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Female Intrasexual Competition Is Affected by the Sexual Orientation of the Target and the Ovulatory Cycle

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Research suggests that women use indirect aggression strategies to compete with same-sex peers and improve their mating prospects. One such tactic involves strategically transmitting reputation-damaging information as opposed to reputation-enhancing information, to lessen the appeal of sexual rivals. The present study further examined whether this strategic information transmission constitutes an intrasexual competition strategy, by comparing denigration of same-sex peers who constitute sexual competitors or noncompetitors as determined by their sexual orientation. This study also explored the impact of the ovulatory cycle on this strategy, following research suggesting that hormone fluctuation drives subtle behavioral changes near ovulation, amplifying other forms of intrasexual competition between women. Results indicated that among women identifying as straight, exposure to a same-sex peer who constituted a sexual rival (straight/bisexual target) led to greater transmission of reputation-damaging information relative to reputation-enhancing information, compared with exposure to a noncompetitor (lesbian target). The ovulatory cycle was found to be associated with denigration, but this did not depend on the sexuality of the target. Participants in the estimated high-estrogen phase showed greater denigration overall than participants in the low-estrogen phase, regardless of the target's sexuality.

Public Significance Statement
This study examined the mechanics of selective transmission of social information as an intrasexual competition strategy. The results suggest that straight women exhibit greater competitive behavior against same-sex peers who constitute sexual rivals (straight and bisexual women) as opposed to nonrivals (lesbian women). They also suggest that the menstrual cycle is linked to intrasexual competition, as women showed greater denigration of other women while in the estimated high-estrogen phase of their cycle than the low-estrogen phase. These findings shed light on how a substantial part of the population socializes and competes, and they provide greater insight into an understudied effect of the menstrual cycle.

Keywords: intrasexual competition, strategic information transmission, menstrual cycle, estrogen, indirect aggression

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People compete for mates and people gossip, so it is perhaps not surprising that one important form of intrasexual competition is the strategic transmission of social information. It has been observed, for instance, that women seek to harm the reputations of other women, to improve their own mating prospects. The present research expanded on this area, by examining women's derogation tendencies as a function of whether a same-sex peer constitutes a rival (due to her sexual orientation) and the derogating woman's estrogen levels. The following sections provide some background on intrasexual competition, the behavioral changes associated

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with the ovulatory phase, and why estrogen levels are relevant in the context of strategic information transmission.

Intrasexual Competition: Theory and Mechanisms

The study of women's intrasexual competition has revealed two commonly used tactics: self-promotion and competitor derogation (Buss & Dedden, 1990; Fisher, 2013; Vaillancourt & Sharma, 2011). Self-promotion involves enhancing one's value as a mate, commonly through beautification tactics (i.e., makeup and revealing outfits), increasing one's resources, and promoting one's social status. Competitor derogation is linked to "indirect" or "social" aggression, and aims to reduce the value of a sexual rival; commonly used strategies include the transmission of rumors challenging the competitor's fidelity and attractiveness, social exclusion, and using subtle bodily and facial cues attacking the rival's self-worth, to discourage them from competing (Fisher & Cox, 2009; Vaillancourt, 2013; Vaillancourt & Sharma, 2011).

Women's use of indirect, covert tactics as opposed to direct confrontation when seeking to secure a mate is mainly attributed to the need to maximize reproductive success (Campbell, 1999; Nikiforidis et al., 2015; Reynolds et al., 2018; Vaillancourt & Sharma, 2011). Indirect aggression strategies have adaptive benefits both in mate acquisition (securing a fit mate and successfully reproducing) and mate retention (maintaining resources and protection) as they minimize chances of detection and retaliation that may put their health and reputation at risk. For instance, prevailing in a physical confrontation may provide the female with greater mate selection and mating opportunities; however, injuries sustained from such confrontation may be long lasting, hindering their ability to reproduce and/or jeopardizing the survival chances of existing offspring dependent on the mother's ability to provide care and protection (Clutton-Brock & Huchard, 2013). This is consistent with meta-analytic data showing greater fearfulness toward physical danger and less risk-taking behavior among females than males, which can be linked to differences in testosterone levels between the sexes (Archer, 2019). Furthermore, overt competition of a potential rival may inadvertently draw men's attention to them, including them in the competition (Fisher & Cox, 2009), and the derogator may lower their value as a mate by appearing cruel (Schmitt & Buss, 1996) and place themselves at risk of rejection and social isolation (Fisher et al., 2010).

Moreover, research suggests that women gossip more than men, and also use gossip as a tool for competition (Hess & Hagen, 2006; Reynolds, 2016). This exchange of social information serves to tarnish the reputations of same-sex competitors, granting the derogators an advantage in accessing high-quality mates (Reynolds, 2016). Research has demonstrated that women can influence a potential mate's perception of a rival woman both positively and negatively by sharing reputation-enhancing or derogatory information, respectively, regardless of the veracity of such statements (Fisher & Cox, 2009). Research has also shown that adolescents using indirect aggression strategies are more likely to secure a partner in the following year, while adolescents victimized by said aggression are less likely to do so (Arnocky & Vaillancourt, 2012).

While the precise mechanisms of intrasexual competition are still unclear, research has identified potential predictors. Characteristics that trigger intrasexual competition are generally those that are most valued by the opposite sex (Fisher et al., 2010); heterosexual women compete on characteristics that heterosexual men seek in a partner. As genetically fit men have been shown to seek out conventionally attractive mates, perceived attractiveness may trigger competitive behavior (Li et al., 2013). This may be related to attractiveness and youthfulness being indicators of fertility and health (Buss, 1989). Additionally, the level of engagement in intrasexual competition differs among women. It has been suggested that certain personal characteristics such as general competitiveness, relationship status, age, self-esteem, and jealousy impact the expression and intensity of intrasexual competition (Arnocky et al., 2012; Borau & Bonnefon, 2019; Reynolds et al., 2018).

