

Florida State University Libraries

Faculty Publications

Department of Educational Psychology and Learning Systems

2013

The effect of olfactory ovulation cues on males' attention allocation and perception of exertion

Itay Basevitch, Selen Razon, Edson Filho, Nataniel Boiangin, Oscar Gutierrez, Robyn Braun, Guler Aarsal, and Gershon Tenenbaum



Authors

Itay Basevitch, Selen Razon, Edson Filho, Nataniel Boianguin, Oscar Gutierrez, Robyn Braun, Guler Aarsal, and Gershon Tenenbaum

Journal of Multidisciplinary Research, Vol. 5, No. 2, Summer 2013, 5-21.
ISSN 1947-2900 (print) • ISSN 1947-2919 (online)
Compilation Copyright © 2013 by St. Thomas University. All rights reserved.

The Effect of Olfactory Ovulation Cues on Males' Attention Allocation and Perception of Exertion

Itay Basevitch

Florida State University

Selen Razon

Ball State University

Edson Filho

University of Chieti-Pescara, Italy

Nataniel Boiangin

Florida State University

Oscar Gutierrez

Florida State University

Robyn Braun

Florida State University

Guler Aarsal

Florida State University

Gershon Tenenbaum

Florida State University

Abstract

The purpose of the present study was to examine the effect of olfactory ovulation cues (i.e., female body odors) on a range of psychological, physiological, and behavioral indices in males during an exertive motor task. Eighty-eight male participants performed a handgrip squeezing task at 20% of maximum squeezing capacity to volitional fatigue. There were three conditions to the study: control, placebo, and ovulation. Researchers recorded participants' rate of perceived exertion (RPE), attention allocation, heart rate (HR), and skin conductance response (SCR). Multivariate analysis did not reveal significant differences among the groups. However, as task duration increased, small to large effect sizes (Cohen's d ; $d = .13 - .60$) emerged between the ovulation and both the control and placebo groups for HR, SCR, and attention allocation. Effect size magnitude suggests female ovulation cues may have a delayed effect on males' attention and RPE during an exertive task. Future research should focus on alternative methods of collection and distribution of olfactory ovulation cues. To increase ecological validity, research also needs to test these effects by means of diverse tasks and settings (aerobic tasks, team tasks).

Keywords: exercise, body odor, attention, perceived exertion

Introduction

The use of two broad attentional strategies, association and dissociation, helps coping with exertive stimuli (Tenenbaum, 2001). Associative strategies entail directing attentional focus to internal and bodily cues, whereas dissociative strategies entail directing attentional focus outward and away from bodily cues (Tenenbaum, 2001; 2005). Empirical evidence suggests that during performance on physical tasks, individuals alternate between associative and dissociative strategies (Lind, Welch, & Ekkekakis, 2009). The latter is effortless at low-moderate workload intensities; nonetheless, associative strategies tend to prevail above sub-maximal intensities (Lind et al., 2009; Tenenbaum, 2001). This phenomenon, i.e., the attention shift, accounts for the tendency to shift attention from dissociative (e.g., non-task related stimuli) to associative (e.g., task related stimuli) focus as a function of the physical workload (Tenenbaum, 2001).

In an effort to increase exercise adherence, recent studies have examined the relationship between environmental stimuli and task performance (Connolly & Tenenbaum, 2010; Hutchinson & Tenenbaum, 2007; Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009; Tenenbaum, 2005). Findings from these revealed that presentation of external stimuli (e.g., visual and auditory cues) mediates attention shift, perceived exertion, and consequently, influences task enjoyment (e.g., perceived hedonic and functionality tones) and task adherence.

However, scant research within the exercise psychology domain has addressed the relationship between olfactory stimuli, attention allocation, and performance on physical tasks. Among these, Raudenbush, Corley, and Eppich (2001) investigated the effect of olfactory stimuli (i.e., peppermint) on a range of physical tasks (e.g., handgrip, push-ups, and running) to determine whether task performance improves under olfactory conditions. Similarly, Basevitch et al. (2011) concluded that peppermint and lavender cues may affect attention diversion and mediate performance in physical tasks (Basevitch et al., 2011). Noteworthy, although these tested the impact of synthetic olfactory stimuli (e.g., peppermint, lavender) on select behavioral outcomes, no research has examined the impact of natural olfactory stimuli during physical tasks.

This study is an initial attempt to investigate the impact of females' ovulation cues on a set of performance variables in males during a physical task. This initiative is congruent with previous research suggesting that women's natural scents affect endocrinological responses in men (Miller & Maner, 2011) most probably because body odors activate the amygdala region, which, in turn, excites dopaminergic arcuate neurons involved in the regulation of sexual behavior (Dulac & Kimchi, 2007).

As per the specific effects of olfactory cues on performance, evidence from evolutionary biology further suggests that body odors may alter physical performance (see Gage, 2003). Of particular interest, female ovulation cues promote cognitive and behavioral changes in males (Haselton & Gangestad, 2006). To that end, body odors affect social and sexual behavior, mediate social interactions, influence mood, increase skin conduction, change pain perception, increase testosterone levels, and direct attention to emotions (Gangestad, Thornhill, & Garver-Apgar, 2005). Precisely, evidence suggests that following exposure to female ovulation scents males are more likely to change their behaviors, take higher risks, and attempt to seduce the ovulating female (Haselton & Gildersleeve, 2011). Furthermore, post exposure to the scent of an ovulating woman, men display increased levels of testosterone and sympathetic activity (Miller & Maner, 2010) as well as greater heart rate and skin conductance responses (see Adolph, Schlosser, Hawighorst, & Pause, 2010).

