The effect of fertility on loss aversion

Kristina M. Durante[a,*], Vladas Griskevicius[b], Sevincgul (Sev) Ulu[c]

[a] Rutgers Business School at Newark and New Brunswick, 1 Washington Park, Newark, NJ 07016, United States of America
[b] Marketing Department, Carlson School of Management, University of Minnesota
[c] NJCU School of Business, New Jersey City University, Harborside 2, 200 Hudson Street, Jersey City, NJ-07311, United States of America

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ABSTRACT

Loss aversion is the tendency to be more sensitive to losses than comparable gains. Recent work has shown that men's loss aversion can change when they have a currently activated mating motivation. The current research examined whether women's sensitivity to loss might be influenced by the hormones that regulate fertility, which are known to activate intra-sexual competition and mating motivation. Three studies found that women became less sensitive to loss at peak fertility—near ovulation—in some contexts. Ovulating women reported being less upset at the prospect of losing hypothetical amounts of money and products (e.g., laptop, tennis shoes), as well as accepted lower selling prices for a picture frame, an indication of decreased loss aversion. We also uncovered a theoretically-derived boundary condition for this effect: ovulation led women to become more loss averse when the product was directly relevant for enhancing attractiveness (e.g., lipstick).

1. Introduction

Loss aversion is the tendency of people to be more sensitive to losses than comparable gains and is considered to be one of the most robust findings in the behavioral sciences (Ariely, Huber, & Wertenbroch, 2005; Camerer, 2005; Kahneman & Tversky, 1979; Tversky & Kahneman, 1991; Zhang & Fishbach, 2005). Recently, however, research has shown that the extent of loss aversion can wax and wane dependent upon such factors as whether the stakes associated with the loss are construed by the decision-maker as high or low (Ariely et al., 2005; Ert & Erev, 2013; Gal, 2006).

From an evolutionary perspective, the value associated with a particular object is likely contingent upon a currently activated motivational state relevant to enhancing reproductive fitness—the passing of genes on to future generations (Griskevicius & Kenrick, 2013; Li, Kenrick, Griskevicius, & Neuberg, 2012). This suggests that decision biases such as loss aversion might differ when people are motivated to solve one evolutionary challenge versus another (Cosmides & Tooby, 1996; Gigerenzer, 2000; Haselton & Nettle, 2006; Kenrick et al., 2009; Wang, 1996), whereby loss aversion might weaken when people are confronted with decisions in domains where it might not have been adaptive to be loss averse (Aktipis & Kurzban, 2004; Hill & Buss, 2010). For example, activating a mating motive for men enhances monetary risk-taking and leads loss aversion to weaken because weakened sensitivity to loss enables riskier decisions that can bring larger payoffs that attract mates (Baker & Maner, 2009; Li et al., 2012).

In the current research, we focus on women. We propose that women's loss aversion may be linked to fluctuations in ovarian hormones across the ovulatory cycle (Gangestad & Thornhill, 1998; Gangestad, Thornhill, & Garver-Apgar, 2005). Because women's sexual behavior can only result in reproduction near ovulation (as opposed to men's sexual behavior, which always carries the possibility of resulting in successful reproduction), ovulation has been shown to attune women's decision-making toward goals relevant to mating (Durante, Griskevicius, Hill, Perilloux, & Li, 2011; Durante, Li, & Haselton, 2008; Gangestad, Thornhill, & Garver, 2002). Thus, women may experience a decrease in loss aversion specifically near ovulation because decreased sensitivity to loss near ovulation may function to facilitate intra-sexual competitiveness and mate acquisition goals (Durante & Arsena, 2015; Durante, Griskevicius, Cantu, & Simpson, 2014). For example, a weakened sensitivity to loss at high fertility could help facilitate strategic risky decision-making in the service of reproductive goals, such as the decision to be receptive to a better mating option than a current partner or engage in competition with a rival woman for male attention.

The current research examined the effect of fertility on loss aversion in three studies, including a study using hormonal measures of ovulation and incentive-compatible behavior. We predicted that women's sensitivity to loss should weaken near ovulation, but that there should be an important exception to this effect: ovulation should not weaken women's loss aversion when the loss domain (i.e., the product category)

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is relevant to advancing a mating goal. Study 1 demonstrates that women become less sensitive to loss near ovulation. Specifically, ovulating women reported less upset associated with losing hypothetical amounts of money and products. Study 2 and study 3 conceptually replicate study 1. Near ovulation, women reported less upset about losing a pen and were willing to accept a lower selling price for an endowed picture frame—an index of lowered sensitivity to loss. However, this effect was moderated by product type. Consistent with predictions, the effect of fertility on loss aversion was reversed when the product could be used to enhance attractiveness. This means that ovulation increased loss aversion, whereby ovulating women reported greater upset and higher acceptable selling prices when the endowed product was lipstick (a product that can advance mating goals). This research contributes to the consumer behavior literature by being the first to identify how and when ovulation—a biological factor responsible for modulating women's mating motivations—shifts women's sensitivity to loss.

