

# Peppermint Odor and Athletic Performance: An Ergogenic Aid or An Expectancy Effect?



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# Peppermint Odor and Athletic Performance: An Ergogenic Aid or An Expectancy Effect?



Athletes are always looking for an edge.

There is a plethora of supplements and ergogenic aids available that purport abilities to improve performance – most are big sellers because of marketing hype or inaccurate reporting of research findings.

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*An ergogenic aid is any substance used to improve performance by enhancing physical power, mental strength, or mechanical edge (Williams, 2002).*

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A recent study by Raudenbush, Corley, & Eppich (2001) revealed findings that suggest peppermint may be the newest ergogenic aid.

Research question: In what manner – psychological, physiological, or other – does inhalation of peppermint oil affect athletic performance?

# The Olfactory System – A Brief Review



Mouth – *retronasal inhalation*    Nares – *orthonasal inhalation*

Volatile chemicals pass by turbinates, affecting the pattern of air as it flows to the olfactory epithelium, the location of odor detection and the site of ~50 million primary sensory receptor cells.

Odors bind to receptors, causing the onset of a cascade of biochemical events. Sensory signals are transmitted along olfactory nerves, which extend to the olfactory bulb in the limbic region of the brain.

At this point, the sensory signals are refined and transformed into spatial and temporal patterns of output neurons that are relayed to higher cortical centers of the brain.

# The Olfactory System & Other Sensory Modalities



Gustation and olfaction systems work concurrently to evoke unified oral perception of flavor

Trigeminal nerve provides the sensations of warmth, coolness, irritation, and pungency; elicitation of these cutaneous mucosal sensations via odorous stimulation act as a warning system and supplement to the sensations of taste and scent by intensifying the sensations

# The Olfactory System: Adaptation



Responds to novel stimuli, while becoming less sensitive or responsive to sensory stimuli of which it has already been exposed

This ability provides a means of preventing the nervous system from experiencing an overload or saturation level, and to maximize an organism's ability to discern new information from old (Dalton, 2002)

An odor's influence depends, at least in part, upon the duration and frequency of odorous stimulation.

# The Olfactory System: Differences



## *Gender differences –*

Females perform better on standard odor detection tests  
(Brand & Millot, 2001; Marchand & Arsenault, 2002)

Females perceived intensity of odors at much higher levels than males  
(Wysocki & Gilbert, 1989)

Females experience larger EEG amplitude and larger evoked responses to odorous substances than men (Evans, Cui, & Starr, 1995)

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## *Age differences –*

Through natural process of aging, there is a loss of acuity (Dalton, 2002)

Pollutants and bacteria augment deterioration over time (Dalton, 2002)

# The Influence of Olfaction on...



- Affective State and Perception of Well-being
- Physiological State
- Cognition, Behavior and Performance

# The Influence of Olfaction on Affective State And Perception of Well-being



## *Pleasant odors*

evoke positive affective states (Knasko, 1995; Baron 1997; Lehrner, et al., 2000)

Induce positive perceptions of health and decreases the number of reported health symptoms (Knasko, 1992, 1995)

Lower anxiety levels and increase calmness (Lehrner, et al., 2000)

Increase positive response to room environments (Knasko, 1995; Baron & Bronfen, 1994; Baron, 1990)

# The Influence of Olfaction on Affective State And Perception of Well-being



## *Malodors*

Before concept of “germ” scientifically discovered, malodors were considered the markers and carriers of disease and illness (Dalton, 2002)

Environments reported as less pleasant in unpleasant odor condition (e.g. dimethyl sulfide, Knasko, 1992; Baron, 1990)

# The Influence of Olfaction on Affective State And Perception of Well-being



## *But, why?*

Theory of Odor Association – scent becomes associated with a particular situation or environment; we create mental models about odor's influence and use those models when a similar situation occurs, eliciting a pre-determined emotional response

Orientating or Masking Effect of Odor – distracting person from task or situation at hand (e.g. eugenol in dentist office; Lehrner, et al. 2000)

Congruity – fit between how the environment is perceived and what is expected according to stored information about past experiences similar to what the individual is presently experiencing.

Can be culture-specific (due to dietary practices?)

# The Influence of Olfaction on Physiology State



- Cardiovascular Response
- Respiratory Rate/Oxygen Consumption
- Perceived Rate of Exertion

# The Influence of Olfaction on Physiology State



## *Cardiovascular Response*

Pleasant odors lowered diastolic blood pressure in a rhythmic handgrip task, but had no effect on a static handgrip task (Nagai, et al., 2000) Perhaps the type of task is a determining factor of odor's effect?

Odor inhalation while performing a 15-min walking treadmill task yielded no irregular responses (Simpson, et al., 2001) Perhaps too low an intensity level?

No significant differences in response among subjects performing a near-maximum effort treadmill task (Raudenbush, 2000) Perhaps odor concentration and exposure duration are the reasons?

# The Influence of Olfaction on Physiology State



## *Respiratory Rate & Oxygen Consumption*

No differences in respiratory rates between scented and unscented conditions during rhythmic and static handgrip tasks (Nagai, et al., 2000)

No significant effect on oxygen consumption in odor condition compared to no-odor condition in low-intensity 15-minute treadmill task, nor in a near-maximum effort treadmill running bout (Simpson, et al., 2001; Ruadenbush, 2000)

# The Influence of Olfaction on Physiology State



## *Rate of Perceived Exertion*

RPE is a subjective rating of performance on a physical task

Psychological factors – personality, anxiety, fear, etc. – can affect the somatic response of an individual (Borg, 1998)

Several scales exist to measure this: Borg's 6-20 scale; NASA

No differences in ratings of perceived exertion found between odor and no-odor conditions for a 15-minute low intensity treadmill exercise (Simpson, et al., 2001)

Association found between administration of peppermint odor during near-maximum treadmill exercise with a reduction in RPE and increase in perceived performance (Raudenbush, 2000)

# The Influence of Olfaction on Behavior



Often construed as the result of the effect of odor on mood, which subsequently determines behavior

Thus, if odors have the potential to elevate mood, then, in turn, this elevated mood can affect a person's behavioral decisions (Baron, 1990; Baron & Bronfen, 1994; Knasko, 1995)

# The Influence of Olfaction on Behavior



## *Individuals inhaling pleasant odors*

Set higher goals during a clerical coding task (Baron, 1990)

Will spend less time working on a later difficult task (word puzzle) when the same odor is present during first difficult task, compared to those exposed to different odor or no odor at all (Herz, et al., 2003)

Are more willing to provide immediate assistance to strangers in a public venue (e.g. shopping mall) (Baron, 1997)

*\*However, when mood was entered into the regression equation as a mediator of the fragrance condition, the pleasant fragrance was no longer a significant predictor of helping. Suggests that positive affect mediates the effects of pleasant odor on helping*

# The Influence of Olfaction on Behavior



## *Individuals inhaling pleasant odors*

Will encourage approach behaviors when the scent is congruent with the product or situation in which the scent is being experienced with (Fiore, et al., 2000).