Nonetheless, most scientific efforts addressing the effect of body odors on behavior are within the comparative biology realm. While abundant evidence on the olfactory capacity is available within the animal population (Dulac & Kimchi, 2007), research findings are equivocal as per the relationship between body odors and simultaneous behavioral responses in humans (Doty, 2010). Consequently, there is a need for investigating the dynamics between women's ovulation scents and male biopsychosocial behavior (see Miller & Maner, 2011; Singh & Bronstad, 2001). The purpose of this study was to examine the effect of olfactory ovulation cues (i.e., female body odors) on a set of psychophysiological indices in males performing a strength-endurance task. Specifically, we examined the effect of body odors on the psychological (i.e., attention allocation, perceived exertion), behavioral (i.e., task adherence and attrition rate), and physiological (i.e., heart rate and skin conductance response) responses of male participants during a handgrip squeezing task. We hypothesized that exposure to female ovulation cues would (a) extend task adherence, (b) delay the dissociative-associative attention shift, (c) divert attention from the exertive task, and (d) affect both heart rate and skin conductance responses in males during effort expenditure.

Method

Participants

Eighty-eight male college students ($n = 88$) from a university located in the southeastern United States participated in the study for course credit. No data collection occurred prior to the approval of the Institutional Review Board. Due to the physical nature of the task, only healthy individuals participated in the study. To check for health status, potential participants answered General Health and Lifestyle Questionnaire (GHLQ) and a set of additional items gauging medical history on pre-existing olfactory concerns (e.g., chronic sinusitis, septal deviation, hyposmia). Due to the motivational requirement of the task, participants also answered

motivational and commitment checks. Data analysis did not include those (i.e., the data) of participants ($n = 8$) scoring low in task motivation and task commitment (i.e., scores of 5 or lower on the Task-Specific Self-Efficacy and Commitment Check questionnaires). The final data included 80 male participants. Participants' age ranged 18-38 years ($M_{age} = 21.78$, $SD = 3.70$).

Apparatus and Handgrip Task

A calibrated Lafayette TM handgrip dynamometer Model 78010 (Lafayette instrument company, Lafayette, Indiana) helped measure handgrip capacity. The dynamometer included an adjustable hand bar connected to a steel spring that when the participant squeezed the dynamometer, moved a pointer and displayed applied force in kilograms on the face of the device. The testing anchors for the dynamometer ranged between 0 and 100kg. Previous studies have confirmed the validity of the handgrip squeezing task in regard to measuring perceived effort (Basevitch et al., 2011; Razon et al., 2011).

Task Conditions

This study followed a random assignment protocol, and there were three conditions to the study: (1) ovulation ($n = 26$, $M_{age} = 21.77$, $SD = 4.50$) (i.e., exposure to a T-shirt worn previously by an ovulating female), (2) placebo ($n = 26$, $M_{age} = 21.69$, $SD = 3.79$) (i.e., exposure to a new unused T-shirt washed with unscented detergent, and, therefore, without an ovulation scent), and (3) control ($n = 28$, $M_{age} = 21.86$, $SD = 2.84$) (i.e., no exposure to a T-shirt at all). Prior to task performance, participants in the ovulation and placebo conditions smelled a T-shirt with and without the female ovulation cues, respectively. Participants in the control condition did not smell a T-shirt.

Odor Collection Method

Two female researchers helped collect the ovulation cues for this study. Consistent with the previously validated body odor collection paradigms (see Miller & Maner, 2011; Singh & Bronstad, 2001), the ovulation cues consisted of the females' T-shirt worn during ovulation phases. In compliance with the validated protocols, the two females were not on hormonal contraceptives and had regular menstrual cycles of approximately 26-34 days in length. Considering the onset of menstrual blood flow as Day 0, the women wore the T-shirt during the nights of Days 13, 14, and 15 (i.e., late follicular phase, near ovulation). When the women did not wear the T-shirts (i.e., during day time) they kept them in a sealed hermetic freezer bag. Also, to avoid superfluous odors, during Days 13, 14, and 15, the women bathed using fragrance-free soap and shampoo, and refrained from (a) using perfumes, deodorants, and antiperspirants on both themselves and their bed linens; (b) eating odor-producing food (e.g., chili, garlic, pepper, vinegar, asparagus); (c) smoking cigarettes, drinking alcohol, and using drugs; and (d) engaging in sexual activity and sleeping in the same bed with someone else. At the completion of each three-day session, the women returned the T-shirts to the researcher. To best ensure appropriate implementation of the protocol, the women also returned an odor collection log they filled each day of the three-day session. Congruent with the body odor collection paradigms, participants smelled the T-shirts within three days of women wearing them.

Instrumentation

The General Health and Life Type Questionnaire (GHLQ; British Columbia Department of Health, 1975). A part of the Physical Activity Readiness Questionnaire (PAR-Q), GHLQ included eight items answered in a dichotomous (YES-NO) format. The original GHLQ consisted of items with specific relevance to coronary and cardiovascular health. For the purposes of this study, the scale did not include some of the cardiovascular items. Additional items to the scale included items related to olfactory precondition and allergies.

Demographic information. The form helped collect demographic information including name, age, gender, and frequency of physical activity participation. For the purposes of the current study, additional but optional items included those related to relationship status and sexual preference.

Ratings of Perceived Exertion (RPE; Borg, 1982). The 10-point category-ratio scale with anchors ranging from 0 (i.e., *nothing*) to 10 (i.e., *extremely strong*) helped measure perceived exertion. RPE is a reliable measure of physical discomfort and possesses high intra-test ($r = .93$) and test re-test ($r = .83 - .94$) reliabilities. RPE also correlates with a number of physiological and chemical markers of exertion including Lactic Acid (LA), Heart Rate (HR), Maximal Oxygen Consumption (VO_2), and Ventilation (VE) (Borg, 1982).

