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Emotional distress and tobacco demand during the menstrual cycle in female smokers

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ABSTRACT

Fluctuations in ovarian hormones over the menstrual cycle contribute to cigarette reward, however less is known about menstrual cycle influences on emotional distress in female smokers. We examined between-group differences in emotional distress (negative affectivity, emotion dysregulation, distress intolerance) and hypothetical cigarette purchasing (i.e. tobacco demand) among female smokers at three different menstrual stages. Women ($n = 32$) were non-treatment seeking daily smokers not on hormonal contraceptive, and were currently in their follicular (estradiol-dominant; $n = 10$), early-mid luteal (progesterone-dominant; $n = 15$), and late-luteal phase (decreasing progesterone/estradiol; $n = 7$). Effect sizes are reported given the small sample. Women in the late-luteal phase, relative to the follicular and early-mid luteal phases, reported higher levels of negative affectivity ($d = 0.69$), emotion dysregulation ($d = 1.03$), and distress intolerance ($d = -0.86$). Compared to the early-mid luteal and late-luteal phases, women in the follicular phase reported the highest hypothetical cigarette consumption when cigarettes were free ($d = 0.71$) and made the largest maximum expenditures on cigarettes ($d = 0.74$). Findings offer preliminary evidence that the late-luteal phase is characterized by emotional distress, and the follicular phase is associated with elevated tobacco demand, which if replicated could implicate ovarian hormones in emotion-focused smoking.

Introduction

Although the prevalence of smoking is higher in men versus women (Centers for Disease Control and Prevention, 2016), women are less successful in quitting (e.g. Japuntich et al., 2011). Ovarian hormones have been examined as a mechanism for the maintenance of smoking in women (Weinberger et al., 2015), particularly estradiol and progesterone, which fluctuate throughout the menstrual cycle (Allen et al., 2015). Estradiol and progesterone are both low during menstruation (onset of menses).

Relative increases in estradiol occur in the early-mid follicular phase (while progesterone remains low), with estradiol peaking during the late follicular phase, prior to ovulation, which is followed by a decrease in estradiol. During the early luteal phase, progesterone increases drastically, and peaks at the midpoint of the phase, at which point estradiol also reaches a second peak. This is followed by a late-luteal phase large decrease in progesterone and moderate decrease in estradiol.

The estradiol-dominant follicular phase is associated with enhanced nicotine reward, whereas the progesterone-dominant luteal phase is associated with decreased motivation for nicotine (Lynch & Sofuoglu, 2010). For example, lower ratio of progesterone to estradiol in female smokers (corresponding with follicular phase) are associated with greater tobacco consumption (Schiller, Saladin, Gray, Hartwell, & Carpenter, 2012) and the positive subjective effects of smoking are decreased during the progesterone-dominant luteal phase (Weinberger et al., 2015).

Estradiol and progesterone can also have anxiolytic and mood-regulatory effects when elevated (Li & Graham, 2016). In particular, during the late-luteal phase when progesterone is rapidly declining, women report worsening of emotional distress (Nillni et al., 2015; Nillni, Rohan, & Zvolensky, 2012) and use of less effective emotional coping strategies (Sigmon, Whitcomb-Smith, Rohan, & Kendrew, 2004) relative to other menstrual phases. Despite the link between emotional distress and reliance on cigarettes in women (Perkins, Karelitz, Giedgowd, & Conklin, 2013; Weinberger & McKee, 2012), the effect of ovarian hormones on emotional distress and in the maintenance of smoking has received limited scholarly attention. Female smokers may be most vulnerable to dysregulated emotional states and emotion-focused smoking during the late-luteal phase—the time immediately preceding the estradiol-dominant follicular phase. Smoking may be subsequently maintained during the follicular phase due to estradiol's influence on nicotine reward.

The current study is an initial evaluation of emotional distress and tobacco demand (i.e. the perceived value of cigarettes) following approximately 60 min of smoking deprivation, among a small sample of women at different stages of their menstrual cycle. We hypothesized that (a) women in the late-luteal phase would report higher emotional distress relative to women in the other phases and that (b) tobacco demand would be highest among women who are in the follicular phase relative to other phases.

Method

Participants

We utilized cross-sectional data from premenopausal female smokers ($n = 32$, cigarettes/day = 15.7 ± 5.8) with normal menstrual cycles not influenced by hormonal contraception, who participated in a larger study (Farris & Zvolensky, 2016). Women self-identified race primarily as black (46.9%) and white (43.8%). Approximately half of women completed at least some college (56.3%). Current menstrual phase was categorized as follicular (estradiol-dominant; $n = 10$, 31.3%), early-mid luteal (progesterone-dominant; $n = 15$, 46.9%), and late-luteal (decreasing progesterone/estradiol; $n = 7$, 21.9%).

