A Psychophysiological Mechanism Underlying Women's Weight-Management Goals: Women Desire and Strive for Greater Weight Loss Near Peak Fertility

Andrea L. Meltzer[1], James K. McNulty[2], Saul L. Miller[3],
and Levi R. Baker[4]

Abstract

Three studies demonstrated that conception risk was associated with increased motivations to manage weight. Consistent with the rationale that this association is due to ovulatory processes, Studies 2 and 3 demonstrated that it was moderated by hormonal contraceptive (HC) use. Consistent with the rationale that this interactive effect should emerge when modern appearance-related concerns regarding weight are salient, Study 3 used a 14-day diary to demonstrate that the interactive effects of conception risk and HC use on daily motivations to restrict eating were further moderated by daily motivations to manage body attractiveness. Finally, providing evidence that this interactive effect has implications for real behavior, daily fluctuations in the desire to restrict eating predicted daily changes in women's self-reported eating behavior. These findings may help reconcile prior inconsistencies regarding the implications of ovulatory processes by illustrating that such implications can depend on the salience of broader social norms.

Body weight is strongly tied to physical health. Not only is having a high body weight associated with numerous health problems, such as coronary heart disease, type 2 diabetes, and high cholesterol (see Must et al., 1999), having a low body weight is associated with other health problems, such as malnutrition, poor muscle strength, and low bone density (see Andreoli et al., 2001). Given that health-related goals and intentions are a strong predictor of health-related behaviors (McEachan, Conner, Taylor, & Lawton, 2011), understanding the sources of people's weight-management goals is crucial to understanding and even promoting healthy weight maintenance.

Two independent lines of research suggest a novel source of weight-management goals among women. The first is a body of research indicating that some women conform to modern norms regarding attractive weight to secure and maintain interpersonal relationships. In many modern cultures, heterosexual women recognize that it is normative for men to desire thin partners to heavier ones (e.g., Fallon & Rozin, 1985), and the salience of this norm varies across situations. For example, women demonstrate elevated body-appearance concerns when viewing various advertisements (Lavine, Sweeney, & Wagner, 1999; Tiggemann & McGill, 2004) and magazines (Morry & Staska, 2001), anticipating interacting with a man (Calogero, 2004), and wearing a swimsuit (Hebl, King, & Lin, 2004). Thus, although different women may attempt to attract and secure partners in different ways (e.g., wearing make-up, tanning, using diet pills, through clothing choice, etc.; see Buss, 1988; Durante, Griskevicius, Hill, Perilloux, & Li, 2011; Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007; Hill & Durante, 2011), some women attempt to attract and secure a partner by managing their weight (Li, Smith, Griskevicius, Cason, & Bryan,

[1]Southern Methodist University, Dallas, TX, USA
[2]Florida State University, Tallahassee, USA
[3]University of Kentucky, Lexington, USA
[4]University of North Carolina at Greensboro, Greensboro, USA

Corresponding Author:
Andrea L. Meltzer, Southern Methodist University, P.O. Box 750442, Dallas, TX 75275, USA.
Email: ameltzer@smu.edu

2010; Meltzer & McNulty, 2015; Meltzer, Novak, McNulty, Butler, & Karney, 2013; Mori, Chaiken, & Pliner, 1987). In one study, for example, women ate less in the presence of a desirable man than when in the presence of a less desirable man or another woman (Mori et al., 1987).

The second line of research is a growing literature demonstrating that women's goals to attract and secure relationship partners shift across the ovulatory cycle. According to the ovulatory-shift hypothesis (Gangestad & Thornhill, 2008), women are increasingly motivated to attract partners with features that were indicative of high genetic quality ancestrally during peak fertility (i.e., approximately 12-16 days before the next menstruation). These shifting motivations lead to corresponding shifts in behavioral attempts to compete for high-value mates (Cantú et al., 2014; Gangestad, Thornhill, & Garver-Apgar, 2005; Haselton & Gangestad, 2006). Given the relative importance of physical appearance to men (Li et al., 2013; Meltzer, McNulty, Jackson, & Karney, 2014), one way women near peak fertility compete for men is to engage in a variety of behaviors that enhance their appearance (Durante, Li, & Haselton, 2008; Haselton et al., 2007; Hill & Durante, 2009). For example, women are more likely to dress fashionably (Haselton et al., 2007) and choose clothing that reveals more skin (Durante et al., 2008; Haselton et al., 2007) when near peak fertility than when not.

Considering these two bodies of work together leads to the novel hypothesis that women who tend to respond to modern cultural norms regarding body attractiveness by managing their weight may be particularly motivated to manage their weight near peak fertility. Indeed, existing physiological research on the hormonal correlates of eating provides indirect support for this possibility. For example, several studies demonstrate that estradiol, a hormone elevated near peak fertility, is associated with restricted eating in both humans and non-human mammals (Czaja & Goy, 1975; Edler, Lipson, & Keel, 2007). Furthermore, several other studies demonstrate that women consume fewer calories near peak fertility (e.g., Brown, Morrison, Calibuso, & Christiansen, 2008; Gong, Garrel, & Calloway, 1989; Saad & Stenstrom, 2012; for an earlier review, see Fessler, 2003).

Nevertheless, this research provides only indirect support for the current theoretical perspective that such behaviors reflect women's tendencies to respond to modern cultural norms regarding body attractiveness. Specifically, none of the existing studies demonstrate that ovulatory shifts in eating behavior are linked to psychological motivations and/or appearance-related concerns. In fact, given that these effects have emerged in both human and non-human animals, they have been interpreted in terms of non-appearance-related neuroendocrinological factors (Fessler, 2003; Frank, Kim, Krzemien, & Van Vugt, 2010). Indeed, one explanation is that this tendency is an adaption that allows for time-allocation trade-offs females make near peak fertility (i.e., time devoted to activities related to reproduction versus time devoted to activities related to food foraging; see Fessler,

2003). Although such trade-offs may indeed be one reason for ovulatory shifts in eating among non-humans and humans alike, it nevertheless remains possible that some human females are additionally more motivated to lose weight near peak fertility for body-appearance-related reasons. Providing evidence for this psychological mechanism would deepen our theoretical understanding of weight motivations by suggesting a novel psychophysiological mechanism for such effects.

Overview of the Current Research

We conducted three studies that examined whether women's weight-management goals shift across the ovulatory cycle. Study 1 used a within-person design to examine whether women desire to lose more weight when they are near versus far from peak fertility. Study 2 aimed to replicate this implication of the ovulatory shift in an independent sample of women and provide stronger evidence that it is indeed due to ovulatory processes by examining whether it emerges only among women who do not use hormonal contraceptives (HCs; for example, the pill, vaginal ring, the patch; see Durante et al., 2011; Fleischman, Navarrete, & Fessler, 2010). Finally, Study 3 examined whether the interactive effect of fertility and HC use emerged only when women's desire to manage the appearance of their bodies was relatively salient, as well as whether the fluctuating motivations associated with ovulation predict a primary behavioral mechanism of weight maintenance: caloric restriction. In line with the notion that the predicted effect should be driven by heterosexual women's desire to manage the appearance of their bodies for men, all three studies focused exclusively on heterosexual women.

Study 1

Participants

Participants were 22 naturally cycling (i.e., not using HCs) undergraduate women who were selected from a broader within-person study because they were those who (a) reported experiencing a regular menstrual cycle and (b) completed both components of the within-person design. This broader study consisted of 39 heterosexual women (the total number of participants was determined by the number of undergraduates who volunteered for this study during a time frame of one academic semester); however, 8 participants failed to respond correctly to quality-control items and 7 participants failed to complete both components of the within-person design and thus could not be used in the within-person analyses. Two additional participants were excluded from analyses: 1 who was over the age of 35 (because women over the age of 35 experience a significant decline in fecundability; Rothman et al., 2013) and 1 who reported a desire to lose an extreme amount of weight relative to the rest of the sample

(114.50 pounds, $SD = 3.54$, vs. the 16.64 pounds, $SD = 15.10$, reported by the other 22 participants). Notably, with the exception of the 1 participant who was excluded because she reported a desire to lose an extreme amount of weight, the 22 women who were included in the analyses did not differ from those who were excluded in either their current weight, $t(37) = 1.18$, *ns*, or ideal weight, $t(37) = -1.41$, *ns*.[1] These 22 participants reported a mean age of 18.71 years ($SD = 1.01$); most (81.80%) were Caucasian.