Relevant Research and Development of the Current Study

Reynold and colleagues' (Reynolds et al., 2018) research examined overt sexuality, expressed through behavior or dress, as a threat that triggers competitor denigration. Their work consisted of five studies, each exploring different aspects of the transmission of social information about sexual competitors. Female participants were presented

with a potential rival either possessing characteristics shown to increase the level of threat (e.g., attractiveness, flirtatious behavior, and provocative dress) or not, alongside five reputation-damaging and four reputation-enhancing statements about the rival. Participants were told to assume that the rival had joined their social group and that they had found out some information about her, and they were asked how likely they would be to pass along each of these nine statements. The findings revealed a pattern consistent with mating objectives, highlighting selective social information transmission as an intrasexual competition tactic. Overall, women sought to harm the reputation of rivals posing a direct (flirting with their partner) or indirect (conventionally attractive, dressed promiscuously) threat to their mating prospects by selectively transmitting reputation-damaging pieces of information and withholding reputation-enhancing ones.

Hughes et al. (2020) expanded on Reynolds and colleagues' work by exploring whether lesbian women use similar competitive strategies. Female participants identifying as straight or lesbian viewed a sexualized or neutral photograph of a woman and were asked how likely they would be to share certain reputation-damaging statements about the rival's life with others. The results indicated that both groups of women were more likely to spread reputation-damaging information about targets they viewed as sexual competitors, suggesting that this is a universal strategy used regardless of sexual orientation.

Those findings left certain questions unanswered. In Hughes and colleagues' study (Hughes et al., 2020), straight participants were presented with only straight targets and lesbian participants with only lesbian targets. This is understandable given that the purpose of their study was to examine intrasexual competition within each sexuality group. However, the sexual orientation of the target may be a critical factor. If denigration of this kind aims to improve one's mating prospects, straight women should be more likely to denigrate other straight women (i.e., sexual competitors) than lesbian women (i.e., noncompetitors). If straight women were found to denigrate both lesbian and straight women equally, this may challenge our conventional understanding of strategic information transmission as an intrasexual competition tactic.

Furthermore, a significant limitation of the literature is that research on intrasexual competition has overlooked the potential effect of menstrual cycle and ovarian hormones on selective social information transmission, despite calls for such research (Nikiforidis et al., 2015; Vaillancourt & Sharma, 2011). The following sections address why the menstrual cycle may be relevant to competitive mating strategies.

The Ovulatory Shift Hypothesis

The menstrual cycle is divided into phases accompanied by cyclic changes in ovarian hormone levels. The phase of interest for this work is a window termed the "ovulatory phase" during which women's chances of conception are greatest (Wilcox, 2000). This window is estimated to include 5 days before ovulation and the day of ovulation itself, with ovulation occurring on Day 14 of a standardized 28-day cycle, an estimate supported by large-scale biological studies (Wilcox, 2000). The ovulatory shift hypothesis argues that this phase is associated with nonconscious changes in women's behavior geared toward obtaining a genetically fit mate (Gangestad & Thornhill, 2008; Nikiforidis et al., 2015). More specifically, it suggests that during the ovulatory phase of their cycle, women favor uncommitted sexual relationships with males possessing characteristics thought to reflect reproductive fitness (e.g., body, facial, and vocal masculinity, facial symmetry, body odors, and dominant behaviors), while seeking mates with prosocial traits outside the fertile window (Jones et al., 2019; Wood et al., 2014).

Behavioral changes documented in the literature include the following: Women near ovulation show a preference for traditionally masculine male faces (Penton-Voak et al., 1999; Penton-Voak & Perrett, 2000), pay more attention to conventionally attractive men (Anderson et al., 2010), experience a decrease in loss-aversion that is suggested to promote risky mate-seeking behavior (Durante et al., 2019), show a greater tendency to physically engage men other than their partner (Durante & Li, 2009; Gangestad et al., 2002), spend more on beautification products (Durante et al., 2011, 2019; Saad & Stenstrom, 2012), and choose to wear more revealing outfits (Durante et al., 2008).

This shift in behavior and preferences is thought to be driven by fluctuations of key reproductive hormones in the female body (Jones et al., 2019). Research has revealed links between estrogen levels and mating behavior, suggesting a unified system by which endocrine mechanisms regulating fertility also regulate these behavioral changes

(Durante et al., 2014; Durante & Li, 2009; Gangestad & Thornhill, 2008; Grammer et al., 2004; Law Smith et al., 2006; Penton-Voak et al., 1999; Vukovic et al., 2009). Such behavioral changes have been shown to be suppressed in women using hormonal contraceptives (Nikiforidis et al., 2015), though this has recently been called into question. Hormonal contraceptives work by introducing synthetic estrogen and progesterone into the body, which suppresses production of these hormones, leading to lower overall levels in the body and evening out any fluctuations that would otherwise occur across the cycle (Fleischman et al., 2010).

To summarize the underlying biological concepts, the key ovarian hormones regulating women's fertility are estrogen (of which estradiol is the strongest form) and the luteinizing hormone (Nikiforidis et al., 2015). During the ovulatory phase, the ovaries secrete estrogen. The rise in estrogen triggers a surge in the luteinizing hormone (LH), which in turn initiates ovulation (Jones & Lopez, 2006; Nikiforidis et al., 2015). From that point onward, there are two views on hormone levels. One consensus is that estrogen levels sharply drop postovulation (Jones & Lopez, 2006; Nikiforidis et al., 2015). In this model, estrogen peaks during the ovulatory phase, and this 6-day window constitutes the high-estrogen phase of one's cycle. However, other depictions of the endocrine cycle indicate a secondary rise of estrogen postovulation, followed by a sharp decrease near the end of the cycle (Jones & Lopez, 2006; Reed & Carr, 2000). This secondary rise is also evident in graphs depicting hormonal shifts throughout the menstrual cycle (Hedayat & Lapraz, 2019; Knudtson & McLaughlin, 2019; Marsh et al., 2011; Reed & Carr, 2000), though the precise timing and the magnitude of the second spike are still debated.

Despite a substantial body of evidence supporting this hypothesis, recent large-scale studies and meta-analyses have called some of these effects into question, raising methodological concerns and inconsistencies. Researchers have pointed to inappropriate sample sizes (Stern et al., 2020) and underpowered studies (Jones et al., 2019), as well as concerns with relying mostly on between-subjects designs (Jones et al., 2019; Stern et al., 2020) and potential inaccuracies in estimating the fertile window (Marcinkowska, 2020). Some researchers have treated findings in the area as artifacts arising from publication bias (Harris, 2013).