2. Literature review

2.1. Loss aversion

Greater sensitivity to loss is seen in men, women, and children, as well as across species (Apicella, Azevedo, Christakis, & Fowler, 2014; Brosnan et al., 2007; Chen, Lakshminarayanan, & Santos, 2006; Harbaugh, Krause, & Vesterlund, 2001; Lakshminaryanan, Chen, & Santos, 2008; Mahajan et al., 2011; Plott & Zeiler, 2005). This tendency is known as loss aversion, and it is presumed to underlie several biases found in behavioral economics such as the endowment effect (Thaler, 1980), the status quo bias (Samuelson & Zeckhauser, 1988), the equity premium puzzle (Benartzi & Thaler, 1995), and framing effects (Tversky & Kahneman, 1981). For example, loss aversion is used to explain the endowment effect, which refers to people's tendency to value an object more once they possess it compared to the value people place on the same object if they did not possess it (Thaler, 1980). The increased value placed on an item once it is owned is presumed to be a reflection of motivation to prevent the loss of the item.

From an evolutionary perspective, loss aversion is viewed as an adaptive bias that helped humans solve survival-related ancestral challenges (Chen et al., 2006). Because change (versus stasis) involves uncertainty and a potential cost, human attention evolved to be sensitive to change, especially if the change threatens to make things worse—like the loss of a resource already owned (McDermott, Fowler, & Smirnov, 2008). Although loss aversion likely evolved to solve critical problems that affected reproductive fitness, such as access to shelter and food (Barlow, Cosmides, & Tooby, 1992), a sensitivity to loss could have been transferred to other decisions over time—like those involving consumer products (e.g., Loewenstein, Weber, Hsee, & Welch, 2001). A sensitivity to loss of possessions that seem inconsequential to reproductive fitness—such as a coffee mug—may be a by-product of evolved loss sensitivity in survival-related domains (e.g., loss of food or shelter). However, an evolutionary-informed view suggests that loss aversion should be moderated by context (Aktipis & Kurzban, 2004; Hill & Buss, 2010; Li et al., 2012). For example, people may become more or less sensitive to loss dependent upon a currently activated evolutionary motivational state.

Human evolutionary motivational states tend to correspond to challenges that had to be surmounted to achieve reproductive success. These fundamental ancestral challenges included: (1) evading physical harm, (2) avoiding disease, (3) making friends, (4) attaining status, (5) acquiring a mate, (6) keeping a mate, and (7) caring for family (Ackerman & Kenrick, 2008; Griskevicius & Kenrick, 2013; Kenrick, Neuberg, Griskevicius, Becker, & Schaller, 2010). Thus, the value people place on a particular object—and subsequently the degree of loss aversion exhibited—should increase or decrease dependent upon whether the resource can help advance a currently activated

fundamental motivation. This assertion is consistent with work suggesting that loss aversion wanes and waxes depending on the situation (Gal, 2006; Gal & Rucker, 2018; Morewedge, Shu, Gilbert, & Wilson, 2009; Novemsky & Kahneman, 2005).

One important fundamental motivation that may influence loss aversion is that of acquiring and retaining a mate. Research shows that activating a mating goal can increase risk-taking and cause loss aversion to vanish in men (Baker & Maner, 2009; Li et al., 2012). For example, leading men to believe they will soon meet a single, attractive woman increases their risk preference, resulting in the decision to gamble for a larger payoff (Baker & Maner, 2009). And, for men, triggering the motive to attract a mate leads loss aversion to reverse itself, leading gains to loom larger than losses (Li et al., 2012). For women, a mating goal leads to increased willingness to incur risks to enhance appearance (e.g., tanning, diet pills; Hill & Durante, 2011). Together this work suggests that mating goals can alter people's risk tolerance and sensitivity to loss. One biological factor that modulates women's mating behavior, and thus might play a role in how mating goals alter women's loss sensitivity, is fluctuation in fertility status across the ovulatory cycle.

2.2. Ovulation, mating goals, and sensitivity to loss

The ovulatory cycle spans, on average, 28 days, during which a woman can become pregnant only during the week long ovulatory phase of the cycle – the time each month when estrogen levels are particularly high. Research has shown that ovulation can non-consciously alter women's mating psychology. For instance, ovulating women report less commitment to and satisfaction with their current romantic partner and increased sexual attraction to other men (Durante & Li, 2009; Gangestad et al., 2002). Ovulating women are particularly attracted to men who display markers of genetic fitness (e.g., physical attractiveness, masculinity, social dominance; Cantú et al., 2014; Durante, Griskevicius, Simpson, Cantu, & Li, 2012; Gangestad & Thornhill, 1998; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004; Gangestad et al., 2005; Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Penton-Voak et al., 1999). Consequently, ovulating women are more likely to cheat on their spouse or partner, particularly if they are not satisfied with their current partner or their current partner lacks indicators of genetic fitness (Bellis & Baker, 1990; Durante, Eastwick, Finkel, Gangestad, & Simpson, 2016; Garver-Apgar, Gangestad, Thornhill, Miller, & Olp, 2006; Larson, Pillsworth, & Haselton, 2012). An ovulatory increase in sexual desire near ovulation specifically for men who display markers of genetic fitness might have evolved because of the genetic benefits that could be passed onto offspring. Passing beneficial genes to offspring increases women's reproductive success via the increased likelihood that such offspring would survive and successfully reproduce in later ancestral environments (Durante et al., 2016; Gildersleeve, Haselton, & Fales, 2014). Taken together, this work suggests that near ovulation—when conception probability is highest—women are motivated to optimized mate choice.

