2007

The effects of odor on weightlifting in men and women

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DOI: <https://doi.org/10.31979/etd.5p9j-hyb>
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THE EFFECTS OF ODOR ON WEIGHTLIFTING IN MEN AND WOMEN

A Thesis

Presented to

The Faculty of the Department of Kinesiology

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Kristina Marie Drummond

August 2007

UMI Number: 1448883

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ABSTRACT

THE EFFECTS OF ODOR ON WEIGHTLIFTING IN MEN AND WOMEN

By Kristina M. Drummond

Olfactory research has shown that odor affects psychological and physiological responses. However, odor effects during physical activity, as well as possible gender differences, are still being researched. The current study investigated the effects of peppermint and dimethyl sulfide on elbow flexion in men and women. Thirty participants performed biceps curls to fatigue. Heart rate and electromyography were utilized, along with the Profile of Mood States and NASA-Task Load Index. Dimethyl sulfide caused significant increases in resting heart rate, but had no significant effect on muscle activation. It also increased total mood disturbance, tension, temporal demand, frustration, and anger. Peppermint odor caused participants to feel less depressed, more vigorous, and, for women, less fatigued. Although there was no effect of odor condition on muscle activation, there were changes noted in EMG activity, suggesting psychological responses may affect muscle activation.

Acknowledgements

The author would like to thank everyone who participated in the study and those who helped recruit volunteers. A special thanks to Peggy Plato for enduring many hours of bad odor and helping cipher through a lot of data. To Ali Khadem and Craig Clemens for being kind guinea pigs while we figured out odor concentrations. Last, but most certainly not least, to Walt Drummond, who not only had to spend a year dealing with an insane wife, but who also turned over one million lines of EMG data into around 200.

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Chapter I

Introduction

Aromatherapy and olfactory research has been growing over the past two decades. The body's response to, and detection of, odor has led to the creation of products such as aromatherapy candles and oils. New research is focusing on the benefits of essential oils as an aid to athletic performance (Nagai, Wada, Usui, Tanaka, & Hasebe, 2000; Raudenbush, Corley, & Eppich, 2001; Raudenbush, Meyer, & Eppich, 2002). These studies show a positive correlation between improved performance with certain odors and psychological changes in response to the odor, such as increased motivation and vigor. Although research has shown how odors can affect performance at a psychological level (Diego et al., 1998; Ilmberger et al., 2001; Knasko, 1992; Schiffman, Sattely-Miller, Suggs, & Graham, 1995), evidence linking physiological changes has yet to be fully discovered.

Anatomically, the olfactory bulb has many direct and indirect connections to areas of the brain including the limbic system, thalamus, and the frontal cortex (Jacob, n.d.). These areas are known to control mood, motivation, pain, learning, memory, and physiological changes in the body (Carlson, 1992; McArdle, Katch, & Katch, 2001). Magnetic resonance imaging (MRI) and positron emission tomography (PET) scans show that odors with particular hedonic values, or level of pleasantness, will activate these areas of the brain (Cheng, n.d.; Zatorre, Jones-Gotman, & Rouby, 2000).

Research into psychological changes has shown that odors can create a variety of moods. The intermittent, unpleasant odors emitting from a commercial swine operation caused increased reports of mood disturbances, confusion, anger, and decreased vigor (Schiffman et al., 1995). The introduction of a pleasant ambient odor, known to be associated with past memories, led to increased gambling at a slot machine in a Las Vegas casino (Hirsch, 1995).

Physiologically, changes in electroencephalogram (EEG) measures have been associated with pleasant and unpleasant odors (Diego et al., 1998; Fulbright et al., 1998; Hongratanaworakit, 2004). Increases in alpha and beta activation, denoting either a relaxed or active state, were seen when individuals were presented with lavender oil compared to rosemary and no odor control groups (Diego et al., 1998). Lavender was also shown to improve performance and decrease the time required to perform math computations (Diego et al., 1998). Cedrol, a derivative of sandalwood, caused decreased heart rate and blood pressure at rest (Dayawansa et al., 2003). Studies by Raudenbush, Koon, Smith, and Zoladz (2003) and Raudenbush et al. (2002) have shown that the presence of pleasant or stimulating odors can increase sleep quality, motivation, and arousal, and decrease attention to time and perception of work.

The psychological and physiological changes that occur in the presence of various odors raise questions on how physical performance may be affected. Raudenbush et al. (2002) found that the presence of odor during a maximal treadmill test led to changes in motivation and perception of work; however, there were no changes in physiological responses such as heart rate and blood pressure. It is possible

that the physiological changes brought about by odor are not strong enough to override the changes induced by physical stress that comes with maximal effort. In a follow-up study, Raudenbush et al. (2001) found that the inhalation of peppermint odor improved athletic performance during a timed 400 m dash and push-ups to exhaustion. Although these experiments suggest that the presence of a stimulating odor can increase motivation and athletic performance, physiological changes, as well as the effects of unpleasant odors on performance, were not explored. The current study examined psychological and physiological responses to peppermint, dimethyl sulfide, and no odor during elbow flexion to fatigue. In addition, gender-specific responses were examined.

The Profile of Mood States (POMS) and the NASA-Task Load Index (NASA-TLX) were used to examine psychological responses. Different versions of the POMS (standard, shortened, & bipolar) have been used in thousands of studies to measure general mood states at a particular moment in time (McNair, Heuchert, & Shilony, 2003). The POMS has also been utilized by several researchers examining the effect of odor on mood (Diego et al., 1998; Raudenbush et al., 2002; Schiffman et al., 1995). A shortened version was created in the late 1980s to accommodate patients who, because of illness, needed more time to complete the profile (Shacham, 1983). Validity was established by Shacham (1983), who compared results of cancer patients on the standard 65 question POMS with the shortened 37 question format. The two forms produced comparable results, suggesting that the shortened version was as valid to test mood states as the longer version. Based on a 5-point scale, the POMS is divided into a variety of themes including Tension-Anxiety, Anger-Hostility, Revitalization,

Tranquility, and Physical Exhaustion (<https://www.mhs.com/index.htm>). The NASA-TLX was created by NASA Ames and utilized by Raudenbush et al. (2002) to measure perceived workload of an activity based on mental, physical, and temporal demands; personal performance; effort; and frustration. These questionnaires were used to determine mood and overall feelings about the task during the experimental sessions (NASA Ames, n.d.).

To determine hedonic value of each session, participants were asked to rank the odor on a scale of 0 to 10, where 10 equaled “very bad” and 0 equaled “very good”. If participants didn’t smell anything, they marked, “Did not smell anything.” Ratings of perceived exertion (RPE) were determined using the Borg 6-20 scale (Borg, 1976).

To date, the effect of odor on weightlifting performance has not been investigated. Since muscle movement is initiated in the brain and neuromuscular changes contribute to strength (McArdle et al., 2001), it seems logical that odor may affect the activation required to perform a task. Nonodor-related research has shown that positive arousal increased handgrip strength in athletes compared to negative arousal (Perkins, Wilson, & Kerr, 2001). Nonodor studies have shown that as the intensity of a biceps curl increased, perceived exertion and electromyographic activity of the biceps brachii muscle also increased (Lagally et al., 2002). The mechanism is believed to be due to neural branches that feed back to the sensory cortex. As more muscle is needed to lift an object, increased signals from the motor cortex are sent to the muscle to increase muscle fiber activation. These increased signals activate branches that go to the sensory cortex, increasing perceived work (Lagally et al., 2002). Whether

changes in perceived exertion with the presence of odor affect electromyographic activity is unknown. To investigate this phenomenon, integrated electromyography (iEMG) was measured from the biceps brachii to determine the amount of muscle activation during each repetition of a biceps curl in the presence of each odor. Heart rate was also measured at three intervals during each test session. Heart rate increases during exercise (McArdle et al., 2001) and is affected by particular odors (Bensafi et al., 2002; Dayawansa et al., 2003). Odor application was similar to Raudenbush et al. (2001), where a band-aid was infused with two drops of odorant and placed under the participant's nose. These odors have been previously found to be either stimulating (peppermint) or unpleasant (dimethyl sulfide) (Raudenbush et al., 2001, Raudenbush et al., 2002).

Several studies have suggested that odor may have a stronger effect on women than men. When presented with an orange scent in a dental waiting room, women experienced greater decreases in anxiety compared to men (Lehrner, Eckersbergerb, Wallaa, Potsch, & Deecke, 2000). In a study by Marchand & Arsenault (2002), women were able to tolerate the pain of having their hands submerged in hot water longer while inhaling a pleasant odor. Compared to males, female rats have also exhibited changes in pain behavior as well as altered limbic system activation after inhaling lemon odor (Ceccarelli, Lariviere, Fiorenzani, Sacerdote, & Aloisi, 2004). Finally, Yousem et al. (1999) found that odor caused activation of the frontal cortex in both men and women; however, women showed higher overall activation in both the frontal and temporal lobes.

Statement of the Problem

Odors have been shown to cause physiological and psychological responses such as changes in brain EEG, heart rate, blood pressure, mood, and perceived exertion (Bensafi et al., 2002; Dayawansa et al., 2003; Diego et al., 1998; Fulbright et al., 1998; Knasko, 1992; Nagai et al., 2000; Raudenbush et al., 2002; Schiffman et al., 1995). Currently, researchers are trying to determine whether these changes influence athletic performance. To date, a small number of studies have shown that certain odors, such as peppermint, may enhance performance. However, these studies have only shown a relationship between enhanced performance and psychological changes such as increased motivation and vigor, and decreased perception of work. It is unclear whether there are physiological changes that also facilitate these improvements. The effect of odor on strength performance has not been investigated to date. Finally, research has shown that gender differences may exist in the response to odor. Females have shown stronger responses to odors than men. Thus, women may show a stronger exercise response to odor.

Statement of Purpose

The purpose of this study was to determine whether there are gender-specific EMG and heart rate changes that correlate with mood, perceived exertion, and performance during elbow flexion to fatigue in the presence of peppermint and dimethyl sulfide.

Research Hypotheses

1. Under the dimethyl sulfide condition, participants will experience increased anxiety levels, tension, and fatigue. Vigor will be decreased, and the task will be labeled more difficult. These results will be reversed under the peppermint condition.
2. Ratings on the NASA-TLX will be higher under the dimethyl sulfide condition compared to the peppermint and nonodor control conditions. Physical, mental, and temporal demand will be higher, as well as effort and frustration levels. The peppermint condition will result in the opposite effect.
3. The increased anxiety caused by the dimethyl sulfide will cause increases in heart rate compared to the peppermint and control conditions.
4. Since muscle activity has been shown to increase as muscle movements become more difficult or intense, muscle activation during elbow flexion will be greater under the dimethyl sulfide compared to the peppermint and control conditions.
5. Since pleasant odors have been shown to decrease pain perception and improve physical performance, the number of repetitions in the presence of peppermint will be higher compared to the dimethyl sulfide and control conditions.
6. Since there is evidence that women exhibit a greater response to odor compared to men, it is expected that they will show greater changes in EMG

and heart rate (HR), as well as higher psychological ratings compared to men.

Delimitations

- Participants consisted of men and women between the ages of 18 and 35 years-of-age.
- Due to the apparatus being used, participants were required to curl 10 lbs (4.5 kg) at least 5 times to be included in the study.
- Due to the method of odor delivery, men were required to remove or trim facial hair above the upper lip.
- The odorants used were limited to peppermint and dimethyl sulfide.
- Since the study relied on one's sense of smell, individuals with allergies, sinus, or olfactory problems were excluded from the study.

Limitations

- Since the participants in the study were between 18 and 35 years-of-age, the results may not be generalized to other age groups.
- Whether an odor is labeled as pleasant or unpleasant is subjective. Although past research has labeled these odors as such, there may have been individual differences and, therefore, different responses to the odors.
- The current study did not test motivation levels at the time of the experiment. This could have affected performance and RPE.

- The experimental room was located next to a men's locker room. Although the room was aired out between participants, other odors, whether detected or not, could have affected the results.
- Participants who experienced the dimethyl sulfide in the first session may have experienced a condition aversion to the testing in general, which may have affected later sessions.
- Any muscle activation changes during elbow flexion cannot be attributed to one muscle. Both biceps brachii and brachioradialis are activated during elbow flexion. Since these muscles overlap, EMG electrodes can only be placed over the biceps brachii. Therefore, the signal picked up was a combination of both biceps brachii and brachioradialis.
- In order to accurately measure differences in EMG, each curl was performed within the set time limits of the experiment. Although participants had several occasions to practice, some participants may have had difficulty, which could have affected EMG and some psychological ratings, such as temporal demand, effort, or frustration.