Measures

Emotional distress

The *Positive and Negative Affect Scale* (Watson, Clark, & Tellegen, 1988) is a self-report measure of the extent to which individuals generally feel 20 different feelings and emotions. The 10-item negative affect scale was used in the current study, which includes rating to what extent different negative affective states were experienced, rated from 1 (*not at all*) to 5 (*very much*). Items are summed to derive a total score, with higher scores reflecting greater levels of negative affectivity. The *Difficulties with Emotion Regulation Scale* (Gratz & Roemer, 2004) is a 36-item self-report measure that assesses the degree to which individuals experience greater difficulties in regulating emotional states. Participants are asked to rate "how often" each item applies on a Likert-like scale ranging from 1 (*almost never*) to 5 (*almost always*). Items are summed to create a total score and higher scores reflect greater difficulties with emotion regulation. The *Distress Tolerance Scale* (Simons & Gaher, 2005) is a 14-item self-report assessment of one's perceived ability to experience and endure negative emotional distress states. Items are answered on 5-point Likert-type scales ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). Items are summed, and a mean score is computed with higher scores reflecting greater tolerance for distress (lower intolerance for distress).

Tobacco demand

The state version of the hypothetical *Cigarette Purchase Task* (MacKillop et al., 2008) was used to assess hypothetical cigarette consumption at various price points, an index of the relative value of cigarettes under changing conditions (MacKillop et al., 2008). Participants were provided with the following instructions:

> Imagine that you could smoke RIGHT NOW. The following questions ask how many cigarettes you would consume if they cost various amounts of money. Assume the available cigarettes are your favorite brand. Assume that you have the same income/savings that you have now and NO ACCESS to any cigarettes or nicotine products other than those offered at these prices. In addition, assume that you would consume cigarettes that you request at this time. You cannot save or stockpile cigarettes for a later date. Be sure to consider each price increment carefully.

The price points included: Free, 1¢, 5¢, 10¢, 20¢, 30¢, 40¢, 50¢, 60¢, 70¢, 80¢, 90¢, $1, $2, $3, $4, $5, $6, $7, $8, $9, $10. Factor analytic studies of the purchase task indicate that intensity (hypothetical cigarette consumption when price is unrestricted) and O_{max} (maximum expenditure on hypothetical cigarettes) indices are strongly linked to volumetric tobacco consumption (Bidwell, MacKillop, Murphy, Tidey, & Colby, 2012). Demand indices were non-normally distributed, thus intensity was square-root transformed and O_{max} was log-transformed for statistical analyses. Raw means are presented for descriptive purposes for ease of interpretation.

Procedures

Written informed consent was obtained prior to initiation of study procedures, which was approved by the Institutional Review Board where the study took place. Participants completed measures of emotional distress under satiated states (i.e. after

recent consumption of a single cigarette) and tobacco demand was assessed approximately 60 min post-smoking; thus, all participants were in acute nicotine deprivation. Participants were compensated $25 for the completing the baseline assessment.

Results

Analysis of variance was conducted with Brown-Forsythe test as needed. Contrasts codes referenced the late-luteal phase for emotional distress and follicular phase for tobacco demand. Due to the small sample, we relied on effect size estimates using Cohen's *d* (1988), where values of .2, .5, and .8 can be considered small, medium, and large, respectively.

Emotional distress

Results for negative affectivity ($F[2,11.9] = 1.31$, $p = .306$, $\eta^2 = 0.11$) indicated higher scores were reported in the late-luteal phase (26.3 ± 14.5) compared to follicular (19.2 ± 7.9) and early-mid luteal (18.5 ± 7.7) phases ($d = 0.69$, $p = .233$). Results for difficulties with emotion regulation ($F[2,29] = 2.90$, $p = .071$, $\eta^2 = 0.17$) indicated greatest difficulties were reported in the late-luteal phase (89.9 ± 22.1) versus follicular (67.7 ± 23.9) and early-mid luteal (68.7 ± 18.3) phases ($d = 1.03$, $p = .023$). For distress tolerance ($F[2,29] = 2.06$, $p = .146$, $\eta^2 = 0.12$), women in the late-luteal phase had lowest tolerance for distress (2.5 ± 0.9) compared to follicular (3.4 ± 1.1) and early-mid luteal (3.3 ± 1.0) phases ($d = -0.86$, $p = .052$).

