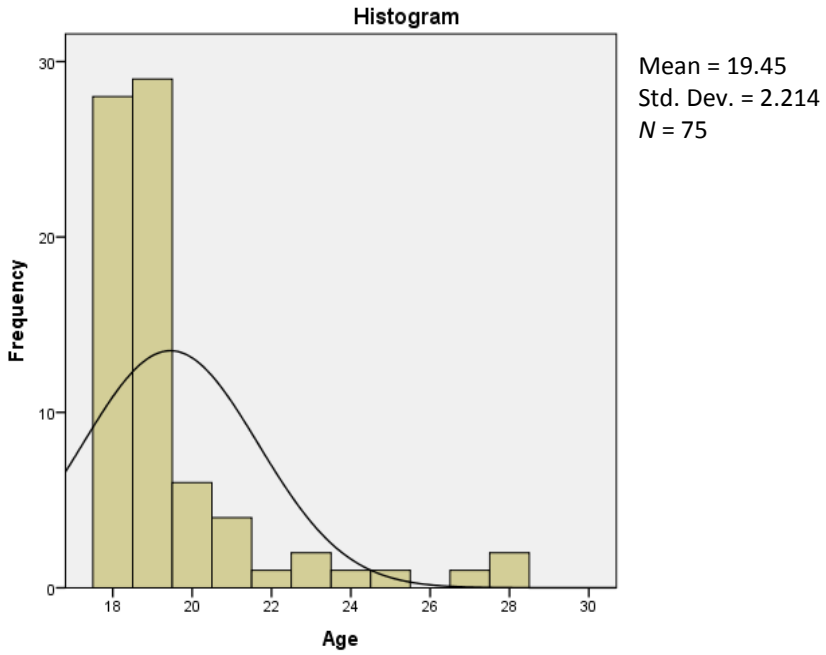

Figure 3. Age Distribution Frequency.

Frequency distribution of participants in each type of science class was calculated. The sample was distributed fairly evenly among three first or second year science classes with a small number in Biology 101 (see Table 1).

Table 1. Participant Distribution by Class.

Class	Frequency	Percent
BIOLOGY 101	5	6.7
BIOLOGY 103	25	33.3
BIOLOGY 207	25	33.3
CHEMISTRY 109	20	26.7
Total	75	100.0

Aromatherapy scent distribution was as follows: 28/75 (37.3%) participants received the control scent of apple, 22/75 (29.3%) received peppermint and 25/75 (33.4%) received rosemary. This resulted in a fairly equal distribution of the scents in the three groups, and a fairly even distribution by gender. Table 2 and Figure 4 illustrate scent distribution by gender. Frequency distribution of scent based on like/dislike of the scent is illustrated in Figure 5. More than half of the respondents (52/75, 69.3%) liked the scent they were given. Participants liked the apple scent the most (21/28, 75%) and rosemary the least (15/25, 60%).

Table 2. Scent by Gender, Sample Distribution.

Scent	Gender		Total
	Male	Female	
Apple	7	21	28
Peppermint	5	17	22
Rosemary	8	17	25
Total	20	55	75

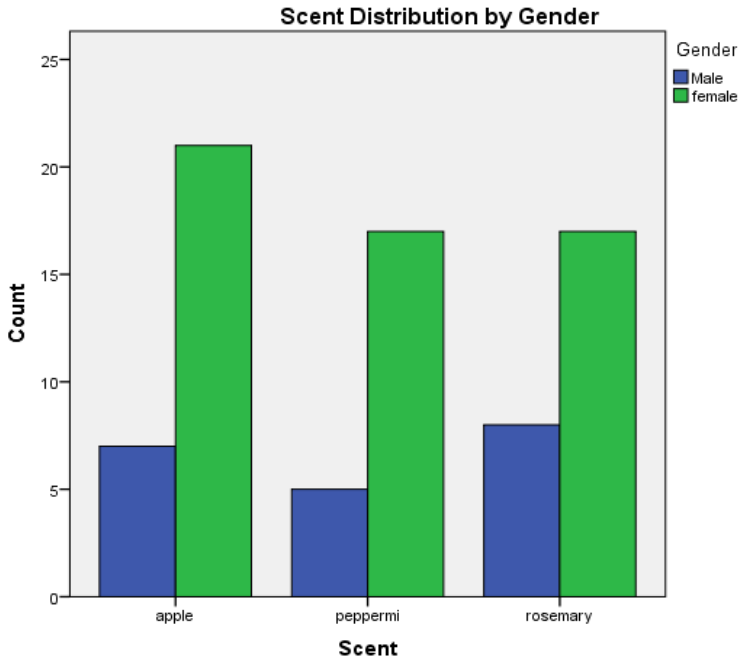

Figure 4. Scent Distribution by Gender.