Procedures

Following approval from the Institutional Review Board, all participants provided informed consent and then provided information necessary for calculating their likelihood of conception (see next section; Wilcox, Dunson, Weinberg, Trussell, & Baird, 2001). To ensure within-person variability in conception risk, we used this information to instruct participants to complete online measures of ideal weight (and measures of current weight and self-esteem, to be used as covariates) on a high-fertility day and a low-fertility day. High-fertility sessions were scheduled 16 days prior to their next estimated menstruation (near estimated ovulation), and low-fertility sessions were scheduled 6 days prior to their next estimated menstruation, according to whichever day came first (for similar procedures, see Miller & Maner, 2010). Sixteen participants completed their low-fertility session first. Participants were compensated with course credit.

Materials

Conception risk. Participants varied in the exact day on which they completed each session, and thus, we created a continuous measure of conception risk. Consistent with prior psychological research examining ovulation effects (e.g., Eastwick & Finkel, 2012; Haselton & Gangestad, 2006), participants reported the start date of their previous menstruation and their average menstrual cycle length that was used to (a) place women on a "standard" 29-day cycle and (b) calculate conception risk (range = .000-.094) on the day of participation using the reverse-cycle-day method (see Garver-Apgar, Gangestad, & Thornhill, 2008) and actuarial medical data (see Wilcox et al., 2001). Higher scores indicate higher probability of conception with a single act of unprotected intercourse. Given the variability in women's follicular phase compared with the luteal phase, this backward-count method is preferred over the forward-count method (Fehring, Schneider, & Raviele, 2006). Nevertheless, given recent concerns that researchers can choose whichever method of estimation that provides support for their predictions (Harris, Chabot, & Mickes, 2013), we attempted to replicate our predicted effect with estimates formed using the forward-cycle-day method (based only on the self-reported start date of women's previous menstruation; range = .000-.086; see Garver-Apgar et al., 2008).

Weight. Participants reported how much they would ideally like to weigh, as well as their current height and weight, at each session.

Covariate. Prior work demonstrates that women have lower self-esteem when they are ovulating (Hill & Durante, 2009), and such lower self-esteem may result in increased desired weight loss (Striegel-Moore, Silberstein, & Rodin, 1986) independent of ovulation. Thus, we assessed self-esteem at each high- and low-fertility session using the Rosenberg Self-Esteem Scale (Rosenberg, 1965) and controlled for it in a supplemental analysis. This scale is a 10-item, Likert-type scale on which participants responded from 1 = *strongly disagree* to 4 = *strongly agree*. Higher scores indicate higher global self-esteem. Internal consistency was high ($\alpha = .95$ for high-fertility sessions, $\alpha = .94$ for low-fertility sessions).

Results

On average, participants weighed 149.91 ($SD = 27.13$) pounds and wanted to ideally weigh 133.27 ($SD = 15.32$) pounds, indicating that women wanted to lose 16.64 ($SD = 15.10$) pounds. Women were on average 65.34 ($SD = 2.74$) inches tall and had an average body mass index (BMI) of 24.65 ($SD = 3.93$), which falls at the upper end of the normal range as defined by the Centers for Disease Control and Prevention.

To test the prediction that desired weight change varied within women's ovulatory cycle, we used multilevel modeling (using the Hierarchical Linear Modeling 6.08 program; Bryk, Raudenbush, & Congdon, 2004) to estimate the within-person association between fertility and desired weight change by regressing participants' ideal weight onto the standardized score of *person-centered* (within-person differences in) conception risk, controlling for the standardized score of *person-centered* (within-person differences in) current weight in the first level of the model, and the standardized scores of between-person means of conception risk and current weight, as well as session order, in the second level of the model. Removing the variance in ideal weight that is shared with current weight leaves only the difference between ideal weight and current weight (i.e., desired weight change) to be explained by the remaining predictors. Furthermore, statistically controlling for current weight in this way allowed us to avoid confounding participants' desired weight change with their current weight, a notable problem in difference scores analyses (Edwards, 1994; Griffin, Murray, & Gonzalez, 1999; Lord, 1967).

Results are reported in Table 1. Consistent with predictions, within-person changes in conception risk were negatively associated with desired weight; women desired greater weight loss when they were closer to peak fertility than when they were farther from peak fertility. Notably, participants' current weight was marginally positively associated with conception risk, $b = 0.58$, $SE = 0.30$, $t(39) = 1.93$, $p = .061$,

Table 1. Association Between Conception Risk and Ideal Weight in Study 1.

	b	*SE*	95% CI	Effect size *r*
Intercept	133.96	1.53	[130.898, 137.027]	—
Session order	−0.82	1.66	[−4.134, 2.495]	.12
Between-person current weight	12.40***	1.38	[9.635, 15.167]	.90
Between-person conception risk	−2.31†	1.23	[−4.770, 0.150]	.41
Within-person current weight	1.06**	0.34	[0.382, 1.745]	.46
Within-person conception risk	−0.42*	0.21	[−0.839, −0.008]	.32

Note. df = 18 for intercept, session order, and between-person effects; *df* = 37 for within-person effects. Effect size $r = \sqrt{t^2/(t^2+df)}$. CI = confidence interval.
†*p* < .10. **p* < .05. ***p* < .01. ****p* < .001.

95% confidence interval (CI) = [−0.022, 1.192], effect size *r* = .30, suggesting that women reported weighing more near peak fertility. To ensure that the association between women's ideal weight and conception risk emerged independent of the association between women's current weight and conception risk, we regressed women's conception risk onto person-centered ideal weight and current weight, controlling for between-person differences in ideal weight and current weight in the second level of the model. Within-person changes in ideal weight remained marginally negatively associated with conception risk, *b* = 0.01, *SE* = 0.00, *t*(39) = −1.77, *p* = .085, 95% CI = [−0.012, 0.001], effect size *r* = .27, suggesting that changes in women's current weight across their ovulatory cycle did not account for changes in women's ideal weight across their ovulatory cycle. Notably, in this small sample of 22 women, self-esteem was not associated with within-person changes in conception risk, controlling for session order, *b* = 0.02, *SE* = 0.02, *t*(39) = 1.21, *ns*, 95% CI = [−0.016, 0.065], effect size *r* = .19. Furthermore, the primary effect emerged as marginally significant controlling for self-esteem, *b* = −0.41, *SE* = 0.21, *t*(36) = −1.94, *p* = .060, 95% CI = [−0.834, 0.012], effect size *r* = .31. Finally, three additional supplemental analyses demonstrated that this primary within-person effect (a) replicated using the forward-count estimate of conception risk, *b* = −0.49, *SE* = 0.23, *t*(36) = −2.15, *p* = .038, 95% CI [−0.942, −0.035], effect size *r* = .34; (b) held controlling for a dummy code of race, Caucasian = 0, non-Caucasian = 1; *b* = −0.42, *SE* = 0.21, *t*(36) = −2.04, *p* = .049, 95% CI = [−0.839, −0.008], effect size *r* = .32; and (c) was not moderated by either within-person differences in current weight, *b* = −0.42, *SE* = 1.78, *t*(36) = −0.24, *ns*, 95% CI = [−3.988, 3.140], effect size *r* = .04, or between-person differences in current weight, *b* = −0.23, *SE* = 0.28, *t*(36) = −0.83, *ns*, 95% CI = [−0.788, 0.326], effect size *r* = .14.