But, will spend more time viewing photos in either of two pleasant odor conditions (Knasko, 1995)

Yet, will rate a pseudo-store environment as more favorable and the merchandise was evaluated more positively than the unscented setting (Spangenberg, et al., 1996)

# The Influence of Olfaction on Behavior



## *But Why?*

Optimal Arousal Theory – minor changes in the environment will increase the environment's perceived novelty and pleasure, resulting in persons providing significantly more positive evaluations of the environment, and thus encouraging the approach behaviors of those individuals (Spangenberg, et al., 1996)

If the odor can put the individual in a positive affective state, then perhaps the positive mood of the individual mediates the effect of odor on behavior.

# The Influence of Olfaction on Cognition and Performance



## *Odors*

Improve reaction time performance to simple visual and auditory response tasks, whether pleasant or unpleasant (Milot, et al., 2002),

Improve performance on word construction and decoding tasks in both low and high stress-induced conditions (Baron & Bronfen, 1994)

When unpleasant, can impair performance on complex proofreading task, but not affect performance on a simple arithmetic task (Rotton, 1983)

Perhaps odor influences tasks requiring deeper concentration by causing an orienting response, distracting subject from task at hand (as shown by Lehrner, et al., 2000)

# The Influence of Olfaction on Cognition and Performance



## *Odors*

When pleasant, improve proofreading task performance (Kliauga, et al., 1995)

That are sedative, improve productivity of tasks requiring concentration and mental focus, while those that are awakening improve performance of static monotonous work (Kawakami, et al., 1999)

Have a negative effect on performance of a monotonous visual vigilance task, but this decrement in performance disappears during a second session directly following the first (Gould & Martin, 2001) Perhaps the odor caused distraction or depressed attention in the first, while Ss habituated to the odor in the second.

# The Influence of Olfaction on Cognition and Performance



## *Odors*

When administered intermittently, have much more of an effect on performance of static monotonous work than a continuous rate of exposure (Kawakami, et al., 1999)

Have different effects, dependent upon odor itself; jasmine improved arithmetic task performance, but lavender adversely affected performance (Ludvigson & Rottman, 1989)

Influence on performance declines over time of exposure (ibid)

Can enhance affective state while, at the same time, be detrimental to cognitive performance (ibid)

# The Influence of Olfaction on Cognition and Performance



## *Why the difference in odor's effect?*

The type of task – fleeting or of long duration; simple or complex

Administration of odor – constant or intermittent

Type of odor – relaxing, alerting, pleasant, unpleasant

## **Combination of all three?**

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It is also possible that preconceived notions (mental models) of an odor, and its effect, are likely to impact performance in much the same way as it can influence mood and perceived health.

# Olfaction and Expectancy Information



Can people be affected by odor merely because of preconceived or recently constructed mental models, without the odor having any real effect?

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To test whether associations can be formed (experimenter-induced) and then used to influence subjects' emotional state, two popular methods are:

1. Inform Ss that an odor is present in the environment, when one is not
2. Provide information regarding the odor's effect to Ss prior to their exposure to that odor

# Olfaction and Expectancy Information



Expectation of pleasant odor (when no odor given), improves mood (Kansko, et al., 1990) However, expectation of an unpleasant odor did not have an effect.

Expectation of harmful effects of odor (when not) resulted in significantly higher reports of symptoms post-exposure, and were reported as higher in intensity and more irritable than the same odor given with a “healthful” message (Dalton, 1996; 1999)

Subjects’ brain wave activity patterns responded to odor according to the message they received, not the actual odor (Lorig & Roberts, 1990)

# Olfaction and Expectancy Information



High-use peppermint inhaler collegiate basketball athletes reported less fatigue and frustration and higher motivation, energy, strength and alertness than low-use group – but no difference in actual performance (Raudenbush, et al., 2004)

Researchers suggest peppermint had an effect on a variety of psychological aspects during game performance.

*\*However, was marketing to blame? Inhaler labeled: “All Natural, Pure Peppermint Boost...Speed – Strength – Endurance...Gives you a competitive edge naturally” (Also, unclear what subjects were told prior to commencement of peppermint use.)*

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The effect of expectancy information on athletic performance has not been whole-heartedly explored or known.

# The Influence of Olfaction on Athletic Performance



Presently, there is a dearth of published research on the effects of odor on athletic performance.

However, many studies are in press at this time, and the reason for this new interest is due to one particular study...

# A Closer Look at the Study that Sprouted this Little Green Plant into its Supplement Status



Raudenbush, Corley, & Eppich (2001) attempted to assess if and how peppermint odor may affect actual athletic task performance.