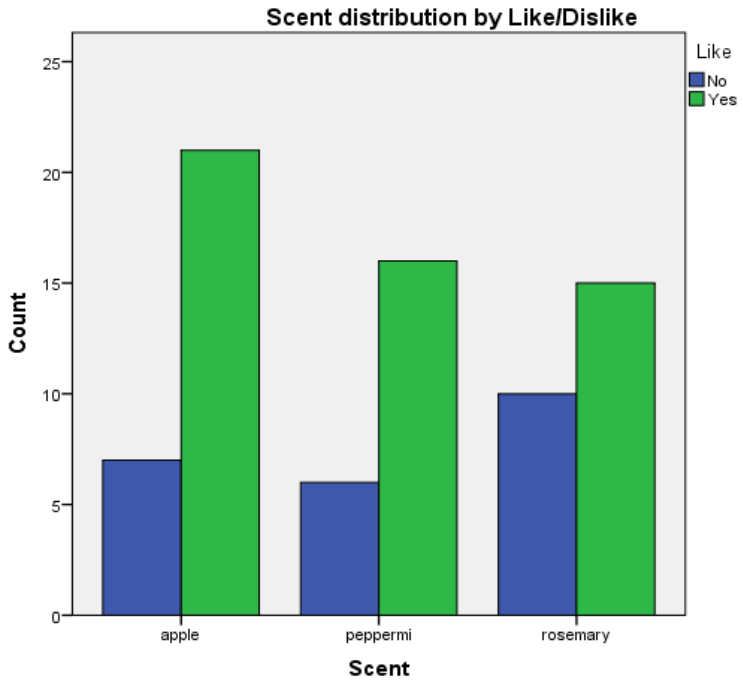

Figure 5. Scent Distribution by Like/Dislike of Scent.

Test Anxiety Scores

Test anxiety level of participants was determined before the aromatherapy intervention through the Spielberger (1980) Test Anxiety Inventory (TAI) as total test anxiety score, and with the subscales of emotionality and worry. Pre-intervention total Test Anxiety Inventory (Pre-TTAI) scores ranged from 24-74, with a mean score of 43.8 (*SD* = 12.89). The possible range for total TAI is 20-80. The emotionality subscale of the Test Anxiety Inventory (ETAI) includes eight items from the original 20 items of the TAI. Pre-intervention ETAI scores ranged from 8-32 with a mean score of 17.97 (*SD* = 6.10). The possible range for this subscale is 8-32. The worry subscale of the Test Anxiety Inventory (WTAI) also includes eight items from the original TAI. Pre-intervention WTAI scores in this sample ranged from 9-30 with a mean score of 16.69 (*SD* = 5.36). The possible range for this subscale is also 8-32 (see Table 3). The mean score results of the Pre-TTAI, Pre-ETAI and Pre-WTAI of this sample indicate a moderate level of test anxiety among participants. There were 34 participants who scored lower than 16 on the Pre-ETAI, 35 participants who scored lower than 16 on the Pre-WTAI, and only 10 participants that scored higher than 23 on the Pre-WTAI.

Table 3. Test Anxiety Scale Scores.

	N	Minimum	Maximum	Mean	*SD*
PreTTAI	75	24.00	74.00	43.81	12.89
PreETAI	75	8.00	32.00	17.97	6.04
PreWTAI	75	9.00	30.00	16.69	5.36
Valid *N*	75				

Effect of Scent on Anxiety and Test Scores

Four mixed effects ANOVAs were performed to note any significant effect of scent on anxiety and test scores. Results of these analyses were used to answer the research questions.

Research Question 1

Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported total test anxiety score? A mixed effects ANOVA was computed to assess the effect of scent used before and during testing on students' self-reported total test anxiety score. Scent (with three levels: peppermint, rosemary, and apple) was entered into SPSS® as the between subjects factor, and pre and post total anxiety response scores from the TAI were used as the within subjects factors. Tables 4 and 5 display descriptive statistics for pre and post Total Test Anxiety Inventory Scores (Pre-TTAI, Post-TTAI), and the results of the mixed ANOVA for Total Test Anxiety Scores by scent.

Table 4. Descriptive Statistics for Pre and Post Total Test Anxiety Scores by Scent.

	Scent	Mean	*SD*	*N*
Pre-TTAI	Apple	45.6	14.77	28
	Peppermint	40.1	10.46	22
	Rosemary	45.0	12.22	25
	Total	43.8	12.84	75
Post-TTAI	Apple	42.21	15.05	28
	Peppermint	38.64	11.16	22
	Rosemary	44.48	14.05	25
	Total	41.92	13.69	75

Table 5. Mixed Effects Analysis of Variance (ANOVA): Scent by Anxiety.

Source	*F*	*df*	*p*
Anxiety	3.884	1, 72	.053
Scent	1.219	2, 72	.302
Anxiety X Scent	.946	2, 72	.393

The interaction of scent and anxiety was not significant ($p < .05$), therefore the answer to Research Question 1 is no; inhaling the essential oils of peppermint or rosemary did not significantly affect college students' self-reported total test anxiety score.