Operational Definitions

Fatigue: The point where a given weight can no longer be lifted with proper form and tempo.

One Repetition Maximum (1RM): The amount of weight that can be lifted, with proper form, for one repetition. Proper form is based on National Strength and Conditioning Association (NSCA) guidelines for biceps curls (Earle & Baechle, 2004).

Ten Repetition Maximum (10RM): The amount of weight that can be lifted, with proper form, ten times.

Summary

Odor has been shown to change mood, affect motivation, and alter pain perception. There have also been physiological changes in EEG and heart rate associated with these emotional changes. Since odors affect behavior and physiology, odor may also affect physical activity. Research has shown that odor can change perceived effort and increase performance; even nonodor research has shown that athletes who were positively aroused were able to perform better compared to when negatively aroused. However, there is no evidence linking psychological and physiological responses. Studies show increased EMG recordings when RPE and weight levels increase. Several studies have shown gender differences in odor responses, so there is a question whether those differences will carry over to physical activity. The current study investigated psychological and physiological responses in men and women during elbow flexion to fatigue in the presence of peppermint and dimethyl sulfide.

Chapter II

Review of Literature

This section will begin by focusing on the basic anatomy concerning the sense of smell. It will include the major brain areas found to be affected by odors and evidence that links odors to the activation of particular brain areas. The next section will review physiological and psychological responses to odor. Evidence regarding gender differences will also be discussed. The final section will discuss the next step in olfactory research: how odors, both pleasant and unpleasant, could hinder or help physical performance.

Anatomy of Smell

The sense of smell begins with the inhalation of an odor through the nose. At the roof of the nose lies a mucus layer where the odor attaches to proteins and is carried to receptor cells. These receptor cells terminate on the olfactory bulb. From there, signals are sent by way of the olfactory tract to various areas of the brain, including the limbic system, thalamus, and the frontal cortex (Jacob, n.d.).

The limbic system is considered the emotional center of the brain. It is made up of several brain areas including the amygdala, septal nuclei, prepyriform cortex, entorhinal cortex, hippocampus, and subiculum. These structures are involved with emotion, learning, memory, and motivation, as well as effecting physiological changes in the body (Carlson, 1992; Jacob, n.d.). For example, the amygdala regulates fear responses and conditioning. It receives direct inputs, not only from the olfactory system, but also the visual and auditory systems. Once the amygdala is stimulated,

signals are sent to the hypothalamus and brainstem, activating the autonomic nervous system (ANS), to prepare the body's fight or flight response (Molavi, 1997).

Recording functional magnetic resonance imaging during the presentation of pleasant and unpleasant odors, Cheng (n.d.) found that both odors activated the left orbitofrontal cortex, the olfactory gyrus, and the piriform cortex. Unpleasant odors alone were shown to also activate the cerebellum, which the researchers interpreted as the body preparing for flight. In a second study by Zatorre et al. (2000), PET scans showed that both the pleasantness, or hedonic value, and intensity of an odor, activated the right orbitofrontal cortex as well as the cerebellum. The hypothalamus was also activated, but only when an odor was being judged for its hedonic value, and not its intensity. Fulbright et al. (1998) found changes in EEG in the presence of odors, with activation occurring in areas controlling motor functions and memory; however, unlike Cheng, they also noted varying activation patterns based on different hedonic values. Although clementine and isovaleric acid activated many of the same brain areas, the response strength differed for each odor. These results suggest that characteristics of an odor affect where it is processed in the brain, and response strength varies for odors processed in the same brain area.

In summary, anatomical data have shown that there are direct and indirect connections made from the olfactory bulb to areas of the brain that deal with emotion, motivation, and the body's physiological responses to stimuli. Various methods have been used to determine brain activation patterns based on characteristics such as hedonic value and intensity. Although more information is needed to fully understand

how odors are processed, it's probable that there are several brain areas affected by odors.

The Physiology and Psychology of Odor

There has been a surge of research investigating physiological and behavioral changes in the presence of an odor. Odor has been shown to create changes in mood (Diego et al., 1998; Knasko, 1992; Schiffman et al., 1995), alertness (Ilmberger et al., 2001), sleep quality (Badia, Boecher, & Wright, n.d.; Raudenbush et al., 2003), perception of pain (Marchand & Arsenault, 2002) and EEG (Diego et al., 1998; Fulbright et al., 1998), as well as ANS functions, such as heart rate and blood pressure (Bensafi et al., 2002; Dayawansa et al., 2003; Hongratanaworakit, 2004; Nagai et al., 2000). Variations in EEG activity have been seen in response to different odors. Diego et al. found increased alpha and beta power, denoting a relaxing effect, when participants were presented with lavender oil compared to rosemary, which decreased alpha and beta power.

Previous studies have also examined odor-induced emotions and ANS responses. In a study by Vernet-Maury, Alaoui-Ismaili, Dittmar, Delhomme, and Chanel (1999), skin potential, skin blood flow, temperature, instantaneous respiratory frequency, and instantaneous heart rate were recorded while participants inhaled five odors and rated them on hedonic value. Results indicated that there was a strong association between the quality of an odor and the emotional and ANS responses. For example, lavender was perceived as a pleasant odor and created feelings of happiness. This was also coupled with a significant drop in heart rate. Other studies have also

shown ANS changes. Unpleasant odors, such as isovaleric acid and thiophenol, were shown to increase heart rate (Bensafi et al., 2002). The odor cedrol, a derivative of cedarwood oil, has been shown to have a relaxing effect by decreasing heart rate and blood pressure compared to a nonodor control group (Dayawansa et al., 2003). By using high and low frequency heart rate variability, Dayawansa et al. were able to look at changes in baroreceptor sensitivity. They found that cedrol increased baroreceptor activity, causing an increase in parasympathetic activity and a decrease in sympathetic activity. These results suggest that brain areas such as the frontal cortex, hypothalamus, and limbic system are involved in controlling baroreceptor activity due to their involvement in odor processing. (Dayawansa et al., 2003).

Odors have been shown to be related to pain perception. In a study with male and female rats, Ceccarelli et al. (2004) determined that long term exposure to lemon increased the amount of time a rat was able to keep its paw on a radiant heat floor before removal. Female rats also exhibited a decrease in licking with exposure to lemon, a behavior performed in an area that is experiencing pain, after formalin, an irritant, was injected into their paws. Marchand and Arsenault (2002) compared the pleasantness of an odor with pain perception. Women first ranked a series of odors as being pleasant, unpleasant, or neutral. Those odors were then presented while the woman's hand was submerged in hot water. Results showed that the presentation of a pleasant odor increased the amount of time a hand was submerged in hot water compared to an unpleasant odor or neutral control. Raudenbush, Koon, Meyer, Corley, and Flower (2004) also found decreased pain sensations while investigating the effect of

peppermint and jasmine during a cold water pressor test. They noted that under both odor conditions, participants were able to tolerate a painful situation longer.

Psychological tests also showed that under the odor conditions, there was less anxiety, and decreased mental and physical demands. Physiological measures were also affected; there was an increase in pulse and decrease in blood pressure under the odor conditions compared to the nonodor control. Not all studies show an analgesic response to pain in the presence of an odor. Gedney, Glover, and Fillingim (2004) tested thermal, pressure, and ischemic pain in the presence of two known relaxing odors, lavender and rosemary. Results showed that odor did not increase the amount of pain that was tolerated, but did change the objective feelings toward the pain in that the overall experience was rated as being less intense and unpleasant in the presence of the odors.

Another psychological variable shown to be affected by odor is mood. Odors such as lavender, rosemary, and orange have been shown to create a more pleasant mood and decrease anxiety (Diego et al., 1998; Lehrner et al., 2000). Intermittent, unpleasant odors, such as those present in commercial swine operations, caused increased mood disturbances, confusion, and anger, and decreased vigor in individuals who lived nearby (Schiffman et al., 1995). In studying the effects of orange odorant and anxiety in women, Lehrner et al. (2000) found that when the odorant was infused into the waiting room of a dental office, female patients noted decreased anxiety and were in a better mood compared to control patients. Diego et al. (1998) found mood, alertness, and math computation changes in the presence of lavender and rosemary. For

both odors, participants felt more relaxed; however, those inhaling lavender were in a better mood. Rosemary was also shown to increase alertness in the participants. In both conditions, math computations were completed at a much faster rate compared to the nonodor control group; however, only the lavender group showed increased accuracy. It was suggested that the rosemary distracted the participants; however, since computations were completed in the same amount of time, the distraction effect may have been minimal.

Although the idea that odors may cause distraction in a task cannot be assumed by the Diego et al. (1998) study, this has been shown in studies investigating motor time. Ilmberger et al. (2001) had participants perform a simple motor task of releasing their hand from one button and moving to another button. This was done first in the presence of water, then in the presence of either no odor (control condition) or one of several odors including menthol, ylang-ylang, jasmine, cineole, and peppermint (experimental condition). A learning effect was noted in the nonodor control group; there was a decrease in the amount of time needed to perform the task. Except for the odor cineole, all other odors caused an increase in time which was attributed to the distraction of the odors. This conclusion is more clearly seen when looking at the emotional experience between the first and second sessions. Those participants who perceived the water in the first session as pleasant found the presence of the odor in the second session as unpleasant and, as a result, showed a longer reaction time during the test. It is possible that the unexpected odor caused the attachment of a negative emotion, despite any positive hedonic value that would regularly be attributed to the

odor. This was also seen in a study by Heuberger, Hongratanaworakit, Bohm, Weber, and Buchbauer (2001) where both psychological and pharmacological responses to odor were tested. The odor (-)-carvone, an odor which smells like spearmint, was deemed pleasant and led to a cheerful psychological response that was associated with decreases in blood pressure and pulse rate. However, increases in respiratory rate, leading to an increase in the amount of fragrance being inhaled, caused an increase in anxiety and blood pressure. This shows that although an odor may be judged as pleasant and associated with specific physiological changes, variations in the intensity of the odor may cause a different response.

The variation in responses should be taken into account when trying to understand the true effect of an odor. If a once neutral odor is paired with an emotional stimulus, that alone would cause physiological changes; that once neutral odor will be capable of initiating the same physiological responses as the emotional stimulus. This phenomenon has been referred to as a conditioned response (Carlson, 1992). The classic example is the work of Ivan Pavlov. The presence of food causes a dog to salivate. When the presence of food was regularly paired with the sound of a bell, the bell alone initiated the same salivating response (Carlson, 1992). It is possible that the decrease in anxiety in the Lehrner et al. (2000) study, where an orange odor was infused in a dental waiting room, was not due to any direct effect of orange odor on the brain, but by masking the smell of eugenol, an odor found in dental products and associated with pain. The odors emitted from the swine operations (Schiffman et al., 1995) may have been mixed with possible toxic chemicals in the area, causing physical sickness

and subsequent conditioning. However, the presence of toxic chemicals was an explanation suggested by the authors and has not been confirmed. In a study by Knasko (1992), students were exposed to a room with lemon, lavender, dimethyl sulfide, or no odor. Intelligence, personality, mood, and pleasantness were measured. Results indicated that for unpleasant odors, mood was decreased. They also noted a conditioning effect where those who received the unpleasant odor in the first session were in a bad mood when returning to the same room, even when no odor was present.

Although responses in the presence of a particular odor may be caused by a conditioned response, research has also shown that an odor's specific characteristic alone can have its own effect. Odors that have either been described with similar attributes, or have gone undetected, resulted in different EEG changes (Lorig, 1991). In a study by Raudenbush et al. (2003), participants were exposed to three separate odor conditions while sleeping: jasmine, lavender, and no odor. When exposed to jasmine, participants experienced a decrease in movement which improved the quality of that night's sleep. Participants were also more motivated and less anxious the next day, and showed increases in cognitive performance. Although the results of this study seem promising for a good night's rest, Badia et al. (n.d.) found that the introduction of a pleasant odor during sleep caused increased phase shifts, leading to intermittent sleep. In a second experiment, the same author presented the odor androstenone, an odor that holds pheromone-like properties and has been labeled as pleasant, unpleasant, or has been undetected. This experiment not only compared the effects of odor based on hedonic value (pleasant, unpleasant, or neutral), but also looked at anosmics (people

who cannot smell) and osmics (those who can smell the odor). All participants, except those who rated the odor as neutral, showed a disruption of sleep, suggesting that chemical make-up of odor is, at times, all that is needed to cause a physiological response.