Controversy in this area was fueled by two meta-analyses coming to diverging conclusions on cyclic mate preference shifts (Gildersleeve et al., 2014; Wood et al., 2014). More recently, a number of large studies following most current recommendations in methodology did not show a link between hormone levels and a preference for facial, bodily, and vocal masculinity (Jones et al., 2018; Stern et al., 2020, 2021). This suggests a more complex link between the menstrual cycle and partner preferences than previously proposed.

In light of these findings, there are considerations regarding whether alternative models may better capture the relationship between hormones and women's sexual behavior. One such model is the "estrous" model, proposing that the ovulatory phase is linked to increased sexual motivation and general sexual desire, while not making predictions about preferences for specific types of men (Jones et al., 2019). Cycle shifts in sexual desire (as opposed to mate preferences) remain substantially supported in the literature (Stern et al., 2020).

It is important to note that the current study does not investigate the types of men that women seek out as potential mates. It focuses on the behavior of females toward potential competitors, regardless of the characteristics of the mate they may be competing over. Therefore, inconsistent findings on the ovulatory shift hypothesis are not necessarily an impediment to this work; rather, they serve to highlight how this mechanism is not yet fully understood and how they may be more complex and context-specific than previously thought.

Ovulation and Intrasexual Competition: Is There a Link?

The "ovulatory competition hypothesis," coined by Durante and colleagues (Durante et al., 2014), argues that ovulation amplifies women's intrasexual competition tendencies. There are clear advantages to engaging in competition during peak fertility periods. By focusing competitive efforts during the time of highest reward, women maximize the effectiveness of their efforts, making the risks more likely to pay off (Nikiforidis et al., 2015).

Initial work in this area has shown links between periods of fertility and an increase in competitive behavior. Women not using hormonal contraceptives show a pattern of dehumanization (perceiving a person as lacking uniquely human-like traits) of other women, in line with their conception risk. Women in the more fertile phase have been found to attribute more animal-related words (e.g., paw)

than human-related words (e.g., culture) to same-sex peers (Piccoli et al., 2013). The interpretation of this finding as linked to mating competition strategies is strengthened by the fact that the dehumanization of nonsexual competitors (men, elderly people) did not differ throughout the menstrual cycle (Piccoli et al., 2013). Women have also been shown to become more competitive over resources during peak fertility periods, further reinforcing this link (Lucas et al., 2007).

Moreover, it has been suggested that this tendency toward increased competition, like other behavioral changes witnessed during ovulation, could be attributed to estrogen levels. In a key study examining derogation as an intrasexual competition strategy, it was found that during the high-estrogen phase of their cycle women rated other women as less attractive than during the low-estrogen phase (Fisher, 2004). While estrogen levels significantly impacted attractiveness ratings of female faces, no such difference was found with regard to ratings of male faces (Fisher, 2004). This is further supported by the fact that postmenopausal women were found to be less derogating of attractive female faces than premenopausal women; the researchers speculated that this difference may be due to hormonal changes, as estrogen levels decrease during menopause (Vukovic et al., 2009).

Should the ovulation competition theory apply in the strategic transmission of information tactic, one would expect that women transmit more reputation-damaging information against sexual competitors during the high-estrogen phase of their cycle than during the low-estrogen phase. This would provide them with a competitive advantage, by lowering the desirability of competitors as mates in a period during which securing a mate is more likely to lead to conception.

Sexuality and the Ovulatory Cycle: Lessons From Error Management Theory

How might the ovulatory cycle affect denigration of noncompetitors? Would women show heightened denigration of all other women during their high-estrogen phase, or might they discriminate between sexual competitors and noncompetitors? This issue is informed by error management theory, which proposes that humans developed biases to guide their behavior adaptively, to reduce potential costs and maximize benefits (Haselton & Buss, 2000). In terms of error management theory, a "false positive" would mean a woman is perceived as a sexual competitor when she is not; if denigration strategies are used, they would constitute wasted resources as no competition existed in the first place. A "false negative" would mean a woman is not perceived as a sexual competitor when she is; if denigration strategies are not used, then there is a risk of a potential mate choosing a competitor. In terms of reproductive success, a false negative (missing an opportunity to mate with a high-quality mate) may be more costly than a false positive (wasted resources, along with other possible consequences of denigration). Therefore, it may be that when a woman is at her most fertile, she competes indiscriminately with all women to avoid the costly false negative. Furthermore, as there is no guarantee that a potential mate would have knowledge of the target's sexual orientation, women may compete to ensure the potential mate does not spend energy and resources pursuing the noncompetitor over themselves.

The Present Study

This study was novel in two ways. First, it expanded on female intrasexual competition research by exposing participants identifying as straight to a target described as straight, lesbian, or bisexual, and comparing denigration levels across these three conditions. This allowed us to explore whether selective transmission of social information can be attributed to intrasexual competition, by comparing denigration levels toward a sexual competitor versus noncompetitor. Furthermore, by including a bisexual target, this study examined whether the negative stereotypes often associated with bisexuality (e.g., being promiscuous, nonmonogamous, and sexually open) would lead to greater denigration of a bisexual target relative to a straight or lesbian target (Hertlein et al., 2016; Zivony & Saguy, 2018).

Second, to our knowledge, this is the first study to explore the impact of the menstrual cycle on women's strategic transmission of reputation-relevant information against same-sex peers. If derogation is impacted by ovarian hormone fluctuation, then transmission of reputation-damaging over reputation-enhancing information against sexual rivals would increase when estrogen levels are at their highest.

Specifically, the following predictions were tested: participants will show greater denigration toward a straight or bisexual target than toward a

lesbian target (Prediction 1), participants will show the most denigration toward the bisexual target (Prediction 2), participants in the high-estrogen phase of their cycle will show greater denigration when viewing a sexual competitor, compared with participants in the low-estrogen phase (Prediction 3a), and, alternatively (based on error management considerations), participants in the high-estrogen phase of their cycle will show greater denigration regardless of sexual orientation of target (Prediction 3b).

Method

Design

This study utilized a 3 (Sexuality of Target: Straight/Lesbian/Bisexual) × 2 (Estrogen Level: High/Low) between-subjects factorial design to determine whether the sexual orientation of the target and the participant's estrogen level at the time of participation impacted the transmission of reputation-relevant information.