Research Question 2

Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported worry and emotionality? Two, mixed effects ANOVAs were performed to assess the effect of scent on the subscales of emotionality and worry. As in the analysis to answer research question one, scent with three levels was used as the between-subjects factor. Pre and post emotionality subscale scores were used as the within-subjects factors of the first analysis. Pre and post worry subscale scores were used as the within subjects factors of the second analysis. Descriptive statistics for scent and emotionality are displayed in Table 6. Descriptive statistics for scent and worry are shown in Table 7.

Table 6. Descriptive Statistics for Pre and Post Emotionality Subscale Scores by Scent.

	Scent	Mean	*SD*	*N*
Pre-ETAI	Apple	19.25	6.90	28
	Peppermint	15.45	4.51	22
	Rosemary	18.76	5.50	25
	Total	17.97	5.97	75
Post-ETAI	Apple	17.75	6.86	28
	Peppermint	15.09	4.77	22
	Rosemary	18.68	5.58	25
	Total	17.28	5.99	75

Table 7. Descriptive Statistics for Pre and Post Worry Subscale Scores by Scent.

	Scent	Mean	*SD*	*N*
Pre-WTAI	Apple	17.29	6.32	28
	Peppermint	15.91	4.75	22
	Rosemary	16.84	4.96	25
	Total	16.73	5.41	75
Post-WTAI	Apple	15.54	6.16	28
	Peppermint	15.27	4.90	22
	Rosemary	16.40	6.04	25
	Total	15.75	5.72	75

Use of aromatherapy scent did not significantly interact with emotionality scores in this sample (see Table 8). Also, there was no interaction of scent with worry among participants of the study (see Table 9). Results of the mixed effects ANOVA therefore reveal that the answer to the second research question is no; inhaling

essential oils of peppermint and rosemary before and during testing did not significantly affect college students' self-reported worry and emotionality. However, a main effect was found in that students reported being less worried from pre-treatment to post-treatment condition.

Table 8. Mixed Effects Analysis of Variance (ANOVA): Scent by Emotionality.

Source	*F*	*df*	*p*
Emotionality	2.142	1,72	.148
Scent	2.826	2,72	.066
Emotionality X Scent	1.031	2,72	.362

Table 9. Mixed Effects Analysis of Variance (ANOVA): Scent by Worry.

Source	*F*	*df*	*p*
Worry	4.679	1,72	.034
Scent	.244	2,72	.784
Worry X Scent	6.621	2,72	.940

Research Question 3

Does inhaling the essential oils of peppermint or rosemary before and during testing increase test performance in college students? Through a mixed effects ANOVA using scent with the three levels (apple, peppermint, and rosemary) as the between-subjects factor and pre and post test scores as the within-subjects factors, no significant interaction was found between scent and test scores. Table 10 presents descriptive statistics for scent and test scores. Table 11 displays the results of the mixed effects ANOVA.

Table 10. Descriptive Statistics for Pre and Post Test Scores by Scent.

	Scent	Mean	*SD*	*N*
Pre-test	Apple	71.68	16.89	28
	Peppermint	77.32	14.70	22
	Rosemary	77.28	17.46	25
	Total	75.20	16.49	75
Post-test	Apple	75.71	15.41	28
	Peppermint	75.64	13.86	22
	Rosemary	75.28	17.07	25
	Total	75.55	15.35	75

Table 11. Mixed Effects Analysis of Variance (ANOVA): Scent by Test Scores.

Source	*F*	*df*	*p*
Test Scores	.007	1,72	.935
Scent	.289	2,72	.750
Test Scores X Scent	1.951	2,72	.150

Qualitative Responses

On the second TAI, participants were asked to comment on their experience with the essential oil inhaler while studying and while taking the post-intervention tests. Responses were manually analyzed for themes and several themes emerged among those participants who indicated they liked the scent they were given: calming effect, increased attention (focus) on study material, and increased attention to task. Typical statements for these themes included: “It relaxed me and kept me calm while studying.” “I felt like I could focus more. It kept me on track.” For those who disliked

the scent they were given, several indicated that they thought the scent made them more alert, but since they didn't like it, they didn't think it enhanced their study.

CHAPTER V

DISCUSSION

The purpose of this study was to determine the effects of aromatherapy – specifically, the essential oils of peppermint (*Mentha piperita*) and rosemary (*Rosemary officinalis*) – on test anxiety and test performance among college students. In this chapter, a review of the study results related to the research questions is provided. Reflection on salient literature related to study findings is presented, and study limitations are addressed. Recommendations for future research in the area of aromatherapy and test anxiety are also included.

Review of Study Results

Research questions of the study were:

1. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported total test anxiety score?
2. Does inhaling the essential oils of peppermint or rosemary before and during testing affect college students' self-reported worry and emotionality?
3. Does inhaling the essential oils of peppermint or rosemary before and during testing increase test performance in college students?