In summary, odors can cause psychological as well as physiological changes in the body. Mood, anxiety, pain perception, EEG, heart rate, and blood pressure have changed in response to the hedonic values of an odor. The actual changes that occur can be driven by either direct stimulation between the odor molecules and the brain, or associations created between an odor and an event or memory. Future research should focus on these differences to further our understanding of the nature of odor and how we can best utilize the benefits that come from its use.

Gender Differences

Several studies suggest that the response to odor may be greater in females than males (Ceccarelli et al., 2004; Lehrner et al., 2000; Marchand & Arsenault, 2002; Yousem et al., 1999). When presented with an orange scent in a dental waiting room, Lehrner et al. found that women experienced greater decreases in anxiety compared to men. In a study by Marchand & Arsenault (2002), women were able to tolerate the pain of having their hand submersed in hot water longer while inhaling odors labeled as pleasant, such as baby oil, vanilla, and almond. Compared to males, female rats have exhibited changes in pain behavior as well as altered limbic system activation after inhaling lemon odor (Ceccarelli et al., 2004). Magnetic resonance images taken during inhalation of odor shows activation in the right frontal cortex for both sexes; however,

there was greater overall temporal lobe activation in women compared to greater left temporal lobe activation in men (Yousem et al., 1999). The same study also showed that women had greater activation in most areas compared to men. Although more studies are warranted to confirm these data, there may be gender differences in the sense of smell. Whether these differences can be attributed to hormonal changes or anatomical differences in the brain has yet to be fully determined.

Odors and Physical Performance

The psychological and physiological changes that occur in the presence of various odors raise questions whether physical performance may be affected. Only a few research studies have looked at the effects of odors on physical performance. In the presence of peppermint odor during a maximal treadmill test, increased motivation and decreased perception of work were noted; whereas, decreased motivation and increased perception of work were seen in the presence of dimethyl sulfide (Raudenbush et al., 2002). The study also looked at physiological differences in heart rate, blood pressure, oxygen saturation, and mean arterial pressure. None of the expected physiological changes were observed. Although lavender had been shown to decrease heart rate in another study (Vernet-Maury et al., 1999), there was no overall decrease in heart rate at maximal effort. In a follow-up study by Raudenbush et al. (2001), athletes were required to perform several sport-training tasks, such as a timed 400 m dash and push-ups to exhaustion, in the presence of peppermint odor. They found that performance improved with the inhalation of peppermint compared to a nonodor control. Although these experiments confirmed that increases in motivation due to the presence of a

stimulating odor may enhance athletic performance, associated physiological changes are still in question. Lavender is known to cause relaxation (Diego et al., 1998; Vernet-Maury et al., 1999). During the maximal treadmill test, however, there was no decrease in heart rate at the maximal level. It is possible that the physiological changes brought about by odor are not strong enough to override the changes brought about by the physical stress that comes with maximal effort. Physiological changes have been seen, however, during hand grip exercises in the presence of a pleasant odor. Nagai et al. (2000) studied blood pressure (BP), finger pulse (FP), respiratory rate (RR) and skin temperature (ST) responses during rhythmic and static hand grip exercises while participants inhaled an odor they found relaxing. Results showed that both rhythmic and static exercises alone caused increases in BP, RR, and FP; however, diastolic blood pressure significantly decreased for participants in the odor group during rhythmic hand grips. More research is needed to investigate whether there is a relationship between the psychological effects that odors have on performance and the physiological changes seen during performance.

Summary

The sense of smell anatomically taps into various areas of the brain that control emotions, motivations, and physiological changes. It has been shown that there are strong psychological links between the hedonic value of an odor and mood level. Changes in ANS function, such as heart rate and EEG, have also been associated with these psychological changes. Women have greater brain activation to odors than men, which leads to an increased emotional response. Whether one's response to odor is due

to conditioning or direct stimulation, the effects may change behavior and performance. Current and future studies may open new doors to how odors can be utilized to enhance physical performance.

Chapter III

Methodology

This section reviews the manner in which this study was executed. The participants, instruments, research design, and statistical analyses are described.

Participants

Participants consisted of 30 volunteers (14 men and 16 women) between the ages of 18-35 years. Participants were both trained and untrained, and participating in some sort of weekly exercise activity. Participants who had allergies, sinus/olfactory problems, or arm injuries were excluded from participating in the study.

Instruments

Profile of Mood States (POMS). The POMS was used to determine active mood states. Used extensively in previous research, it provides feedback regarding the mood at a particular moment in time. Participants rated 37 words that describe mood on a 5-point scale based on six different areas: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment (Multi-Health Systems Inc., n.d.; Raudenbush et al., 2002). Ratings were scored following the QuickScore instructions provided with the POMS. In addition to the six areas indicated, the QuickScore form also provided results for Total Mood Disturbance based on a combination of the six subsections. Results for each condition were then transferred to an Excel (Microsoft Corporation) document for analysis.

NASA-Task Load Index (NASA-TLX). The NASA-TLX assessed perceived workload of an activity based on six subscales. Three subscales measure the demands

imposed on the participant: mental, physical, and temporal, and three subscales measure the perception of the task itself: participant's performance, effort, and frustration (NASA Ames, n.d.). The computer version of the test was utilized for this experiment. Once participants completed the test, scores for each subscale were calculated by the program and saved. These scores were then placed in an Excel document for analysis.

Electromyography (EMG). A BIOPAC MP30 was used to measure the electrical activity associated with a muscle contraction. Participants were asked to flex at both the shoulder and elbow of their right arm. A permanent black marker was used to place a line across the greatest circumference of the biceps area. Two surface electrodes, 35mm in diameter (BIOPAC EL503), were placed on either side of that line, without touching, while a reference electrode was placed at the acromion process (Basmajian & Blumenstein, 1980). The sites were shaved, abraded, and wiped with alcohol to remove oils and enhance transmission of the EMG signal. Electrodes were connected to a four input analog-to-digital converter via a shielded electrode lead set (BIOPAC SS2L). EMG data were collected 1 s before, and continuously during the biceps curl exercise until the point of fatigue. Incoming signals were then converted to digital signals. Using Microsoft Excel, raw data were corrected for DC bias and full wave rectified. Linear envelopes were created using a Butterworth program. A frequency of 1 Hz was used to smooth the data. A computer program was written to locate the maximum and minimum values within the data, note the point in time that each peak occurred, determine each curl cycle, and calculate iEMG between each peak (Appendix A). The time taken to perform each curl was then calculated. Curls shorter

than 2.7 s or longer than 3.3 s were removed from the session. Data from participants who performed fewer than five valid curls for a session were removed from the EMG analysis. The average iEMG for each session was determined and placed in an Excel sheet for analysis.

Odors. Peppermint (Sigma Aldrich) and dimethyl sulfide (Sigma Aldrich) were used during the study. Each odor had been previously shown to have specific characteristics such as stimulating or unpleasant (Raudenbush et al. 2001; Raudenbush et al., 2002). Similar to the study by Raudenbush et al. (2001), two drops of undiluted peppermint oil were placed on the cotton area of a band-aid and adhered under the participant's nose. It had been determined that one drop was similar to a 20 μ l amount drawn from a pipette. To keep both odor amounts consistent, two 20 μ l drops of odorant were used. Since dimethyl sulfide has not previously been delivered by this method, the concentration of dimethyl sulfide, comparable to the undiluted peppermint, was subjectively determined. Two volunteers, who did not participate in the study, had an adhesive strip placed under their noses with a dilution of dimethyl sulfide. They were asked to think about the intensity of the smell rather than the hedonic value of the odor. The strip was left on for at least 2 min to confirm that the odor intensity could be maintained for that period of time. Once the strip was removed, they were asked to breathe outside air for 5 min while the peppermint strip was prepared. The same procedure was followed with a peppermint strip. The process was repeated until it was determined that two 20 μ l drops of a solution consisting of 50% dimethyl sulfide, 50% ethyl alcohol provided the same intensity as the undiluted peppermint oil.

Pulley machine for biceps curls. A Universal Gym pulley machine with a single hand grip was used to perform biceps curls. All participants performed curls using their right arm. A piece of felt was attached to the front of the weight stack to prevent the participant from viewing the weight lifted.

Heart rate monitor. A Polar heart rate transmitter was placed just below the chest. Tap water was used to wet the skin side of the transmitter. The watch monitor was placed around the participant's left wrist.

Research Design

This study was approved by the University's Institutional Review Board (Appendix B). Participants attended four test sessions alone, with only the test administrator in the room. Each session was separated by no less than 48 hr. Odor conditions were randomly assigned for each participant and counterbalanced. Between testing sessions, participants were asked to refrain from weight lifting and other activities that would fatigue their upper body. They were also asked to refrain from aromatherapy or using scented soaps, perfumes, or lotions for the duration of the study. Deodorants were accepted; however, participants were asked not to change their current product during the study. Men with facial hair were instructed to shave mustaches in order to participate in the study. Men with upper lip stubble were accepted as long as the band-aid was able to adhere to the skin. Prior to reporting to the first session, participants were asked to complete a medical history form (Appendix C). Upon arrival, the participant read and signed a consent form agreeing to participate in the study (Appendix D). Procedures were then described, and instructions for the NASA-

TLX were read to the participant (Appendix E). Participants were also shown a copy of the POMS to review. The participant was then allowed to ask any questions for clarification. The participant was instructed on the proper technique for performing a biceps curl and practiced curls at the tempo required for the test using a 2 lb (0.9 kg) dumbbell. The test tempo for performing a curl consisted of a 1 s concentric contraction, followed by a 2 s eccentric contraction. National Strength and Conditioning Association instructions and guidelines were used to estimate trial loads for 10RM testing (Earle & Baechle, 2004; Appendix F). After instructions were given, the participant warmed up by performing 10 biceps curls with a dumbbell that weighed 50% of the estimated 10RM workload at the test tempo. After the participant warmed up, 10RM was determined and 1RM was estimated using NSCA tables (Earle & Baechle, 2004). The participant was then scheduled for the second test session.

For the remaining three sessions, participants entered the testing area and attached a heart rate monitor. During this time, they were instructed that they would be lifting a random weight that was a percentage of their estimated 1RM; however, they were not able to see the weight stack being lifted or told the exact percentage. They were also told they would have a strip placed under their nose that may smell pleasant, unpleasant, or like nothing at all. Electrode placement was then determined, and the sites over the biceps brachii were prepared. After the EMG was hooked up, the participant was asked to sit quietly while baseline heart rate was determined. Baseline HR was taken when HR fluctuations were within 1-2 beats per minute. After this, a band-aid infused with peppermint, dimethyl sulfide, or water was placed under the

participant's nose. After 30 s, a second heart rate was recorded. The participant was then instructed to stand and pick up the pulley handle. Once in position, the participant was instructed when to start, and biceps curls were performed until fatigue while EMG was recorded. At fatigue, a final HR was recorded, and the EMG electrodes were removed. Each participant was then instructed to complete a questionnaire regarding the odor's hedonic value and RPE for the overall task (Appendix G). Next, the POMS and NASA-TLX questionnaires were completed. Participants were reminded to ask for clarification when needed. A copy of the subscale definitions for the NASA-TLX was provided for reference (Appendix H). The participants were then scheduled for any additional test sessions. After the final session, participants were asked what they thought of the study, if they noticed any changes in weight, and other comments.

Statistical Analysis

The independent variables in the study were the odor conditions (peppermint, dimethyl sulfide, no odor) and gender. The dependent variables included average iEMG, number of biceps repetitions, RPE, heart rate, POMS, and NASA-TLX data. Two-way repeated measures analysis of variance (ANOVA) using Sigma Stat version 3.5 (Systat Software, Inc.) was used to examine the effects of odor and gender on each of the dependent variables.

Summary

Participants performed biceps curls to fatigue under three odor conditions. Psychological and physiological data were collected and analyzed for significant differences between odor conditions, gender, and interaction between odor conditions and gender.

Chapter IV

Results

The following section examines the effect of odor on physiological responses. In addition, differences between men and women were examined.

Heart Rate

Heart rate measurements were taken at rest with no odor present (RNO), at rest after 30 s of odor presentation (RO), and at fatigue (FAT). Since there are individual differences in resting heart rates, differences between RNO-RO, FAT-RO and FAT-RNO were calculated. A two-way repeated measures ANOVA was performed to examine differences between gender, odor condition, and the interaction between gender and odor. Heart rate data are shown in Table 1. A negative number indicates that the second measure was larger than the first. Since there was no statistically significant difference in heart rate responses in men and women, data in Table 1 represent differences by odor condition only.