Attention (Tammen, 1996). A 10-point scale with anchors ranging from 0 (i.e., *attention away from task and body*) to 10 (i.e., *attention on task and body*) helped measure attention allocation throughout the task performance. Attention scale is a valid tool for measuring attention strategies during effort expenditure (Tammen, 1996).

Task-Specific Self-Efficacy (TSSE; Bandura, 1997). The TSSE helped measure participants' beliefs in their physical ability to tolerate the physical exertion and discomfort associated with the task. A sample item of TSSE included "How confident are you that you will perform adequately on this task?" Participants rated each item on Likert-type scale ranging from 0 (i.e., *not at all*) to 10 (i.e., *very much*).

Commitment and smell check. The scale helped gauge participants' task commitment. A sample item included "How committed were you to the task while performing?" Participants rated each item on a Likert-type scale ranging from 0 (i.e., *none, not at all*) to 10 (i.e., *very much, very well*). For the purposes of this study, three additional items measured the perceived pleasantness and intensity of the ovulation cues for the experimental and placebo conditions. A sample additional item included "To what degree was the smell pleasant or unpleasant?" Participants rated each item on a Likert-type scale ranging from 0 (i.e., *no odor, extremely unpleasant, not at all*) to 10 (i.e., *extremely strong odor, extremely pleasant, very much*).

Skin Conductance Response (SCR - ProComp Module; Thought Technology Ltd., 1975). Thought Technology's physiological biofeedback system helped measure SCR via sensors placed on participants' index and middle fingers. Skin conductance response is a measure of cognitive attention and arousal regulation (Adolph et al., 2010; Albrecht et al., 2011).

Heart Rate measure (HR - Polar T31; Polar Electro Inc., 1977). Polar's T31 HR monitor system helped measure participants' HR via a wrist worn HR receiver unit and a chest worn sensor strap.

Task duration and attrition rate. A standard stopwatch helped measure the amount of time each participant endured on the handgrip task to the nearest second. These data served to determine the attrition rate.

Procedure

Participation in the study included one session of approximately 45 minutes. In an attempt to control for procedural bias, the primary researcher was blind to all conditions, with the exception of the control condition. Specifically, a double-blind trial design, within experimental conditions, entailed one researcher administering the surveys and assigning participants to either the ovulation or placebo groups. A second researcher who ran the experiment was blind to the participant's condition – i.e., did not have knowledge whether the T-shirt was of ovulation or unused. Prior to task-performance, participants read and signed the informed consent form. Subsequently, the researcher instructed participants to squeeze the dynamometer at maximal strength in one explosive effort. Congruent with previously validated protocols (Basevitch et al., 2011; Cline, Doscher, & Hoff, 2004), participants squeezed the dynamometer during three consecutive attempts, and the highest of these corresponded to the participant's maximum volume contraction (MVC). Next, the researcher computed 20% of the participant's MVC. Twenty percent MVC is appropriate (i.e., not too extraneous) with moderately active populations, and similar studies of effort perception have used the same protocol (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008; Razon et al., 2009).

Subsequently, participants received a detailed explanation of the handgrip squeezing protocol and answered the TSSE scale. Following, participants wore the HR monitor and the researcher connected participants' non-dominant hand to the biofeedback system. At this point, the researcher recorded HR and SCR during a three-minute baseline session. During pre-testing and testing participants did not view or receive feedback of their physiological data. To avoid distraction, the researcher placed the biofeedback display screen in only his view. Upon completion of the baseline session, participants in the ovulation and placebo groups took three nasal inhalations from a bag that the researcher held up in front of them at nose level. To prevent visual bias, participants were blindfolded at the time of the nasal inhalations.

Next, using their non-dominant hand, participants squeezed and held the dynamometer at 20% of their MVC for as long as they could. Congruent with previous research using similar paradigms (Basevitch et al., 2011; Razon et al., 2011), participants verbally reported RPE and attention throughout the task performance at every 30s (using scales placed in front of them, at eye level). Upon task completion, participants responded to a commitment check, and the researcher debriefed participants on any questions related to the experiment.

Participants in the placebo condition underwent an identical protocol. Participants in the control condition did not smell any T-shirt, and squeezed the handgrip dynamometer at 20% of MVC for as long as they could.

Results

Manipulation Checks

Self-efficacy check. Results from a Multivariate Analysis of Variance (MANOVA) revealed no significant self-efficacy differences among three groups (ovulation, placebo, control) on the self-efficacy items of the TSSE scale, *Wilk's* $\lambda = .88$, $F(8, 146) = 1.16$, $p = .32$, $\eta_p^2 = .06$. On average, participants were highly self-efficacious about their ability to perform well on the handgrip squeezing task ($M = 8.41$, $SD = 1.35$).

Commitment check. Results from a MANOVA revealed no significant differences among three groups on the commitment items of the task commitment scale, *Wilk's* $\lambda = .89$, $F(6, 150) = 1.46$, $p = .20$, $\eta_p^2 = .06$. In general, participants reported high commitment levels to the handgrip squeezing task ($M = 8.70$, $SD = 1.23$).

Smell check. Results from a MANOVA of the three smell check dimensions (e.g., pleasantness, relaxing or arousing quality, attention), for the two task conditions (e.g., placebo and ovulation) revealed significant differences, *Wilk's* $\lambda = .83$, $F(3, 47) = 3.15$, $p = .03$, $\eta_p^2 = .70$. Univariate F tests also revealed significant differences in attention diversion, $F(1, 50) = 4.43$, $p = .04$. The ovulation ($M = 1.73$, $SD = 1.66$) group reported less attention diversion than the placebo group ($M = 3.00$, $SD = 2.57$, $d = .60$).