Survey data were collected from first and second year science students about perceived test anxiety using the Spielberger (1980) Test Anxiety Inventory. Participants were surveyed twice; once before a scheduled test, and again before a subsequent scheduled test. In between the surveys, students were given an aromatherapy inhaler to use. Aromatherapy inhalers contained the essential oils of peppermint *(Mentha piperita*), rosemary *(Rosmarinus officinalis*), or a control (non-essential oil) scent of apple. It was hypothesized that the effect of inhaling the aromatherapy scents would be to decrease test anxiety, and consequently increase student test performance. It was also hypothesized that effects of inhaling aromatherapy scents could increase memory and attention, which could also positively affect test scores. Pre and post intervention test scores were obtained to note any change.

Four mixed effects Analysis of Variance (ANOVA) were performed to explore the effects of inhaling rosemary, peppermint, or a control scent of apple on self-reported total test anxiety scores and the subscales of emotionality and worry. No significant effects were found among total test anxiety, emotionality, worry, and aromatherapy scent.

A possible reason no effect of inhaling essential oils on anxiety, emotion, worry, and test scores was seen in this study may have been because the sample size may have been too small to demonstrate a significant influence of aromatherapy on test anxiety and performance. The sample may have been too varied or not varied enough in terms of anxiety level, gender, or other unidentified characteristics to

illustrate any effect of aromatherapy on test anxiety and performance. Perhaps a larger, more randomized sample would produce more significant results.

Kenny et al. (2002) noted that "data from small group studies are said to be *nonindependent*, which means that persons who are in the same group are more similar (or dissimilar) to one another than are the persons who are members of different groups" (p. 126). Nonindependence undermines the statistical assumption of ANOVA and regression models. Kenny et al. go on to describe three factors that might produce nonindependence in groups: compositional effect (when persons are not randomly sorted into groups), common fate (when members of groups coexist in the same environment), and mutual influence (when one aspect of the group influences other aspects of the group). Nonindependence may have been a confounding factor in this study, because participants came from a convenience sample and not a random sample; participants coexisted in the same environment; and members experienced mutual influence in the form of science class structure.

Reflections of Study Findings in View of the Literature

The results of this research study indicated no significant effects of inhaling aromatherapy scents on emotionality in college students. Other researchers have noted that emotionality is not as great a factor in test anxiety and performance as worry (Hembree, 1988; Liebert & Morris, 1967 Morris & Liebert, 1970; Zeidner, 1998). Emotionality, although disturbing to students, has been shown to dissipate quickly in testing situations and does not have a significant effect on performance. This may

have been the reason no significant effect was found between use of aromatherapy scent and emotionality.

Inhaling the scents of peppermint and rosemary were not found to significantly affect test anxiety, worry, or performance. This may have been because the mean anxiety score of the sample was too low; therefore, participants did not exhibit sufficient anxiety to demonstrate enough change in test anxiety or improvement in test performance with the use of aromatherapy. Many researchers have noted that those who exhibited higher levels of test anxiety demonstrated greater response to test anxiety treatments (Hembree, 1988; Putwain, 2008b; Tse and Pu, 2012; Wong, 2008; Zeidner, 1998). This study sample exhibited only moderate levels of test anxiety; therefore, they may not have demonstrated enough test anxiety to show a significant change from pre to post intervention conditions. Also, it is possible that those with higher test anxiety did not complete the study, either by choice, or class attrition. One hundred-twenty students completed a consent form, but only 75 completed the study.

It may be that aromatherapy alone is not effective for test anxiety reduction, or, for focus and attention enhancement. Perhaps, although aromatherapy is able to increase memory and focus, and decrease test anxiety, it does not affect other aspects of the test anxiety construct that contribute to overall performance.

It is also possible that the response to aromatherapy is more individualized, as persons may respond differently based on the emotional response they have to a particular scent (Herz, 2009). Lazarus and Folkman (1984) noted that anxiety encompassed an interaction between person and environment. Perceived

environmental threats increased the anxiety response. Perhaps aromatherapy did not do enough to change that interaction. It is possible that the relationship among facets of test anxiety is more complex than is currently understood and intervening on only one or two of the facets is not effective in reducing anxiety and increasing performance.

Perhaps a simple causal model for test anxiety and performance is too simplistic for this phenomenon. As other researchers have noted, a combination of study skills, relaxation, and cognitive therapies may be more effective in reducing test anxiety and increasing test performance, than cognitive and relaxation interventions alone (Hembree, 1988; Zeidner, 1998).

Test Anxiety Worry subscale scores did decrease significantly in participants, although it was not associated with scent. Test anxiety scores decreased from pre-test to post-test, and test scores increased, but not in relation to the use of aromatherapy scent, and not to a level of statistical significance. Test score and anxiety score changes in participants might be attributed to familiarity with the testing style of the instructor and increased comfort with the type of material being tested. Tse and Pu (2012) suggested that repeat testing was more effective in increasing student success with word recall than re-study of material before testing. This may be true of content in science courses. Repeated exposure to material in testing situations may naturally increase test performance.