RNO-RO. There was a statistically significant difference in heart rate based on odor condition ($F_{(2,56)} = 4.22, p = .02$). Post-hoc analysis using a Tukey test showed that heart rate was higher after the odor strip was presented in the dimethyl sulfide group compared to the control group. There was no statistically significant difference for gender and the interaction between gender and odor.

FAT-RNO and FAT-RO. There was no statistically significant difference for odor condition, gender, and the interaction between gender and odor at fatigue. The heart rate required for maximal effort was the same for each odor condition. Heart rate

increased an average of 36 beats per min when compared to heart rate during rest with no odor. Heart rate also increased an average of 34 beats per min when compared to heart rate at rest with odor present.

Table 1

Heart Rate Response for Each Odor Condition

Calculation	Control	Peppermint	Dimethyl Sulfide
RNO-RO	-.49 (1.10)	-2.40 (1.10)	-5.00 (1.10)
FAT-RNO	35.75 (2.19)	36.30 (2.24)	37.04 (2.31)
FAT-RO	35.26 (2.20)	33.76 (2.25)	33.38 (2.32)

Note. Top numbers are means. Numbers in parentheses are standard deviations. RNO = resting no odor; RO = resting with odor strip; FAT = fatigue. Fatigue heart rates were not recorded for two participants during the dimethyl sulfide condition, and one participant during the peppermint condition.

Performance

There was no statistically significant difference in the number of biceps curls performed by men and women. The number of repetitions ranged from 7 to 17 with an average of 10 reps. Odor did not affect the number of curls performed at fatigue.

EMG

A two-way repeated measures ANOVA was performed on the average iEMG for each condition. Means and standard deviations for each odor condition are shown in Table 2. Five participants were removed from this analysis because they did not meet the minimum requirement of 5 repetitions after EMG data were smoothed and analyzed. There was no statistically significant difference based on odor. There was a statistically significant difference between men and women ($F_{(1,46)} = 10.19, p = .004$). Data showed that muscle activation was higher in men, 931.74 mV·sec (± 88.19) compared to women who averaged 507.30 mV·sec (± 99.50).

Physiological data show that during rest, there was a significantly higher heart rate response when presented with dimethyl sulfide. Although there were no significant differences in performance or EMG activation in the presence of odor, men had greater muscle activation compared to women.

Table 2

iEMG Results for Odor Condition and Gender

	Control	Peppermint	Dimethyl Sulfide
Average iEMG: Men	957.80 (27.72)	918.81 (27.72)	918.62 (27.72)
Average iEMG: Women	474.59 (31.27)	496.11 (31.27)	551.21 (31.27)
Average iEMG: Combined	716.19 (20.89)	707.46 (20.89)	734.91 (20.89)

Note: Top numbers are means. Numbers in parentheses are standard deviations. All results are in mV·sec.

The following section examines the effect of odor on the following psychological measures: Hedonic Value, RPE, POMS, and NASA-TLX. In addition, differences between men and women were examined.

Hedonic Value

Participants were asked to rate the hedonic value of the odor on a scale from 0 to 10 (very pleasant to very unpleasant) with 5 being neutral; they could also check “I did not smell anything”. Results for peppermint ranged from 0-5 with 63% of the participants rating between 0 and 2, and 37% rating between 3 and 5. Only one participant gave peppermint a 5 rating. Ratings for dimethyl sulfide ranged from 4 to 10 with 40% of the participants rating between 4 and 7, and 60% of the participants

rating between 8-10. Only 1 participant rated dimethyl sulfide at a 4. All but four participants said they could not smell anything during the control session. Of those four, three rated the odor at a 5 and one person rated it a 6.

Ratings of Perceived Exertion

At the end of each session, participants were asked to note their RPE on a scale of 6-20. There were no significant differences between odor condition or the interaction between gender and odor. Ratings ranged between 8-17 with only a 1-3 step difference within each participant's data. Although not statistically significant, men tended to rate their exertion higher ($F_{(1,56)} = 3.65, p = .066$). Questions posed to the participants after the study failed to yield a consistent response in regard to the amount of weight lifted. Although some participants felt one session was more difficult, there was no consistency as to which condition was harder.

Profile of Mood States

A two-way repeated measures ANOVA was performed for each POMS subsection. Gender, odor condition, and the interaction between gender and odor were evaluated. Table 3 shows the means and standard deviations for effects of odor for each subsection of the POMS test. Higher numbers indicate an increase for the particular measure. For example, a higher number for fatigue means that participants were more fatigued for that condition compared to the others. Except for fatigue, there were no significant differences for gender or the interaction between gender and odor. Therefore, Table 3 shows the means and standard deviations for each subsection with genders combined. Figure 1 shows the ratings of fatigue for men and women.

Table 3
POMS Results for Each Odor Condition

	Control	Peppermint	Dimethyl Sulfide
Total Mood	3.91	.82	5.79
Disturbance	(.93)	(.93)	(.93)
Tension	2.21 (.29)	1.36 (.29)	2.60 (.29)
Depression	.30 (.13)	.29 (.13)	.65 (.13)
Anger	.61 (.23)	.10 (.23)	1.02 (.23)
Vigor	5.68 (.49)	6.46 (.49)	4.92 (.49)
Fatigue	2.56 (.28)	2.42 (.28)	2.69 (.28)
Confusion	3.42 (.22)	3.11 (.22)	3.71 (.22)

Note: Top numbers are means. Numbers in parentheses are standard deviations.

Figure 1. Gender differences in the POMS rating for fatigue.

Total mood disturbance, tension, and anger. Odor had a significant effect on total mood disturbance ($F_{(2,56)} = 7.22, p = .002$), tension ($F_{(2,56)} = 4.82, p = .012$), and anger ($F_{(2,56)} = 4.14, p = .021$). Post-hoc analyses using the Holm-Sidak method showed ratings in these subsections were higher under dimethyl sulfide compared to the peppermint condition. Analysis also showed a statistically significant difference between the control and peppermint conditions for total mood disturbance, with peppermint resulting in a lower mood disturbance. There were no statistically significant differences between men and women for these subsections.

Depression and vigor. Although not statistically significant, odor affected depression ($F_{(2,56)} = 2.50, p = .091$) and vigor ($F_{(2,56)} = 2.47, p = .094$). Participants appeared more vigorous and less depressed under the peppermint condition compared to dimethyl sulfide.

Fatigue and confusion. There was a significant difference in the interaction between gender and odor for fatigue ($F_{(2,56)} = 3.35, p = .042$). Post-hoc analysis using the Holm-Sidak method showed women rated themselves as less fatigued (1.63 ± 0.38) under the peppermint condition compared to men (3.21 ± 0.41). There were no other statistically significant differences for fatigue and no statistically significant differences for confusion.

NASA-Task Load Index

A two-way repeated measures ANOVA was performed for each subsection of the NASA-TLX. Gender, odor, and the interaction between gender and odor were evaluated. Table 4 shows the effects of odor on each subsection of the NASA-TLX.

Since there were no statistically significant differences between men and women, the data were combined. A higher number for each subsection indicates a higher demand or effort was indicated for the task.

Table 4

NASA-TLX Results for Each Odor Condition

NASA-TLX Subsection	Control	Peppermint	Dimethyl Sulfide
Total Work Load	48.96 (1.53)	49.52 (1.53)	50.86 (1.53)
Physical Demand	54.58 (1.82)	58.55 (1.82)	53.26 (1.82)
Mental Demand	29.04 (3.07)	27.08 (3.07)	35.58 (3.07)
Temporal Demand	41.14 (2.97)	48.55 (2.97)	51.36 (2.97)
Effort	53.30 (2.57)	58.33 (2.57)	51.63 (2.57)
Performance	42.19 (2.39)	38.82 (2.39)	43.82 (2.39)
Frustration	23.19 (3.19)	21.38 (3.19)	32.66 (3.19)

Note: Top numbers are means. Numbers in parentheses are standard deviations.

Total workload, physical demand, mental demand, effort, and performance. For the above subsections, there were no statistically significant differences for odor conditions. Additionally, there were no significant differences between men and women, or the interaction between gender and odor condition.

Temporal demand. There was a statistically significant difference for odor condition ($F_{(2,56)} = 3.17$, $p = .050$). However, post-hoc analysis using the Holm-Sidak method did not yield a statistically significant difference for any of the paired comparisons. Looking at the means, temporal demand, or the pressure felt due to the pace of the task, was rated higher in the dimethyl sulfide session compared to the control session. There was no significant difference for gender.

Frustration. There was a significant difference for odor condition ($F_{(2,56)} = 3.60$, $p = .034$). Post-hoc analysis using the Holm-Sidak method showed higher frustration levels under dimethyl sulfide compared to peppermint. There was no significant difference for gender.

Results from the psychological data show that dimethyl sulfide increased total mood disturbance, tension, anger, temporal demand, and frustration. There was also a trend in that participants felt less depressed and more vigorous under the peppermint condition, with women feeling significantly less fatigued.

Chapter V

Discussion

The purpose of this study was to determine whether there are gender-specific EMG and heart rate changes that are consistent with changes in mood, perceived exertion, and performance during elbow flexion to fatigue in the presence of peppermint and dimethyl sulfide.

Results from psychological measures yielded similar results to other studies. Exposure to dimethyl sulfide caused participants to have increased mood disturbance, tension, and anger. These results are similar to Schiffman et al. (1995) who found increased anxiety, depression, and anger ratings in people who lived near a commercial swine factory. Although there was not a significant difference in depression, there was a close to significant trend in depression rating with the dimethyl sulfide odor. Participants rated themselves more depressed during the dimethyl sulfide session. Although not statistically significant, there was a close to significant increase in ratings of vigor under the peppermint condition. Previous research by Raudenbush et al. (2002) showed increased vigor ratings under a peppermint condition when participants performed a maximal aerobic test. In the current study, comments by participants after the peppermint condition included “increased energy” and “I felt like I wanted to do more.”

Ratings from the NASA-TLX differed from previous research. Similar to Raudenbush et al. (2002), increased frustration with dimethyl sulfide was found. Also, as reported by Raudenbush (2002), a difference in temporal demand was also found;

however, our post-hoc analysis did not yield a significant difference between conditions. It's possible that, despite several practice sessions, the timing established for the phases of the biceps curl continued to confuse some participants. This would increase temporal demand for all three conditions. Another comment was, "I could have kept going, but not at that pace." Unlike Raudenbush et al. (2002), no significant differences were found for physical demand, mental demand, effort, and performance.

Several studies have shown that HR is affected by odor (Bensafi et al., 2002; Dayawansa et al., 2003; Nagai et al., 2000). Although we found that HR was significantly higher when presented with dimethyl sulfide at rest, odor did not have an effect on HR at fatigue, despite an increase in anxiety levels. This is similar to Raudenbush et al. (2002) who found that HR and blood pressure were not affected by odor during maximal effort. Since participants were working to fatigue, it is likely that the body's own needs would override any effect the odor would produce. Under submaximal effort, this may not be the case.

It was hypothesized that the number of repetitions would change based on odor condition. Since peppermint has been shown to have pain-reducing qualities (Ceccarelli et al., 2004; Marchand & Arsenault, 2002; Raudenbush et al., 2004), as well as improving performance of push-ups and a 400 m dash (Raudenbush et al., 2001), it was expected that the number of repetitions would increase during the peppermint session. However, this was not found under the conditions of the current study. As mentioned previously, one participant noted that he/she could have continued performing curls if able to do so without taking pace into consideration. Since EMG was being measured,

the quality of the movement needed to be more precise than would ordinarily be expected during a workout session or sporting activity. This could have affected any improvement of performance due to the stimulating effect of the odor. In a study by Perkins et al. (2001), performance increased when positively aroused. However, handgrip strength was measured, which may be considered less complex than a biceps curl.

Although gender differences have been found in the presence of odors (Ceccarelli et al., 2004; Lehrner et al., 2000; Marchand & Arsenault, 2002; Yousem et al., 1999), studies involving physical activity have not shown an interaction between gender and odor. In the current study, only one statistically significant gender/odor interaction was found in how women rated their fatigue. Lower levels of fatigue were found in women under the peppermint condition; whereas, men were more fatigued compared to the other two conditions. These results differ from Raudenbush et al. (2002) who found a significant difference in odor condition, but not a gender and odor interaction. The cause of the increase in fatigue under the peppermint condition is unknown. It's unclear whether these results are due to random chance or if the stimulating effect of peppermint caused men to work harder, thereby becoming more fatigued. Men did have significantly higher EMG activation compared to women; however, there were no odor differences in EMG.