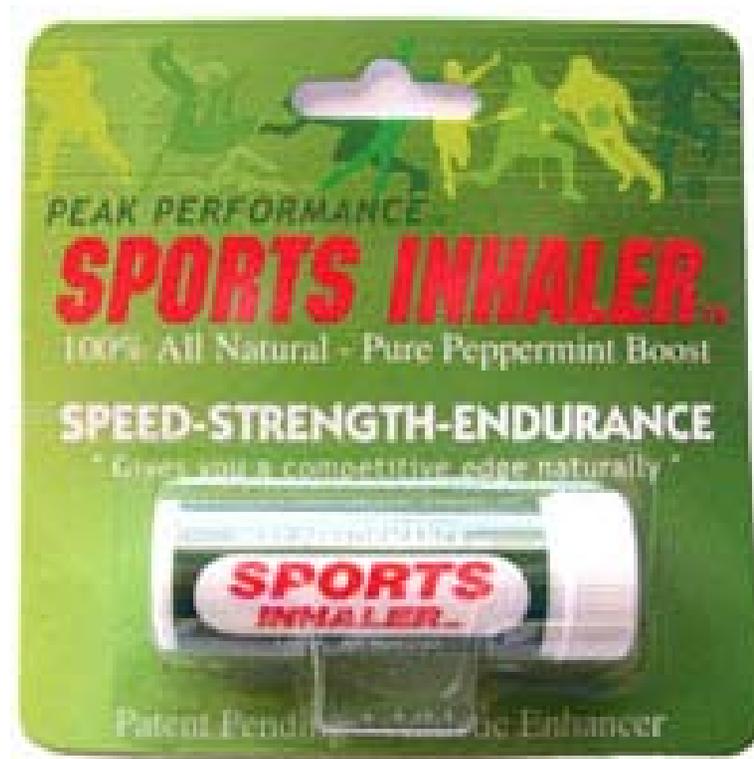
Four tasks: hand grip, push-ups, free throws, 400 m run

40 athletes

Two test conditions: nasal strip with 2 drops peppermint or no odor

Researchers claim that their findings indicate that actual athletic performance was enhanced with peppermint inhalation.

So, should athletes run to the nearest store for products like this?



# Peppermint – *Mentha piperita*



A perennial herb native to Europe and Asia (Spirling & Daniels, 2001)

Widely cultivated in North America; leaves and extracted oil

Believed to be used for its medicinal properties since ancient Egyptian , Greek, and Roman times (Tisserand, 1993)

Popular addition to foods (desserts, candy, drinks) and over-the-counter medications and hygiene products

Primary constituents are menthol, menthone, and menthyl acetate –these chemical elements are believed to be the source of peppermint’s purported effects on humans

# Peppermint – Medicinal Uses



## *When capsules of the oil are ingested, peppermint is...*

- A soother of digestive irritation and heartburn (Blatman, 2002)
- Effective in treating gallstones (Balchin, 1997), irritable bowel syndrome (Kline, et al., 1998), colonic spasm (Kingham, 1995), and dyspepsia (Blatman, 2002)

All through its internal antispasmodic action on the body (Blatman, 2002; Tate, 1997)

## *When inhaled, peppermint is...*

An effective and low-cost supplemental treatment for postoperative nausea (Tate, 1997)

# Peppermint – Effects on Mind and Body



Peppermint odor administered intermittently to a sleeping individual will quicken heart rate and EEG activity (Badia, et al., 1990)

However, very few studies have found any other physiological effects of peppermint odor inhalation (Simpson, et al, 2001; Raudenbush, 2000)

# Peppermint – Effects on Human Performance



Improved performance on a vigilance task (Warm, et al., 1990)

Decreased estimation of 60-second time period (Lorig, 1992)

Improved performance of word construction and decoding task (Baron & Bronfen, 1994)

Improved proofreading performance (Kliauga, et al., 1995)

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Most importantly, peppermint inhalation improved physical performance of 400-meter dash and marginally improved performance of handgrip strength and push-ups to exhaustion task (Raudenbush, Corley, & Eppich, 2001)

But these findings are questionable...

# Questionable Methodology of the Raudenbush, Corley, & Eppich study



Claims do not match results: Significant results found for only one athletic task – only the 400 m dash had a p-value of .005

Possibility of an expectancy effect confounding the results

Ambiguous methods:

- No account of a prescreening for nasal/olfactory abilities
- No determination of Ss fitness level or odor preferences
- No account for how handled questions concerning nasal strips
- No mention of environmental conditions
- No measure of Ss emotional state

# Research Hypotheses



H1: Subjects' performance on the 400-m running task will reflect what they expect will occur – not merely an effect of the odor

Experimenter-induced expectation of an effect (biased information) regarding the consequences of peppermint odor inhalation will influence performance on the task.

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H2: Subjects' affective state will influence performance on the running task

# Research Methods of the Present Study



A repeated measures, double-blind, placebo-controlled design was utilized to test for a possible expectancy effect, as well as control/account for the many ambiguities of the previous research.

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24 Ss: 3 x 400 m (5-min breaks btw runs), on 2 nonconsecutive test days.

Masks, as opposed to nasal strips, were used to control for inhalation of oil and to disguise the purpose of the research. Ss told that the purpose of the study is to determine impact of air-protection mask on physical performance and that there may or may not be a harmless odor in the mask.

All 18 subjects experience 3 test levels in balanced order: a) no mask b) unscented mask c) peppermint scented mask (within subjects).

Each will be told 1 of 3 expectancy information messages regarding peppermint's effect on physical performance (between subjects).



# Statistical Design of Thesis Research

"You are participating in this study to determine the impact of wearing an air-protection mask on your physical abilities. Wearing a mask can help to protect you against air pollutants, bio-terrorism concerns, and the SARS virus. Some masks may have a harmless odor, such as peppermint. Recent research has shown that people who breathe peppermint run faster because the odor enhances performance."

			DEPENDENT VARIABLES				
			Performance	Activity Level	Heart Rate	Rate of Perceived Exertion	Perceived Performance
			Digital Stopwatch	Biotrainer Pro data	Polar S810 Monitor	RPE Scale	"Do you think you performed better, worse, or the same as your previous run(s)?"
INDEPENDENT VARIABLES			(time)	(kcal expended)	(bpm)	(subjective measure of exertion)	(subjective measure of performance)
Category: Expectancy Info	Test Conditions (balanced order)	Runs (D1, R1 = Day 1, Run 1)					
Peppermint enhances performance, hinders performance, or told nothing	NM, UM, PM randomly assigned to Ss; same on both test days	D1, R1					N/A
		D1, R2					
		D1, R3					
		D2, R1					N/A
		D2, R2					
		D2, R3					

# Research Methods of the Present Study



All Ss underwent a prescreening olfactory identification test.

All 18 subjects were female because of gender sensitivity differences.  
Age bracket set between 18 and 24.

Peppermint oil diluted with sunflower oil (1:20); .14 g sprayed onto mask  
via perfume atomizer

Strict adherence to scripted explanation for masks, prescreening test, and  
expectancy information was maintained.