It is interesting to note that more participants liked the apple (control) scent than either of the other scents used in the study. Qualitative data provided more insight

into how participants experienced the apple scent. Participants reported that they found this scent calming, or relaxing; and that it increased focus and attention to task. It may be that if participants were allowed to choose a scent that they liked, use of chosen scents may have resulted in more positive effects (i.e., reduced test anxiety, improved memory, improved attention, and improved performance), regardless of the chemical constituent properties of the scent. The researcher chose aromatherapy scents for this study based on therapeutic properties of the oils attributed to its chemical constituents. The aromatherapy scents of peppermint and rosemary were also chosen because of research evidence demonstrating their positive effects on memory, attention, and test performance. The researcher did not consider participants' like/dislike of a scent in aromatherapy scent choice.

Herz, Schankler, and Beland (2004) found that odor associative learning may be contingent on whether or not the learner finds the scent pleasurable. Herz et al. investigated emotional associative learning in relation to odors and subsequent behavioral effects. In this study, participants were exposed to an unfamiliar ambient odor during a frustrating situation. Participants were then asked to work on puzzles again in three different treatment situations (negative-same odor, different odor, and no odor). Results indicated that participants spent less time on the puzzles in the negative-same-odor situation. The authors concluded that this was due to the negative associative learning related to the unpleasant ambient odor. This finding suggests that odors readily become associated with emotions and can influence behavior.

In 2009, Herz completed a review of studies on aromatherapy effects on mood, physiology, and behavior and noted two hypotheses regarding the effects of aromatherapy oils: the pharmacological hypothesis and the psychological hypothesis. The pharmacological hypothesis proposed that the effects of essential oil aromas on mood, physiology, and behavior are related to an odor's direct and intrinsic ability to interact and affect the autonomic nervous system. Several studies supported this proposal, and subjective ratings of an odor's pleasantness were positively correlated to positive emotional and physiologic effects of the odor (This was the researcher's approach to aromatherapy oil choice.).

Conversely, the psychological hypothesis stated that odors exerted their effects through emotional learning, conscious perception, and belief/expectations. A response to a certain odor is learned through association with an emotional experience. Odors take on the properties of the associated emotion and promote a certain type of emotional, cognitive, behavioral, or physiological effect. Herz (2009) noted:

> Only two synapses separate the olfactory nerve from the amygdala, a structure critical for the expression and experience of emotion and human emotional memory; and only three synapses separate the olfactory nerve from the hippocampus, involved in the selection and transmission of information in working memory, short-term and long-term memory transfer and in various declarative memory functions. (p. 277)

In this hypothesis, an odor is associated with a remembered emotion and influences behavior based on the elicited emotion; rather than an odor causing an emotion that can affect behavior. Research reviewed by Herz supports the position that a person's like or dislike of an odor is directly related to the mood change that occurs and the behavior that follows. Therefore, if individuals are given a choice of odor, and find one that is pleasant to them, it may positively affect memory and behavior.

Hamilton (2000) studied the effects of rosemary on test anxiety and memory in eighth graders. Instead of discovering that rosemary had an effect on test performance and anxiety, Hamilton found that lemon, the control scent in the study, decreased test anxiety and improved memory on spelling lists. Perhaps lighter scents, such as lemon, are more pleasant than the heavier scent of rosemary, and this is the reason that lemon scent decreased anxiety and increased performance in this situation. Lemon is known as a "mood-lifter," and therefore, may contribute to a positive emotional association with learning (Cooksley, 2002).

Many authors believe that aromatherapy blends act synergistically, and therefore, have a larger effect than single essential oils (Battaglia, 2003; Cooksley, 2002). In the future, blends of essential oils that are considered pleasant to participants and that have chemical constituents consistent with increased memory, attention, and performance might be studied. Blends containing rosemary, peppermint, lemon, and lavender might be considered for study, because of the research-supported effects of these scents: rosemary is noted to increase memory, peppermint is noted to increase attention, lemon is a mood lifter, and lavender induces relaxation (Atsumi & Tonosaki,

2007; Barker et al., 2003; Diego et al., 1998; Ho & Spence, 2005; Hamilton, 2000; Moss et al., 2003). This combination may be more effective in reducing test anxiety and in increasing test performance than single oils, such as were used in the current study.

Finally, it may be that aromatherapy is more effective in repetitive task or memory situations, rather than situations that require judgment or decision-making. Some of the research where aromatherapy was effective in increasing test performance related to task performance, rather than recall, or metacognitive use of information (using related information in a logical manner to solve a problem; Barker et al., 2003; Goel & Lao, 2006). More scientific study is needed as to how aromatherapy directly affects memory, recall, and metacognition.

Study Limitations

There were several methodological limitations of this study that are important to consider when examining results and implications. As in the case of much social science research, data were collected under naturalistic conditions, so it was not possible to make the study's design as robust as would have been preferable. Since the participants were recruited from a convenience sample of science classes, true random assignment of participants was not possible.

The nature of aromatherapy oils is that they work individually in each person. Effectiveness of aromatherapy may be influenced by the user's individual response to it, and may vary among individuals. Individual responses were not taken into account

in this study, and this may have been a factor in the results obtained regarding the effectiveness of the use of aromatherapy in reducing test anxiety.