The first independent variable (sexuality of target) was experimentally manipulated: Participants were randomly assigned using the "flow" setting in Qualtrics (Provo, UT; Qualtrics Software, 2020) to view a target described as either straight, lesbian, or bisexual. The second independent variable (estrogen level) was measured: Depending on the day of their cycle at the time of participation, participants were separated into high-estrogen and low-estrogen groups. Two different criteria were used to define which days of the person's cycle constituted high- and low-estrogen days, the Fisher and the Wilcox criteria (described below). The dependent variable (denigration) was measured as a single score with higher numbers indicating greater transmission of reputation-damaging information relative to reputation-enhancing information. The study protocol was approved by the Ethics Committee at the University of Bristol (approval code: 280520104943).

Estrogen Levels

Due to lack of a clear best practice, two separate analyses were conducted using two different criteria for estimating each participant's high/low estrogen days. As this study was conceived as an extension of Fisher's (2004) work, her criterion defining high- and low-estrogen dates was initially adopted. Fisher (2004) determined Days 12–21 of a standardized 28-day cycle as high estrogen, and 1–11 and 22–28 as low estrogen. While the biological basis for choosing these dates were not clearly outlined by Fisher, these days may have been chosen to account for the secondary rise and presence of estrogen postovulation. Additionally, this was the only study in this area proposing high-estrogen days that accounted for the secondary peak. The second criterion was based on Wilcox's (2000) research on ovarian hormone fluctuation during the ovulatory phase, according to which the 6-day ovulatory phase window constitutes the high-estrogen phase. Other researchers in the area have followed this criterion, classing 5 days before ovulation and the day of ovulation itself, or the days between the end menses and ovulation inclusive, as fertile days (Anderson et al., 2010; Penton-Voak et al., 1999). Notably, this 6-day window closely matches the peak fertility days in a woman's cycle where most nonconscious behavioral changes have been observed.

Having determined which days of the cycle would be considered as high/low estrogen under each criterion, the "backward-counting" method was utilized to estimate these dates based on the participants' predicted start date of their cycle. Blake and colleagues (Blake et al., 2016) summarized the two indirect counting methods used to estimate a participant's ovulation date. The forward-counting method estimates ovulation to occur 14–15 days after the start of the menstrual cycle, whereas the backward-counting method estimates one's ovulation date by subtracting 14 days from the predicted start date of the following menses (Blake et al., 2016; Piccoli et al., 2013). The difference is important; for a 30-day cycle, for example, forward-counting estimates the day of ovulation as Day 14, whereas backward-counting predicts it as Day 16 of the cycle. Backward-counting is regarded as being more accurate than forward-counting, as the latter half of women's menstrual cycle shows less variability in length than the first half (Blake et al., 2016; Gildersleeve et al., 2013; Gonzales & Ferrer, 2016; Jones & Lopez, 2006); the present study used backward-counting.

For the Fisher criterion, an adapted version of the backward-counting methodology was adopted as it is unclear how the researcher originally applied this criterion. For a standardized 28-day cycle, Days 12 and 21 can be calculated by subtracting 16 and 7, respectively, from 28. Bearing in mind that variation in the length of the first half of the cycle predominantly accounts for the variation in cycle length,

while the length of the latter half remains relatively consistent (Jones & Lopez, 2006; Nikiforidis et al., 2015), this window of Days 12–21 can best be calculated irrespective of cycle length by subtracting 16 and 7 days, respectively, from the predicted start date of the next period. If the date the participant took the questionnaire fell on or between their estimated first and last high estrogen day, they were placed in the high-estrogen group. Otherwise, they were placed in the low-estrogen group.

The Wilcox criterion involved a straightforward application of backward-counting. The participant's date of ovulation was estimated by subtracting 14 days from the predicted start date of their next cycle. As the first day of the fertile window, according to Wilcox (2000), occurs 5 days before the ovulation day, it was calculated by subtracting 19 days from the predicted start date of the next cycle. As per the Fisher criterion, if the date the participant took the questionnaire fell on or between their estimated first fertile day and the day of ovulation, they were placed in the high-estrogen group. Otherwise, they were placed in the low-estrogen group.

Period Regularity

As these windows can fluctuate widely between women, research on the menstrual cycle generally uses participants who have regular periods, as their hormonal fluctuations are more easily predictable. The key consideration is whether the length of time between the start of each period is "regular." However, there is no agreed standard regarding what constitutes a regular period (Fraser et al., 2007). Studies in this area provide little guidance, with researchers stating that they excluded participants with "irregular" periods without specifying the criteria they used (Anderson et al., 2010; Fisher, 2004; Haselton & Miller, 2006; Johnston et al., 2003; Piccoli et al., 2013) or referring to a criterion without providing scientific justification (Esen et al., 2016). As per the work of Wilcox and colleagues (Wilcox et al., 2001), cited by other researchers in the field (Morrison et al., 2010; Piccoli et al., 2013), participants were asked whether the length of time between the first day of each menstrual cycle was about the same for each cycle. In addition to this, participants were asked to consider whether they have a period "roughly every 21–35 days" (Bull et al., 2019); in accordance with the National Health Service, periods occurring more frequently than every 21 days or less often than 35 days were considered irregular in length (NHS, 2018).

Procedure

Participants were asked to respond to a short online survey about how women form impressions of others and what impact the menstrual cycle has on this. They were presented with a photograph of a woman (the target), nine reputation-relevant statements, and the following description:

> This is Francesca. She just joined your social group. She is 23 years old, is undertaking an MSc in Biology, and is the eldest of two siblings. She is currently single and identifies as straight/lesbian/bisexual. You found out the following information about her. For each piece of information, indicate how likely it is that you would pass it on to your friends.

The photograph of the target shown was the same for all participants. The only difference between conditions was the sexuality of the target (straight/lesbian/bisexual) stated in the accompanying text description. They were then asked to respond to six supplementary questions about their general impression of the target. Following this section, participants whose periods had not stopped and who had not missed a period in the past 3 months were asked to complete a series of questions about their menstrual cycle (regularity, tracking habits, dates of previous and expected period, and average cycle length), pregnancy, and use of contraceptives. Those who did not fulfil the criteria were asked to skip to the next section. Participants were then asked a series of demographics questions (sexuality, age, and ethnicity). At the end, participants were debriefed regarding the purpose of the study and asked to provide final consent for their data to be used.

Materials

The questionnaire was developed using Qualtrics Software (2020).