# Controlling for Extraneous Variables and Experimenter's Bias



Environment accounted for:

Barton Hall  $\frac{1}{8}$  mile Recaflex Indoor Track

Humidity and temperature measured.

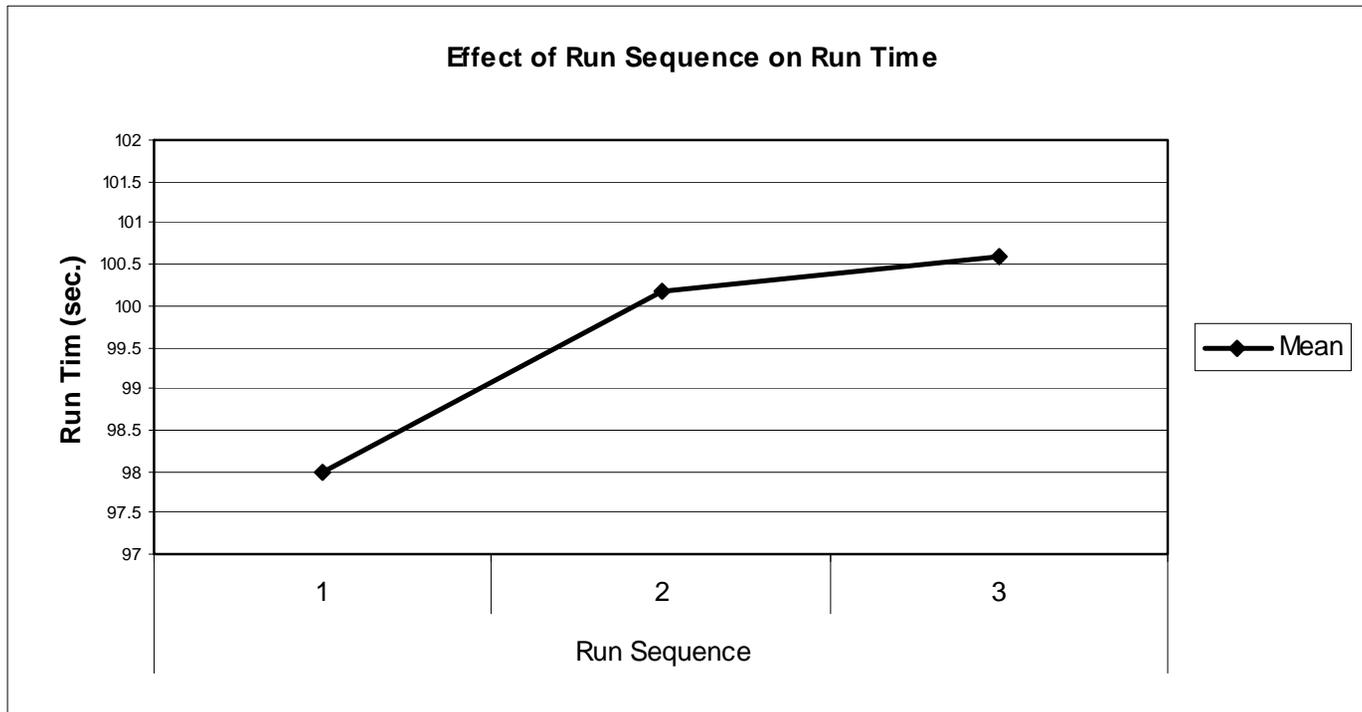
Level of fitness, chemical sensitivity, level of stress, affective state, time-of-day, and pleasantness rating questionnaires were administered.

To avoid experimenter bias in timing of the subjects, a separate individual unaware of the Ss expectancy info condition will be responsible for the timing and data collection of participant performance, including HR, caloric expenditure, RPE, and run times.

# Research Findings



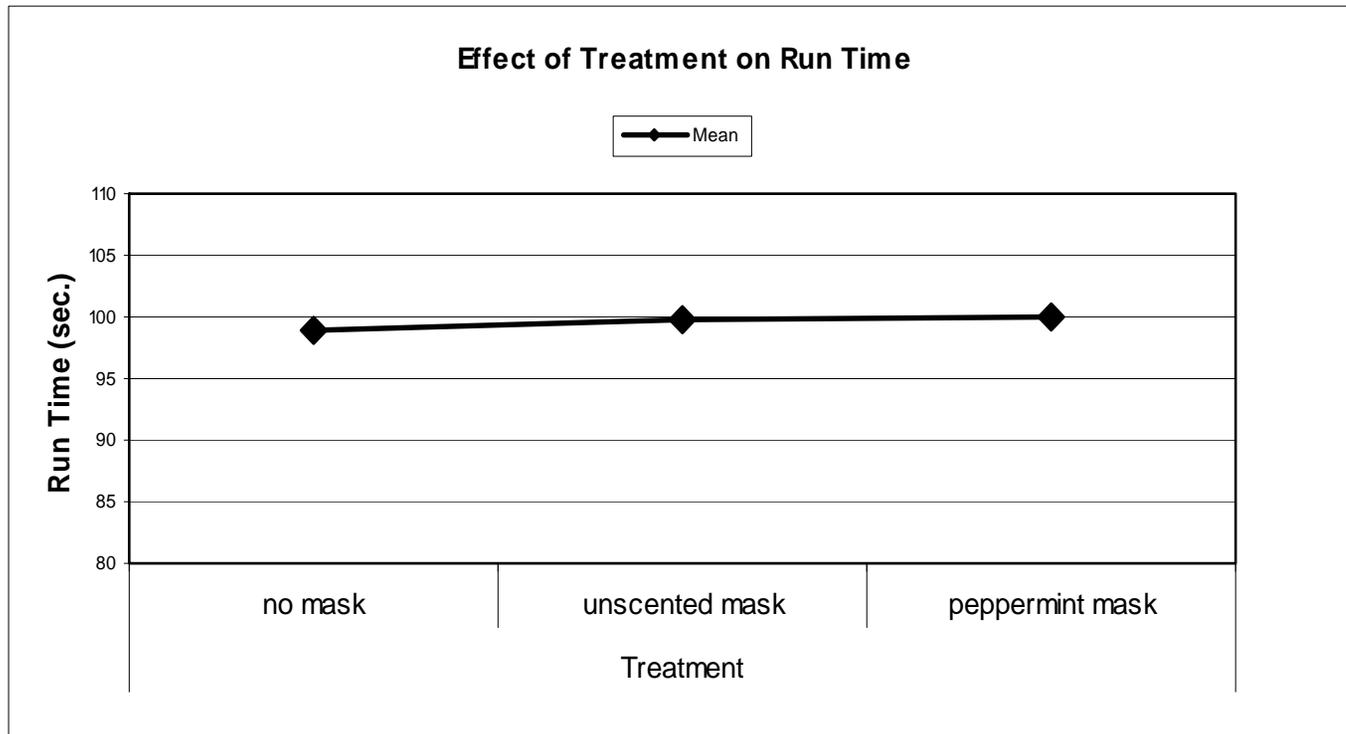
Run order had a significant effect on run time  
( $F_{2, 64} = 5.132, p = .009$ )