In order to effectively optimize the choice of a sexual partner near ovulation, women must also successfully outcompete same-sex individuals for accessibility to desirable mates (Griskevicius & Kenrick, 2013; Kenrick et al., 2010; Saad, 2007, 2011). Among non-human primates, ovulation has been shown to directly influence intra-sexual competition. Specifically, female rhesus monkeys become more aggressive and competitive near ovulation (Mallow, 1981; Walker, Gordon, & Wilson, 1983; Wallen, 2000). Similarly, ovulation has been found to influence women's competitive tendencies, an idea known as the ovulatory competition hypothesis (Durante, Griskevicius, et al., 2014; Nikiforidis, Arsena, & Durante, 2017).

Research has found that near ovulation women are more likely to derogate other females through gossip (Fisher, 2004; Piccoli, Foroni, & Carnaghi, 2013) and prefer an outfit to wear to a party that is sexier and

more revealing in order to increase their attractiveness (Durante et al., 2008; Saad & Stenstrom, 2012), especially when there are many attractive female rivals nearby (Durante et al., 2011). For example, ovulation has the strongest effect on women's desire for sexier clothing when women learn that women in their local environment are very attractive. That is, when there is lots of competition for the most attractive mates.

Recent research drawing on the ovulatory competition hypothesis proposed the idea that ovulation should not only enhance women's mating motivations, but also women's desire to compete with other women for status. For example, in one study, ovulating women preferred products that were better versions of the products other women owned, even if it meant accepting a lesser version of the product overall (Durante, Griskevicius, et al., 2014). And, ovulating women kept more money for themselves in the Dictator Game rather than give it to another woman. When it comes to wanting multiple versions of products, ovulation enhances this, too (Durante & Arsena, 2015).

Because ovulation enhances women's mating motivations (e.g., increased intra-sexual competitiveness and receptivity to alternative, and potentially better, mates), it follows that women may also experience a decreased sensitivity to loss near ovulation. This would be akin to how an activated mating goal and high levels of testosterone dampen men's sensitivity to loss (Li et al., 2012; Sapienza, Zingales, & Maestripieri, 2009; Stanton, Liening, & Schultheiss, 2011). Similarly, an ovulatory decrease in sensitivity to loss may help facilitate optimal competition and mate choice by allowing women to be less focused on any one person, object, or outcome—particularly those that do not serve a mating goal.

3. Overview of the empirical research

Across three studies, we tested the hypothesis that ovulation should decrease women's sensitivity to the loss of money and consumer products. We tested this prediction in laboratory and community (online panel) samples, including the use of hormone tests to determine ovulation and counting estimates to determine fertility status in cross-sectional surveys. In addition, we tested an important boundary condition of the proposed effect: whether or not the product can be used to facilitate a mating goal.

4. Study 1: Fertility & sensitivity to loss of money and products

4.1. Method

4.1.1. Participants

Participants were 51 women with a mean age of 29.00 ($SD = 7.42$, ranging 18–41) who had regular monthly menstrual cycles (25–35 days) and were not on hormonal contraception. Women from the U.S. participated for a small payment via an Internet hosting site (MTurk).

4.1.2. Procedure and materials
4.1.2.1. Assessing fertility. We used the established reverse cycle day method to predict day-of-ovulation for each participant (Gangestad et al., 2016). To do this, we asked women questions related to their ovulatory cycle (Durante et al., 2011, 2012). Specifically, women reported (1) the start date of their last menstrual period and the period before that one, (2) the expected start date of their next period, and (3) the typical length of their cycle.

To create our fertility variable, we first normalized all women's menstrual cycles onto a 29-day cycle length (Gangestad et al., 2016). We then calculated each woman's degree of fertility (or conception probability value) corresponding to the day of the cycle when the survey was completed (Wilcox, Dunson, Weinberg, Trussell, & Baird, 2001). Each participant was assigned a value from 0 to 0.09, with higher values indicating higher fertility (e.g., increased conception

probability). In addition, we also created a dichotomous measure of fertility upon recommendations from Gangestad et al. (2016), whereby women were divided into high and low fertility groups: (1) *High Fertility* group (days 8–15 $n = 18$); (2) *Low Fertility* group (all other days, $n = 33$). These two methods of estimating fertility are the most reliable estimate for cross-sectional data (Gangestad et al., 2016).

4.1.2.2. Loss sensitivity. Participants were first told we were interested in consumer preferences. They were then taken to a page that contained our dependent measures. To assess loss aversion, we used measures adapted from previous research on loss aversion (e.g., McGraw, Larsen, Kahneman, & Schkade, 2010; Mellers, Schwartz, Ho, & Ritov, 1997; Mukherjee, Sahay, Pammi, & Srinivasan, 2017). Specifically, we asked participants to indicate on 9-point scales the degree of unpleasantness associated with losing money in increments of $10, $15, and $20, as well a pair of tennis shoes and a laptop (Very Unpleasant – Very Pleasant). The money items read, "Please indicate how unpleasant losing: (1) $10 would be for you; (2) $15 would be for you; (3) $20 would be for you". For the consumer products, participants were asked to (4) "Imagine a pair of tennis shoes that you own. Please indicate how unpleasant losing this pair of shoes would be for you" and (5) "Imagine your laptop. Please indicate how unpleasant losing your laptop would be for you". Items were reverse-coded such that higher numbers reflected a greater degree of upset about losing the item. We present results using both a composite measure of loss sensitivity (collapsing across items; $\alpha = 0.70$) and for each individual item.

4.2. Results and discussion

For the composite measure of loss sensitivity across items, there was a significant decrease in loss sensitivity at high compared to low fertility (dichotomous fertility status: $M_{high\ fertility} = 7.15$ vs. $M_{low\ fertility} = 8.23$; $F(1, 49) = 16.08$; $p < .001$) and a significant negative relation between fertility and loss aversion (continuous conception probability: $r(51) = -0.43$, $p = .002$). See Fig. 1. This means that women were less sensitive to losses when they were ovulating.