Tobacco demand

Hypothetical tobacco consumption when cigarettes were free (demand intensity: $F[2,15.1] = 1.97$, $p = .174$, $\eta^2 = 0.14$) was highest among women in the follicular phase (18.8 ± 22.8 cigarettes) versus late-luteal (11.0 ± 17.9 cigarettes) and early-mid luteal (5.9 ± 7.0 cigarettes) phases ($d = 0.71$, $p = .202$). For O_{max} ($F[2,29] = 1.89$, $p = .170$, $\eta^2 = 0.12$), women in the follicular phase reported highest maximum expenditure on hypothetical cigarettes ($8.97 ± 7.54) compared to late-luteal ($3.96 ± 5.65) and early-mid luteal ($3.66 ± 7.14) phases ($d = 0.74$, $p = .070$).

Discussion

Among female smokers, the late-luteal phase is associated with heightened emotional distress, whereas the subsequent follicular phase is associated with heightened tobacco demand. Specifically, the late-luteal phase appears to be associated with heightened negative affectivity, emotion dysregulation, and distress intolerance compared to other phases. This set of findings is consistent with the non-smoking literature on the role of decreasing/low levels of progesterone and estradiol and their link to dysregulated emotional states (Nillni et al., 2015, 2012). We also found evidence of menstrual cycle differences in hypothetical cigarette purchasing behavior during acute nicotine deprivation. Specifically, women in the follicular phase smoked approximately three times the number cigarettes if free during a

hypothetical purchase task, compared to the early-mid luteal phase. Women in the follicular phase also spent nearly twice as much money to purchase hypothetical cigarettes compared to women in the early-mid luteal phase and late-luteal phase. This is consistent with evidence that the estradiol-dominant follicular phase is linked to increased smoking reward (Lynch & Sofuoglu, 2010). Collectively, these complimentary findings provide initial evidence for an emotion-based perspective of persistent smoking during the menstrual cycle. Theoretically, heightened emotional distress during the late-luteal phase could increase smoking to cope with distress (i.e. negative reinforcement drug motivation). This type of emotion-focused smoking may "prime" women to nicotine's rewarding effects in the days leading up to and during a critical hormonal transition (i.e. rising levels of estradiol as women enter the follicular phase), which may act as an accelerant for heightened tobacco demand due to estradiol's effect on nicotine reward (via appetitive motivational processes). This feed-forwarding process and its sequelae require empirical study using a prospective study design.

This is the first study to examine emotional distress and tobacco demand at different menstrual phases in female smokers. It is important to note that inferences are limited by the small sample, self-reported assessment of menstrual cycle phase, and between-subjects design, which prohibited examination of *changes* across menstrual phases. We acknowledge that this study is underpowered to detect group differences, thus we relied on effect size estimates. Although effect sizes are biased by small samples, our confidence in these findings is increased by the fact that many of the pairwise comparisons produced mean differences that approached statistical significance (based on $p < .05$ standards). Additionally, although ovarian hormones were inferred indirectly by menstrual phase, these data underscore the importance of understanding how *fluctuations* in progesterone and estradiol influence smoking and emotional processes. Fine-grained examination of these processes has the potential to inform the extent to which ovarian hormones act as a sex-specific biological mechanism underlying the link between emotion and persistent smoking. Fluctuating estradiol and progesterone over the course of the menstrual cycle may be related to intermittent periods of exacerbated emotional distress that deplete adaptive responses to distress, which in turn, can heighten the perceived value of cigarettes. In contrast, the early-mid luteal phase may reflect a "protective" window for women characterized by greater emotional stability and lower tobacco demand (Saladin et al., 2015). If these findings can be replicated in larger, within-subject trials with direct hormone measurement, this work has the potential to ultimately inform the development of well-specified and tailored emotion-focused interventions to augment hormone-based smoking cessation interventions.

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References

Allen, A. M., McRae-Clark, A. L., Carlson, S., Saladin, M. E., Gray, K. M., Wetherington, C. L., … Allen, S. S. (2015). Determining menstrual phase in human biobehavioral research: A review with recommendations. *Experimental and Clinical Psychopharmacology*, *24*(January2016), 1–11.

Bidwell, L. C., MacKillop, J., Murphy, J. G., Tidey, J. W., & Colby, S. M. (2012). Latent factor structure of a behavioral economic cigarette demand curve in adolescent smokers. *Addictive Behaviors*, *37*(11), 1257–1263. doi: 10.1016/j.addbeh.2012.06.009

Centers for Disease Control and Prevention. (2016). Current cigarette smoking among adults—United States, 2005-2015. *Morbidity and Mortality Weekly Report*, *65*, 1205–1211.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. New York, NY: Routledge Academic.