# Research Findings



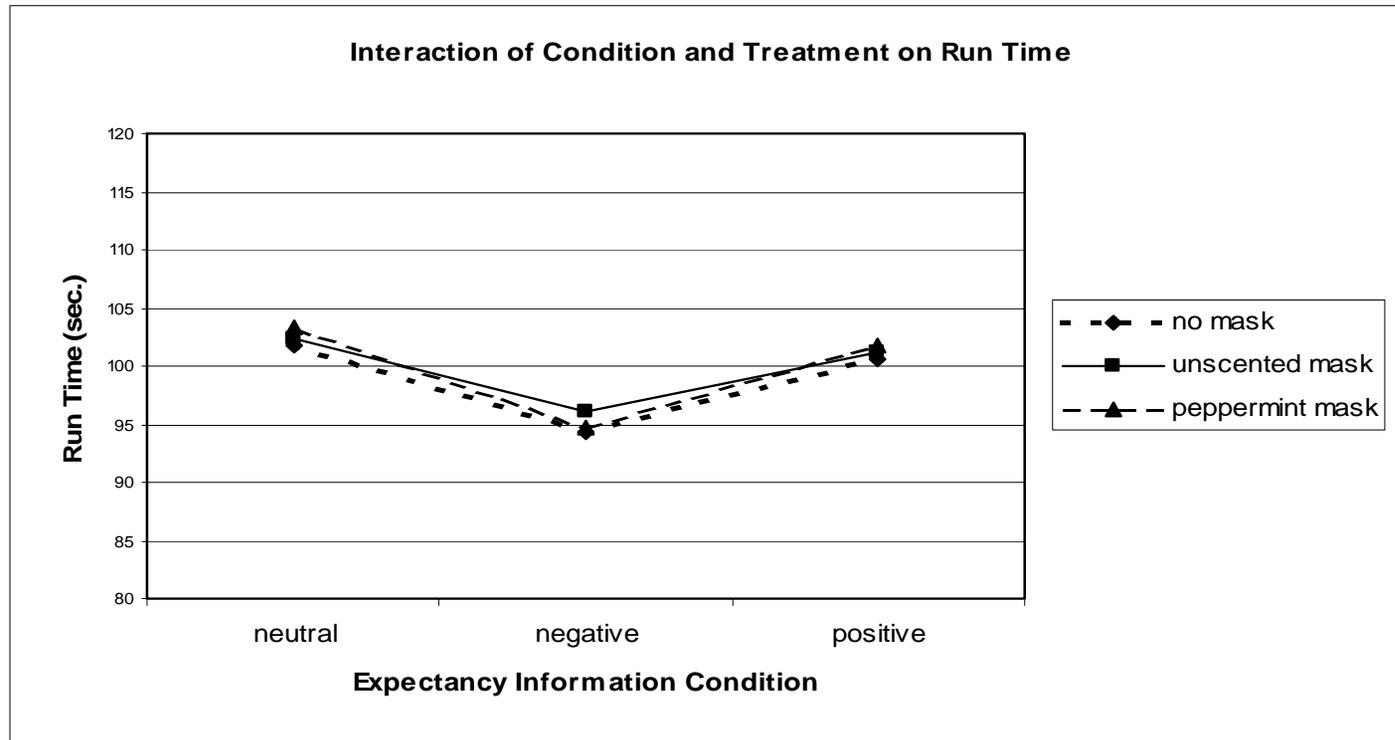
Treatment had no detectable effect on run time performance