Looking at each item separately, there was a negative relation between conception probability and loss sensitivity for $20 (continuous conception probability: $r(51) = -0.30$, $p = .033$; dichotomous fertility status: $M_{high\ fertility} = 6.72$ vs. $M_{low\ fertility} = 7.82$; $F(1, 49) = 5.33$;
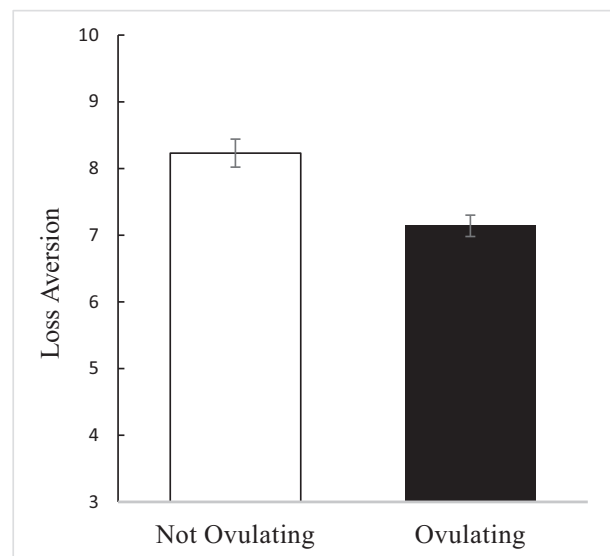

Fig. 1. Women's loss aversion as a function of fertility (Study 1). Loss aversion is indexed by reported upset at the loss of money and consumer products as a function of fertility.
Note: Error bars represent the standard error of the mean.

$p = .025$), tennis shoes (continuous conception probability: r $(51) = -0.26$, $p = .07$; dichotomous fertility status: $M_{high\ fertility} = 8.06$ vs. $M_{low\ fertility} = 8.97$; $F(1, 49) = 6.82$; $p = .012$), and a laptop (continuous conception probability: $r(51) = -0.35$, $p = .013$; dichotomous fertility status: $M_{high\ fertility} = 8.06$ vs. $M_{low\ fertility} = 8.97$; $F(1, 49) = 6.82$; $p = .012$), indicating that as fertility increased, sensitivity to losing these items decreased. The relation between fertility and loss sensitivity was directionally consistent with the other items for $10 and $15, although it did not reach conventional levels of significance ($10: continuous conception probability: $r(51) = -0.14$, $p = .32$; dichotomous fertility status: $M_{high\ fertility} = 6.28$ vs. $M_{low\ fertility} = 6.88$; $F(1, 49) = 1.44$; $p = .24$; $15: continuous conception probability: r $(51) = -0.18$, $p = .22$; dichotomous fertility status: $M_{high\ fertility} = 6.72$ vs. $M_{low\ fertility} = 7.30$; $F(1, 49) = 1.52$; $p = .22$). Unlike the consumer product items, it is possible that imagining the loss of money, particularly without the possibility of gambling to receive a larger amount as in previous work (Baker & Maner, 2009; Li et al., 2012), was confounded by individual differences in women's perceptions of what the money could buy. Despite this limitation, results provide preliminary support for the notion that, near ovulation, women experience decreased loss sensitivity as indicated by less unpleasant feelings associated with losing hypothetical amounts of money and products.

5. Study 2: Fertility, loss sensitivity, and the role of product type

Study 2 sought to examine a potentially important moderator to the proposed effect. Because previous research has found that women seek to enhance their attractiveness near ovulation (Durante et al., 2008, 2011; Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007; Saad & Stenstrom, 2012), we predicted that the effect of fertility on loss sensitivity should reverse—whereby women become more sensitive to loss—when the product can be used to enhance a women's appearance. Because products that can enhance a woman's appearance should be especially sought and used when mating motivates are active, we predicted that ovulation should lead women to be particularly sensitive to losing a product that can enhance their appearance.

To examine this prediction, study 2 employed a similar design as study 1. Women reported how unpleasant it would be to lose a product that they owned. For approximately half of the women, this product was a pen. For the other half, this product was lipstick—a product that can be used to enhance attractiveness. We predicted that fertility would lead women to report less upset at the loss of the pen, but report increased upset at the loss of lipstick (i.e., a product that serves a mating goal). To ensure that fluctuations in mood are not responsible for the effect of fertility on loss aversion, we also included measures of positive and negative affect.

5.1. Method

5.1.1. Participants

Participants were 318 normally cycling women with a mean age of 31.57 ($SD = 5.52$, ranging 20–49) who were not on hormonal contraception. Women from the U.S. participated for a small payment via MTurk.

5.1.2. Procedure and materials

5.1.2.1. Assessing fertility. Fertility was calculated as reported in study 1. For this study, participants also reported how certain they were about the start date of their last menstrual period and the period before their last period (9-pt scale; $1 = $ *Not at All*, $5 = $ *Somewhat*, and $9 = $ *Completely*). Following previous research (Durante, Arsena, & Griskevicius, 2014), we excluded women who were not certain of the start date of their last menstrual periods (i.e., a 5 or lower on the 9-pt scale) or if they answered "yes" to a question that asked if they had recently completed a similar survey on MTurk. The final analysis included 181 women ($M_{age} = 31.70$, $SD = 5.35$, ranging 20–47).