Task Analyses

Total time duration and attrition rate. Results from a one-way Analysis of Variance (ANOVA) revealed the groups did not differ on total task duration, $F(2, 79) = .56$, $p = .57$. The mean time duration on the task was approximately 300s ($M = 305.74$, $SD = 109.90$), i.e., 10 time intervals of 30s. At the 8th-time interval (i.e., 240 s), 25% of the participants dropped out (see Figure 1). As a result, the main analyses of the data had 8th time interval frame as the reference point.

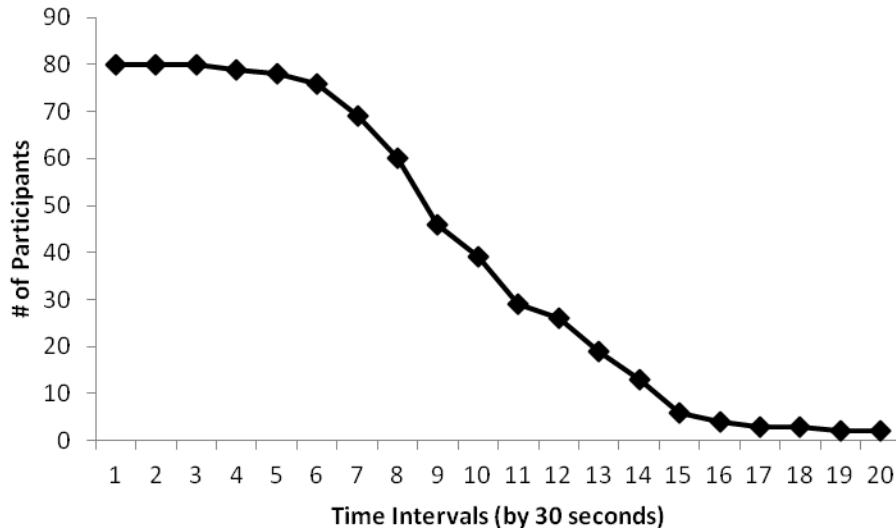


Figure 1. Total attrition rate.

Ratings of Perceived Exertion (RPE). Results from a mixed model Repeated Measure (RM) ANOVA with time interval as a within subject factor (i.e., eight time intervals) and task condition (i.e., control, placebo, ovulation) as a between subject factor revealed a significant main effect for time, $GG_{ms} = 766.19$, $F(2.25, 128.43) = 227.63$, $p < .001$, $\eta_p^2 = .80$. RPE increased linearly with time, regardless of task condition. Analysis revealed no significant main effects for task condition, $F(2, 57) = .13$, $p = .88$, $\eta_p^2 < .01$. Additionally, the time by condition interaction effect was non-significant, $GG_{ms} = 1.01$, $F(4.51, 128.43) = .30$, $p = .90$, $\eta_p^2 = .01$.

Attention. Results from eight (time intervals) by three (task conditions) mixed model Repeated Measure Analysis of Variance (RM ANOVA) on attention allocation revealed a main effect for time interval, $GG_{ms} = 255.82$, $F(1.83, 102.33) = 37.08$, $p < .001$, $\eta_p^2 = .40$. There were no significant effects for task condition, $F(2, 56) = .25$, $p = .78$, $\eta_p^2 < .01$, and time by task condition interaction, $F(3.66, 102.33) = 8.63$, $p = .30$, $\eta_p^2 = .04$.

RPE by attention. Results from a graph depicting the relationship between RPE and Attention and the effect sizes at each time interval (see Figure 2 and Table 1) revealed that at lower RPE levels the ovulation group diverted attention at greater levels than placebo and control, but these differences somewhat declined as the RPEs increased.

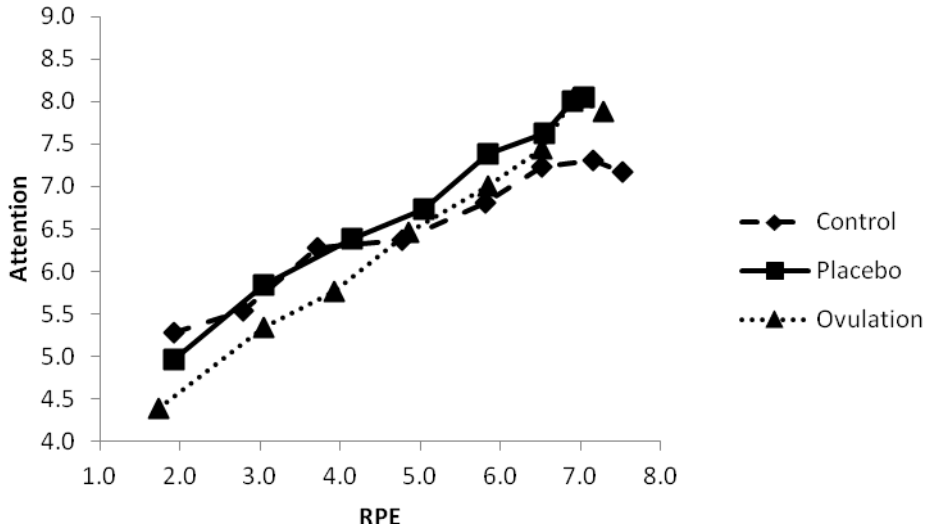


Figure 2. Means RPE by Attention for each task condition.

Table 1

Effect Size (Cohen’s *d*) for RPE and Attention between ovulation and placebo and ovulation and control conditions at each time interval

Time Intervals (30s)	<u>Ovulation-Control</u>		<u>Ovulation-Placebo</u>	
	RPE	Attention	RPE	Attention
1	0.12	0.32	0.11	0.21
2	-0.12	0.07	0.00	0.20
3	-0.09	0.21	0.10	0.25
4	-0.03	-0.04	0.08	0.12
5	-0.01	-0.08	0.00	0.18
6	0.00	-0.09	0.01	0.10
7	0.12	-0.34	0.00	-0.02
8	0.13	-0.28	-0.10	0.07

Heart Rate measure (HR). Results from eight (time intervals) by three (task conditions) RM ANOVA revealed a significant main effect for time interval, $GG_{ms} = .09$, $F(3.83, 214.21) = 4.93$, $p < .001$, $\eta_p^2 = .08$. There was no significant main effect for task condition. Although analysis revealed a non-significant interaction effect, the HR by task condition interaction, $GG_{ms} = .03$, $F(7.65, 214.21) = 1.62$, $p = .12$, $\eta_p^2 = .06$, revealed that HR increased at a greater pace in the ovulation condition in course of the effort expenditure (see Figure 3 and effect sizes in Table 2).