There was substantial attrition of participants during the study. One hundred-twenty consented to be in the study, and only 75 completed all aspects of the study. Small sample size may have resulted in nonindependent groups.

Considerations for Future Study

Aromatherapy should not be discounted as a possible intervention to decrease test anxiety and increase test performance. Aromatherapy may be useful as an adjunctive measure in treating test anxiety to enhance focus, memory, and attention, rather than a sole treatment of the condition. If used with a system of interventions aimed at targeting all aspects of the test anxiety construct (i.e., cognitive, behavioral and affective, as well as study skills deficits), aromatherapy might be helpful to treat test anxious individuals. A combination of aromatherapy, study skills training, test-taking skills training, and cognitive interventions may increase the total effect of interventions on test anxiety and performance.

Screening a potential population to note the level of test anxiety and including only those with high test anxiety in a study of aromatherapy and test anxiety may show more significant results. Positive effects of aromatherapy might be greater in those with higher levels of test anxiety.

Spielberger and Vagg (1995) developed the Transactional Process Model of test anxiety that included cognitive interference (worry/emotionality), study skills deficits, test taking skills deficits, information processing deficits, and individual

differences. It was thought that by intervening on one aspect of this model, test anxiety might be decreased and test performance increased. That supposition was not borne out in the present study. It may be that several aspects of test anxiety need to be addressed simultaneously in order for positive change to occur. Therefore, as suggested by Poorman (2009), it may be useful to develop screening tools that pinpoint specific aspects of test anxiety that are problematic for individuals, and cultivate interventions tailored to these needs. Identifying characteristics of individuals with test anxiety using a qualitative approach might also be advantageous.

Recommendations

Test anxiety is a complex-multidimensional phenomenon that affects student performance. It may require a multi-factorial approach to treatment, and because of its devastating effect, warrants further study on strategies to decrease it and help students succeed.

Although the aromatherapy scents of peppermint and rosemary were not associated with reduction in test anxiety and improved test performance in this study, the idea of aromatherapy as a useful modality in the treatment of test anxiety should not be ruled out. The individualistic nature of this intervention needs to be considered in its future use. It might also be useful to consider a qualitative approach to data collection and analysis to provide a deeper understanding of the relationship of aromatherapy to test anxiety and performance. Future studies might include a larger sample and use aromatherapy across a longer time frame to enhance its effects. Possible participants might be screened for degree of test anxiety and those with

higher test anxiety included for study. The type of aromatherapy used in future studies needs to be considered as well. If participants are given a choice of scent, and discover one that they find pleasant, it may precipitate increased use and effectiveness. A blend of essential oils should also be considered.

APPENDICES

APPENDIX A

INFORMED CONSENT

TITLE: *The Effect of Aromatherapy on Test Anxiety*

PROJECT DIRECTOR: *Jocelyn M. Dunnigan*

PHONE # *701-471-0064*

DEPARTMENT: *Teaching and Learning*

STATEMENT OF RESEARCH
A person who is to participate in the research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects include only subjects who choose to take part. Please take your time in making your decision as to whether to participate. If you have questions at any time, please ask.

WHAT IS THE PURPOSE OF THIS STUDY?
You are invited to be in a research study about the effects of aromatherapy on test attitudes because you are taking this first year chemistry class. The purpose of this research study is to note if using aromatherapy while studying and during testing has any effect on the participant's ability to focus, concentrate and recall information.

HOW MANY PEOPLE WILL PARTICIPATE AND HOW LONG WILL I BE IN THIS STUDY?
Approximately 100 people will take part in this study at the University of Mary. Your participation in the study will last approximately one week.

WHAT WILL HAPPEN DURING THIS STUDY?
Participants will be asked to complete a 20-item test attitude inventory at the beginning of the study, then will be given an aromatherapy inhaler to use by breathing in the scent during studying and while taking a test in the chemistry class. The participants will also be asked to re-take the test attitude inventory just prior to the chemistry test.

WHAT ARE THE RISKS OF THE STUDY?
There may be some risk from being in this study. Persons allergic to plants or who have a history of high blood pressure should exclude themselves. Some people find the aroma of essential oils to be very strong and may not like the scent. Participants may find answering the test attitude inventory frustrating or difficult. If you feel uncomfortable completing the inventory, you may stop and withdraw from the study at any time. If you become pregnant during the research, there may be unknown risks to the embryo or fetus, or risks to the embryo or fetus that we did not anticipate.

WHAT ARE THE BENEFITS OF THIS STUDY?
You may benefit personally from being in this study because many people find aromatherapy pleasant and it may have a positive effect on concentration.

ALTERNATIVES TO PARTICIPATING IN THIS STUDY
If you choose not to participate in this study, there are no adverse consequences. You will engage in the chemistry class as you normally would.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY? WILL I BE PAID FOR PARTICIPATING?
You will not have any costs for being in this research study. You will not be paid for participating in the study.