# Research Findings



The interaction between condition and treatment on run time was not significant

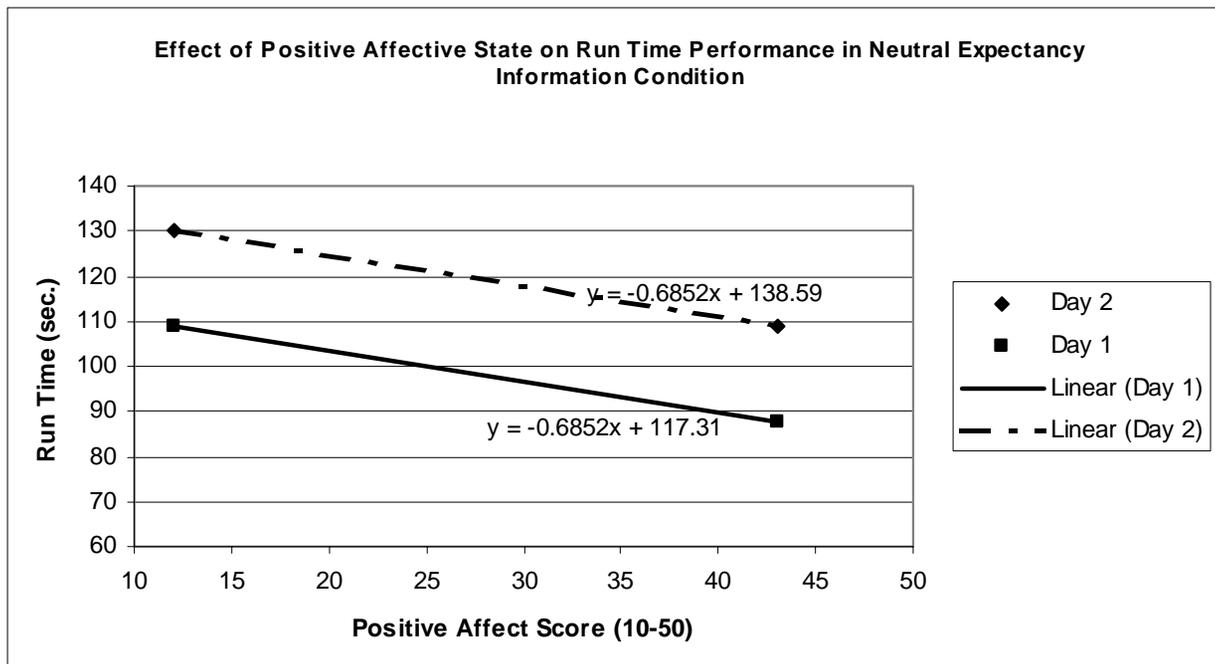


# Research Findings



Affective state had a significant effect on run time performance in all three expectancy information conditions.

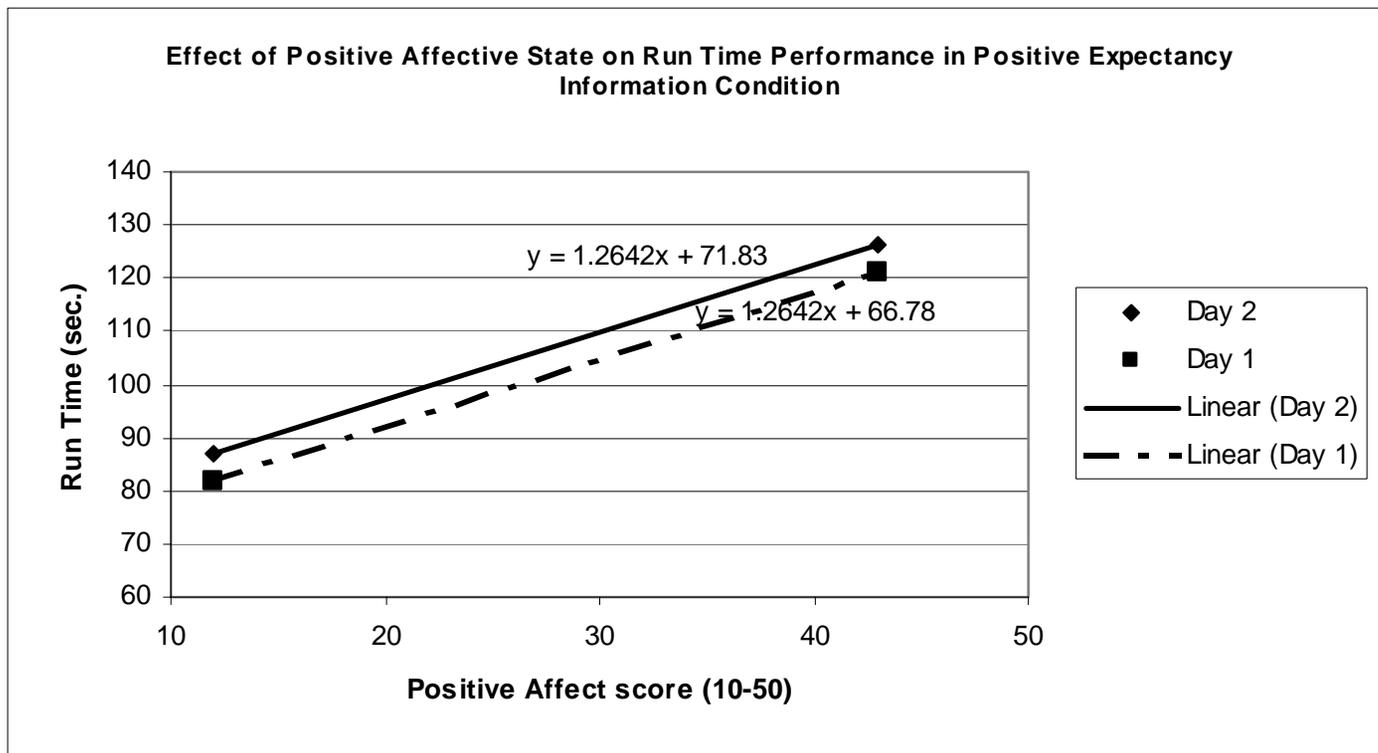
Ss in the neutral expectancy information condition who scored high on the positive affective state scale completed the 400-m dash in less time than those who scored at the low end of the scale ( $t_2 = -5.570, p = .035$ )