Again, each participant was assigned a value from 0 to 0.09, with higher values indicating higher fertility. We also created a dichotomous measure of fertility whereby women were divided into high and low fertility groups: (1) *High Fertility* group (days 8–15 $n = 52$); (2) *Low Fertility* group (all other days, $n = 129$).

5.1.2.2. Loss sensitivity. As in study 1, participants were first told we were interested in consumer preferences. They were then taken to a page that contained our dependent measures. Participants were asked to indicate on 9-point scales the degree of unpleasantness (Not at all Unpleasant – Very Unpleasant) associated with losing either their favorite pen ($n = 79$) or their favorite lipstick ($n = 102$). Higher numbers reflected a greater degree of upset about losing the item. In addition, on 7-pt. scales (Not at All – Very Much), participants were asked to report how they felt right now for the following randomized items: happy, confident, excited, strong, frustrated, anxious, ashamed, and scared. The positive affect items and the negative affect items were averaged into composites (positive $\alpha = 0.86$; negative $\alpha = 0.87$).

5.2. Results and discussion

For the dichotomous fertility status measure, a 2 (Fertility: High vs. Low; between subjects) × 2 (Product: Mug vs. Lipstick; between subjects) ANOVA revealed a significant fertility by product interaction (F $(1, 177) = 4.99$, $p = .027$). For the lipstick, consistent with our prediction, there was a significant increase in loss sensitivity at high compared to low fertility ($M_{high\ fertility} = 6.19$ vs. $M_{low\ fertility} = 4.93$; $F(1, 177) = 6.60$, $p = .01$). There was no significant difference across fertility status for the pen. However, directionally consistent with study 1, there was a decrease in loss sensitivity at high compared to low fertility for the pen ($M_{high\ fertility} = 5.25$ vs. $M_{low\ fertility} = 5.71$; $F(1, 177) = 0.60$; $p = $ ns). See Fig. 2. There were no main effects.

For the continuous conception probability measure, the fertility by product interaction on loss sensitivity approached significance (F $(1, 164) = 2.52$, $p = .11$). There was a positive relation between conception probability and loss sensitivity for the lipstick ($r = 0.19$, t $(164) = 1.96$, $p = .052$). This means that women were more sensitive to the loss of lipstick when they were near ovulation. There was no significant relation between conception probability and loss sensitivity for the pen, but the direction was negative, similar to study 1 ($r = -0.06$, $t(164) = -0.44$, $p = $ ns). Again, there were no main effects.

There was no relation between the positive and negative affect measures and fertility status (dichotomous fertility status: positive affect, $F(1, 179) = 0.25$, $p = $ ns; negative affect, $F(1, 179) = 0.12$, $p = $ ns; continuous conception probability: positive affect, r $(168) = 0.003$, $p = $ ns; negative affect, $r(168) = 0.004$, $p = $ ns). Controlling for positive and negative affect also did not influence the interaction between fertility and product on loss aversion. This suggests that the effect of fertility on loss sensitivity is not better explained by shifts in mood across the ovulatory cycle.

Consistent with our prediction, the effect of fertility on loss sensitivity found in study 1 reversed when the loss involved a product that could be used to enhance attractiveness—lipstick. Whereas fertility decreased loss sensitivity toward products that do not directly serve a mating goal, fertility had a different effect when the product could be used to enhanced attractiveness, such as lipstick. Although there was no significant negative effect of fertility on loss aversion for the pen, as expected, ovulating women did report decreased loss sensitivity which is directionally consistent with study 1. The lack of conceptual replication for the pen could be related to sampling error and the cross-sectional, self-reported estimates of fertility. Therefore, study 3 was designed to conceptually replicate and extend these finding using hormone tests to estimate fertility status (the most stringent methodology for estimating ovulatory status) and an incentive compatible measure of loss aversion.
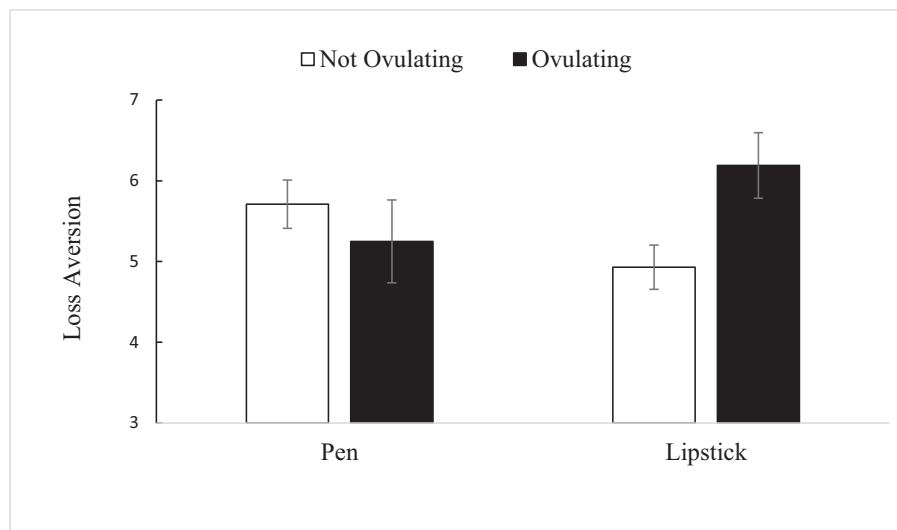
Fig. 2. Women's loss aversion as a function of fertility and product type (Study 2).
Note: Error bars represent the standard error of the mean.