Discussion

Study 1 provided preliminary support for the idea that ovulation is associated with an increased desire to lose weight. Consistent with predictions, naturally cycling, heterosexual women were more likely to report a lower ideal weight, controlling their current weight, during periods of higher conception risk than lower conception risk.

Study 2

Nevertheless, Study 1 is limited in several ways. First, the sample size was relatively small, and a number of participants could not be included for reasons under their own control (e.g., did not correctly respond to quality-control items, did not complete both components of the within-person design). If the effect size obtained in Study 1 was implausibly large, these issues could have contributed to a spurious effect (Funder et al., 2014). Second, it is possible that conception risk was confounded with other within-person factors (unrelated to actual fertility) that predict weight-management goals that may thus account for this association, such as physical symptoms associated with time since previous menstruation or time until next menstruation. One way to help rule out such factors is by demonstrating that the association between conception risk and weight is moderated by the use of HCs, which suppress ovulation. Given these two limitations of Study 1, Study 2 attempted to replicate the effect that emerged in Study 1 but (a) relied on a larger sample size and (b) examined whether it was moderated by the use of HCs.

Participants

Participants were the 92 heterosexual, undergraduate women participating in a broader study who provided usable data. The original sample consisted of 98 women who provided complete data (i.e., current weight, ideal weight, and the data necessary to calculate conception risk; as in Study 1, the total number of participants was determined by the number of undergraduates who volunteered for this study during a time frame of one academic semester); however, 4 participants were excluded because they indicated they were either lesbian or bisexual, 1 participant was excluded because she indicated she was over the age of 35 (see Study 1), and, as in Study 1, 1 participant was excluded because she reported wanting to lose an extreme amount of weight relative to the rest of the sample (105 pounds compared with the average

Table 2. Associations Between Conception Risk, HC Use, and Ideal Weight in Study 2.

	b	SE	95% CI	Effect size r
Intercept	127.71	1.07	[125.570, 129.842]	—
Current weight	17.25***	0.70	[15.852, 18.644]	.94
CR	−2.56**	1.19	[−4.936, −0.184]	.23
HC use	−0.26	1.41	[−3.074, 2.550]	.02
CR × HC use	2.64[†]	1.47	[−0.300, 5.584]	.19

Note. df = 87. Effect size $r = \sqrt{t^2/(t^2 + df)}$. HC = hormonal contraceptive; CI = confidence interval; CR = conception risk.
[†]*p* < .10. **p* < .01. ***p* < .001.

11.45 pounds, *SD* = 12.85, reported by the other 92 participants). Notably, with the exception of the 1 participant who was excluded because she reported a desire to lose an extreme amount of weight, the 92 women who were included in the analysis did not differ from those who were excluded in either self-reported current weight, *t*(95) = 0.27, *ns*, or ideal weight, *t*(95) = 0.67, *ns*.[2] These 92 participants reported a mean age of 19.34 years (*SD* = 1.59), and most (73.90%) were Caucasian. Eighty participants reported that their average menstrual cycle length consistently fell within 26 to 32 days (i.e., was "regular"); 12 participants reported that their average menstrual cycle length was "irregular."

Procedures

In contrast to Study 1, which utilized a within-subjects design, Study 2 utilized a between-subjects design in which participants reported to the laboratory at random times throughout their cycle to complete measures of current weight, ideal weight, HC use, and conception risk. Thus, participants in this study demonstrated a broader range of conception risk values that span the entire ovulatory cycle compared with those in Study 1. Participants were compensated with course credit.

Materials

Conception risk. As in Study 1, women reported the start date of their previous menstruation. But rather than report the average length of their menstrual cycle, women in this study reported whether their menstrual cycle was "regular" or "irregular." Thus, we used participants' self-reported start date of their previous menstruation to calculate their conception risk on the day of participation using the forward-cycle-day method (see Garver-Apgar et al., 2008; Wilcox et al., 2001) and actuarial medical data for women with regular cycles (range = .000-.094) and irregular cycles (range = .000-.065). Without more specific information about the average length of these women's cycles, we were unable to use the reverse-cycle-day method to calculate conception risk.

Weight. As in Study 1, participants reported how much they would ideally like to weigh and their current weight. Sixty-eight participants also reported their height.

HC use. Participants indicated whether they used any form of HC (e.g., the pill, patch, vaginal ring, etc.). HC use was dummy coded, such that 0 = *no HC use* (*n* = 39) and 1 = *HC use* (*n* = 53).

Results

On average, participants weighed 139.10 (*SD* = 28.20) pounds and reported ideally wanting to weigh 127.65 (*SD* = 18.46) pounds, indicating that women wanted to lose 11.45 (*SD* = 12.85) pounds. Participants who reported their height were 64.00 (*SD* = 2.75) inches tall and had an average BMI of 24.30 (*SD* = 5.83), which, as in Study 1, falls at the upper end of the normal range.

Although we were able to calculate a "conception risk value" for all participants based on days since menstruation, that value is only meaningful among women who do not use HCs because HCs suppress ovulation. Thus, we predicted that calculated conception risk values should interact with HC use to only affect desired weight among women not using HCs. To test this prediction, we regressed participants' ideal weight onto their standardized score of conception risk, HC use, and the Conception Risk × HC Use interaction, controlling for their standardized score of current weight.

Results are reported in Table 2. As can be seen, consistent with predictions, women's HC use marginally moderated the association between their desired weight change and conception risk. The interaction is depicted in Figure 1. Simple slopes analyses demonstrated that whereas desired weight change was not associated with conception risk among women who reported using HCs, *b* = 0.08, *SE* = 0.80, *t*(87) = 0.10, *ns*, 95% CI = [−1.648, 1.812], effect size *r* = .01, desired weight change was negatively associated with conception risk among women who reported not using HCs, *b* = −2.56, *SE* = 1.19, *t*(87) = −2.15, *p* = .034, 95% CI = [−4.936, −0.184], effect size *r* = .23. In other words, consistent with the idea that desired weight loss is associated with ovulation, only naturally cycling women reported wanting to weigh less near peak fertility. Additional analyses demonstrated that participants' current weight was not associated with conception risk, *b* = −1.38, *SE* = 2.97, *t*(90) = −0.47, *ns*, 95% CI = [−7.318, 4.557], effect size *r* = .05, and that null effect was not moderated by HC use, *b* = −3.78, *SE* = 6.32, *t*(88) = −0.60, *ns*, 95% CI = [−16.416, 8.860], effect size *r* = .06.
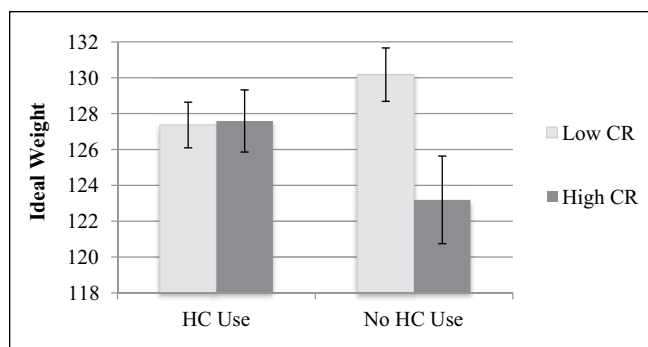
Figure 1. Interactive effects of conception risk (CR) and hormonal contraceptive (HC) use on women's ideal weight, controlling current weight, in Study 2.
Note. Low conception risk = .000; high conception risk = .094. We used the lowest and highest values of conception risk because they represent low and peak fertility in women's ovulatory cycles.

Furthermore, two additional analyses demonstrated that this Conception Risk × HC Use interaction (a) remained marginally significant controlling for a dummy code of race, Caucasian = 0, non-Caucasian = 1; $b = 2.44$, $SE = 1.45$, $t(86) = 1.68$, $p = .096$, 95% CI = [−0.463, 5.349], effect size $r = .18$, and (b) was not further moderated by between-person differences in current weight, $b = 0.46$, $SE = 2.09$, $t(84) = 0.22$, *ns*, 95% CI = [−3.734, 4.654], effect size $r = .02$.