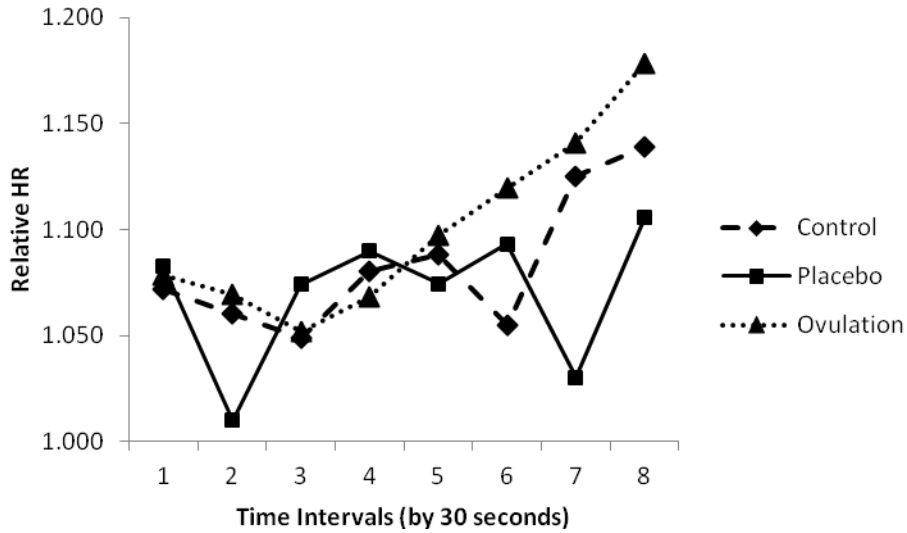


Figure 3. Mean HR through eight time intervals by task condition

Table 2

Effect Size (Cohen's *d*) for HR and SCR between ovulation and placebo and ovulation and control conditions at each time interval.

Time Intervals (30s)	<u>Ovulation-Control</u>		<u>Ovulation-Placebo</u>	
	HR	SCR	HR	SCR
1	-0.12	-0.04	0.12	0.42
2	-0.09	-0.07	-0.17	0.36
3	-0.22	0.06	0.30	0.51
4	-0.05	0.09	0.25	0.48
5	-0.15	0.08	-0.12	0.44
6	-0.46	0.02	-0.29	0.52
7	-0.31	0.13	-0.60	0.27
8	-0.28	0.25	-0.52	0.55

Skin Conductance Response (SCR). Results from a RM ANOVA revealed a significant main effect for time interval, $GG_{ms} = 6.78$, $F(1.61, 81.89) = 30.04$, $p < .001$, $\eta_p^2 = .37$, indicating SCR increased linearly with time. There were no significant effects for task condition, $F(2, 51) = 1.14$, $p = .33$, $\eta_p^2 = .04$, and time by task condition interaction, $GG_{ms} = 1.02$, $F(3.21, 81.89) = 1.02$, $p = .44$, $\eta_p^2 = .04$ (see Figure 4 and effect sizes in Table 2).

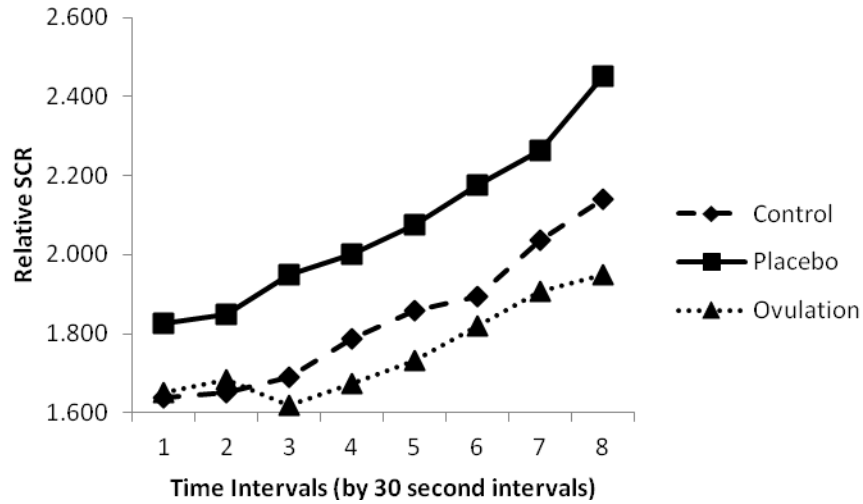


Figure 4. Mean SCR through eight time intervals by task condition

Discussion

The purpose of this study was to examine the effect of female olfactory ovulation cues on a set of psychophysiological indices in males performing a strength-endurance task. Next, a multi-dimensional analysis (i.e., psychological, behavioral and physiological) offers a broad perspective on the relevant findings.

Behavioral Level

Task duration and attrition rates did not differ among groups, suggesting that female ovulation cues did not seem to affect performance. Previous findings from research examining the effects of olfactory cues on similar task performance also were equivocal (Simpson, Coady, Osowski, & Bode, 2001). This may be due to the relatively weak dosage of the olfactory stimuli in comparison to the strong demands inherent in the physical task (Raudenbush, Meyer, & Eppich, 2002). Olfactory stimuli could exert some effects on tasks, which are less physically demanding; however, as the physicality (i.e., workload) of the task increases, the effects of the olfactory stimuli may decrease and become extinct (see Basaevitch et al., 2011).