Although several other researchers have used dimethyl sulfide, this is the first study to deliver dimethyl sulfide on a strip that fit under the nose. A concern during the study was that the intensity of the dimethyl sulfide solution diminished with time. It's

also important to remember that odor pleasantness is subjective. Comments received after the dimethyl sulfide exposure were: “That smelt bad, but it reminded me of my mother’s kim chi.” “My girlfriend is vegan and has made worse smelling stuff than this.” Additionally, other participants felt that the odor reminded them of garlic or asparagus. It’s possible that the concentration of dimethyl sulfide was not strong enough and, therefore, seemed more familiar for those individuals with specific diets. Two other measures showed significant or close to significant effects for gender, but not for odor. Men had higher RPE values and EMG activity. Previous research has shown higher RPE with increased EMG activity (Lagally et al., 2002). Although men and women were working at their 10RM workload, because men have more muscle mass, they would be expected to activate more muscle to complete a curl at any relative intensity. This would especially be seen at fatigue where the majority of muscle fibers are likely to be activated. Although, why they would have higher RPE levels is unknown.

This is the first study to examine the effect of odor on performance while also measuring muscle activity. Since increased ratings of physical demand have been reported in the presence of dimethyl sulfide (Raudenbush et al., 2002) and increased workload has led to increases in both RPE and EMG (Lagally et al., 2002), it could be hypothesized that muscle activity would be increased if a task was perceived as more physically demanding. However, there was no significant difference in EMG activity between peppermint and dimethyl sulfide conditions.

Although no research has been done to determine what value would indicate a significant increase in EMG activity, 9 of the 25 participants had a 200-400 mV·sec difference between the various conditions. Of these 9, the odor condition that had the highest average EMG differed. It should also be noted that RPE and number of repetitions also differed. For example, one participant produced higher EMG activity during the dimethyl sulfide session compared to the control and peppermint sessions. However, his RPE was higher during the peppermint session (16) compared to control (14) and dimethyl sulfide (15), and the number of repetitions differed: 15 (peppermint), 14 (control), and 16 (dimethyl sulfide). Since the weight lifted at each session remained constant and the participants indicated no injuries or fatigue prior to starting a session, it's unclear why there would be a large change in EMG between sessions, and why it could not be predicted based on odor condition. It's possible that the answer lies in the subjective feelings of the participants. Individuals who are distracted by the odor may feel they can work harder during the no odor session. Those who are bothered by the dimethyl sulfide may feel the need to give more because they feel more anxiety, or they may work less so they can finish faster. Finally, the increased vigor caused by the peppermint odor could encourage participants to work harder with each curl. Whatever the cause, any large change in muscle activation may be related to an emotional response.

There are several areas where future research could focus. The POMS test was only provided at the end of each session. Since mood could have been affected by events before each session, mood should be evaluated both before and after the exercise

task. Odor is also a subjective measure. The odors chosen for this experiment have been shown to cause certain reactions; however, even the dimethyl sulfide was rated toward neutral by some participants. Future studies could individualize odor selection. After a participant rates a variety of odors, those odors rated as pleasant and unpleasant could then be used for that participant. Because an older model pulley machine was used to perform the biceps curls, the minimum amount of weight that could be lifted was 10 lbs (4.5 kg). This made it difficult to find female participants who were fit enough to perform a 10 lb single arm biceps curl 10 times with proper form. Also, it is likely that participants were lifting slightly more than 10 lbs since the weight of the handle or pulley system was probably not used to compute overall weight lifted. Future research might focus on single leg knee extensions since leg strength is generally greater, allowing for more qualified participants. Since studies measuring heart rate have been done at maximal effort or to fatigue, responses during submaximal effort should be explored. More research on the mechanisms underlying the effects of odor could also shed light on why certain odors, such as peppermint, effect changes in mood and pain perception. Applications of this research could be used to answer questions such as: Would infusing an odor such as sandalwood into a yoga studio help participants relax? Would infusing a gym with peppermint increase attendance in fitness centers and enhance workouts?

Summary

This study sought to determine whether exposure to pleasant and unpleasant odor caused gender-specific changes in muscle activity that were associated with subjective and objective measures such as mood, exertion, and performance. Several results mirrored past research. There was increased anxiety and frustration during the dimethyl sulfide condition compared to peppermint. There were also ratings of increased vigor during the peppermint condition. However, muscle activity was not consistent with the subjective measures. Differences in EMG activity do leave open the question whether odor plays a role in muscle activation. Gender differences in fatigue were seen during the peppermint condition and could be caused by increased olfactory sensitivity previously seen in women. The effects of odor on physiological responses and performance are still not completely understood. Further studies are needed to fully understand this relationship and future applications of this research.

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Appendix A

Program to organize iEMG data. Created by Walter F. Drummond III, 2007.

```
#!/usr/bin/perl
use Getopt::Std;

$RISING = 1;
$FALLING = -1;
$STARTING = 5;
$ROWS = 3;

$SEEN_FIRST_PEAK = 0;

@out = undef;

sub peak {
    my $line = shift;
    my $row = shift;
    my $value = shift;
    my $nextvalue = shift;
    my $force = shift;
    local *rundata = shift;
    my $p = 0;
    my $peak = 0;
    my $s = 0;

    if ($force) {
        $s = $rundata{sum};
        $p = $value;
        $peak = $value;
    } else {
        my $newdir = $nextvalue <=> $value;
        if ($newdir != 0 && $newdir != $rundata{direction}) {
            if ($rundata{direction} == $RISING) {
                # There's about to be a direction change. If the
current direction
                # is RISING, we're about to FALL, so save the
accumulated sum
                # and zero the counter but only if we've seen a peak
already.
                if ($SEEN_FIRST_PEAK) {
                    $s = $rundata{sum} + $value;
                    $rundata{sum} = -$value;
                    # printf("\t EOC: value $value sum $s force
$force\n");
                }
            }
        }
    }
}
```

```

    }
    $peak = $value;
    $SEEN_FIRST_PEAK = 1;
    }
    $rundata{direction} = $newdir;
    $p = $value;
  }
}

$rundata{sum} += $value if ($SEEN_FIRST_PEAK);
$out[$line][$row][0] = $value;
$out[$line][$row][1] = $p;
$out[$line][$row][2] = $peak;
$out[$line][$row][3] = $s;

}

### MAIN

getopts('ab');

# Setup hashes as needed.
for($i = 0; $i < $ROWS; $i++) {
    $h[$i]{direction} = $STARTING;
    $h[$i]{sum} = 0;
    $h[$i]{row} = $i;
}

# Read data set into memory
$l = 0;
$lines = 0;
while (<>) {
    chomp();
    @p = split(',');
    for ($j = 0; $j < $ROWS; $j++) {
        $l[$lines][$j] = $p[$j];
    }
    $lines++;
}

# Process
for ($i = 0; $i < $lines; $i++) {
    for ($j = 0; $j < $ROWS; $j++) {
        if ($i == $lines - 1) {
            peak($i, $j, $l[$i][$j], $l[$i][$j], 1, \"%{$h[$j]}");
        } else {

```

```

        peak($i, $j, $l[$i][$j], $l[$i+1][$j], 0,
\%{$h[$j]});
    }
}

if ($opt_a) {
    print "#";
    for ($j = 0; $j < $ROWS; $j++) {
        printf("Data Run %d, Hi/LLow,Peak,Sum,", $j);
    }
    printf("\n");

    for ($i = 0; $i < $lines; $i++) {
        for ($j = 0; $j < $ROWS; $j++) {
            printf("%0.08f,%0.08f,%0.08f,%0.08f,",
                $out[$i][$j][0], $out[$i][$j][1],
                $out[$i][$j][2], $out[$i][$j][3]);
        }
        printf("\n");
    }
}

if ($opt_b) {
    # If Hi/Low == 0, skip,  collapse columns
    undef(@line);
    for ($i = 0; $i < $lines; $i++) {
        for ($j = 0; $j < $ROWS; $j++) {
            next if ($out[$i][$j][1] == 0);
            $l = $line[$j];
            $P[$l][$j][0] = $i;
            $P[$l][$j][1] = $out[$i][$j][1];
            $P[$l][$j][2] = $out[$i][$j][2];
            $P[$l][$j][3] = $out[$i][$j][3];
            $line[$j]++;
            $max_line = $line[$j] if ($line[$j] > $max_line);
        }
    }

    print "#";
    for ($j = 0; $j < $ROWS; $j++) {
        printf("Row,Hi/Low,Peak,Sum,");
    }
    printf("\n");

    for ($i = 0; $i < $max_line; $i++) {

```



```
    for ($j = 0; $j < $ROWS; $j++) {  
        printf("%d,%0.08f,%0.08f,%0.08f,",  
            $P[$i][$j][0], $P[$i][$j][1],  
            $P[$i][$j][2], $P[$i][$j][3]);  
    }  
    printf("\n");  
}  
}
```

Appendix B

Review Board Approval

San José State
UNIVERSITY

Office of the Provost
Associate Vice President
Graduate Studies & Research

One Washington Square
San José, CA 95192-0025
Voice: 408-924-2427
Fax: 408-924-2477

E-mail: gradstudies@sjsu.edu
<http://www.sjsu.edu>

To: Kristina M. Drummond
3421 Amburn Ave.
San Jose, CA 95148

From: Pam Stacks *Pam Stacks*
AVP, Graduate Studies & Research

Date: November 30, 2005

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"The effects of peppermint and dimethyl sulfide on weightlifting in men and women."

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Pam Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subjects portion of your project is in effect for one year, and data collection beyond November 30, 2006 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

Cc: Peggy Plato ✓

The California State University:
Chancellor's Office
Bakersfield, Channel Islands, Chico,
Dominguez Hills, East Bay, Fresno,
Fullerton, Humboldt, Long Beach,
Los Angeles, Maritime Academy,
Monterey Bay, Northridge, Pomona,
Sacramento, San Bernardino, San Diego,
San Francisco, San José, San Luis Obispo,
San Marcos, Sonoma, Stanislaus

*filed
12/8/05*

Appendix C**Medical and Activity History**

Name _____

Age _____ Date of Birth _____

Phone _____ (work) _____ (home or cell)

e-mail _____

Address:

Person to contact in case of emergency: _____

Relationship to you _____ Phone _____

Personal physician _____ Phone _____

I certify that, to the best of my knowledge, the information on the Medical and Activity History (3 pages), dated _____, is accurate and true.

Signature _____ Date _____

* * * * *

ID# _____

Medical and Activity History

Please complete this form to the best of your ability, answering questions as accurately and completely as possible. All information will be kept confidential. Please print or write clearly.

ID # _____ Date _____

Personal Medical Information

In the past, have you ever had:

Yes	No	Don't Know	Yes	No	Don't Know
☐	☐	☐ Heart attack or stroke	☐	☐	☐ Elevated cholesterol (>200 mg/dl)
☐	☐	☐ Heart surgery	☐	☐	☐ Low HDL cholesterol (<35 mg/dl)
☐	☐	☐ Diseases of arteries	☐	☐	☐ Severe leg pain while exercising
☐	☐	☐ Heart rhythm problems	☐	☐	☐ Diabetes (age at onset _____)
☐	☐	☐ Heart murmur	☐	☐	☐ Orthopedic problems
☐	☐	☐ High blood pressure	☐	☐	☐ Arthritis
☐	☐	☐ Asthma	☐	☐	☐ Injuries to back, knees, ankles
☐	☐	☐ Pulmonary (lung) disorders	☐	☐	☐ Injuries to upper body/upper extremities
☐	☐	☐ Peripheral circulatory disorders			
☐	☐	☐ Osteoporosis			

In the past 12 months, have you had:

Yes	No	Yes	No
☐	☐ Pain or discomfort in the chest or arms	☐	☐ Lightheadedness or dizziness
☐	☐ Heart palpitations or rapid heart rate	☐	☐ Ankle swelling
☐	☐ Awakened short of breath	☐	☐ Loss of coordination or balance
☐	☐ Shortness of breath at rest	☐	☐ Chronic muscle soreness
☐	☐ Shortness of breath with usual activities	☐	☐ Joint soreness or swelling
☐	☐ Unexplained loss of consciousness	☐	☐ Back pain
☐	☐ Unexplained extreme weakness	☐	☐ Unusual fatigue with usual activities
☐	☐ Pain or discomfort with mild exertion		

Describe any illnesses, hospitalizations, medical problems, or surgeries you have had in the past 12 months:

Do you have any limitations that may affect your ability to exercise? ☐ Yes ☐ No

If yes, please explain:

Are you currently under a physician's care? ☐ Yes ☐ No

If yes, please explain:

List any allergies you have (including drug allergies):

List all medications (prescribed or self-prescribed) that you currently take:

Medication	Condition being treated or reason for taking
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

How would you describe your general health?