Reputation Relevant Statements

This study utilized the nine reputation-relevant statements used in Reynolds et al. (2018); five statements were reputation damaging (e.g., "She sleeps around a lot") and four were reputation enhancing (e.g., "She speaks four different languages"). Slight modifications were made to two statements to align with the target's sexuality in each condition ("She cheated on her last boyfriend*/girlfriend/partner*," "She hooked up with two men/*women/a man and a woman* the previous night"). Participants responded on a 7-point scale (1 = *not at all likely*, 7 = *extremely likely*) how likely they would be to pass

along each piece of information about the target to their friends. A "denigration" variable was created by reverse scoring the reputation-enhancing statements (4, 5, 6, and 7) and calculating the mean score of the nine reputation-relevant items. Higher scores reflected greater transmission of reputation-damaging information, while lower scores reflected less transmission of such information. The full set of statements can be found in Appendix A.

An internal consistency reliability analysis carried out on these statements indicated a Cronbach's α of .59. However, it should be noted that this set of items was not developed as a scale. Research aiming to generate a scale could further explore the factor structure of these items.

Supplementary Target Questions

The six supplementary questions about the target found in Reynolds et al. (2018) were also used (see Appendix A). The questions referred to general characteristics attributed to the target (e.g., "How attractive do you think men find Francesca?") and measured the participant's impression about them on a 7-point scale (1 = *not at all*, 7 = *very much*).

Photograph of Target

Six potential photographs for the target were compiled based on criteria that have been shown to trigger competition, such as youthfulness, attractiveness, makeup, and tight and revealing attire (Hughes et al., 2020; Vaillancourt & Sharma, 2011). These photos were sent to four straight women outside the context of the study. They were asked to indicate which of the women they would find the most threatening or would feel the most uncomfortable spending time with their boyfriend. The photograph that attracted the most hostile remarks was chosen for the study (see Appendix B). As this was done unofficially to assist us in choosing which photograph to use, the supplementary questions from Reynolds et al. (2018) on target perception were used to confirm that the target triggered competitive feelings from the participant sample (see online supplemental materials).

Participants

The study was divided into two main parts using the same participant sample. This was done to utilize as many responses as possible, as the exclusion criteria for the two parts differed, with the second part being extremely restrictive. All participants included in the analysis identified as heterosexual, cisgender women and were premenopausal. Cisgender means that one's gender identity and expression match the biological sex assigned to them at birth. For this study, it meant participants reported their biological sex as female and identified as women.

Part A examined whether the sexuality of the target impacted the level of denigration shown toward them. This analysis excluded participants who were under 16 years old, participants who did not complete the required sections in full or did not provide final consent at the end of the survey, and participants who identified as nonheterosexual (participant sexual orientation was self-reported). Part B introduced the second independent variable, seeking to examine the relationship between denigration, sexuality of target, and estrogen levels. As research on ovarian hormones is highly sensitive to characteristics of a woman's menstrual cycle, additional exclusion criteria were applied; participants who stated their cycle was irregular, did not track their cycle at all, were pregnant, did not provide a predicted start date of their next period, and had used hormonal contraception within 3 months before taking the survey were excluded.

Overall, 568 participants were recruited from various social media websites (Facebook, Twitter, Instagram, and Reddit). Based on the criteria listed above, the following exclusions were made (see Appendix C for more detail).

For Part A: (a) 146 participants did not complete or declined the final consent check, (b) 107 participants identified as nonheterosexual, and (c) 26 participants did not indicate their age or were under 16 years old. Therefore, the final sample for Part A consisted of 289 female participants aged 16–53 years ($M = 25.31$, $SD = 6.10$). Of those, 223 identified as White (77.2%), 23 as mixed/having multiple ethnic groups (8%), 22 as Asian/Asian British (7.6%), three as Black African/Caribbean/Black British (1%), five preferred not to answer (1.7%), and 13 indicated belonging to another ethnic group (4.5%). Ethnicity was recorded according to the recommendations of the Office for National Statistics (2016) for surveys in England.

Due to lack of studies using a similar design, the required participant numbers were estimated following Reynolds and colleagues' (Reynolds et al., 2018) strategy; the aim was approximately 100 participants per condition. Of the 289 participants included in the final sample, 94 viewed a straight target, 98 viewed a lesbian target, and 97 viewed a

bisexual target, meeting the sample size objective. Post hoc power analysis using G*Power (Faul et al., 2007) confirmed there was sufficient power to detect the effects (power > .9).

For Part B, in addition to the exclusions in Part A: (a) 66 participants were excluded as they did not provide information on the regularity of their cycle or stated their cycle was irregular, (b) 20 participants stated they did not track their cycle or did not provide information on this, (c) four participants stated they were or may be pregnant, (d) 64 participants stated they had used in the past 3 months or currently were using hormonal contraceptives or did not specify their use of contraceptives, (e) four participants did not provide an anticipated start date for their next period. The final sample size for Part B was 130 participants. Post hoc power analysis for $N = 130$ indicated that power was <.70 to detect a main effect for estrogen, and <.60 to detect a main effect for sexuality of target or an interaction effect.

Results

Part A: Denigration Scores Across Sexuality of Target Conditions

A one-way between-subjects analysis of variance (ANOVA) was conducted to examine the effect of the target's sexuality (straight, lesbian, and bisexual) on denigration levels ($N = 289$). Alpha was set to .05 for this and all subsequent analyses. The following assumptions were met for this and all subsequent analyses in this report: (a) the Levene statistic was nonsignificant (all *p*s were between .065 and .449), meaning the requirement of homogeneity of variance was met, (b) the assumption of independence was met, and (c) the normality assumption was met, having reviewed histograms and normal Q-Q plots.

There was a statistically significant effect of the target's sexuality on denigration levels, $F(2, 286) = 6.28$, $p = .002$, $\eta^2 = .044$. Post hoc comparisons of the means using Tukey's honest significant difference (HSD) indicated significance in two of the comparisons made, shown in Table 1 and Figure 1. In support of Prediction 1, participants who viewed a lesbian target ($M = 2.82$, $SD = .80$) showed significantly lower levels of denigration toward the target than participants who viewed a straight ($M = 3.25$, $SD = .83$, Cohen's $d = .53$) or a bisexual target ($M = 3.11$, $SD = .95$, $d = .33$). Not supporting Prediction 2, participants who viewed a bisexual target were no more likely to denigrate the target than those who viewed a straight target ($p = .504$).