6. Study 3: The effect of fertility on loss sensitivity in a marketplace exchange

Study 3 sought to test the effect of fertility on loss aversion using the most stringent methodology to assess fertility and an incentive compatible measure of loss sensitivity. As in the previous studies, we predicted that ovulation should lead women to be particularly sensitive to losing products that can enhance their appearance, but lead to a decrease in sensitivity when the product does not serve a mating goal.

To examine these predictions, study 3 assessed selling prices in an actual marketplace exchange. Past research has shown that a higher selling price indicates more loss aversion (Aggarwal & Zhang, 2006). That is, the higher the selling price, the more a consumer values the product, and thus the greater the impact of losing that product would be for the consumer. We predicted that fertility would lead women to accept lower selling prices in a marketplace exchange—an index of loss aversion—except when the product is used as a tool to enhance attractiveness (i.e., serves a mating goal).

Study 3 also utilized a more direct measure of ovulation – urinalysis. This methodology provides the most precise measure of ovulation and also allows us to examine behavioral change within the same woman (with each woman serving as her own control) at different points across the ovulatory cycle.

6.1. Method

6.1.1. Participants

Participants were 65 undergraduate female students at a large American university with an average age of 22.4 (SD = 5.5; ranging 18–42) who had regular monthly menstrual cycles (25–35 days) and were not on hormonal contraception. Women participated in exchange for course credit or for a $30 cash payment, whichever they preferred.

6.1.2. Procedure and materials

6.1.2.1. *Assessing fertility.* Women came into the lab for two experimental sessions – once on a high fertility day (near ovulation) and again on a low fertility day. The sessions were counterbalanced and ovulation was confirmed via over-the-counter urine applicator tests. See Durante et al. (2012) for detailed information on fertility assessment. High-fertility testing sessions took place on the day of or one day after a positive urine test indicated a surge in luteinizing hormone signifying ovulation; low-fertility testing sessions occurred approximately seven days before menses. Roughly half of the participants completed high-fertility testing first. Detailed debriefing indicated that none of the participants were aware of the research hypotheses, and none believed the urine tests were being used to detect ovulation.

6.1.2.2. *Dependent measure.* At each laboratory session, women were given either a picture frame or a palette of lipstick and told the item retailed for $5.00. Although the participants kept the item with them during a portion of each testing session, participants returned the item before leaving the laboratory during their first testing session. Participants were told that the item was theirs to keep and take home with them upon completion of the study.

Approximately 10 min after the participants were given the product, they were informed that a participant in the same study was interested in buying the frame (or lipstick palette), and the participants were asked to indicate at what price they would be willing to sell the frame or lipstick. All women indicated a selling price. Thus, the selling price served as our dependent measure.

Because each woman completed two separate testing sessions, women were told that they would either receive payment for the sale of the item upon completion of the study or the item would be returned to them at the end of the study if the other participant refused to buy the item at the indicated price. Detailed debriefing revealed that all of the women thought that the task was an actual marketplace exchange. After debriefing each woman received the frame or the lipstick to keep.

6.2. Results and discussion

A 2 (Fertility: High vs. Low; within subjects) × 2 (Product: Frame vs. Lipstick; between subjects) repeated measures ANOVA revealed a significant fertility by product interaction (F (1, 63) = 17.30, $p < .001$). See Fig. 3. For the frame, women reported significantly lower selling prices when they were at high fertility compared to when they were at low fertility ($M_{high\ fertility}$ = $6.59 vs. $M_{low\ fertility}$ = $8.46; F (1, 28) = 10.16, $p = .004$, $\eta_p^2 = 0.27$). For the lipstick palette, by contrast, women reported significantly higher selling prices when they were at high fertility compared to when they were at low fertility ($M_{high\ fertility}$ = $7.43 vs. $M_{low\ fertility}$ = $6.68; F (1, 35) = 5.82, $p = .021$, $\eta_p^2 = 0.14$).

In summary, study 3 found that ovulation leads women to become less sensitive to losses for products unrelated to directly attracting a mate (e.g., frame). Consistent with study 2, ovulating women reported higher acceptable selling prices when the endowed product was
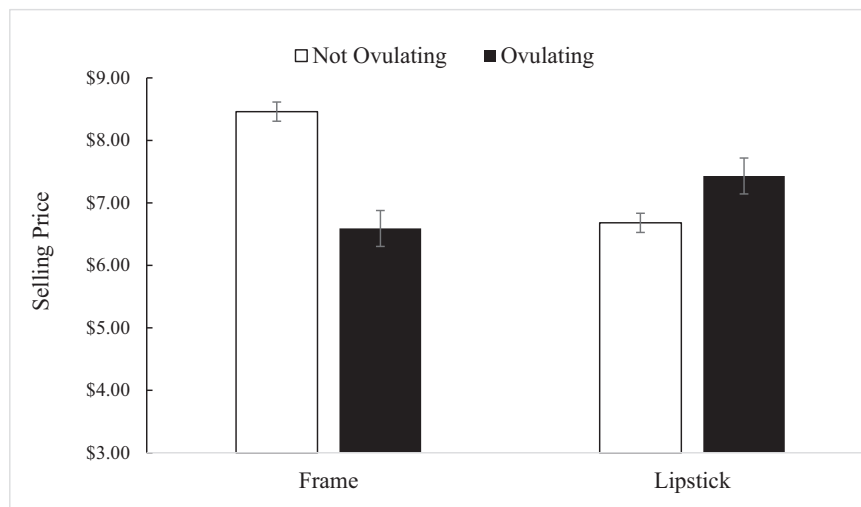
Fig. 3. Women's selling prices in a marketplace exchange as a function of fertility and product type (Study 3). Lower selling prices indicate weakened levels of loss aversion.