Discussion

Study 2 provided additional evidence that ovulation is associated with an increase in women's motivation to manage their weight. Not only did Study 2 replicate the association that emerged in Study 1 by demonstrating that conception risk was associated with the desire to lose more weight among naturally cycling women, Study 2 also provided stronger evidence that this association was due to ovulation by showing that it depended on HC usage and did not emerge among women who reported using HCs.

Study 3

Although Studies 1 and 2 provide convergent evidence for the role of ovulation in shaping women's desires to be thin, several important questions remain. First, like the large majority of research examining the link between human ovulation and mating motivations (see Gildersleeve, Haselton, & Fales, 2014), Studies 1 and 2 were conducted on college undergraduate students. Given that ovulation is theorized to be particularly important to women's short-term mating psychology, it may not have the same implications for women in more committed relationships like marriage. Indeed, one recent study (Durante, Rae, & Griskevicius, 2013) demonstrates that ovulation had very different implications for women's voting preferences depending on whether those women were single or in committed relationships. It is thus

possible that ovulation is differentially related to women's weight motivation in marriage. This is particularly important, given that marriage appears to be a significant source of weight gain (Jeffery & Rick, 2002). Nevertheless, given that even some married women may be motivated to appear attractive by managing the appearance of their bodies near peak fertility, whether for their partners or for other men, ovulation may be associated with an increased desire to be thin even among such women. Thus, Study 3 attempted to replicate the effect in a sample of married women. Second, although consistent with the theoretical framework that fertility shifts lead women to desire to manage their weight when norms regarding body weight and thus the desire to enhance the appearance of their bodies are salient, Studies 1 and 2 did not provide evidence that ovulation was associated with the desire to lose weight for body-appearance-enhancing reasons. As noted earlier, only some women attempt to manage their weight to attract and/or secure relationship partners, and the current theoretical framework suggests, it is these women who should demonstrate an increased desire to manage their weight near peak fertility. That is, although heterosexual women are more motivated to appear attractive to men at peak fertility on average, only women who respond to such motivations by improving or maintaining the appearance of their bodies should desire to manage their weight; other women may respond to ovulation by managing non-body-related aspects of their appearance (e.g., wearing make-up, tanning, through clothing choice, etc.). To provide necessary support for the idea that the way in which the fertility-related motivations to appear attractive manifest depends on which attractiveness-related norms are salient at a given time, Study 3 examined whether this effect was stronger among naturally cycling women who were particularly motivated to enhance the appearance of their bodies. Finally, Studies 1 and 2 did not demonstrate that shifting fluctuations in women's weight-maintenance goals have any implications for women's actual behavior. Although a robust literature indicates that people's intentions and motivations are one of the strongest predictors of behaviors (e.g., McEachan et al., 2011), situational factors can constrain these links (Fazio, 1990), and it is possible that ovulation is associated with various situational factors that constrain the implications of women's weight motivations for their actual behaviors. Thus, Study 3 examined whether the association between women's weight motivations and fertility shifts translated into actual eating behaviors.

Participants

Participants were the 89 married women participating in a broader study of marital couples who provided the information necessary to compute their conception risk.[3] This broader study consisted of 131 heterosexual couples (the total number of participants was determined by the maximum number of couples we were able to compensate for

participation); however, 6 wives were excluded because they were older than 35 (see Studies 1 and 2), 1 wife was excluded because she did not complete the daily diary portion of the study, and an additional 35 wives were excluded because they did not provide information necessary for computing conception risk (e.g., were pregnant, had experienced menopause, or reported that their most recent menstrual period occurred over 60 days prior for other reasons). The 89 women who were included in the analyses did not differ from those who were excluded in their current weight, $t(128) = 0.78$, *ns*; mean motivation to restrict eating, $t(129) = -0.65$, *ns*; mean motivation to manage body attractiveness, $t(129) = -1.28$, *ns*; or mean tendency to actually restrict eating, $t(129) = -0.46$, *ns* (2 wives did not report current weight).[4]

Couples were recruited through (a) fliers around a large university in the Southeastern United States, (b) craigslist. com, and (c) facebook.com. On average, these 89 wives were 29.09 ($SD = 3.42$) years of age (2 wives did not report their age), had been married for 4.22 ($SD = 3.30$) years, and earned US\$34,848.17 ($SD = 28,636.96$) per year; 85.4% self-identified as "White or Caucasian," 4.5% self-identified as "Asian," 4.5% self-identified as "Hispanic or Latina," 2.2% self-identified as "Black or African American," and 3.4% self-identified as "two or more ethnicities."

Procedures

Couples who responded to any of the methods of solicitation were emailed a link to an initial online battery of questionnaires. These questionnaires included items necessary for calculating wives' conception risk, an item assessing wives' HC use, an item assessing wives' current weight and a measure assessing wives' self-esteem (each to be used as covariates), and various questionnaires beyond the scope of the current analyses. Subsequent to completing these questionnaires, each member of the couple was emailed a link to a daily questionnaire every day for 14 days. For wives, this daily questionnaire included items assessing weight motivations, appearance motivations, and dieting behaviors. After the 14th day, couples were mailed a check for participating. Couples were paid US\$15 per person for completing the baseline questionnaires and US\$1 per person per diary day completed. As an incentive to complete more diaries, each person was additionally paid US\$11 for completing at least 12 diaries if they also completed a follow-up survey 6 months later, which is beyond the scope of the current analyses. Wives completed an average of 13.42 ($SD = 1.17$) days; 96.6% of wives completed at least 12 days.

Measures

Daily conception risk. Given that the wives in this study provided their average menstrual cycle length at baseline, we estimated wives' conception risk for each day of the daily diary using the same reverse-cycle-day method used in Study

1. Specifically, we used wives' self-reported start date of their previous menstruation and average menstrual cycle length to place all wives on a 29-day cycle and calculate their conception risk for each day of the 14-day diary (see Garver-Apgar et al., 2008; Wilcox et al., 2001). Notably, also as in Study 1, we attempted to replicate any effects with estimates formed using the forward-cycle-day method to calculate women's conception risk.

HC use. As in Study 2, wives indicated whether they used HCs. HC use was dummy coded, such that 0 = *no HC use* ($n = 46$) and 1 = *HC use* ($n = 43$).

Daily motivation to restrict eating. We assessed wives' motivation to restrict eating each day of the daily diary using one item: "To what extent were you motivated to restrict how many calories you ate today?" where 1 = *not at all* and 7 = *very*. In the interest of full disclosure, we also assessed wives' motivation to lose weight each day of the daily diary using one item: "To what extent were you motivated to lose weight today?" where 1 = *not at all* and 7 = *very*. Conception risk, HC use, and daily motivation to manage body attractiveness did not significantly interact to account for variance in women's daily motivation to lose weight, $b = -0.04$, $SE = 0.08$, $t(86) = -0.74$, *ns*, 95% CI = $[-0.198, 0.122]$, effect size $r = .08$.[5]

Daily motivation to manage body attractiveness. We assessed wives' motivation to manage the appearance of their bodies each day of the daily diary using one item: "To what extent were you motivated to improve/maintain the appearance of your body today?" where 1 = *not at all* and 7 = *very*.

Daily eating behavior. We assessed whether wives restricted their eating each day using one item: "Did you restrict how many calories you ate today?" where 0 = *no* and 1 = *yes*.

Covariates. As in Studies 1 and 2, participants reported their current weight, which we used as a covariate in all analyses, and height at baseline. On average, participants weighed 157.78 ($SD = 42.90$) pounds, were 66.34 ($SD = 2.49$) inches tall, and had an average BMI of 25.06 ($SD = 6.41$), which falls in the overweight range. In addition, as in Study 1, participants reported their self-esteem (assessed at baseline with the Rosenberg [1965] Self-Esteem Scale, $\alpha = .92$), which was used as a covariate in a supplemental analysis.