An additional one-way between-subjects ANOVA was conducted including only participants aged 16–35 years ($N = 271$), to explore whether transmission of reputation-damaging information may be more pronounced in an age range where women are more likely to be seeking a mate. This age range was selected based on statistics finding that the mean age women marry at is 35 years old (Office for National Statistics, 2020). This constrained sample showed a conceptually identical pattern of results.

Part B: Sexuality of Target, Estrogen Levels, and Interaction Analysis

Two separate two-way ANOVAs were conducted to examine the effects of the target's sexuality and estrogen level on denigration ($N = 130$). The first analysis was conducted using the Fisher criterion for high/low estrogen days (10-day window), and the second used the Wilcox criterion (6-day window).

When using the Fisher criterion for ovulation (see Table 2, Figure 2), there was a significant main effect of estrogen level, $F(1, 124) = 4.43$, $p = .037$, $\eta_p^2 = .034$, with higher denigration levels among participants who took the survey in the high-estrogen phase ($M = 3.39$, $SD = .76$) than in the low-estrogen phase ($M = 2.93$, $SD = .85$). The main

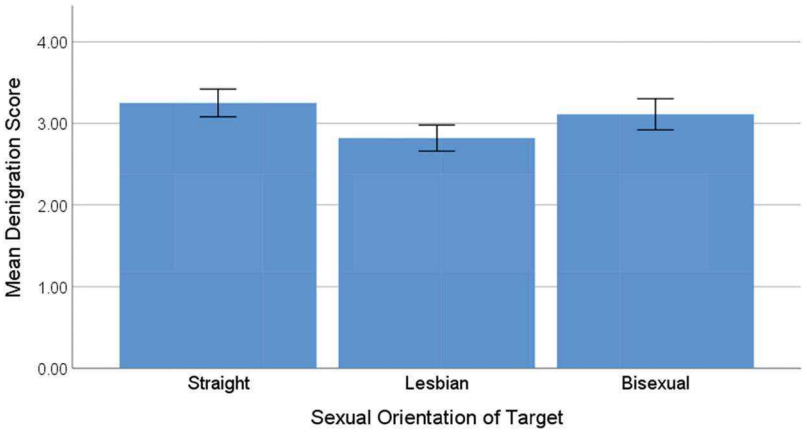
Table 1
ANOVA Comparisons of Denigration Levels Across Sexuality of Target Conditions

				Tukey's HSD comparisons		
Sexuality of target	*N*	*M*	*SD*	Straight	Lesbian	Bisexual
Straight	94	3.25	0.83	–	–	–
Lesbian	98	2.82	0.80	.002	–	–
Bisexual	97	3.11	0.95	.504	.049	–

Note. $N = 289$.

Figure 1

Mean Denigration Scores in the Straight, Lesbian, and Bisexual Target Conditions, With Error Bars Showing 95% Confidence Intervals



Note. The mean differences between straight and lesbian (p = .002), and lesbian and bisexual groups (p = .049) were statistically significant. The mean difference between straight and bisexual groups was nonsignificant (p = .504). See the online article for the color version of this figure.

effect of the target's sexuality was nonsignificant, $F(2, 124) = 1.05$, $p = .350$, $\eta_p^2 = .017$. The interaction was also nonsignificant, $F(2, 124) = 1.01$, $p = .365$, $\eta_p^2 = .016$, meaning that the effect of the target's sexuality on denigration did not change depending on estrogen levels. These results support Prediction 3b (rather than 3a).

When using the Wilcox criterion to define high/low estrogen days (see Table 3, Figure 3), the main effect for the target's sexuality was nonsignificant, $F(2, 124) = 2.24$, $p = .111$, $\eta_p^2 = .035$, as was the main effect for estrogen levels, $F(1, 124) = 2.40$, $p = .124$, $\eta_p^2 = .019$. The interaction was also nonsignificant, $F(2, 124) = .45$, $p = .641$, $\eta_p^2 = .007$.

Discussion

This study examined whether and how the sexuality of the target and the perceiver's estrogen level affects intrasexual competition, specifically the strategic transmission of information. Prediction 1, that straight women will transmit more reputation-damaging information when viewing a straight or bisexual target than when viewing a lesbian target, was supported in our larger sample (N = 289). Against Prediction 2, there was no difference between denigration shown toward the bisexual and the straight target. Participants estimated to be in the high-estrogen phase of their cycle showed greater denigration regardless of the target's sexuality, compared with participants estimated to be

Table 2

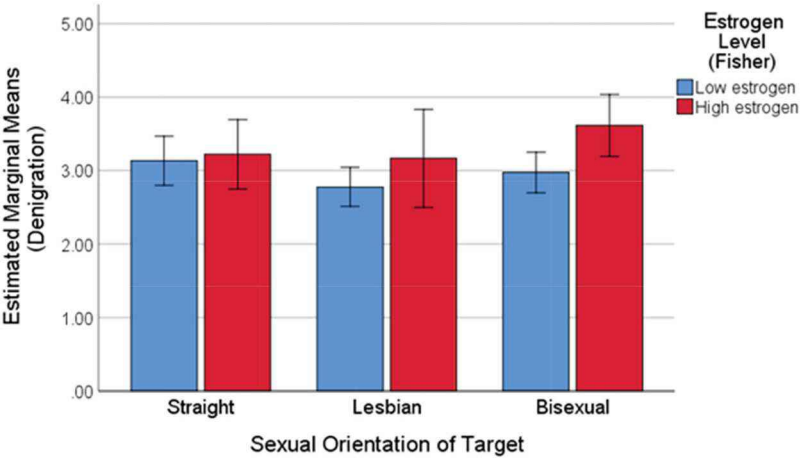
Means, Standard Deviations, and Group Sizes for Denigration Scores as a Function of a 3 (Sexuality of Target) x 2 (Estrogen Level) Design Using the Fisher Criterion

Estrogen level	Sexuality of target	*M*	*SD*	*n*
Low estrogen	Straight	3.13	0.75	24
	Lesbian	2.78	0.86	38
	Bisexual	3.00	0.90	35
High estrogen	Straight	3.22	0.53	12
	Lesbian	3.17	0.55	6
	Bisexual	3.61	0.92	15

Note. N = 130.