Note: Error bars represent the standard error of the mean.

lipstick, indicating that fertility increased loss aversion in a category of product that enhances attractiveness. These results conceptually replicate study 1 and study 2 using methodologically rigorous, within-subject measurements of fertility (urinalysis) and a dependent measure with a real monetary incentive.

7. General discussion

Loss aversion is a universal facet of human nature (Benartzi & Thaler, 1995; Samuelson & Zeckhauser, 1988; Thaler, 1980; Tversky & Kahneman, 1981). The ubiquity of loss aversion is viewed as an adaptive bias that helped humans solve survival-related ancestral challenges (Chen et al., 2006). Sensitivity to loss in non-survival related domains—such as those involving consumer products—could have evolved as a by-product of loss sensitivity that enhanced reproductive fitness in survival-related domains (Loewenstein et al., 2001). This is because the loss of any resource in ancestral environments would have likely been particularly devastating. Although loss aversion is likely adaptive, a fundamental motives approach suggests that loss aversion should be moderated by context (Aktipis & Kurzban, 2004; Griskevicius & Kenrick, 2013; Hill & Buss, 2010; Li et al., 2012). For example, goals related to mating have been found to decrease loss aversion and enhance risk-taking in men (Li et al., 2012; Sapienza et al., 2009). Given that women's intra-sexual competition and mating motivations are modulated by hormones that regulate fertility (Gangestad et al., 2002; Gangestad & Thornhill, 1998), we predicted the women should exhibit decreased loss sensitivity near ovulation unless the loss domain is directly related to mating.

Three studies find support for the prediction that the hormonal fluctuations associated with ovulation modulate loss aversion depending on context. Near ovulation, women experienced a decrease in loss sensitivity for both money and products such as tennis shoes, laptop, pen, and picture frame. However, this effect was reversed when the product was lipstick—a product that could be used to reach the mating goal of enhancing attractiveness. This consistent effect was found in community panel surveys and a controlled experiment using hormone tests and real products in a marketplace exchange.

Although previous work on loss aversion has used similar measures (McGraw et al., 2010; Mukherjee et al., 2017), one important limitation of the current work is that measures of upset at the idea of losing money and products (studies 1 and 2) can be construed as measuring negative affect more so than loss aversion. This limitation would be particularly critical if mood shifts near ovulation relative to other times during the

cycle, but mood has not been found to shift near ovulation (Laessle, Tuschi, Schweiger, & Pirke, 1990; Wilcoxon, Schrader, & Sherif, 1976) and the current work did not find fertility shifts in positive or negative affect in study 2. This limitation is also lessened by the reverse pattern of upset near ovulation found for lipstick in study 2 and directly addressed in study 3 with the use of a different measure of loss aversion.

It is also important to note that our predictions are based on the idea that the loss of items not directly related to a mating goal will be less critical for women near ovulation. This includes the loss of money. We reasoned that the lack of a direct cognitive link between money and attractiveness enhancement would lead ovulating women to be less upset about the prospect of losing it, particularly because the accumulation of money does not help women attract mates (Baker & Maner, 2009; Griskevicius et al., 2009). But, we recognize that money can be used to buy products, including those that serve mating goals. This could be one reason why we did not find a significant relation between fertility and loss sensitivity for each of the monetary amounts in study 1.

To our knowledge, this research is the first to examine whether and how ovulation is related to loss aversion. This research adds to the literature on loss aversion and provides additional evidence demonstrating how biological factors such as hormones can influence robust psychological phenomena commonly studied in marketing and decision research.

8. Implications

This research has several implications. For marketers, a potentially valuable insight is that the ovulatory cycle can systematically influence women's loss sensitivity and, thus, their attachment to any one product. This opens the door for marketers to strategically target product messages at a time when women are more likely to trade in an older version of a product and try something new. Although our research examined fertility at the individual level, and marketers are unlikely to gain access to information that can predict fertility at this level, the use of smartphones and wearables has enabled marketers to more seamlessly target consumers in a personalized manner. Important to the current work, millions of women use digital apps to track their fertility status (Lupton, 2015; Mangone, Lebrun, & Muessig, 2016). These apps (like Fertility Friend, Glow, and Kindara) allow women to enter information about their cycles and carefully track their own fertility. Companies that partner with these fertility-tracking apps can time marketing messages to specific days of the ovulatory cycle as determined by the

data women enter. For example, when a particular user is near ovulation (e.g., day 8 of a 29-day cycle), these apps could deliver marketing messages for products women are more likely to be interested in purchasing, like new products or brands, as well as other products that can be used to attract mates and deter rivals (Durante et al., 2011).

Our findings can also inform how marketers can best frame messages in advertising and other promotional materials. Examining the effects of estrogen—the hormone that regulates fertility—on women's consumer behavior provides insight into the mating goals that guide women's desire for various products. The current research suggests that goals related to mate attraction and competition impact women's loss sensitivity, weakening loss aversion except when the loss is in a product category that can be used to attract men and compete with other women. Thus, women might be especially responsive to advertising, promotions, and messages that frame products as tools that can be used to gain attractiveness relative to other women.