Psychological Level

The three groups did not differ on the RPEs. All participants increased RPE ratings linearly as time progressed. Additionally, as the task became increasingly difficult, participants diverted their attention from the stimulus and focused on exertive sensations. Previous studies also have indicated a linear relationship between the duration of the exertive task and RPE (Hutchinson & Tenenbaum, 2007). Similarly, groups did not differ on the attention focus. However, at lower RPEs, attention of the ovulation group was dissociative, relative to the control and placebo groups; this difference, however, decreased as the RPEs increased. Previous research

has indicated that attention is exclusively associative at higher levels of RPE (Tenenbaum, 2001). Therefore, the increased levels of RPE in this study may have probed associative strategies, which, in turn, are less susceptible to olfactory stimulation.

Although research has shown increased hormonal response in males following exposure to female ovulation cues (Miller & Maner, 2010), most of the extant literature has used different paradigms and investigated variables related to sexual behaviors (Gangestad, Thornhill, & Garver-Apgar, 2005). The current study was the first to investigate the effects of female ovulation cues during a physical task. It, therefore, may be plausible that female ovulation cues have only a minimal effect on task performance when task are not from the sexual realm. Other plausible explanations for the findings may pertain to methodological shortcomings (e.g., dosage of the ovulation cues, administration methods) and accuracy of measurement tools.

Physiological Level

Previous research has indicated that chemosensory cues may increase HR and SCRs (see Adolph, Schlosser, Hawighorst, & Pause, 2010; Albrecht et al., 2011). However, in the current study, HR did not differ among the groups. There was a main effect of time for all conditions indicating that as time on task increased, HR increased accordingly and linearly. Furthermore, although the interaction failed to reach significance, as time on task increased, HR increased at a faster pace in the ovulation group relative to participants in the control and placebo groups. The apparent differences in effect sizes in HR among the ovulation and the placebo and control groups as a function of time further confirmed this observation. Arguably, exposure to ovulation cues could have a delayed effect on physiological variables. Thus, initially, ovulation cues may not have had an effect on HR. However, with greater time on task, physiological differences may have gained further prominence. Previous research on the effects of body odors on sexual behaviors has suggested a delayed effect (i.e., that peaks more than an hour after exposure to stimulus) for some variables (e.g., genital arousal, sexual lust) (see Tuiten, Van Honk, Koppeschaar, Bernaards, Thijssen, & Verbaten, 2000).

Finally, as per the SCR, there was a significant time effect indicating that as time on task increased, SCR also increased. Nevertheless, condition and condition by time interaction were not significant. Effect sizes for the experimental group, however, remained large relative to the placebo group, which may suggest a similarly delayed effect of the ovulation cues on SCR.

Conclusion, Limitations and Future Research

Findings from previous research examining the effect of body odors on human behavior and physical performance are equivocal at best. The current study aimed to delineate the effects of female ovulation cues on behavioral, psychological, and physiological variables in males during a strength-endurance task. Although no significant differences emerged among the groups (i.e., ovulation, placebo and control), effect sizes of the psychological and physiological variables suggest that time on task may mediate some of the effects. From a methodological standpoint, one may argue the between-subject design inherent in this study may have led to increased nuisance within the measurement of highly subjective physiological data. While the individual variability presents concerns in any between-subject protocol, to control for variability, participants in this study answered to two manipulation checks (i.e., TSSE and commitment

check) and did not differ on either. More importantly, due to fatigue and practice effects that may be inherent in a handgrip squeezing task, the present protocol did not use alternative designs including within-subject protocols.

Yet another factor that may have added to the noise with regard to the physiological data in the present study may be the small number of donors. Previous studies have used similar amounts of donors (see Miller & Maner, 2010). However, recent studies have used a greater number (see Saul & Miller, 2011) of donors thus future research could benefit from additional donors during the odor sampling procedure. It is also important to note the use of a non-ovulation condition could have enhanced the design of the present study. The introduction of a second experimental condition entailing to smelling a T-shirt worn by women far from ovulation (see Miller & Maner, 2010) could further contrast the results, and provide more adequate comparisons, thus offering additional insights into the effects of olfactory ovulation cues on select indices within physical effort settings.

Consequently, beyond using different tasks and designs, future research also may target the extent to which women's bodily cues may affect the secretion of select chemicals (e.g., testosterone). To that end, identifying the effects of natural body scents within diverse performance settings such as aerobic activity (e.g., cycling and running) and team sports (e.g., soccer and basketball) may increase the ecological validity of the findings, and prove important for the advancement of knowledge in the field.

References

- Adolph, D., Schlösser, S., Hawighorst, M., & Pause, B. M. (2010). Chemosensory signals of competition increase the skin conductance response in humans. *Physiology & Behavior*, *101*(5), 666-671. doi: <http://dx.doi.org/10.1016/j.physbeh.2010.08.004>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Basevitch, I., Thompson, B., Braun, R., Razon, S., Aarsal, G., Tokac, U.,...Tenenbaum, G. (2011). Olfactory effects on attention allocation and perception of exertion. *The Sport Psychologist*, *25*(2), 144-158. Retrieved from <http://search.proquest.com/docview/896405870?accountid=4840>
- Borg, G. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sport and Exercise*, *14*(5), 377-381. Retrieved from http://fcesoftware.com/images/15_Perceived_Exertion.pdf
- Connolly, C. T., & Tenenbaum, G. (2010). Exertion-attention-flow linkage under varying workloads. *Journal of Applied Social Psychology*, *40*(5), 1123-1145. Retrieved from <http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291559-1816/issues>
- Doty, R. L. (2010). *The great pheromone myth*. Baltimore, MD: Johns Hopkins University Press. Retrieved from <http://search.proquest.com/docview/622272724?accountid=4840>
- Dulac, C., & Kimchi, T. (2007). Neural mechanisms underlying sex-specific behaviors in vertebrates. *Current Opinion in Neurobiology*, *17*(6), 675-683. doi:<http://dx.doi.org/10.1016/j.conb.2008.01.009>
- Gangestad, S. W., Thornhill, R., & Garver-Apgar, C. (2005). Adaptations to ovulation: Implications for sexual and social behavior. *Current Directions in Psychological Science*, *14*(6), 312-316. doi:10.1111/j.0963-7214.2005.00388.x