Figure 2

Denigration Scores of Participants Who Viewed a Straight, Lesbian, or Bisexual Target Are Shown for Low and High Estrogen Level Using the Fisher Criterion



Note. Error bars show 95% confidence interval. Only the main effect of estrogen was found to be statistically significant. See the online article for the color version of this figure.

in the low-estrogen phase (in line with Prediction 3b), but only when using the Fisher criterion to define high/low estrogen groups. There were no further notable findings.

Prior research has indicated that women seek to harm the reputation of same-sex competitors by transmitting reputation-damaging and withholding reputation-enhancing information (Hughes et al., 2020; Reynolds, 2016; Reynolds et al., 2018). The current work adds to this literature by demonstrating that the sexuality of the potential rival impacts the type of reputation-relevant information likely to be transmitted, further supporting the notion that this selective information transmission constitutes an intrasexual competition strategy. In our sample ($N = 289$), straight women viewing a lesbian target, a noncompetitor, were less likely to transmit reputation-damaging information than those viewing a straight or bisexual target.

In addition, it was expected that participants estimated to be in the high-estrogen phase of their cycle will denigrate sexual rivals more than participants in the low-estrogen phase of their cycle. As highlighted in prior literature, women in the ovulatory phase of their cycle show subtle behavioral shifts geared toward securing a mate, often attributed to the fluctuating levels of estrogen across the menstrual cycle (Anderson et al., 2010; Durante et al., 2014; Durante & Li, 2009; Fisher, 2004; Gangestad & Thornhill, 2008; Penton-Voak & Perrett, 2000; Vukovic et al., 2009). Therefore, as similar mating behaviors have been shown to become amplified as

Table 3

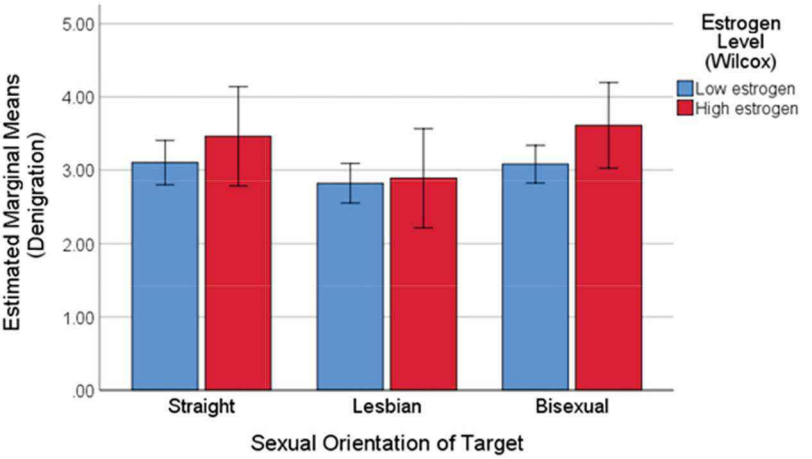
Means, Standard Deviations, and Group Sizes for Denigration Scores as a Function of a 3 (Sexuality of Target) x 2 (Estrogen Level) Design Using the Wilcox Criterion

Estrogen level	Sexuality of target	*M*	*SD*	*n*
Low estrogen	Straight	3.10	0.72	30
	Lesbian	2.82	0.87	38
	Bisexual	3.08	0.95	42
High estrogen	Straight	3.46	0.36	6
	Lesbian	2.89	0.62	6
	Bisexual	3.61	0.87	8

Note. $N = 130$.

Figure 3

Denigration Scores of Participants Who Viewed a Straight, Lesbian, or Bisexual Target Are Shown for Low and High Estrogen Level Using the Wilcox Criterion



Note. Error bars show 95% confidence interval. No effect was found to be statistically significant. See the online article for the color version of this figure.

estrogen levels rise, it was predicted that behaviors seeking to harm the reputation of competitors would similarly intensify. As no clear methodology to estimate the high-estrogen phase of a woman's cycle when using self-report methods has been established, two separate strategies utilized by researchers were used. Regardless of the criterion used, no interaction effect between sexuality of target and estrogen level was found (going against Prediction 3a). This could indicate that (a) the ovulatory competition hypothesis is false, (b) the ovulatory competition hypothesis is accurate but limited in scope, affecting certain behaviors while not applying to information transmission strategies, (c) the study was underpowered, and/or (d) other parts of the methodology were problematic, such as how the high/low estrogen phases were estimated. Given that from the sample of 289, data from just 130 participants qualified for this analysis and of those only 33 (with the Fisher criterion) and 20 (with the Wilcox criterion) were in the high-estrogen phase, it seems likely that the sample was too small to draw meaningful conclusions. Moreover, although backward counting is viewed as the most accurate self-report method of estimating the day of ovulation, there is a high likelihood of misclassifying women. Research has also indicated that for the majority of women the timing of their fertile window could fluctuate widely, even among those who experience regular cycles (Wilcox, 2000). Such methodological problems have been raised by recent studies in this area (as explored in the beginning of the article), which stress the need for more reliable estimates of the ovulatory window utilizing physiological parameters, LH measurement, and hormone collection (Allen et al., 2016; Gangestad et al., 2016; Gonzales & Ferrer, 2016; Stern et al., 2021).

An interesting finding was that when using the Fisher criterion, participants in the high-estrogen phase showed greater denigration toward the target than participants in the low-estrogen phase, regardless of sexuality of the target (in line with Prediction 3b). This is in line with Fisher's (2004) earlier findings that women in the high-estrogen phase denigrate the attractiveness of sexual competitors more than women in the low-estrogen phase. Furthermore, this finding can be seen to be in line with error management theory: During high-estrogen phases, women may not rely on knowledge about their peer's sexuality but rather denigrate indiscriminately to avoid missing out on a mating opportunity or on resources spent by the potential mate in pursuit of their peer (Haselton & Buss, 2000). However, when using the Wilcox criterion, no such effect was found. This further highlights the importance of clear, accurate, and consistent methodology when studying hormone levels, as slightly different criteria lead to different outcomes.