Results

In line with the idea that the association between women's conception risk and desired weight loss should be particularly strong among women who were (a) not taking HCs (as in Study 2) and (b) motivated to have an attractive body, we tested whether the association between conception risk and the motivation to restrict eating was moderated by (a) HC

Table 3. Associations Between Conception Risk, HC Use, Attractiveness Motivations, and Motivations to Restrict Eating in Study 3.

|	*b*	*SE*	95% CI	Effect size *r*
Intercept	3.12	0.08	[2.959, 3.271]	—
Current weight	0.08†	0.04	[−0.004, 0.155]	.20
Mean eating motivations	0.90***	0.07	[0.756, 1.052]	.80
Day	−0.01	0.01	[−0.033, 0.011]	.11
Within-person CR	0.11*	0.06	[0.003, 0.226]	.22
HC Use	−0.16	0.11	[−0.384, 0.057]	.16
BAM	0.92***	0.09	[0.738, 1.102]	.74
CR × HC use	−0.15†	0.08	[−0.301, 0.009]	.20
CR × BAM	0.14*	0.06	[0.025, 0.251]	.25
HC use × BAM	−0.17	0.11	[−0.402, 0.055]	.16
CR × HC use × BAM	−0.16*	0.07	[−0.300, −0.023]	.24

Note. df = 87 for day; *df* = 84 for intercept, current weight, mean eating motivations, and HC use; *df* = 86 for all other effects. Effect size $r = \sqrt{t^2/(t^2+df)}$.
HC = hormonal contraceptive; CI = confidence interval; CR = conception risk; BAM = body attractiveness motivations.
†*p* < .10. *p* < .05. ***p* < .001.

use and (b) women's motivation to manage the appearance of their body. Specifically, we regressed women's daily reports of their motivation to restrict their eating onto the standardized scores of their daily conception risk, daily motivation to manage their body appearance, and the Conception Risk × Body Appearance Motivation interaction in the first level of a multilevel model (using the Hierarchical Linear Modeling 6.08 program), and then entered HC use, which did not vary across the days, onto all necessary Level-2 equations to estimate the crucial Conception Risk × HC Use × Body Appearance Motivation interaction, along with all lower-order effects, controlling for day of assessment, the standardized score of current weight, and between-person differences in the motivations to restrict eating on the Level-2 intercept.

The results are reported in Table 3. As can be seen, consistent with Studies 1 and 2, conception risk was positively associated with daily motivations to restrict eating and, consistent with Study 2, this association was moderated by HC use. Nevertheless, consistent with predictions, this interaction was further moderated by the motivation to manage body attractiveness. To decompose this interaction, we first examined the Conception Risk × HC Use interactions separately for those high (1 *SD* above the sample mean) versus low (1 *SD* below the sample mean) in motivations to manage the appearance of their body. Among women low in body-appearance motivations, the Conception Risk × HC Use interaction was not significant, *b* = 0.01, *SE* = 0.09, *t*(86) = 0.18, *ns*, 95% CI = [−0.156, 0.186], effect size *r* = .02, and conception risk was not associated with motivation to restrict eating on average, *b* = −0.02, *SE* = 0.07, *t*(86) = −0.35, *ns*, 95% CI = [−0.157, 0.111], effect size *r* = .04. Among women high in body-appearance motivations, in contrast, the Conception Risk × HC Use interaction was significant, *b* = −0.31, *SE* = 0.12, *t*(86) = −2.58, *p* = .012, 95% CI = [−0.547, −0.069], effect size *r* = .27. This two-way interaction is depicted in Figure 2. We further decomposed this interaction
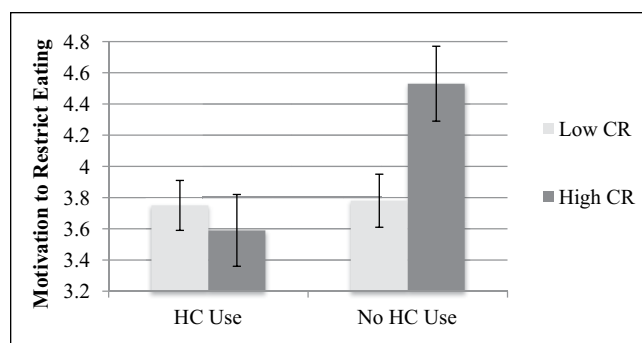
Figure 2. Interactive effects of conception risk (CR) and hormonal contraceptive (HC) use on women's motivation to restrict eating among women high in body attractiveness motivations, controlling current weight, in Study 3.
Note. Low conception risk = .000; high conception risk = .094. We used the lowest and highest values of conception risk because they represent low and peak fertility in women's ovulatory cycles.

by estimating the simple effects of high body-appearance-motivated women's conception risk for those using versus not using HCs. Consistent with predictions, high body-appearance-motivated women's conception risk was positively associated with the motivation to restrict eating among those not using HCs, *b* = 0.25, *SE* = 0.09, *t*(86) = 2.80, *p* = .006, 95% CI = [0.072, 0.432], effect size *r* = .29, but unrelated to the motivation to restrict eating among those using HCs, *b* = −0.06, *SE* = 0.08, *t*(86) = −0.70, *ns*, 95% CI = [−0.214, 0.102], effect size *r* = .08. Notably, self-esteem was not significantly associated with between-person differences in conception risk on average, *b* = 0.3, *SE* = 0.06, *t*(86) = 0.54, *ns*, 95% CI = [−0.087, 0.150], effect size *r* = .06. Although this null effect was moderated by HC use, *b* = 0.26, *SE* = 0.12, *t*(84) = 2.20, *p* = .031, 95% CI = [0.023, 0.490], effect size *r* = .23, the negative association between conception risk and self-esteem among those using HCs did not

reach significance, $b = -0.09$, $SE = 0.08$, $t(84) = -1.13$, *ns*, 95% CI = [−0.255, 0.071], effect size $r = .12$. Furthermore, a supplemental analysis demonstrated that this effect held controlling for self-esteem, $b = -0.17$, $SE = 0.07$, $t(86) = -2.48$, $p = .015$, 95% CI = [−0.300, −0.032], effect size $r = .26$. In addition, current weight at baseline was not associated with between-person conception risk at baseline, $b = -5.34$, $SE = 4.63$, $t(85) = -1.16$, *ns*, 95% CI = [−14.599, 3.911], effect size $r = .12$, and this null effect was not moderated by HC use, $b = 2.21$, $SE = 9.23$, $t(83) = 0.24$, *ns*, 95% CI = [−16.246, 20.668], effect size $r = .03$. Finally, additional supplemental analyses demonstrated that the Conception Risk × HC Use × Body Appearance Motivation interaction (a) replicated using the forward-count estimate of conception risk, $b = -0.21$, $SE = 0.08$, $t(86) = -2.75$, $p = .007$, 95% CI = [−0.367, −0.058], effect size $r = .28$, (b) held controlling for race, where Caucasian = 0 and non-Caucasian = 1, $b = -0.16$, $SE = 0.07$, $t(86) = -2.26$, $p = .027$, 95% CI = [−0.297, −0.018], effect size $r = .24$, and (c) was not further moderated by between-person differences in current weight, $b = -0.06$, $SE = 0.07$, $t(84) = -0.76$, *ns*, 95% CI = [−0.206, 0.092], effect size $r = .08$.