- Gage, M. J. G. (2003). Evolutionary biology: Scramble for the eggs. *Nature*, 426(6962), 22-23. doi: <http://dx.doi.org/10.1038/426022a>
- Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior*, 49(4), 509-518. doi: <http://dx.doi.org/10.1016/j.yhbeh.2005.10.006>
- Haselton, M. G., & Gildersleeve, K. (2011). Can men detect ovulation? *Current Directions in Psychological Science*, 20(2), 87-92. doi:10.1177/0963721411402668
- Hutchinson, J. C., Sherman, T., Martinovic, N., & Tenenbaum, G. (2008). The effect of manipulated self-efficacy on perceived and sustained effort. *Journal of Applied Sport Psychology*, 20(4), 457-472. doi:10.1080/10413200802351151
- Hutchinson, J. C., & Tenenbaum, G. (2007). Attention focus during physical effort: The mediating role of task intensity. *Psychology of Sport and Exercise*, 8(2), 233-245. doi:10.1016/j.psychsport.2006.03.006
- Karageorghis, C. I., & Terry, P. C. (1997). The psychophysical effects of music in sport and exercise: A review. *Journal of Sport Behavior*, 20(1), 54-68. <http://search.proquest.com/docview/619072037?accountid=4840>
- Lind, E., Welch, A. S., & Ekkekakis, P. (2009). Do mind over muscle strategies work? Examining the effects of attentional association and dissociation on exertional, affective, and physiological responses to exercise. *Sports Medicine*, 39(9), 743-764. doi:10.2165/11315120-000000000-00000
- McCurdy, K., Langford, G. A., Cline, A. L., Doscher M., & Hoff R. (2004). The reliability of 1- and 3m tests of unilateral strength in trained and untrained men and women. *Journal of Sports Science and Medicine*, 3(3), 190-196. Retrieved from <http://www.jssm.org/vol3/n3/10/v3n3-10pdf.pdf>
- Miller, S. L., & Maner, J. K. (2010). Scent of a woman: Men's testosterone responses to olfactory ovulation cues. *Psychological Science*, 21(2), 276-283. doi:10.1177/0956797609357733
- Miller, S. L., & Maner, J. K. (2011). Ovulation as a male mating prime: Subtle signs of women's fertility influence men's mating cognition and behavior. *Journal of Personality and Social Psychology*, 100(2), 295-308. doi:10.1037/a0020930
- Raudenbush, B., Corley, N., & Eppich, W. (2001). Enhancing athletic performance through the administration of peppermint odor. *Journal of Sport & Exercise Psychology*, 23(2), 156-160. <http://search.proquest.com/docview/619580496?accountid=4840>
- Raudenbush, B. B., Meyer, B. B., & Eppich, B. B. (2002). The effects of odors on objective and subjective measures of athletic performance. *International Sports Journal*, 6(1), 14-27. Retrieved from <http://web.ebscohost.com/ehost>
- Razon, S., Arsal, G., Nascimento, T., Simonavice, E., Loney, B., Gershgoren, L., Loney, B., Panton, L., & Tenenbaum, G. (2010, Fall). Perceptions of exertive pain, attention allocation, and task adherence in patients with fibromyalgia using imagery. *Journal of Multidisciplinary Research*, 2(2), 5-24.
- Razon, S., Basevitch, I., Land, W., Thompson, B., & Tenenbaum, G. (2009). Perception of exertion and attention allocation as a function of visual and auditory conditions. *Psychology of Sport and Exercise*, 10(6), 636-643. doi:10.1016/j.psychsport.2009.03.007

- Razon, S., Basevitch, I., Medeiros Filho, E., Land, W., Thompson, B., Biermann, M., & Tenenbaum, G. (2010). Associative and dissociative imagery effects on perceived exertion, attention, and adherence. *Journal of Imagery Research in Sport and Physical Activity*, 5, article 5. Retrieved from <http://www.degruyter.com/view/j/jirspa>
- Singh, D., & Bronstad, P. M. (2001). Female body odour is a potential cue to ovulation. *Proceedings of the Royal Society of London B*, 268, 797-801.
- Simpson, W. F., Coady, R. C., Osowski, E. E., & Bode, D. S. (2001). The effect of aromatherapy on exercise performance. *Kinesiology On-Line*. Retrieved from <http://www.iowaahperd.org/journal/simpson.html>
- Tammen, V. V. (1996). Elite middle and long distance runners associative/dissociative coping. *Journal of Applied Sport Psychology*, 8(1), 1-8. doi: 10.1080/1041320960840630
- Tenenbaum, G. (2001). A social-cognitive perspective of perceived exertion and exertion tolerance. In R. N. Singer, H. A. Hausenblas, & C. Janelle (Eds.), *Handbook of sport psychology* (pp. 810-822). New York: Wiley.
- Tenenbaum, G. (2005). The study of perceived and sustained effort: Concepts, research findings, and future directions. In D. Hackfort, J. Duda, & R. Lidor (Eds.), *Handbook of research on applied sport psychology* (pp. 335-349). Morgantown, WV: Fitness Information Technology.
- Tenenbaum, G., & Connolly, C. T. (2008). Attention allocation under varied workload and effort perception in rowers. *Psychology of Sport and Exercise*, 9(5), 704-717. doi:10.1016/j.psychsport.2007.09.002
- Tenenbaum, G., Lidor R., Lavyan N., Morrow, K. Tonnel, S., Gershgoren, A.,...Johnson, M. (2004). The effect of music on cycling perseverance and coping with effort sensations. *Psychology of Sport and Exercise*, 5(2), 89-109.
- Tuiten, A., Van Honk, J., Koppeschaar, H., Bernaards, C., Thijssen, J., & Verbaten, R. (2000). Time course of effects of testosterone administration on sexual arousal in women. *Archives of General Psychiatry*, 57(2), 149-153. doi:10.1001/archpsyc.57.2.149