For consumers, our findings suggest that monthly hormonal fluctuations increase women's likelihood of trading in an owned product in favor of something new and potentially taking greater risks with their finances. Female consumers could use this knowledge to control their spending habits. Specifically, the current work suggests that women might be less upset about losing money via expenditures on unnecessary products especially when they are ovulating. Indeed, Saad and Stenstrom (2012) found that ovulating women spent more money on clothing and other products that enhance attractiveness. To save money and avoid unnecessary spending, female consumers that are made aware of the effects of fertility on spending can course-correct for the nonconscious desire to seek out and purchase expensive and conspicuous products.

For scholars, this work contributes to our understanding of how hormones influence consumer behaviors (Durante et al., 2011, Durante & Arsena, 2015, Durante, Arsena, & Griskevicius, 2014, Saad & Stenstrom, 2012, Sapienza et al., 2009) and how mating goals can alter decision biases such as loss aversion (Baker & Maner, 2009; Li et al., 2012). Whereas an externally primed mating goal lowered men's sensitivity to loss, no similar effect was found for women (Li et al., 2012). The current work suggests that parallel effects for women depend on fluctuations in the hormones that regulate fertility. Women became less sensitive to loss via an internally primed, physiological factor that regulates attunement to mating-related goals: ovulation. Given that ovulation is the only time for women that mating behavior can result in reproduction, it follows that the effect of mating goals on decision-making is heightened for women when conception probability is highest.

Other fundamental motivations likely influence decision biases such as loss aversion (Griskevicius & Kenrick, 2013). For example, parenting or self-protection motives are driven by different hormones and might influence loss sensitivity in a way that is very different from a mating motive. In the current work, we found that selling prices for the picture frame were particularly high at a low fertility point in the cycle when progesterone levels are high. Progesterone begins to rise after ovulation has occurred in order to prepare a women's body for pregnancy (Venners et al., 2006). If an ovum is fertilized, progesterone continues to rise, and high levels are maintained during pregnancy (Jones, 1997). It could be that progesterone leads to enhanced loss sensitivity in domains that serve goals related to kin care, affiliation, or nesting behavior (Frye, Petralia, & Rhodes, 2000). This may be why we found an effect of fertility on loss sensitivity for picture frames. That is, rather than ovulation decreasing loss sensitivity for picture frames, it could be that because picture frames tend to be used to hold pictures of loved ones—and thus can serve kin care-related goals—enhanced progesterone at low fertility may be responsible for the reported effect. Given the null effect of fertility on loss sensitivity for pens in study 2, the alternative proposition that considering a picture frame inadvertently primes kin care motivation is particularly reasonable. Future research could investigate this possibility and use a control product that is more

neutral with respect to fundamental motives. Additionally, hormones associated with parenting (oxytocin in women; vasopressin in men; Young & Insel, 2002) and self-protection (cortisol; Dickerson & Kemeny, 2004) might modulate loss aversion. Future research is poised to examine how other hormones influence decision biases, including the underlying motives responsible for such effects.

9. Conclusion

Research on how mating goals influence decision biases has found that loss aversion decreases and risk-seeking increases in men when mating motives are salient (Baker & Maner, 2009; Li et al., 2012) and when testosterone levels are particularly high (Sapienza et al., 2009). We proposed that women's sensitivity to loss would decrease near ovulation—when mating goals for women are particularly salient. We supported this prediction across three studies. Women's sensitivity to the loss of money and products was decreased near ovulation unless the product could be used to enhance attractiveness. This research strengthens our understanding of how fertility influences women's consumer behavior and is among the first to highlight the role the hormones that regulate fertility play in women's decision biases. We hope our findings will lead to further research on understanding the factors that uniquely influence women's consumer behavior.

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Kristina Durante is Associate Professor of Marketing and Ph.D. Program Coordinator at Rutgers Business School at Newark and New Brunswick. Kristina is a social psychologist interested in the biology of decision-making. Kristina's research program focuses on women's consumer choice and luxury spending, family consumer decisions, and hormones and behavior. Kristina's work has been published in the leading academic journals

in marketing, psychology, and biology. Kristina spoke about her research in a recent TEDx talk. Her studies have been featured in *USA Today*, *The Wall Street Journal*, *The New York Times*, and *The Chicago Tribune*, as well as hundreds of other media outlets worldwide. Kristina spent seven years as an entertainment marketing executive at *Metro-Goldwyn-Mayer*, *Loud Records*, and *Planet Hollywood* before entering academia.

Vladas Griskevicius is the Carlson Family Foundation Endowed Chair in Marketing. He currently serves as chairperson of the marketing department and as associate editor of the *Journal of Marketing Research*. Griskevicius has an extensive background in psychology and studies social influence, green marketing, and the evolutionary roots of modern behavior. Griskevicius has received numerous awards for his teaching, research, and

service, including named one of the "World's Top 40 Business Professors Under 40" by *Poets & Quants* and Best Article Award from the *Journal of Consumer Research.*

Sevincgul (Sev) Ulu is an assistant professor in the Marketing Department at NJCU. She obtained her PhD in Marketing from Rutgers University and she also holds an MBA degree from Freeman School of Business, Tulane University, with a concentration in Marketing and Global Leadership. Sev's research focuses on online behavior, authenticity, gender differences, and evolutionary psychology. Prior to entering academia, she worked for SONY as an online marketing project manager where she developed her interest in digital marketing. Her work experience includes CRM specialist in HSBC and behavioral lab manager in Rutgers University.