Next, we tested whether this Conception Risk × HC Use × Body Appearance Motivation interaction indirectly predicted women's actual eating behavior through women's motivation to restrict their eating by computing an asymmetric CI for the indirect effect on eating behavior using the RMediation program and procedure developed by Tofighi and MacKinnon (2011). This procedure requires two steps. The first is to estimate the effect of the distal predictor, in this case the Conception Risk × HC Use × Body Appearance Motivation interaction, on the expected mediator, in this case women's motivations to restrict their daily caloric intake. This association is the one tested and observed in the previous paragraph. The second step involved estimating the effect of the predicted mediator, in this case, women's motivations to restrict their daily caloric intake, onto the predicted outcome, in this case, women's daily eating behavior, controlling for the distal predictor. Thus, we repeated the analysis described above except this time we substituted women's daily eating behavior for women's daily eating motivations as the dependent variable and added daily eating motivations as a time varying predictor in Level 1 of the model, with a random effect. Importantly, given that any indirect, interactive effects of conception risk on eating behavior should be driven by *within-person* fluctuations in eating motivation, rather than any between-person differences in eating motivation, we person-centered eating motivations and entered the between-person mean differences in eating motivation on the Level-2 intercept. Given the binary nature of the dependent variable, we specified a Bernoulli sampling distribution. Consistent with the second criterion necessary to establish mediation, this analysis indicated that women's motivations to restrict their daily caloric intake significantly positively predicted their daily eating behavior, controlling for conception risk, HC use, body-attractiveness motivations, all possible

interactions, day of report, and baseline current weight, $b = 0.74$, $SE = 0.05$, $t(87) = 14.76$, $p < .001$, 95% CI = [0.637, 0.837], effect size $r = .85$. Finally, we multiplied the estimate of that effect together with the estimate of the Conception Risk × HC Use × Body Appearance Motivation interaction to obtain an estimate of the indirect effect, $b = -0.12$, and calculated the 95% CI = [−0.223, −0.017] that indicated the indirect effect was significant. In other words, women who reported not using HCs were more likely to restrict their eating on days when they were more fertile and oriented toward managing the appearance of their bodies because such women were more motivated to do so.

General Discussion

Just as heterosexual women's interpersonal goals shift across their ovulatory cycle (Gangestad & Thornhill, 2008), so does one of their important health-related goals. Across three independent studies, women demonstrated higher motivations to lose weight near peak fertility. Consistent with the idea that this tendency is driven by physiological changes associated with ovulation, it was moderated by HC usage in Studies 2 and 3, such that only women who did not use HCs demonstrated higher motivations to lose weight near peak fertility. Furthermore, consistent with the idea that this effect was at least partially driven by women's desire to have an attractive body, it only emerged among women who reported high motivations to manage the appearance of their body. Finally, consistent with the idea that even small fluctuations in motivations have strong effects on behavior (McEachan et al., 2011), within-person changes in motivations to restrict their caloric intake were strongly positively associated with their actual restricted eating behavior in Study 3. Although the sample size and resultant power of Study 1 was rather modest, the fact that the key effect replicated in two additional larger studies assuages concerns that the significant effect that emerged in Study 1 was due to an implausibly large effect size. Indeed, the effect size of the key simple effect between conception risk and ideal weight/motivation to restrict eating among women not using HCs and motivated to manage the appearance of their bodies (Study 3) was quite consistent across the three studies (in Study 1, effect size $r = .32$; in Study 2, effect size $r = .23$; in Study 3, effect size $r = .29$). Furthermore, the chance that the predicted effect emerged by chance in all three studies is very small (Murayama, Pekrun, & Fiedler, 2014). In addition, not only did the primary effect replicate across three independent studies, it (a) emerged in two samples of undergraduate women from different universities and a sample of married women, (b) did not vary across participants' weight, using two samples of women who had a normal weight on average and one sample of women who were overweight on average, (c) utilized two different methods of assessing conception risk (i.e., the reverse- and forward-cycle-day methods), (d) provided evidence for the theoretical mechanism, and (e)

held controlling for women's actual body size and race in all studies and self-esteem in Studies 1 and 3.

Implications and Future Directions

These findings have several important implications. First, they join an emerging literature highlighting the important role of interpersonal goals in health-related processes (e.g., Pietromonaco, Uchino, & Dunkel Schetter, 2013). What is unique about these findings, however, is that they demonstrate the interactive effects of two different levels of such interpersonal motivations: biological and socio-cultural. Biological processes associated with shifting levels of hormones across the cycle interacted with women's desires to conform to socio-cultural norms regarding body attractiveness to predict an important behavior: eating. Future research may benefit by considering other ways in which these two levels of interpersonal motivation jointly affect important behaviors.

Second, these findings add to the growing literature demonstrating that women, and many non-human mammals, consume fewer calories near peak fertility (e.g., Brown et al., 2008; Fessler, 2003). Previous research has explained this phenomenon in terms of a time-allocation trade-off between mating and foraging (Fessler, 2003). To be clear, the current findings regarding weight motivations do not undermine these explanations. Instead, they suggest an *additional* reason why women may consume fewer calories near peak fertility: Increased motivations to be attractive interact with cultural standards regarding body attractiveness to make some women manage the attractiveness of their bodies. Future research may benefit by exploring the extent to which these various mechanisms operate, either independently or synergistically, to shape eating patterns across women's menstrual cycles. Indeed, both appear to be driven by processes that vary across the ovulatory cycle (e.g., estradiol).

Third, the current studies also join a growing body of research (e.g., Cantú et al., 2014; Durante et al., 2013) in highlighting the importance of contextual factors in psychological research on ovulation. Some recent research demonstrates that contextual factors interact with ovulation to predict women's behavior—for example, fertile women engage in more flirtatious behavior in the presence of attractive and dominant men than when in the presence of less attractive, less dominant men (Cantú et al., 2014). Although Studies 1 and 2 of the current research demonstrated a main effect of ovulation on women's desired weight loss among women not using HCs, Study 3 demonstrated that this effect was moderated by women's motivations to manage the appearance of their body, which tend to be heightened by modern standards regarding what is attractive (Meltzer & McNulty, 2015). Future research may similarly benefit by considering the broader context in which women are situated to best understand the implications of ovulation for women's mating and health psychology. Indeed, failing to recognize

and consider such nuances may help explain controversies over the inconsistencies that have emerged in ovulation research (see Gildersleeve et al., 2014; Harris et al., 2013).

Although these findings may have limited direct implications for changes in women's weight, because actual weight management requires motivations and behaviors that span more than several (fertile) days, the general theoretical notion that socio-cultural processes interact with biological processes to predict behavior likely has important broader practical implications. For example, women who are motivated to manage the appearance of their bodies may be more likely to take diet pills, which tend to have numerous harmful side effects even when only enacted occasionally (Kernan et al., 2000; Pittler, Schmidt, & Ernst, 2005), when they are closer to ovulation. Likewise, because tanned skin is perceived as attractive in Western culture (Hillhouse, Stair, & Adler, 1996), such women may be more likely to engage in sun (or sunless) tanning near peak fertility—behaviors that are also linked to health problems even when only enacted occasionally (Boniol, Autier, Boyle, & Gandini, 2012). Indeed, naturally cycling women report that they tan more frequently near peak fertility than during less-fertile phases of their cycle (Saad & Stenstrom, 2012). Future research may benefit by examining the extent to which these and other risky behaviors vary across women's ovulatory cycles.

Strengths and Limitations

Several strengths of the current research enhance our confidence in the results reported here. First, as noted earlier, the ovulatory shift of desired weight loss replicated across three independent studies, helping to alleviate concerns regarding the use of a small sample in Study 1 and provides confidence in the reproducibility of the primary effect (Funder et al., 2014; Murayama et al., 2014). Second, Study 1 demonstrated the within-person effect, helping to rule out between-person confounds. Third, providing evidence that the primary effect emerged due to hormonal fluctuations across the cycle, it was marginally moderated by HC use in Study 2 and significantly moderated by HC use in Study 3. Fourth, providing support for the theoretical framework that guided our prediction, Study 3 additionally demonstrated that the primary effect emerged only among naturally cycling women who were highly motivated to manage the appearance of their bodies. Finally, as also noted earlier, analyses in the current studies controlled several potential confounds (e.g., current weight, race, self-esteem), thus decreasing the possibility that the results were due to associations with those variables.