About the Authors

Itay Basevitch, Ph.D. (ib05@fsu.edu), has just completed his doctoral studies in sport and exercise psychology at Florida State University. Itay received his bachelor's degree in psychology and sociology from Tel-Aviv University, Israel, and his master's degree in sport and exercise psychology from Florida State University. Itay's research interests revolve around perceptual-cognitive skills (e.g., anticipation and decision-making), perception of attention and exertion, and the link between psychological and physiological variables in sport and exercise settings. Currently, Itay serves as sport psychologist to select college football teams in the U.S.

Selen Razon, Ph.D. (srazon@bsu.edu), is an assistant professor of sport and exercise psychology at Ball State University. Dr. Razon's research interests revolve around the effects of multimodal sensory stimuli on perception of effort and attention focus, and the use of interdisciplinary strategies with a special emphasis for promoting physical activity in healthy and chronically ill populations. Dr. Razon received a doctoral degree in sport and exercise psychology from Florida State University, and a master's degree in counseling psychology from the University of Miami. Dr. Razon is a member of several organizations including the American Psychological

Association (APA), the American College of Sport Medicine (ACSM), and the Association for Applied Sport Psychology (AASP).

Edson Filho, Ph.D. (soares_medeiros@yahoo.com.br), received a doctoral degree in sport and exercise psychology from Florida State University. A Fulbright Scholar recipient, Dr. Filho's research efforts revolve around human and team excellence, with an emphasis on expert performance, interactive brains and shared mental models, and bio-neurofeedback applications. Currently, Dr. Filho is a post-doctoral fellow in neuroscience and psychophysiology at the Behavioral Imaging and Neural Dynamics Center at the University of Chieti-Pescara, Italy, where he studies optimal performance experiences among elite athletes (professional drivers, cyclists, and rifle-shooters) using brain imaging technology.

Nataniel Boiangin (nmb10g@my.fsu.edu) is a graduate student in sport and exercise psychology at Florida State University. He received his B.S. in psychology from Florida State University. Nataniel's research interests revolve around decision-making, visual perception training, attention allocation, and exercise adherence. Nataniel is the Head Coach for the Florida State University Ice Hockey Team and a member of several organizations including the Association for Applied Sport Psychology (AASP), the International Society of Sport Psychology (ISSP), and the North American Society for the Psychology of Sport and Physical Activity (NASPSPA).

Oscar Gutierrez (oag09@fsu.edu) is a doctoral student in sport and exercise psychology at Florida State University. He received his master's degree in counseling psychology from Florida State University. Oscar's research interests revolve around the perception of effort and exertion in response to select sensory stimuli, and psychophysiological effects of exercise participation in humans.

Robyn Braun (rab09g@fsu.edu) is a doctoral student in sport and exercise psychology at Florida State University. Robyn's research interests revolve around the perception of effort and exertion in children as well as the use of sensory modalities in promoting exercise adoption and maintenance in the general population.

Guler Aarsal, Ph.D. (gulerarsal@gmail.com), received a doctoral degree in sport and exercise psychology from Florida State University, and a master's degree in physical education and sports from Middle East Technical University, Turkey. Dr. Aarsal's research interests revolve around expert performance, choking under pressure, and the use of psychological skills in elite sport performance with a special emphasis in protocol analysis method.

Gershon Tenenbaum, Ph.D. (gtenenbaum@admin.fsu.edu), is Benjamin S. Bloom Professor of Educational Psychology at Florida State University. Dr. Tenenbaum is a graduate of Tel-Aviv University and the University of Chicago. He is a former director of the Ribstein Center for Research and Sport Medicine at the Wingate Institute in Israel, and coordinator of the Graduate Program in sport psychology at the University of Southern Queensland in Australia. From 1997 to 2001, he was the president of the International Society of Sport Psychology, and from 1996 to 2008 the Editor of the *International Journal of Sport and Exercise Psychology*. Dr.

Tenenbaum has published extensively in expertise and decision-making, psychometrics, and coping with physical effort experiences within sport and exercise settings. He is the recipient of several distinguished awards for his academic and scientific achievements, and is a member and fellow of numerous scientific and professional organizations.

Discussion Questions

1. As per the focus of the present study, define *Heart Rate (HR)* and *Skin Conductance Response (SCR)*. How are they measured in the present protocol?
2. List two strengths and weaknesses associated with this study. What would you do differently if you were to design a study looking into the effects of olfaction in human behavior?
3. Drawing upon the present research focus, discuss alternative and potential ways in which the olfactory modality could affect human behavior in a variety of domains (e.g., eating behaviors, buying behaviors, overall decision-making process, etc.).

To Cite this Article

Basevitch, I., Razon, S., Filho, E., Boiangin, N., Gutierrez, O., Braun, R., ... & Tenenbaum, G. (2013, Summer). The effect of olfactory ovulation cues on males' attention allocation and perception of exertion. *Journal of Multidisciplinary Research*, 5(2), 5-21.