Future Directions

As research on women's intrasexual competition and the menstrual cycle has been relatively limited, many research avenues can be suggested. First, several recommendations have been proposed for future studies investigating effects tied to the menstrual cycle, to address methodological concerns. One such recommendation is to favor within-subject designs, while using strategies to minimize carry-over effects (Gangestad et al., 2016). Additionally, tracking physiological parameters (e.g., basal body temperature) can provide further accuracy in identifying the fertile period (Bull et al., 2019). Reproductive hormone analysis (estradiol, progesterone, and testosterone), while costly, would provide valuable data as shifts linked to the menstrual cycle are likely driven by these hormones (Gangestad et al., 2016). It should be noted that even hormonal assay is not infallible and there is a possibility for measurement error, as there are difficulties in assessing estradiol levels in saliva samples (Stern et al., 2021). Recommendations state that these measurements should be undertaken daily to provide a more reliable estimate of the fertile window (Stern et al., 2021). With these recommendations in mind, to strengthen the findings of this report and address conflicting results depending on which criterion was used to determine high/low estrogen phases, it would be advisable to test these predictions by collecting urinary and blood samples to directly measure levels of hormones in the body at the time of participation (Allen et al., 2016; Blake et al., 2016; Wideman et al., 2013).

Second, while this study utilized a between-subjects model, there is potential to implement a within-subject design to counter potential confounds from individual differences. In such a design, participants would be exposed to multiple targets of various sexualities. Furthermore, participants could be scheduled to complete the questionnaire in two sessions, one in the high-estrogen and another in the low-estrogen phase of their cycle; this is similar to the methodology in Johnston et al. (2003) and Macrae et al. (2002), but instead of using self-report data, estrogen levels would be determined through biological samples to improve accuracy.

Third, it should be noted that the vast majority of studies on intrasexual competition have focused on a predominantly young population, presumed to have a greater interest in finding genetically fit mates (Campbell, 2004). Studies on postmenopausal women could further illuminate this area and determine whether patterns of information transmission differ for older women who lack incentives to seek mates for reproductive purposes, expanding on the work of Vukovic and colleagues (Vukovic et al., 2009).

Fourth, like most studies in this area, participants were predominantly White, limiting the generalizability of the results to women of various ethnic groups. It would be valuable to examine the potential cultural impact on competition tactics by replicating this study in a more diverse population.

Lastly, this study was restricted to heterosexual participants, as substantial evidence has accumulated for this population indicating the prevalence of denigration as a competition strategy. It is important to further expand on this area by involving participants of various sexual orientations and including this as an additional factor. This would serve to identify whether women's sexuality affects competitive tactics, as was suggested in Hughes et al. (2020), as well as provide further insights into how women who are noncompetitors are viewed and interacted with.

Conclusion

Overall, this study showed that transmission of reputation-relevant information is influenced by the target's sexual orientation, defining them as a sexual competitor or noncompetitor. This reinforces the idea that strategic information transmission may be an intrasexual competition strategy, serving mating objectives. Mixed evidence was found regarding the influence of the ovulatory cycle on this process, highlighting the need for future research utilizing larger samples and more accurate methods for measuring women's estrogen levels. In any case, this work contributes to the discussion on the effects of the menstrual cycle on the selective transmission of social information, shedding light on an understudied area and improving our understanding of how a substantial part of the population socializes and competes.

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(*Appendices follow*)

Appendix A

Reputation-Relevant Statements and Supplementary Questions

Reputation-relevant statements and supplementary questions about the target used in questionnaire, from Reynolds et al. (2018). Modifications in italics.

Reputation-damaging statements:

- She sleeps around a lot.
- She cheated on her last boyfriend/girlfriend/partner.
- She has an STD.
- She is hung over.
- She hooked up with two men/women/a man and a woman the previous night.

Reputation-enhancing statements:

- She donates to charity.
- She speaks four different languages.
- She has traveled all over the world.
- Her IQ classifies her as a genius.

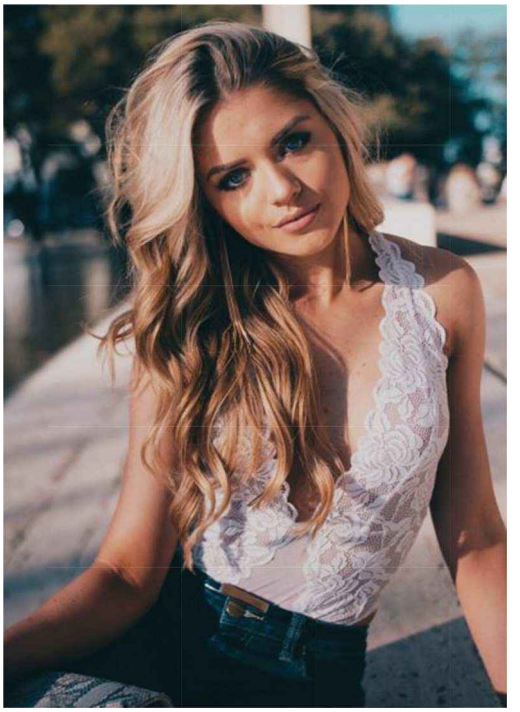
Supplementary questions about the target:

- How attractive do you think men find Francesca?
- How sexually appealing do you think men find Francesca?
- How promiscuous do you think Francesca is?
- How threatening do you think Francesca is?
- How nice do you think Francesca is?
- How comfortable would you be with Francesca spending time with your *romantic partner?*

(*Appendices continue*)

Appendix B

Photograph of Target



Note. Photograph by Jon Ly on Unsplash. Free to use for commercial and noncommercial purposes (https://unsplash.com/photos/ADBOC3UP4eQ). See the online article for the color version of this figure.

(*Appendices continue*)

Appendix C

Breakdown of Exclusion Criteria Application for Each Analysis

Exclusion criteria for part A (N = 289)	Participants excluded
Final consent	
Did not specify	143
Refused	3
Sexuality	
Bisexual	78
Lesbian	3
Did not specify	4
Prefer not to answer	6
Prefer to self-describe	16
Age	
Did not specify	20
Under 16 years old	6
Additional exclusion criteria for Part B (N = 130)	**Participants excluded**
Regularity of menstrual cycle	
Indicated an irregular cycle	49
Did not specify	17
Tracking habits	
Indicated they did not track their cycle at all	20
Did not specify	1
Pregnancy	
Pregnant	1
Unsure	3
Contraception in past 3 months	
Use of hormonal method	57
Use of both hormonal and nonhormonal method	5
Did not specify	2
Predicted start date of next period	
Did not specify	4

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