☐ Excellent ☐ Good ☐ Average ☐ Fair ☐ Poor

Has a physician ever advised you not to exercise because of a medical problem?

☐ Yes ☐ No If yes, please explain

Family History

Has your father, brother, or son had a heart attack, coronary revascularization, or sudden death before 55 years of age? ☐ Yes ☐ No ☐ Don't know

Has your mother, sister, or daughter had a heart attack, coronary revascularization, or sudden death before 65 years of age? ☐ Yes ☐ No ☐ Don't know

Lifestyle Information

Have you ever smoked cigarettes, cigars, or a pipe? ☐ Yes ☐ No

Do you presently smoke? ☐ Yes ☐ No

If you previously smoked but have quit, please answer the following:

How many years did you smoke? _____ years When did you quit? (year) _____

Check the one category that best describes your current level of physical activity:

- ☐ **Inactive:** Most of your day is spent sitting, and you do no regular physical activity.
- ☐ **Somewhat Active:** Your day requires some physical activity, and you occasionally participate in recreational activities (e.g., tennis, golf), or you occasionally do physical activities such as gardening, housecleaning, dancing, etc.
- ☐ **Moderately Active:** Your day requires physical activity and/or you participate in regular recreational or fitness activities (e.g., walking, jogging, swimming, cycling, weight lifting) for at least 20 min, 3 days each week.
- ☐ **Very Active:** Your day requires extensive physical activity and/or you exercise moderately to vigorously for more than 30 min, 4 or 5 days each week.

If you are moderately or very active, please indicate the type and amount of exercise you do:

<u>Type of Activity</u>	<u>Frequency</u> (days/week)	<u>Duration</u> (minutes)	<u>Intensity</u> (light, moderate, hard)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Appendix D

Agreement to Participate in Research

Responsible Investigator(s): Kristina Drummond, B.S.
Peggy Plato, Ph. D.

Title of Protocol: The effects of certain variables on weightlifting in men and women

I have been asked to participate in a research study investigating the effects of changing variables on performance of a biceps curl. This could include the presence of several odors and performing biceps curls at varying intensities based on a percentage of my estimated one repetition maximum. Testing will take place in Spartan Complex, Room 208 and Spartan Complex East, Room 91A.

I will be asked to participate in four testing sessions. On the first day, I will report to San Jose State University, Spartan Complex East, Room 91A. I will warm up by performing 10-12 light weight biceps curls and stretch. I will then complete the necessary biceps curls so that my 10 Repetition Maximum can be determined. I will then return to San Jose State University, Spartan Complex East, Room 91A no less than 48 hours later for my second test. For the rest of the testing days I understand that I will warm up in the same manner as my first session. Areas over my biceps muscle will be shaved, dead skin cells will be removed with a "rough pad" and the area will then be wiped with an alcohol pad to remove skin oil. Electromyography surface electrode pads will then be placed over my biceps brachii to measure the electrical activity of the muscles. A strip containing an odor that I may perceive as pleasant, unpleasant or neutral will be placed under my nose. My heart rate will also be recorded. I will then perform biceps curls to fatigue at a weight that is a percentage of my one repetition maximum. An electrode marker will be placed in the area of the electrode, so that future electrode placement will occur in the same area.

I understand that I will be asked to refrain from weight lifting and other activities that will fatigue my upper body for the duration of the experiment. I will also refrain from aromatherapy or other scented soaps, perfumes, lotions, or changes in my deodorant during testing. I understand that any facial hair will need to be removed in order to participate in the study.

I understand that I will be required to physically exert myself, and there are risks associated with performing these exercises. I may experience sweating, increased heart rate, increased breathing, arm fatigue, nausea and vomiting. In addition, I may experience delayed onset muscle soreness. I will warm up and cool down to reduce the risk of injury.

Initial -----

The occurrence of a serious risk, such as a heart attack, is rare; however, if I report any unusual pain, including discomfort in my chest, arm, neck, or back, the test will be stopped. The testing will also be stopped at my request. I will be monitored for dizziness, fatigue, nausea, muscle cramps, and lightheadedness. Paramedics (911) will be called for a serious, life-threatening emergency. Cardiopulmonary resuscitation (CPR) and/or an automated external defibrillator will be used, if needed, to treat life-threatening cardiac arrhythmias. Participants who experience minor injuries will be encouraged to seek medical attention, as needed, at their own expense. The Student Health Center is available for SJSU students.

I may benefit from this study by learning how different factors may affect my ability to perform physical activity.

I understand that the results of this study may be published or presented, but I will not be identified unless I give expressed written permission for the researcher to do so.

I understand I will not be financially compensated for participating in this study.

Questions I have about this research may be addressed to Kristina Drummond (kmd@wfd3.com). Complaints about the research may be presented to V. Gregory Payne, P.E.D., Kinesiology Department Chair (408) 924-3010. Questions about research, subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2480.

No service of any kind, to which I am otherwise entitled, will be lost or jeopardized if I choose to "not participate" in the study.

My consent is being given voluntarily. I may refuse to participate in the entire study or in any part of the study. I am aware of the possible risks and discomforts associated with testing. The procedures, discomforts, and risks were verbally explained to me. If I decide to participate in the study, I am free to withdraw at any time without any negative effect on my relations with San Jose State University.

I have received a signed and dated copy of this consent form.

- The signature of a subject on this document indicates agreement to participate in the study.
- The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.

Signature

Date

Investigator's Signature

Date

Appendix E

NASA-TLX Instructions

Subject Instructions: Ratings

We are interested not only in assessing your performance but also the experiences you had during the different task conditions. Right now we are going to describe the technique that will be used to examine your experiences. In the most general sense we are examining the "workload" you experienced. Workload is a difficult concept to define precisely, but a simple one to understand generally. The factors that influence your experience of workload may come from the task itself, your feelings about your own performance, how much effort you put in, or the stress and frustration you felt. The workload contributed by different task elements may change as you get more familiar with a task, perform easier or harder versions of it, or move from one task to another.

Physical components of workload are relatively easy to conceptualize and evaluate. However, the mental components of workload may be more difficult to measure. Since workload is something is experienced individually by each person, there are no effective "rulers" that can be used to estimate the workload of different activities. One way to find out about workload is to ask people to describe the feelings they experienced. Because workload may be caused by many different factors, we would like you to evaluate several of them individually rather than lumping them into a single global evaluation of overall workload. This set of six rating scales was developed for you to use in evaluating your experiences during different tasks. Please read the descriptions of the scales carefully. If you have a question about any of the scales in the table, please ask me about it. It is extremely important that they be clear to you. You may keep the descriptions with you for reference during the experiment. After performing the task, six rating scales will be displayed. You will evaluate

the task by marking each scale at the point which matches your experience. Each line has two endpoint descriptors that describe the scale. Note that "own performance" goes from "good" on the left to "bad" on the right. This order has been confusing for some people. Move the arrow to the right or left with the mouse until it points at the desired location. When you are satisfied, press either button to enter your selection. Please consider your responses carefully in distinguishing among the task conditions. Consider each scale individually. Your ratings will play an important role in the evaluation being conducted, thus your active participation is essential to the success of this experiment, and is greatly appreciated.

Subject Instructions: Sources-of-Workload Evaluation

Throughout this experiment the rating scales are used to assess your experiences in the different task conditions. Scales of this sort are extremely useful, but their utility suffers from the tendency people have to interpret them in individual ways. For example, some people feel that mental or temporal demands are the essential aspects of workload regardless of the effort they expended or the performance they achieved. Others feel that if they performed well, the workload must have been low, and vice versa. Yet others feel that effort or feelings of frustration are the most important factors in workload and so on. The results of previous studies have already found every conceivable pattern of values. In addition, the factors that create levels of workload differ depending on the task. For example, some tasks might be difficult because they must be completed very quickly. Others may seem easy or hard because of the intensity of mental or physical effort required. Yet others feel difficult because they cannot be performed well, no matter how much effort is expended. The evaluation you are about to perform is a technique developed by NASA to assess the relative importance of six factors in determining how much workload you experienced. The procedure is simple: You will be presented with a series of pairs of rating scale titles (for example, Effort vs. Mental Demands) and asked to choose which of the items was more important to **your** experience of workload in the task(s) that you just performed. Each pair of scale titles will appear separately on the screen. **Select the Scale Title that represents the more important contributor to workload for the Specific task(s) you performed in this experiment.** Press the left button to select the top item in the pair and the right button to select the bottom item. A pointer shows which title was selected. To enter those choices press the button again and a new pair of titles will appear. If you change your mind, press the other button to cancel your first choice, and then start over. After you have finished the entire series we will be able to use the pattern of your choices to create a weighted

combination of the ratings from that task into a summary workload score. Please consider your choices carefully and make them consistent with how you used the rating scales during the particular task you were asked to evaluate. Don't think that there is any correct pattern; we are only interested in your opinions. If you have any questions, please ask them now. Thank you for your participation.

Task Questionnaire Part 2

Click on the factor that represents the
more important contributor to workload

Mental

Or

Effort

Appendix F

NSCA Procedure for Determining 10RM.

- 1) An estimated trial load, based on body weight, will be determined for each participant
- 2) The participant will be instructed to warm up by completing 10 biceps curls at 50% of the trial weight.
- 3) The participant will then be allowed to rest for 1 to 3 min.
- 4) The weight will be changed to the trial weight and the participant will be instructed to perform as many biceps curls as possible with proper form.
- 5) The number of repetitions will be counted and the weight adjusted as needed to perform at a 10RM.
- 6) If the 10 RM was not completed, the participant will rest for another 1 to 3 min, then complete another set of repetitions with the adjusted weight.
- 7) The sequence will be repeated until the participant's 10RM is established.

Appendix G

Kristina Drummond
 San Jose State University
 Hedonic Value and RPE Questionnaire

Participant ID#: _____

Experimental condition #: _____

1) On the Zero (0) to Ten (10) score below, circle the number that best describes the characteristics of what you smelt or place a check if you did not smell anything.

I did not smell anything _____

2) Based on the Ratings of Perceived Exertion Scale attached, how hard do you feel you worked to perform the task?

RPE: _____

RPE Scale:

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

(Borg RPE Scale, ©Gunnar Borg, 1970, 1985, 1994, 1998. copied from NSCA Essentials of Personal Training book. Copyright 2004.)