Nevertheless, several factors limit interpretations of the current findings until they can be extended. First, although estimations of conception risk have been successfully used in prior research (e.g., Haselton & Gangestad, 2006; Miller & Maner, 2010), some participants may have nevertheless inaccurately reported the start of their previous menstruation and/

or their average cycle length. Likewise, given that we used self-reported eating behaviors rather than objective eating behaviors in Study 3, some participants may have inaccurately perceived or reported the extent to which they restricted their calories. In the absence of reason to expect such errors to be systematic, however, any reporting errors should have reduced our ability to detect effects, rather than contribute to them. Second, our methods allow for the alternative conclusion that women experience an increased motivation to consume *more* calories during non-fertile periods of their ovulatory cycle rather than a decreased motivation to consume fewer calories near peak fertility. It is worth noting, however, that such an interpretation seems unlikely given (a) the pattern of results obtained in Studies 2 and 3, which revealed that naturally cycling women differed from HC users at high rather than low conception risk (see Figures 1 and 2) and (b) that conception risk was unassociated with current weight in Studies 2 and 3. Third, we utilized one-item measures to assess weight loss and appearance motivations in Study 3. Although these measures are high in face validity, and although the primary effect obtained in that study conceptually replicated the effect that emerged in Studies 1 and 2, future research may benefit by examining the specific aspects of eating behavior that account for the effects that emerged. Finally, although the current study controlled for various factors (e.g., current weight, race, self-esteem) and demonstrated a mechanism of the effect (e.g., the motivation to manage body appearance), causal conclusions should be drawn with caution.

Conclusion

The current research establishes that naturally cycling women experience an increased motivation to lose weight near peak fertility compared with less-fertile phases of their ovulatory cycle and that this motivation is driven by women's desires to manage the appearance of their bodies. Not only do these findings indicate that the hormonal shifts that occur across the ovulatory cycle can interact with modern cultural norms regarding what is attractive, but they also suggest such hormonal shifts can have implications for proximal behaviors that on the surface may seem fairly far removed from the ultimate goals they may function to serve (i.e., attaining and securing partners), such as the health-related behaviors examined here.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

Notes

1. The primary effect emerged as marginally significant when the participant who was older than 35 was included, $b = -0.39$, $SE = 0.20$, $t(39) = 1.93$, $p = 0.061$, 95% confidence interval (CI) $= [-0.79, 0.01]$, effect size $r = .30$.
2. In the interest of full disclosure, the primary analysis emerged as non-significant when the participant who was older than 35 was included, $b = 1.80$, $SE = 1.46$, $t(88) = 1.23$, $p = 0.220$, 95% CI $= [-1.12, 4.72]$, effect size $r = .13$, but trended toward marginal significance when age was included as a covariate, $b = 2.25$, $SE = 1.48$, $t(87) = 1.51$, $p = 0.134$, 95% CI $= [-0.71, 5.21]$, effect size $r = .16$.
3. This broader sample was also used to test a different set of hypotheses in another report (Baker & McNulty, 2015).
4. The primary effect remained significant when the six wives who were older than 35 ($M = 39.67$, $SD = 2.80$) were included, $b = -0.16$, $SE = 0.07$, $t(92) = -2.26$, $p = 0.026$, 95% CI $= [-0.29, -0.02]$, effect size $r = .23$.
5. One possible interpretation of this null effect, in light of the fact that the predicted effect emerged as significant on the daily calorie restriction variable, is that women who are highly motivated to manage their body attractiveness and are not taking hormonal contraceptives (HCs) are demonstrating an increased motivation to manage weight (rather than to lose weight) at peak fertility. We believe the results of Studies 1 and 2, where the primary dependent variable was a net weight loss, suggest otherwise, however. Thus, we suggest that, on a daily basis, women are more aware of behaviors that can help them reach proximal goals (i.e., reduced caloric intake) compared with behaviors that can help them reach more ultimate goals (i.e., weight loss). Indeed, most people do not lose weight in a day, but rather do so over time by decreasing caloric intake (and increasing caloric burn) on a daily basis. Thus, any motivations to lose weight that were driven by ovulation in Study 3 may not have manifested as *daily* desires to lose weight. Instead, such motivations likely exist more ultimately, as assessed in Studies 1 and 2.

Supplemental Material

The online supplemental material is available at http://pspb.sagepub.com/supplemental.

References

Andreoli, A., Monteleone, M., Van Loan, M., Proncenzio, L., Tarantino, U., & De Lorenzo, A. (2001). Effects of different sports on bone density and muscle mass in highly trained athletes. *Medicine & Science in Sports & Exercise*, *33*, 507-511.

Baker, L. R., & McNulty, J. K. (2015). Adding insult to injury: Partner depression moderates the association between partner-regulation attempts and partners' motivation to resolve interpersonal problems. *Personality and Social Psychology Bulletin*. Advance online publication.

Boniol, M., Autier, P., Boyle, P., & Gandini, S. (2012). Cutaneous melanoma attributable to sunbed use: Systematic review and meta-analysis. *The British Medical Journal*, *345*, e4757.

Brown, S. G., Morrison, L. A., Calibuso, M. J., & Christiansen, T. M. (2008). The menstrual cycle and sexual behavior: Relationship to eating, exercise, sleep, and health patterns. *Women & Health*, *48*, 429-444.

Bryk, A. S., Raudenbush, S. W., & Congdon, R. T. (2004). *HLM: Hierarchical linear modeling with the HLM/2L and HLM/3L programs*. Chicago, IL: Scientific Software International.

Buss, D. M. (1988). From vigilance to violence: Tactics of mate retention in American undergraduates. *Ethology and Sociobiology*, *9*, 291-317.

Calogero, R. M. (2004). A test of objectification theory: The effect of the male gaze on appearance concerns in college women. *Psychology of Women Quarterly*, *28*, 16-21.

Cantú, S. M., Simpson, J. A., Griskevicius, V., Weisberg, Y. J., Durante, K. M., & Beal, D. J. (2014). Fertile and selectively flirty: Women's behavior toward men changes across the ovulatory cycle. *Psychological Science*, *25*, 431-438.

Czaja, J. A., & Goy, R. W. (1975). Ovarian hormones and food intake in female guinea pigs and rhesus monkeys. *Hormones and Behavior*, *6*, 329-349.

Durante, K. M., Griskevicius, V., Hill, S. E., Perilloux, C., & Li, N. P. (2011). Ovulation, female competition, and product choice: Hormonal influences on consumer behavior. *Journal of Consumer Research*, *37*, 921-934.

Durante, K. M., Li, N. P., & Haselton, M. G. (2008). Changes in women's choice of dress across the ovulatory cycle: Naturalistic and laboratory task-based evidence. *Personality and Social Psychology Bulletin*, *34*, 1451-1460.

Durante, K. M., Rae, A., & Griskevicius, V. (2013). The fluctuating female vote: Politics, religion, and the ovulatory cycle. *Psychological Science*, *24*, 1007-1016.

Eastwick, P. W., & Finkel, E. J. (2012). The evolutionary armistice: Attachment bonds moderate the function of ovulatory cycle adaptations. *Personality and Social Psychology Bulletin*, *38*, 174-184.

Edler, C., Lipson, S. F., & Keel, P. K. (2007). Ovarian hormones and binge eating in bulimia nervosa. *Psychological Medicine*, *37*, 131-142.

Edwards, J. R. (1994). Regression analysis as an alternative to difference scores. *Journal of Management*, *20*, 683-689.

Fallon, A. E., & Rozin, P. (1985). Sex differences in perceptions of desirable body shape. *Journal of Abnormal Psychology*, *94*, 102-105.

Fazio, R. H. (1990). Multiple processes by which attitudes guide behavior: The mode model as an integrative framework. *Advances in Experimental Social Psychology*, *23*, 75-109.

Fehring, R. J., Schneider, M., & Raviele, K. (2006). Variability in the phases of the menstrual cycle. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *35*, 376-384.