WHO IS FUNDING THE STUDY?
The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

CONFIDENTIALITY
The records of this study will be kept private to the extent permitted by law. In any report about this study that might be published, you will not be identified. Your study record may be reviewed by Government agencies, and the University of North Dakota Institutional Review Board.

Any information that is obtained in this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of using student ID numbers not associated with your name to identify your test attitude inventory answers and test scores. If we write a report or article about this study, we will describe the study results in a summarized manner so that you cannot be identified.

IS THIS STUDY VOLUNTARY?
Your participation is voluntary. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Your decision whether or not to participate will not affect your current or future relations with the University of Mary.

CONTACTS AND QUESTIONS?
The researcher conducting this study is **Jocelyn Dunnigan**. You may ask any questions you have now. If you later have questions, concerns, or complaints about the research please contact **Jocelyn at 471-0064.** If you have questions regarding your rights as a research subject, or if you have any concerns or complaints about the research, you may contact the University of North Dakota Institutional Review Board at (701) 777-4279. Please call this number if you cannot reach research staff, or you wish to talk with someone else.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subjects Name: _____

_____ _____
Signature of Subject Date

APPENDIX B

INSTRUMENT

Test Attitude Inventory

For use by Jocelyn Dunnigan only. Received from Mind Garden, Inc., on August 27, 2011

Please provide the following information:

Name:_____ Student ID # _____ Date _____

Gender (please circle): Male Female Age:_____

Directions

A number of statements which people have used to describe themselves are given on the following page. Read each statement and then circle the appropriate number to the right of the statement to indicate how you generally feel:

1=Almost Never, 2=Sometimes, 3=Often, 4=Almost Always

There are not wrong or right answers. Do not spend too much time on one statement but give the answer which seems to describe how you generally feel.

Please answer every statement.

Please turn the page for the statements.

Do not write below this line.

Score: T_____ W_____ E_____

Test Attitude Inventory

For use by Jocelyn Dunnigan only. Received from Mind Garden, Inc., on August 27, 2011

Please circle the class you are in: BIO 101 BIO 103 BIO 207 CHEM 109

Please Provide the following information:
Student ID # _____ Date: _____
Gender (circle): Male Female Age:_____

Directions:
A number of statements which people have used to describe themselves are given. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel:

1 = Almost Never, 2 = Sometimes, 3 = Often, 4 = Almost Always

There are no wrong or right answers. Do not spend too much time on one statement, but give the answer which seems to describe how you generally feel. Please answer every statement.

	Almost Never	Sometimes	Often	Almost Always
1. I feel confident and relaxed while taking tests	1	2	3	4
2. While taking examinations I have an uneasy, upset feeling	1	2	3	4
3. Thinking about my grade in a course interferes with my work on tests	1	2	3	4
4. I freeze up on important exams	1	2	3	4
5. During exams I find myself thinking about whether I'll ever get through school	1	2	3	4
6. The harder I work at taking a test, the more confused I get	1	2	3	4
7. Thoughts of doing poorly interfere with my concentration on tests	1	2	3	4
8. I feel very jittery when taking an important test	1	2	3	4
9. Even when I'm well prepared for a test, I feel very nervous about it	1	2	3	4
10. I start feeling very uneasy just before getting a test paper back	1	2	3	4
11. During tests I feel very tense	1	2	3	4
12. I wish examinations didn't bother me so much	1	2	3	4
13. During important tests I am so tense that my stomach gets upset	1	2	3	4
14. I seem to defeat myself while working on important tests	1	2	3	4
15. I feel very panicky when I take an important test	1	2	3	4
16. I worry a great deal before taking an important test	1	2	3	4
17. During tests I find myself thinking about the consequences of failing	1	2	3	4
18. I feel my heart beating very fast during important tests	1	2	3	4
19. After an exam is over I try to stop worrying about it, but I can't	1	2	3	4
20. During examinations I get so nervous that I forget facts I really know	1	2	3	4

Additional Questions for Second Administration of TAI

Please comment on your experience with the aromatherapy inhalers:

1. **Did you like or dislike the aromatherapy? Yes ☐ or No ☐ Why?**

2. **Did you feel that it enhanced your attention or concentration? Yes ☐ or No ☐ How?**

3. **Did you feel more confident going into the testing situation after using the aromatherapy?**

APPENDIX C

IRB APPROVAL – UNIVERSITY OF MARY

From: Kimberly McDowall-Long
Sent: Monday, June 27, 2011 10:51 AM
To: Jocelyn Dunnigan
Subject: OFFICIAL COMMUNICATION: IRB Proposal 292060811

June 27, 2011

Jocelyn M. Dunnigan
University of Mary
School of Health Sciences

RE: The effects of aromatherapy on test anxiety and test performance, IRB Proposal 292060811

Dear Investigator,

The University of Mary Institutional Review Board has reviewed and approved the above referenced study.

Conditions of Approval: There are five (5) conditions attached to all approval letters. All five conditions must be met, or the IRB's approval may be suspended.