Appendix H

NASA- TLX RATING SCALE DEFINITIONS

Title	Endpoints	Descriptions
MENTAL DEMAND	Low/High	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	Low/High	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	Low/High	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
EFFORT	Low/High	How hard did you have to work (mentally and physically) to accomplish your level of performance?
PERFORMANCE	Good/Poor	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
FRUSTRATION LEVEL	Low/High	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Appendix I

Raw Data

EMG Results

Participant ID#	Sex	Session	Odor	Reps	AVE iEMG
CCHU21	M	3	Con	14	631.273377
CCHU21	M	4	PEP	15	837.041859
CCHU21	M	2	DS	16	892.065884
kden23	F	2	Con	9	749.540862
kden23	F	3	PEP	12	1008.427740
kden23	F	4	DS	9	909.140778
LCAR20	F	4	Con	8	994.417716
LCAR20	F	2	PEP	8	1116.221363
LCAR20	F	3	DS	9	1073.236411
IPER20	F	3	Con	5	300.895771
IPER20	F	4	PEP	7	310.638241
IPER20	F	2	DS	7	309.543223
JNEV23	M	4	Con	11	1054.428846
JNEV23	M	2	PEP	10	948.671624
JNEV23	M	3	DS	12	929.661896
NBAR22	M	2	Con	13	657.438122
NBAR22	M	3	PEP	12	740.487878
NBAR22	M	4	DS	13	710.109884
GHIG26	M	4	CON	12	599.278893
GHIG26	M	2	PEP	7	657.598016
GHIG26	M	3	DS	9	698.730046
AMORE23	M	2	CON	9	932.963075
AMORE23	M	3	PEP	10	946.588239
AMORE23	M	4	DS	11	1036.247345
SCHA35	M	3	CON	11	1228.286412
SCHA35	M	4	PEP	14	1079.149782
SCHA35	M	2	DS	11	1247.299357
AVEL21	M	2	CON	11	880.785809
AVEL21	M	3	PEP	11	831.677217
AVEL21	M	4	DS	10	1106.904314
SPOR21	F	2	CON	14	278.695182
SPOR21	F	3	PEP	17	243.837515
SPOR21	F	4	DS	13	390.122695
TALL21	F	3	CON	12	812.664425
TALL21	F	4	PEP	5	760.632384
TALL21	F	2	DS	10	954.222616
JERI33	F	2	CON	9	221.284767

Participant ID#	Sex	Session	Odor	Reps	AVE iEMG
JERI33	F	3	PEP	8	216.140037
JERI33	F	4	DS	8	208.004242
MCO21	F	3	CON	8	345.853985
MCO21	F	4	PEP	10	213.734550
MCO21	F	2	DS	8	636.815819
PKUS20	M	2	CON	7	1990.380120
PKUS20	M	3	PEP	6	1884.790880
PKUS20	M	4	DS	7	1718.722112
JLEE24	F	2	CON	10	181.452212
JLEE24	F	3	PEP	11	146.451296
JLEE24	F	4	DS	9	167.836283
RWHE28	M	4	CON	17	383.424246
RWHE28	M	2	PEP	11	457.009737
RWHE28	M	3	DS	14	388.068475
SYAC19	F	4	CON	8	757.521712
SYAC19	F	2	PEP	8	729.118039
SYAC19	F	3	DS	10	643.712229
RPOT22	F	4	CON	9	295.853805
RPOT22	F	2	PEP	9	444.945359
RPOT22	F	3	DS	9	513.251800
TMIL28	M	3	Con	8	1125.143029
TMIL28	M	2	PEP	6	1078.119369
TMIL28	M	4	DS	8	964.063857
EFEC27	M	4	CON	12	1071.900778
EFEC27	M	2	Pep	11	965.289531
EFEC27	M	3	DS	12	909.425095
CGOH21	M	3	Con	9	1001.035110
CGOH21	M	4	Pep	7	748.929751
CGOH21	M	2	DS	10	854.701436
CNIE25	F	2	Con	12	282.262186
CNIE25	F	3	Pep	12	267.056897
CNIE25	F	4	DS	9	257.422007
Drop30	M	4	con	10	614.909010
Drop30	M	2	Pep	9	493.881029
Drop30	M	3	ds	9	598.210386
Topy26	M	3	con	10	1237.910112
Topy26	M	4	Pep	11	1194.144437
Topy26	M	2	ds	9	806.450640

POMS Data

[illegible]

ID#	Sex	Session	Cond	TMD	Ten	Dep	Ang	Vig	Fat	Con
SPOR21	F	3	PEP	8	0	0	0	1	5	4
SPOR21	F	4	DS	8	2	0	0	0	2	4
TALL21	F	2	DS	8	8	0	0	7	4	3
TALL21	F	3	CON	18	7	0	6	4	4	5
TALL21	F	4	PEP	-4	1	1	0	10	3	1
JERI33	F	2	CON	8	6	1	1	6	3	3
JERI33	F	3	PEP	-1	0	0	0	6	2	3
JERI33	F	4	DS	14	4	1	5	0	0	4
MCO21	F	2	DS	0	3	0	0	10	3	4
MCO21	F	3	CON	1	3	0	0	7	3	2
MCO21	F	4	PEP	-1	3	0	0	10	3	3
PKUS20	M	2	CON	-6	5	0	0	15	0	4
PKUS20	M	3	PEP	0	0	0	0	6	2	4
PKUS20	M	4	DS	4	2	0	0	2	0	4
JLEE24	F	2	CON	-1	1	0	0	9	5	2
JLEE24	F	3	PEP	1	2	0	0	7	3	3
JLEE24	F	4	DS	8	3	1	0	6	5	5
MCCL20	F	2	DS	5	1	0	0	5	6	3
MCCL20	F	3	CON	9	0	0	0	1	7	3
MCCL20	F	4	PEP	3	1	0	1	4	2	3
RWHE28	M	2	PEP	1	1	1	0	7	4	2
RWHE28	M	3	DS	6	2	0	1	3	4	2
RWHE28	M	4	CON	-1	0	0	0	6	1	4
SYAC19	F	2	PEP	-7	2	0	0	12	1	2
SYAC19	F	3	DS	-6	2	0	0	13	2	3
SYAC19	F	4	CON	-4	2	0	2	12	2	2
RPOT22	F	2	PEP	-3	3	1	0	12	3	2
RPOT22	F	3	DS	7	1	3	1	7	4	5
RPOT22	F	4	CON	20	6	2	5	4	7	4
JMIL31	F	2	Con	3	3	2	0	7	0	5
JMIL31	F	3	PEP	7	3	3	0	4	0	5
JMIL31	F	4	DS	17	5	2	0	1	7	4
TMIL28	M	2	PEP	4	2	0	0	6	5	3
TMIL28	M	3	CON	11	2	0	0	3	6	6
TMIL28	M	4	DS	5	1	0	2	5	3	4
EFEC27	M	2	Pep	5	3	0	1	6	3	4
EFEC27	M	3	DS	14	1	2	7	2	2	4
EFEC27	M	4	CON	17	4	2	1	0	5	5
CGOH21	M	2	DS	3	1	0	0	5	3	4
CGOH21	M	3	Con	8	1	0	0	0	3	4
CGOH21	M	4	Pep	7	0	0	0	0	3	4
CNIE25	F	2	Con	-8	0	0	0	9	0	1
CNIE25	F	3	Pep	-3	0	0	0	5	0	2
CNIE25	F	4	DS	0	0	0	0	3	0	3

ID#	Sex	Session	Cond	TMD	Ten	Dep	Ang	Vig	Fat	Con
Drop30	M	2	Pep	2	2	0	0	8	5	3
Drop30	M	3	ds	3	1	0	0	4	2	4
Drop30	M	4	con	8	5	1	0	5	1	4
Topy26	M	2	ds	0	8	0	0	15	3	4
Topy26	M	3	con	6	3	0	0	14	2	3
Topy26	M	4	Pep	-2	4	0	0	12	3	3

HR, Hedonic Value, & RPE

Participant ID#	Sex	Session	Odor	HR RNO	HR RO	HR FAT	Hedonic Value	RPE
CCHU21	M	2	DS	64	97	?	10	15
CCHU21	M	3	CON	69	73	113	no smell	14
CCHU21	M	4	PEP	70	67	94	2	16
kden23	F	2	CON	69	69	111	5	13
kden23	F	3	PEP	75	86	103	3	12
kden23	F	4	DS	72	88	?	9	15
LCAR20	F	2	PEP	63	72	112	2	9
LCAR20	F	3	DS	61	73	100	6	12
LCAR20	F	4	CON	60	77	105	no smell	12
DGAR28	F	2	PEP	78	94	100	1	14
DGAR28	F	3	DS	74	87	143	10	14
DGAR28	F	4	CON	88	90	146	no smell	13
IPER20	F	2	DS	68	72	77	8	13
IPER20	F	3	CON	74	72	88	no smell	10
IPER20	F	4	PEP	67	70	108	2	15
JNEV23	M	2	PEP	70	65	118	2	12
JNEV23	M	3	DS	64	71	94	10	13
JNEV23	M	4	CON	65	65	75	no smell	12
NBAR22	M	2	CON	63	56	81	no smell	8
NBAR22	M	3	PEP	66	67	90	1	9
NBAR22	M	4	DS	60	76	126	9	11
GHIG26	M	2	PEP	61	68	68	2	13
GHIG26	M	3	DS	60	62	63	9	13
GHIG26	M	4	CON	53	55	61	NO SMELL	13
AMORE23	M	2	CON	67	73	78	NO SMELL	14
AMORE23	M	3	PEP	71	74	105	5	15
AMORE23	M	4	DS	79	85	82	9	15
JHAN29	F	2	DS	54	55	94	7	14
JHAN29	F	3	PEP	58	55	92	3	15

Participant ID#	Sex	Session	Odor	HR RNO	HR RO	HR FAT	Hedonic Value	RPE
JHAN29	F	4	CON	63	60	105	NO SMELL	14
SCHA35	M	2	DS	46	48	84	6	16
SCHA35	M	3	CON	56	58	90	NO SMELL	13
SCHA35	M	4	PEP	59	58	101	4	15
MSUN23	F	2	PEP	61	59	?	4	15
MSUN23	F	3	DS	61	64	107	7	15
MSUN23	F	4	CON	58	56	94	NO SMELL	14
AVEL21	M	2	CON	69	68	121	NO SMELL	17
AVEL21	M	3	PEP	68	74	128	3	16
AVEL21	M	4	DS	70	86	123	10	17
SPOR21	F	2	CON	64	65	83	NO SMELL	12
SPOR21	F	3	PEP	87	96	105	3	14
SPOR21	F	4	DS	83	84	110	7	12
TALL21	F	2	DS	75	74	115	8	11
TALL21	F	3	CON	72	60	117	NO SMELL	13
TALL21	F	4	PEP	62	64	111	0	14
JERI33	F	2	CON	67	68	99	5	9
JERI33	F	3	PEP	63	67	96	3	9
JERI33	F	4	DS	72	69	97	7	11
MCO21	F	2	DS	90	103	105	6	11
MCO21	F	3	CON	98	107	115	NO SMELL	10
MCO21	F	4	PEP	82	97	114	3	10
PKUS20	M	2	CON	72	74	121	NO SMELL	15
PKUS20	M	3	PEP	58	62	96	0	16
PKUS20	M	4	DS	69	72	109	8	15
JLEE24	F	2	CON	70	63	82	NO SMELL	12
JLEE24	F	3	PEP	72	72	86	0	13
JLEE24	F	4	DS	68	80	92	10	14
MCCL20	F	2	DS	85	86	125	6	13
MCCL20	F	3	CON	78	80	119	NO SMELL	12
MCCL20	F	4	PEP	75	80	120	1	15
RWHE28	M	2	PEP	78	82	120	2	13
RWHE28	M	3	DS	89	91	119	5	12
RWHE28	M	4	CON	89	87	115	NO SMELL	11

Participant ID#	Sex	Session	Odor	HR RNO	HR RO	HR FAT	Hedonic Value	RPE
SYAC19	F	2	PEP	71	70	120	1	8
SYAC19	F	3	DS	81	87	116	9	12
SYAC19	F	4	CON	71	74	104	NO SMELL	13
RPOT22	F	2	PEP	73	66	103	2	12
RPOT22	F	3	DS	67	67	112	8	14
RPOT22	F	4	CON	68	66	101	5	15
JMIL31	F	2	CON	70	74	128	6	14
JMIL31	F	3	PEP	69	76	86	2	14
JMIL31	F	4	DS	75	80	140	8	13
TMIL28	M	2	PEP	56	65	111	0	16
TMIL28	M	3	CON	53	54	110	No smell	17
TMIL28	M	4	DS	65	59	100	10	14
EFEC27	M	2	PEP	77	77	125	2	13
EFEC27	M	3	DS	74	69	117	8	11
EFEC27	M	4	CON	74	75	121	No smell	12
CGOH21	M	2	DS	83	90	134	6	13
CGOH21	M	3	CON	79	76	126	no smell	13
CGOH21	M	4	PEP	80	73	136	1	13
CNIE25	F	2	CON	69	69	110	no smell	9
CNIE25	F	3	PEP	67	62	92	2	9
CNIE25	F	4	DS	73	63	101	6	10
Drop30	M	2	PEP	81	74	107	3	13
Drop30	M	3	DS	81	81	114	10	12
Drop30	M	4	CON	78	77	116	no smell	14
Topy26	M	2	DS	60	53	127	4	15
Topy26	M	3	CON	61	61	124	no smell	14
Topy26	M	4	PEP	62	63	116	3	16