Farris, S. G., & Zvolensky, M. J. (2016). An experimental test of the effect of acute anxious arousal and anxiety sensitivity on negative reinforcement smoking. *Journal of Psychopharmacology*, *30*(7), 641–653. doi: 10.1177/0269881116642880

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment*, *26*(1), 41–54. doi: 10.1023/B:JOBA.0000007455.08539.94

Japuntich, S. J., Leventhal, A. M., Piper, M. E., Bolt, D. M., Roberts, L. J., Fiore, M. C., & Baker, T. B. (2011). Smoker characteristics and smoking-cessation milestones. *American Journal of Preventive Medicine*, *40*(3), 286–294. doi: 10.1016/j.amepre.2010.11.016

Li, S. H., & Graham, B. M. (2016). Why are women so vulnerable to anxiety, trauma-related and stress-related disorders? The potential role of sex hormones. *The Lancet Psychiatry*, *366*(16), 1–10.

Lynch, W. J., & Sofuoglu, M. (2010). Role of progesterone in nicotine addiction: Evidence from initiation to relapse. *Experimental and Clinical Psychopharmacology*, *18*(6), 451–461. doi: 10.1037/a0021265

MacKillop, J., Murphy, J. G., Ray, L. A., Eisenberg, D. T. A., Lisman, S. A., Lum, J. K., & Wilson, D. S. (2008). Further validation of a cigarette purchase task for assessing the relative reinforcing efficacy of nicotine in college smokers. *Experimental and Clinical Psychopharmacology*, *16*(1), 57–65.

Nillni, Y. I., Pineles, S. L., Patton, S. C., Rouse, M. H., Sawyer, A. T., & Rasmusson, A. M. (2015). Menstrual cycle effects on psychological symptoms in women with PTSD. *Journal of Traumatic Stress*, *28*(1), 1–7. doi: 10.1002/jts.21984

Nillni, Y. I., Rohan, K. J., & Zvolensky, M. J. (2012). The role of menstrual cycle phase and anxiety sensitivity in catastrophic misinterpretation of physical symptoms during a

CO$_2$ challenge. *Archives of Womens Mental Health*, 15(6), 413–422. doi: 10.1007/s00737-012-0302-2

Perkins, K. A., Karelitz, J. L., Giedgowd, G. E., & Conklin, C. A. (2013). Negative mood effects on craving to smoke in women versus men. *Addictive Behaviors*, 38(2), 1527–1531. doi: 10.1016/j.addbeh.2012.06.002

Saladin, M. E., McClure, E. A., Baker, N. L., Carpenter, M. J., Ramakrishnan, V., Hartwell, K. J., & Gray, K. M. (2015). Increasing progesterone levels are associated with smoking abstinence among free-cycling women smokers who receive brief pharmacotherapy. *Nicotine and Tobacco Research*, 17(4), 398–406. doi: 10.1093/ntr/ntu262

Schiller, C. E., Saladin, M. E., Gray, K. M., Hartwell, K. J., & Carpenter, M. J. (2012). Association between ovarian hormones and smoking behavior in women. *Experimental and Clinical Psychopharmacology*, 20(4), 251–257. doi: 10.1037/a0027759

Sigmon, S. T., Whitcomb-Smith, S. R., Rohan, K. J., & Kendrew, J. J. (2004). The role of anxiety level, coping styles, and cycle phase in menstrual distress. *Journal of Anxiety Disorders*, 18(2), 177–191. doi: 10.1016/S0887-6185(02)00243-8

Simons, J. S., & Gaher, R. M. (2005). The Distress Tolerance Scale: Development and validation of a self-report measure. *Motivation and Emotion*, 29(2), 83–102. doi: 10.1007/s11031-005-7955-3

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063–1070. doi: 10.1037/0022-3514.54.6.1063

Weinberger, A. H., & McKee, S. A. (2012). Gender differences in smoking following an implicit mood induction. *Nicotine & Tobacco Research*, 14(5), 621–625. doi: 10.1093/ntr/ntr198

Weinberger, A. H., Smith, P. H., Allen, S. S., Cosgrove, K. P., Saladin, M. E., Gray, K. M., … McKee, S. A. (2015). Systematic and meta-analytic review of research examining the impact of menstrual cycle phase and ovarian hormones on smoking and cessation. *Nicotine & Tobacco Research : Official Journal of the Society for Research on Nicotine and Tobacco*, 17(4), 407–421. doi: 10.1093/ntr/ntu249