# Research Findings



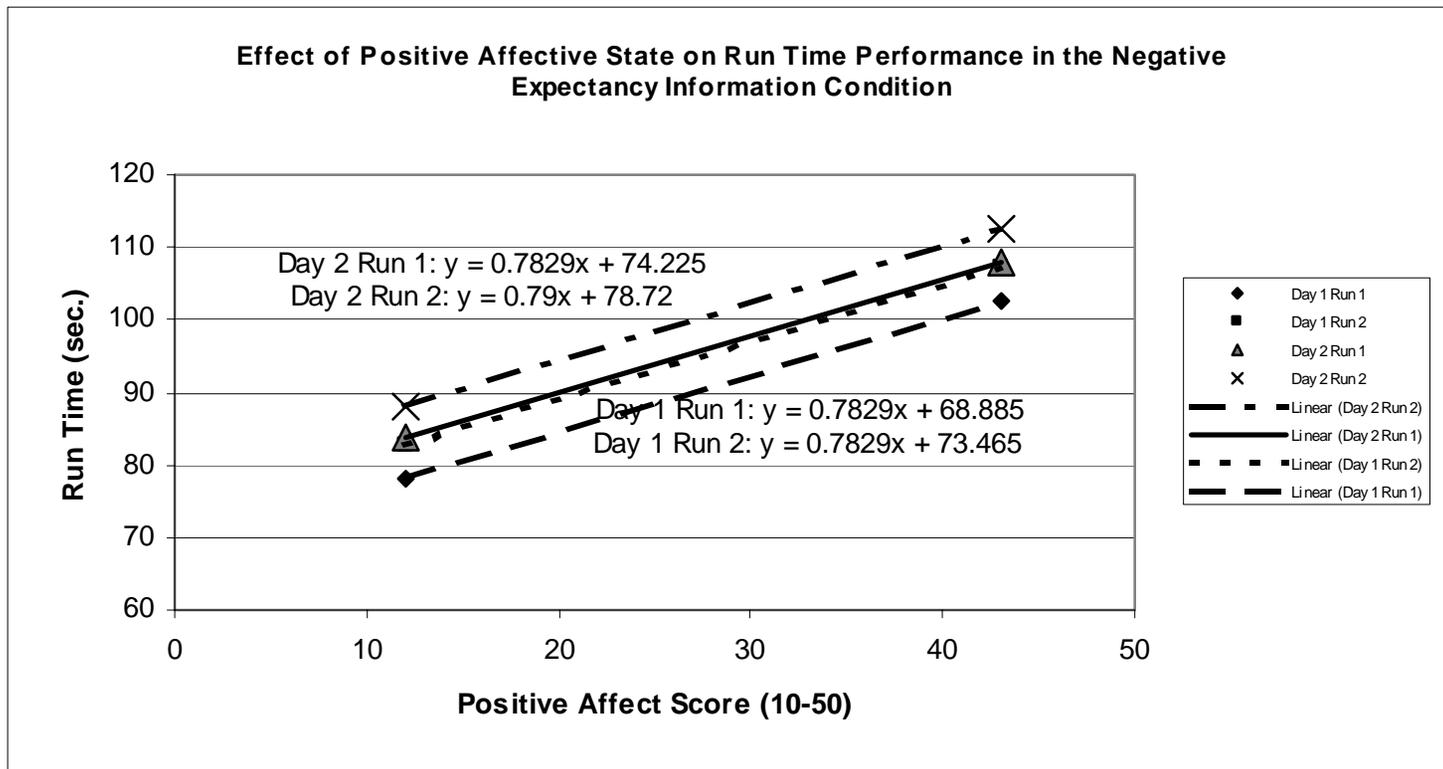
Ss in the positive expectancy information condition who scored high on the positive affective state scale took longer to completed the 400-m dash than those who scored at the low end of the scale ( $t_{31} = 3.738, p = .001$ )



# Research Findings



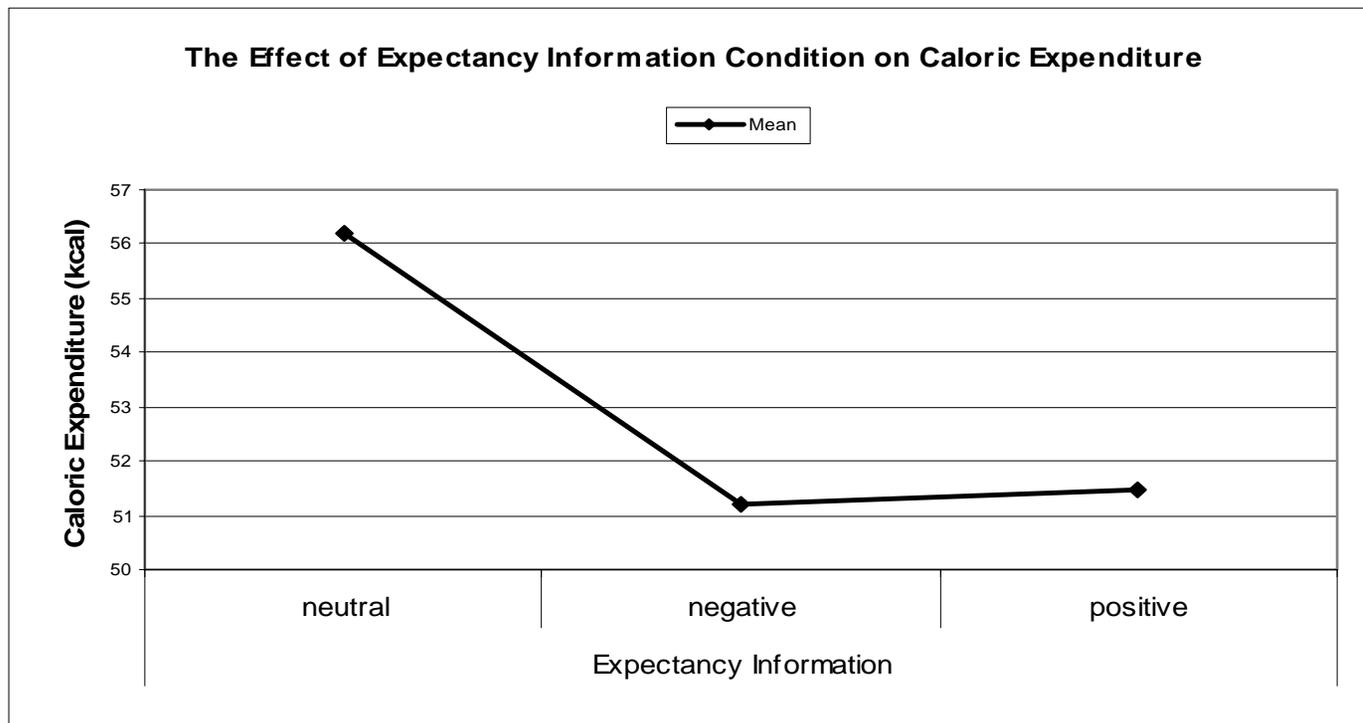
Similarly, Ss in the negative expectancy information condition who scored high on the positive affective state scale took longer to completed the 400-m dash than those who scored at the low end of the scale ( $t_{21} = 2.184, p = .041$ )



# Research Findings



There was a marginally significant effect of expectancy information condition on caloric expenditure ( $F_{2, 93} = 2.392, p = .097$ )