NASA-TLX

ID#	Sex	Ses	Odor	Total Wkload	MentDem	Phys Dem	Temp Dem	Perf	Eff	Frus
CCHU21	M	2	DS	58.6667	50	60	60	60	60	5
CCHU21	M	3	CON	60.3333	55	65	65	45	55	15
CCHU21	M	4	PEP	50.6667	15	65	45	30	65	15
kden23	F	2	CON	31.3333	5	45	30	15	50	5
kden23	F	3	PEP	36	10	60	20	5	50	5
kden23	F	4	DS	48.667	50	60	60	25	60	40
LCAR20	F	2	PEP	8.3333	5	5	10	15	10	5
LCAR20	F	3	DS	24.3333	20	10	40	25	20	10
LCAR20	F	4	CON	10.3333	5	10	10	15	10	5
DGAR28	F	2	PEP	72.3333	10	85	75	95	75	30
DGAR28	F	3	DS	61.33	10	20	40	80	30	90
DGAR28	F	4	CON	82.6667	10	70	80	90	90	85
IPER20	F	2	DS	51	25	90	90	25	25	25
IPER20	F	3	CON	64	5	85	25	50	85	5
IPER20	F	4	PEP	76	65	10 0	75	25	80	15
JNEV23	M	2	PEP	54.333	50	50	50	55	60	15
JNEV23	M	3	DS	69	70	60	65	70	70	70
JNEV23	M	4	CON	51	50	45	40	60	50	35
NBAR22	M	2	CON	37	10	25	10	70	25	15
NBAR22	M	3	PEP	32.6667	10	15	40	50	25	15
NBAR22	M	4	DS	27	15	15	20	45	20	40
GHIG26	M	2	PEP	36.6667	15	60	35	25	55	20
GHIG26	M	3	DS	54	30	60	60	60	60	30
GHIG26	M	4	CON	39	25	30	55	30	45	10
AMORE23	M	2	CON	36.3333	10	70	10	25	65	10
AMORE23	M	3	PEP	54	20	75	50	50	55	15
AMORE23	M	4	DS	52.6667	25	65	55	55	55	20
JHAN29	F	2	DS	50.6667	10	30	60	75	30	10
JHAN29	F	3	PEP	66.3333	10	55	90	75	55	10
JHAN29	F	4	CON	48.6667	10	40	70	35	50	10
SCHA35	M	2	DS	56.3333	55	65	45	35	65	5

ID#	Sex	Ses	Odor	Total Wkload	MentDem	Phys Dem	Temp Dem	Perf	Eff	Frus
SCHA35	M	3	CON	42	5	55	25	40	45	25
SCHA35	M	4	PEP	46.6667	30	65	35	30	55	40
MSUN23	F	2	PEP	36	5	50	30	70	40	40
MSUN23	F	3	DS	57.6667	45	60	50	65	70	50
MSUN23	F	4	CON	51.6667	50	55	60	40	50	30
AVEL21	M	2	CON	69.6667	50	85	60	40	85	5
AVEL21	M	3	PEP	65	50	75	55	35	80	10
AVEL21	M	4	DS	67	70	75	55	35	85	25
SPOR21	F	2	CON	60	40	70	70	55	55	10
SPOR21	F	3	PEP	61	75	75	60	40	60	35
SPOR21	F	4	DS	58.6667	70	60	45	40	65	30
TALL21	F	2	DS	67.6667	25	85	65	30	80	15
TALL21	F	3	CON	59.6667	25	90	35	20	55	80
TALL21	F	4	PEP	59	40	100	25	30	65	10
JERI33	F	2	CON	39.6667	20	20	35	80	30	50
JERI33	F	3	PEP	47	25	30	50	65	80	50
JERI33	F	4	DS	44.3333	30	35	30	50	40	60
MCO21	F	2	DS	28.6667	15	20	20	35	40	5
MCO21	F	3	CON	19.3333	10	25	20	15	30	20
MCO21	F	4	PEP	21	20	25	20	15	20	10
PKUS20	M	2	CON	60.6667	5	100	35	15	80	5
PKUS20	M	3	PEP	65	15	100	70	5	100	5
PKUS20	M	4	DS	61	20	100	55	5	100	5
JLEE24	F	2	CON	44.6667	10	35	35	85	45	15
JLEE24	F	3	PEP	58	20	70	50	70	50	30
JLEE24	F	4	DS	60.3333	65	60	55	70	60	60
MCCL20	F	2	DS	64.3333	25	70	80	30	85	45
MCCL20	F	3	CON	61	60	75	25	35	75	10
MCCL20	F	4	PEP	58	40	70	55	35	70	20
RWHE28	M	2	PEP	46.6667	30	40	65	50	35	10
RWHE28	M	3	DS	39.6667	25	35	60	30	30	45

RWHE28	M	4	CON	27	25	35	20	50	25	15
ID#	Sex	Ses	Odor	Total Wkload	MentDem	PhysDem	TempDem	Perf	Eff	Frus
SYAC19	F	2	PEP	38	40	20	15	15	90	10
SYAC19	F	3	DS	30	30	25	5	35	40	10
SYAC19	F	4	CON	39.3333	25	30	10	35	35	10
RPOT22	F	2	PEP	49	20	50	65	25	65	20
RPOT22	F	3	DS	51.3333	55	55	55	35	55	60
RPOT22	F	4	CON	70.6667	65	70	70	45	80	75
JMIL31	F	2	CON	77.3333	70	85	80	85	70	30
JMIL31	F	3	PEP	50	25	80	40	80	75	75
JMIL31	F	4	DS	65	65	65	75	75	45	50
TMIL28	M	2	PEP	66	30	85	75	30	80	15
TMIL28	M	3	CON	69.3333	60	80	60	20	80	10
TMIL28	M	4	DS	81.3333	85	85	90	70	75	75
EFEC27	M	2	PEP	51.33	40	45	70	45	55	20
EFEC27	M	3	DS	23	25	25	20	20	25	25
EFEC27	M	4	CON	51	50	55	55	55	40	50
CGOH21	M	2	DS	32	5	50	30	5	35	5
CGOH21	M	3	CON	38.667	15	50	10	25	55	15
CGOH21	M	4	PEP	41	15	55	20	15	60	15
CNIE25	F	2	CON	9.6667	5	10	10	10	10	5
CNIE25	F	3	PEP	6.6667	5	10	5	5	10	5
CNIE25	F	4	DS	8.6667	10	5	5	10	10	5
Drop30	M	2	PEP	66	20	75	90	20	65	35
Drop30	M	3	DS	66	25	70	75	65	55	55
Drop30	M	4	CON	63	60	70	75	35	65	40
Topy26	M	2	DS	60.333	15	70	70	55	50	15
Topy26	M	3	CON	52	30	50	50	50	60	10
Topy26	M	4	PEP	60.667	55	60	60	65	60	45

Raw Data

Comments/ Notes

Participant ID#	NOTES/ COMMENTS
CCHU21	Session 4: sore throat and cough. Doesn't feel tired or congested. Felt good with last session because more comfortable with the movement. Temporal demand from tempo (learning effect). No change in weight. Felt worried in session 4 that he was going to get the bad odor.
kden23	Session 3: HR monitor stopped working before test, no interference with the test itself. Session 2: was more concerned with keeping tempo than performing the work itself. Session 4: no change in weight. Felt gross with DS and didn't want to do more---opposite with the peppermint.
LCAR20	Session 3: room smelt of cologne upon arrival but participant claimed she didn't smell anything. Session 4: hard to stay on tempo and felt confused (no odor). No change in weight.
DGAR28	Session 2: a little late getting HR at Fatigue. Session 4: Why frustration high? Because he couldn't do anymore. First trial felt awesome but also felt bad about not being able to lift as much. Didn't feel weight was different but felt more energetic with the peppermint and wanted to do more. DS didn't care. Major PMS at session 4
IPER20	Session 4: weight felt around the same. 1st session the smell bothered her more and was concentrating more on the smell than the activity.
JNEV23	Session 4: After rep 8 weight stack got stuck and wouldn't move. Rested 15 minutes and test was re-started. Part. said he had 2 reps left. Prepped new strip. Felt relaxed with the mint and wanted to leave it on. Forgot time with the bad smell. Unpleasant smell felt about 5 lbs heavier. Session 3: felt tired upon arrival but said that it didn't affect his performance.
NBAR22	Session 2: Had trouble keeping tempo. Session 3: EMG difficulties, it wouldn't start right away. Felt he could have kept going but not at that pace (pep). Session 4 (DS) felt irritated, didn't feel weight change.
GHIG26	Thought keeping tempo was the hardest part. Thought session 4 was heavier (no odor). First two sessions felt the same. Session 2: stopped at 10 rather than fatigue but form was starting to go at this time anyway. Forgot post- HR for this session.
AMORE23	Session 3: noted odor was strong (Pep). Session 4: felt he had more energy today but only because he didn't do anything prior to our session. Session 4 (DS) felt lighter, never noticed a change in weight.

JHAN29	Session 4: Was a little slow during first curl but consistent for the session. Felt different first thing in the morning. Didn't worry about anything. Session 4 felt easier (no odor)
SCHA35	Session 2: first set of curls was off tempo.
MSUN23	Slow with timing (session 4) Last session felt easiest (no odor). Felt hard because of pulley. Weight felt heavier with first 2 trials. Session 3: timing trouble. Seemed sniffly but stated she could smell fine. Thought peppermint smelt like tiger balm for muscle soreness.
AVEL21	Electrode started coming off toward end. Session 4: didn't have definition sheet for NASA-TLX but participant said he didn't need it. Anticipated bad smell. Thought first session was heavier. Other two were about the same.
SPOR21	Session 3 felt harder. Session 2, stopped because she couldn't keep tempo and full ROM but she stated she could have kept going. Session 3: had to be reminded to fully extend during the curl.
TALL21	Session 4: felt fatigued from the heat, wearing jeans that day. Session 3: ate before session. Mood was also altered before session and started 1 curl before I gave the start command.
JERI33	Session 4: tired upon arrival. Extra exercise class and didn't sleep well. Didn't extend all the way on the last 2. No change in weight noted. Felt annoyed during session 4 but said it felt easier (DS)
MCO21	Session 4: at rep 4 had to push on an electrode that looked like it was getting loose. No change in weight. Felt better during session 4 because she felt she was getting the hang of it.
PKUS20	Session 4: first 2 curls were off tempo. Thought it smelt like garlic. Weights felt same.
JLEE24	Session 3: did first curl before instructed to do so. Sessions 3 & 4 felt heavier than 2 (no odor).
MCCL20	Session 3: felt sluggish upon arrival. Said electrodes made her itch when she took them off....not during session. Session 4: Tired upon arrival. Felt weight was same.
RWHE28	Session 2: Weight stack got stuck at end. Had to re-schedule and repeat session two. No weight change felt.
SYAC19	Session 3: got off time. Session 4: HR monitor stopped before curls started. Had to replace it. Could focus more on work today. When smell was good she felt more energetic, just wanted to get through it when the smell was bad.
RPOT22	Session 4: anxious on arrival. Had a bad weekend. Claimed to smell something during no odor session. Claimed session 4 (no odor) was heavier weight but also felt that she worked harder today. Other two felt same.
JMIL31	No difference in weight. Session 4: felt fatigued because it

	was the end of the day. (All other sessions were in the morning). Thought peppermint was relaxing (conditioned resp). Was concerned over low reps & uneasy because feeling can lift only 10X but couldn't do it. Didn't get bothered by time. Thinking about a lot of things. Worried about being able to help me.
TMIL28	No weight change. Felt distracted by the smell.
EFEC27	Had facial hair but the band-aid was able to stick. Stated that he thought the odors had to do with looking at mood. Session 4: noise in locker room. Stated no weight change. Thought DS was easier because he wasn't concentrating on the timing. The good smell was more relaxing.
CGOH21	Used electrode adhesive spray. It had an odor but couldn't smell it with the strip under the nose. Thought the DS smelt like asparagus, which he likes. He also works at a place where there are a lot of foul odors. Was hot during sessions. Weights felt same. States his moods are not easily changed. Even if something smelt bad he would not focus on it.
CNIE25	Used electrode adhesive spray. Was very hot during session 4. No difference in weight noted. Didn't think the DS smelt bad.
Drop30	Session 2: Electrodes started falling off toward end. Started using electrode adhesive spray for the rest of the sessions. Had a hard time with the tempo. Warm during some of the sessions. Session 4: mood was affected by schoolwork due that day. Thought weights felt heavier in session 4 (no odor)
Topy26	Session 2: EMG seems to decrease toward the end. Checked electrodes and they were still on securely. It was hot in the room. Started using electrode adhesive spray for remaining sessions. Weights felt the same.