Fessler, D. M. (2003). No time to eat: An adaptationist account of periovulatory behavioral changes. *The Quarterly Review of Biology*, *78*, 3-21.

Fleischman, D. S., Navarrete, C. D., & Fessler, D. M. (2010). Oral contraceptives suppress ovarian hormone production. *Psychological Science*, *21*, 750-752.

Frank, T. C., Kim, G. L., Krzemien, A., & Van Vugt, D. A. (2010). Effect of menstrual cycle phase on corticolimbic brain activation by visual food cues. *Brain Research*, *1363*, 81-92.

Funder, D. C., Levine, J. M., Mackie, D. M., Morf, C. C., Sansone, C., Vazire, S., & West, S. G. (2014). Improving the dependability of research in personality and social psychology: Recommendations for research and educational practice. *Personality and Social Psychology Review*, *18*, 3-12.

Gangestad, S. W., & Thornhill, R. (2008). Human oestrus. *Proceedings of the Royal Society B: Biological Sciences*, *275*, 991-1000.

Gangestad, S. W., Thornhill, R., & Garver-Apgar, C. E. (2005). Adaptations to ovulation: Implications for sexual and social behavior. *Current Directions in Psychological Science*, *14*, 312-316.

Garver-Apgar, C. E., Gangestad, S. W., & Thornhill, R. (2008). Hormonal correlates of women's mid-cycle preference for the scent of symmetry. *Evolution & Human Behavior*, *29*, 223-232.

Gildersleeve, K., Haselton, M. G., & Fales, M. R. (2014). Do women's mate preferences change across the ovulatory cycle? A meta-analytic review. *Psychological Bulletin*, *140*, 1205-1259.

Gong, E. J., Garrel, D., & Calloway, D. H. (1989). Menstrual cycle and voluntary food intake. *The American Journal of Clinical Nutrition*, *49*, 252-258.

Griffin, D., Murray, S., & Gonzalez, R. (1999). Difference score correlations in relationship research: A conceptual primer. *Personal Relationships*, *6*, 505-518.

Harris, C. R., Chabot, A., & Mickes, L. (2013). Shifts in methodology and theory in menstrual cycle research on attraction. *Sex Roles*, *69*, 525-535.

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*, 509-518.

Haselton, M. G., Mortezaie, M., Pillsworth, E. G., Bleske-Rechek, A., & Frederick, D. A. (2007). Ovulatory shifts in human female ornamentation: Near ovulation, women dress to impress. *Hormones and Behavior*, *51*, 40-45.

Hebl, M. R., King, E. B., & Lin, J. (2004). The swimsuit becomes us all: Ethnicity, gender, and vulnerability to self-objectification. *Personality and Social Psychology Bulletin*, *30*, 1322-1331.

Hill, S. E., & Durante, K. M. (2009). Do women feel worse to look their best? Testing the relationship between self-esteem and fertility status across the menstrual cycle. *Personality and Social Psychology Bulletin*, *35*, 1592-1601.

Hill, S. E., & Durante, K. M. (2011). Courtship, competition, and the pursuit of attractiveness: Mating goals facilitate health-related risk taking and strategic risk suppression in women. *Personality and Social Psychology Bulletin*, *37*, 383-394.

Hillhouse, J. J., Stair, A. W., & Adler, C. M. (1996). Predictors of sunbathing and sunscreen use in college undergraduates. *Journal of Behavioral Medicine*, *19*, 543-561.

Jeffery, R. W., & Rick, A. M. (2002). Cross-sectional and longitudinal associations between body mass index and marriage-related factors. *Obesity Research*, *10*, 809-815.

Kernan, W. N., Viscoli, C. M., Brass, L. M., Broderick, J. P., Brott, T., Feldmann, E., & Horwitz, R. I. (2000). Phenylpropanolamine and the risk of hemorrhagic stroke. *New England Journal of Medicine*, *343*, 1826-1832.

Lavine, H., Sweeney, D., & Wagner, S. H. (1999). Depicting women as sex objects in television advertising: Effects on body dissatisfaction. *Personality and Social Psychology Bulletin*, *25*, 1049-1058.

Li, N. P., Smith, A. R., Griskevicius, V., Cason, M. J., & Bryan, A. (2010). Intrasexual competition and eating restriction in heterosexual and homosexual individuals. *Evolution & Human Behavior*, *31*, 365-372.

Li, N. P., Yong, J. C., Tov, W., Sng, O., Fletcher, G. J. O., Valentine, K. A., . . . Balliet, D. (2013). Mate preferences do predict

attraction and choices in the early stages of mate selection. *Journal of Personality and Social Psychology*, *105*, 757-776.

Lord, F. M. (1967). A paradox in the interpretation of group comparisons. *Psychological Bulletin*, *68*, 304-305.

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*, 97-144.

Meltzer, A. L., & McNulty, J. K. (2015). Telling women that men desire women with bodies larger than the thin-ideal improves women's body satisfaction. *Social Psychological & Personality Science*, *6*, 391-398.

Meltzer, A. L., McNulty, J. K., Jackson, G. L., & Karney, B. R. (2014). Sex differences in the implications of partner physical attractiveness for the trajectory of marital satisfaction. *Journal of Personality and Social Psychology*, *106*, 418-428.

Meltzer, A. L., Novak, S. A., McNulty, J. K., Butler, E. A., & Karney, B. R. (2013). Marital satisfaction predicts weight gain in early marriage. *Health Psychology*, *32*, 824-827.

Miller, S. L., & Maner, J. K. (2010). Scent of a woman: Men's testosterone responses to olfactory ovulation cues. *Psychological Science*, *21*, 276-283.

Mori, D., Chaiken, S., & Pliner, P. (1987). "Eating lightly" and the self-presentation of femininity. *Journal of Personality and Social Psychology*, *53*, 693-702.

Morry, M. M., & Staska, S. L. (2001). Magazine exposure: Internalization, self-objectification, eating attitudes, and body satisfaction in male and female university students. *Canadian Journal of Behavioural Science*, *33*, 269-279.

Murayama, K., Pekrun, R., & Fiedler, K. (2014). Research practices that can prevent an inflation of false-positive rates. *Personality and Social Psychology Review*, *18*, 107-118.

Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *Journal of the American Medical Association*, *282*, 1523-1529.

Pietromonaco, P. R., Uchino, B., & Dunkel Schetter, C. (2013). Close relationship processes and health: Implications of attachment theory for health and disease. *Health Psychology*, *32*, 499-513.

Pittler, M. H., Schmidt, K., & Ernst, E. (2005). Adverse events of herbal food supplements for body weight reduction: Systematic review. *Obesity Reviews*, *6*, 93-111.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Rothman, K. J., Wise, L. A., Sørensen, H. T., Riis, A. H., Mikkelsen, E. M., & Hatch, E. E. (2013). Volitional determinants and age-related decline in fecundability: A general population prospective cohort study in Denmark. *Fertility and Sterility*, *99*, 1958-1964.

Saad, G., & Stenstrom, E. (2012). Calories, beauty, and ovulation: The effects of the menstrual cycle on food and appearance-related consumption. *Journal of Consumer Psychology*, *22*, 102-113.

Striegel-Moore, R. H., Silberstein, L. R., & Rodin, J. (1986). Toward an understanding of risk factors for bulimia. *American Psychologist*, *41*, 246-263.

Tiggemann, M., & McGill, B. (2004). The role of social comparison in the effect of magazine advertisements on women's mood and body dissatisfaction. *Journal of Social & Clinical Psychology*, *23*, 23-44.

Tofighi, D., & MacKinnon, D. P. (2011). RMediation: An R package for mediation analysis confidence intervals. *Behavior Research Methods*, *43*, 692-700.

Wilcox, A. J., Dunson, D. B., Weinberg, C. R., Trussell, J., & Baird, D. D. (2001). Likelihood of conception with a single act of intercourse: Providing benchmark rates for assessment of post-coital contraceptives. *Contraception*, *63*, 211-215.