1. No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date. (Principal Investigators and Sponsors are responsible for initiating Continuing Review proceedings.)

2. All unanticipated or serious adverse events must be reported to the IRB.

3. All protocol modifications must be IRB approved prior to implementation, unless they are intended to reduce risk. This includes any change of investigator or site address.

4. All protocol deviations must be reported to the IRB within 14 calendar days.

5. All recruitment materials and methods must be approved by the IRB prior to being used.

6. The IRB must be notified upon completion of the project. Principal investigators are responsible for making sure that studies are conducted according to the protocol and for all actions of the staff and sub-investigators with regard to the protocol. As a principal investigator, you may have multiple and possibly conflicting responsibilities to the IRB, the research subjects, and any sponsor. If you have any questions or concerns about this approval, please contact the Assistant Vice-President for Academic Affairs, the IRB Chairperson, in the Office of Academic Affairs.

Sincerely,
Kim Long, PhD
Chair, Institutional Review Board
Assistant Vice President for Academic Affairs University of Mary 7500 University Drive Bismarck, ND 58504
T: 701.355.8021
F: 701.255.7687

APPENDIX D

IRB APPROVAL – UNIVERSITY OF NORTH DAKOTA

UNIVERSITY OF UND NORTH DAKOTA

INSTITUTIONAL REVIEW BOARD
c/o RESEARCH DEVELOPMENT AND COMPLIANCE
DIVISION OF RESEARCH
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(701) 777-4279
FAX (701) 777-6708
www.und.edu/dept/rdc/regucomm/IRB

August 16, 2011

Jocelyn M. Dunnigan
927 East Central Avenue
Bismarck, ND 58501

Dear Ms. Dunnigan:

We are pleased to inform you that your project titled, "The Effects of Aromatherapy on Test Anxiety and Test Performance of College Students" (IRB-201108-027) has been reviewed and approved by the University of North Dakota Institutional Review Board (IRB). The expiration date of this approval is June 26, 2012. Your project cannot continue beyond this date without an approved Research Project Review and Progress Report.

As principal investigator for a study involving human participants, you assume certain responsibilities to the University of North Dakota and the UND IRB. Specifically, an unanticipated problem or adverse event occurring in the course of the research project must be reported within 5 days to the IRB Chairperson or the IRB office by submitting an Unanticipated Problem/Adverse Event Form. Any changes to or departures from the Protocol or Consent Forms must receive IRB approval prior to being implemented (except where necessary to eliminate apparent immediate hazards to the subjects or others.)

All Full Board and Expedited proposals must be reviewed at least once a year. Approximately ten months from your initial review date, you will receive a letter stating that approval of your project is about to expire. If a complete Research Project Review and Progress Report is not received as scheduled, your project will be terminated, and you must stop all research procedures, recruitment, enrollment, interventions, data collection, and data analysis. The IRB will not accept future research projects from you until research is current. In order to avoid a discontinuation of IRB approval and possible suspension of your research, the Research Project Review and Progress Report must be returned to the IRB office at least six weeks before the expiration date listed above. If your research, including data analysis, is completed before the expiration date, you must submit a Research Project Termination form to the IRB office so your file can be closed. The required forms are available on the IRB website.

If you have any questions or concerns, please feel free to call me at (701) 777-4279 or e-mail michelle.bowles@research.und.edu.

Sincerely,

Michelle L. Bowles, M.P.A., CIP
IRB Coordinator

MLB/jle

Enclosures

APPENDIX E

PERMISSION FROM COURSE INSTRUCTOR TO CONDUCT STUDY

Hi Jocelyn. I'd be willing to let you solicit participants from my classes. The one problem may be the distribution. One section is 35 students, the other is 70 students. One section is at the same time as Anthropology, so I get this uneven distribution. I usually give 4 tests during the semester, about 4 weeks apart. I haven't scheduled them yet, but will sometime in August. The tests are usually on Wednesdays.

Let me know if you need anything else.

Sr. Nicole

APPENDIX F

PERMISSION TO USE AROMATHERAPY BLANK INHALER FIGURE

20th Jun 2013 @ 12:57 AM

You Said:

I ordered these aromatherapy inhaler blanks to use in my doctoral research. I would like to reproduce the figure that illustrates assembly of the inhaler included with the order in my doctoral dissertation. May I have your permission to do so?
Thank you,
Jocelyn M Dunnigan
927 E Central Avenue
Bismarck ND 58501
701-471-0064
joced@bis.midco.net

20th Jun 2013 @ 10:53 AM

100PureEssentialOils.com Said:

Yes Jocelyn. Sorry the decision took so long!

20th Jun 2013 @ 4:40 PM

You Said:

Thank you so much for granting me permission to use your figure!
Do you have any particular way you would like it to be referenced?
Jocelyn

20th Jun 2013 @ 5:02 PM

100PureEssentialOils.com Said:

You can reference us as www.100PureEssentialOils.com, 100% Pure Essential Oils Online

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