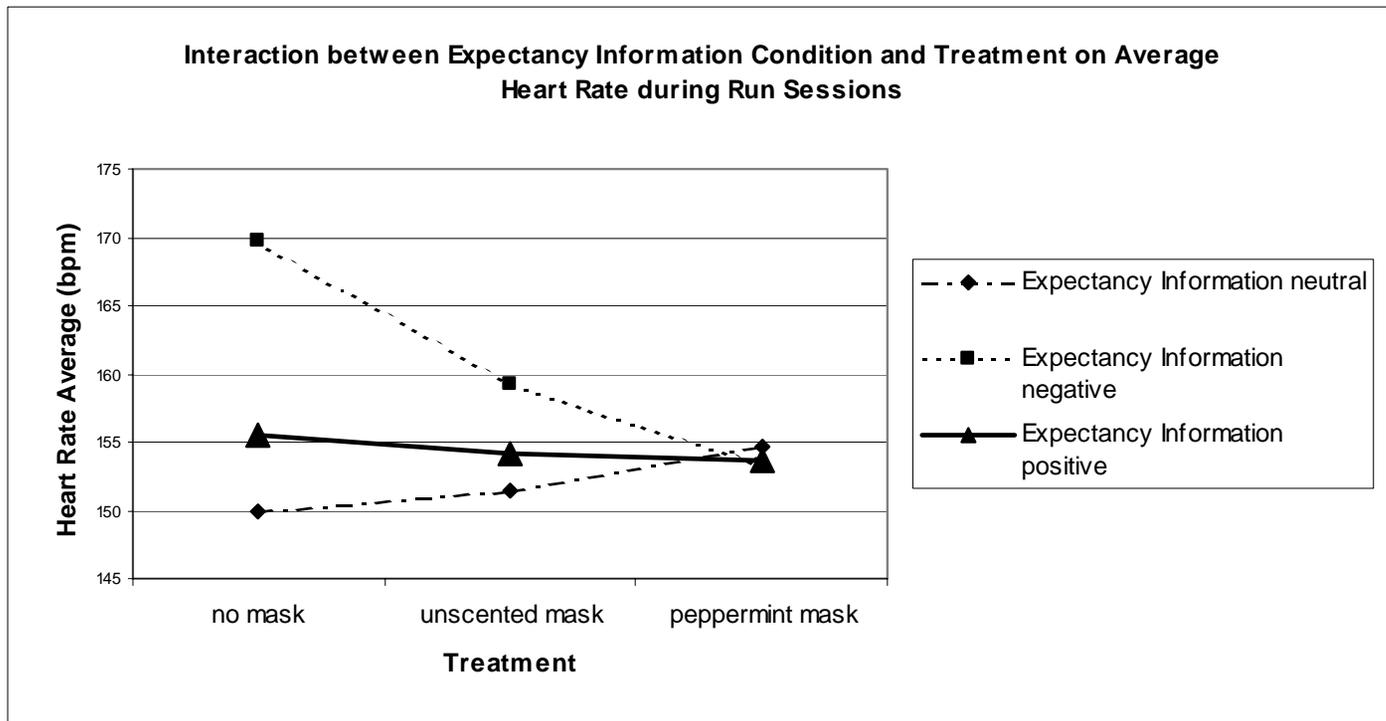


# Research Findings



Significant interaction between expectancy information and treatment on participant's average HR for each run ( $F_{4, 81} = 2.531, p = .047$ )

Treatment randomized, thus fatigue effects not the cause of the results



# Review of Results - Discussion



Neither the peppermint-scented mask, nor the unscented mask, had a significant effect on run time performance.

Why do these results differ from the previously discussed study by Raudenbush, et al. (2001)?

# Review of Results - Discussion



Possible reasons why the present study did not find an effect of peppermint odor inhalation on athletic performance:

- Better experimental controls (double-blind?); perhaps results in previous study were merely an artifact
- Prescreening for olfactory abilities; none mentioned in previous study
- Relatively exact measure of peppermint oil solution ( $\sim 0.14$  g); “two drops” given in previous study
- Type of participant; previous study used collegiate athletes with mean age 20; present study used physically active females, btw ages of 18 and 25, with a variety of fitness levels.
- Environmental conditions not accounted for in previous study; measured and included in data analyses

# Review of Results - Discussion



Previous study did not account for how peppermint oil was administered – that is, did they add the drops of peppermint to nasal strips in front of Ss? Did Ss know that the peppermint oil was the crux of the experiment? What were Ss told regarding the purpose of the study? Was the timer aware of the treatments of each Ss?

## The present study:

- sprayed solution onto masks ~8 min prior to Ss wearing them; this was done when Ss not present
- Ss told purpose of study stemmed from concerns regarding air pollution and growing fear of transmittable diseases; told that masks may have a harmless odor, such as peppermint (lessening chance of hypothesis guessing)
- Ss given scripted expectancy information
- Timer was unaware of treatment and expectancy information conditions of Ss, eliminating experimenter bias

# Review of Results - Discussion



Perhaps most interesting...

Physical performance of individuals in a high positive affective state – those that are more enthusiastic, active, and alert – is negatively influenced when these individuals are given experimenter-induced expectations about an odor's effect on that physical task.

This effect occurs, despite whether the expected effects are positive or negative in nature.

# Implications of Peppermint Odor As An Ergogenic Aid



Peppermint odor does not have an ergogenic effect on athletic performance.

Odor appears to affect the performance of individuals who are given information regarding odor's "influence" on performance while in a state of high positive affect.

When information on what is "expected" to occur is made known, that message – whether positive or negative – may impact athletic performance in a short-duration, dynamic task, such as the 400-m dash.

# Threats to Validity



Run sequence did have a significant effect on run time  
( $F_{2, 64} = 5.132, p = .009$ )

A longer recovery time should have been given.

Run sequence had a significant effect on perceived rate of exertion  
( $F_{2, 81} = 10.040, p = .000$ )

Again, a longer recover time should have been given.

The sample size was smaller ( $n = 18$ ) than what would have been desired when testing possible ergogenic effects on physical performance, due to budget and temporal constraints. However, b/c Raudenbush, et al., found an effect, a similar effect was expected to occur in the present study.

# Future Research



To determine what factor(s) contributed to the difference in results between the Raudenbush, et al. study and the present one. This factor could be the determining factor of peppermint's effect, if any, on physical performance.

To more thoroughly investigate the influence of experimenter-induced (or coach-induced, marketing-induced, etc.) expectations on athletic performance. Perhaps the best way to improve a person's physical capacity is to shower that person with positive messages in order to enhance affective state?

# Peppermint Odor and Athletic Performance: An Ergogenic Aid or An Expectancy Effect?



Thank You