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Women's intrasexual competitiveness, but not fertility, predicts greater competitive behavior toward attractive women across the menstrual cycle

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ABSTRACT

Women compete for mates and social status, but little is known about the mechanisms that underlie these behaviors. Previous work suggests that mating competition should be most intense when women are fertile; thus, we hypothesized that women would exhibit more competitive behavior toward a high, rather than low, mating threat competitor during ovulation compared to other menstrual phases. Additionally, given that social support is crucial for women's access to resources and therefore offspring survival, we hypothesized that women would exhibit more competitive behavior toward a high, rather than low, social threat competitor following ovulation and possible conception. We tested 464 women recruited through social networking sites, psychology classes, and Prolific. Each rated their likelihood of exhibiting competitive behavior toward hypothetical mating and social competitors. Although women were more competitive toward the high, compared to low, mating and social threat competitors, there were no effects of cycle phase. Further, we found that intrasexual competitiveness, but not estimated hormones or other personality variables, predicted stronger competitive responses to the high mating threat competitor. We found no effects for social competitors. Together, these results suggest that in mating contexts, women's competition is dependent on individual tendency toward competition with other women, not fertility.

1. Introduction

Whereas men tend to compete with direct, physical aggression, women tend to use covert strategies, such as character derogation, social exclusion, and self-promotion (Archer, 2009). For women, direct competition poses a greater threat to reproductive success—injury or death could limit their ability to bear and raise offspring. Thus, covert aggression allows for competition without risk of physical harm (Cross & Campbell, 2012; Vaillancourt, 2013). Indeed, indirect aggression effectively facilitates competition for mates (Reynolds, Baumeister, & Maner, 2018; Vaillancourt & Sharma, 2011) and social alliances (Benenson, Markovits, Thompson, & Wrangham, 2011).

Hormone variation across the menstrual cycle provides a proximal mechanism through which physiology might influence women's competition. Estradiol (E_2), which reaches its peak during the late follicular phase and decreases following ovulation (Hampson, 2020), could positively influence competition for mates (e.g., enhancing one's appearance, mate guarding, romantic jealousy) when women are most fertile and immediate reproductive benefits of sex are high (reviewed in Arthur, Casto, & Blake, 2022; Cobey & Hahn, 2017). Progesterone (P), in contrast, remains low during the follicular phase and ovulation, and reaches its peak throughout the luteal phase (Hampson, 2020). During this time, when maintaining a pregnancy may be paramount, P could positively influence competition for social alliances with women who are willing to help with childcare, resource acquisition, and emotional support (Benenson et al., 2011; Hill, 2002; Rucas, 2017), crucial for the health and viability of offspring (see Arthur et al., 2022). Women may therefore prioritize competitive domains (i.e., mating or social) across the menstrual cycle, with hormonal shifts facilitating different strategic behavior depending on phase.

Studies that compare women's mating competition across menstrual cycle phases show that women report higher levels of romantic jealousy (Buunk & van Brummen-Girigori, 2016; Cobey et al., 2012) and mate guarding (Buunk & van Brummen-Girigori, 2016), spend more time evaluating women's, compared to men's, faces (Parma, Tirindelli, Bisazza, Massaccesi, & Castiello, 2012), rate other women's faces less attractive (Fisher, 2004), report being more likely to dress in more revealing clothing (Durante, Li, & Haselton, 2008), and dehumanize

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other women more (Piccoli, Foroni, & Carnaghi, 2013) when conception risk is high compared to low. Other studies, in contrast, have found no differences in clothing choices or characteristics of narcissistic rivalry (Arslan, Schilling, Gerlach, & Penke, 2021) or self-reported intrasexual competitiveness (Cobey, Klipping, & Buunk, 2013). While the reason for the disparate findings remains unclear, studies that compare mating competition across cycle phases without confirmation of ovulation have been criticized for their small sample sizes and lack of precision in determining cycle phase (Blake, Dixson, O'Dean, & Denson, 2016; Gangestad et al., 2016).

Findings from studies that verified cycle phase (e.g., confirmed ovulation with LH testing) and directly measured hormones, however, are also variable. Whereas some have found positive associations between E_2, sexual desire (Roney & Simmons, 2013), and romantic jealousy (Geary, DeSoto, Hoard, Sheldon, & Cooper, 2001), others have shown no effects (Hahn et al., 2020; Hahn, Fisher, Cobey, DeBruine, & Jones, 2016; Stern, Hildebrand, & Casto, 2023). Still others have found no effects of cycle phase or E_2 on women's self-reported clothing choices, make-up, or hairstyle (Stern, Ostermann, & Penke, 2024), or attractiveness ratings for other women's faces (Stern et al., 2023) or bodies (Stern, Kordsmeyer, & Penke, 2021). Cyclic shifts in women's intrasexual competition for mates may therefore be more subtle than previously thought; behavioral mechanisms that facilitate mating competition across the cycle require further study. One possibility is that women may selectively target their competitive behavior toward strong versus weak mating competitors to maximize reproductive benefits.

Less is known about competition for social alliances across the cycle, but several lines of evidence support a link with P. First, P lowers stress and facilitates affiliative behavior (reviewed in Wirth, 2011), suggesting women may be more motivated toward social alliances during the luteal phase. Second, although they did not directly assess P levels, studies using economic games have shown that women were less interested in competition (Buser, 2012) and more willing to cooperate with same-sex competitors (Eisenbruch & Roney, 2016; Lucas & Koff, 2013) during the luteal phase. This contrasts with other studies showing that more direct forms of social competition are positively associated with E_2 (c.f., Ball et al., 2014 and Schultheiss, Dargel, & Rohde, 2003; physical challenge, Casto, Arthur, Lynch-Wells, & Blake, 2023; implicit power motive, Stanton & Edelstein, 2009; Stanton & Schultheiss, 2009) or greater conception risk (e.g., motivation for direct competition and status; Arthur & Blake, 2022; Blake, 2022). Others have found no cycle effects (Arthur, Bastian, & Blake, 2024). Together, these results suggest that during the luteal phase, women may be less interested in direct, assertive competition, and might engage in covert, indirect competition strategies. Third, Reynolds et al. (2018) showed that P was positively associated with attachment anxiety across the cycle, suggesting women may be attuned to potential social competitors during these days. Relatedly, Maner and Miller (2014) showed that women were more accurate at detecting facial expressions when P levels were high (luteal phase) compared to low (follicular phase). They also showed that P levels positively predicted women's attention to social (i.e., faces) versus non-social (i.e., shapes) stimuli, suggesting that women may be primed to respond to social threat during the luteal phase. If so, they may also be more competitive toward high versus low social threat competitors, as ignoring the former could cost them beneficial alliances whereas ignoring the latter would not.

Here, we used composite faces to elicit women's competitive motivation in mating and social contexts to investigate effects of menstrual cycle phase and rival status on their competitive responses. We hypothesized that high fertility leading up to and during ovulation (i.e., high E_2 levels) would facilitate women's competition for mates, and low fertility following ovulation (i.e., high P levels) would facilitate women's competition for social alliances. Further, we predicted that women would be more competitive toward a strong versus weak mating competitor during high fertility, and more competitive toward a strong versus weak social competitor during low fertility.

2. Materials and methods

2.1. Participants and procedure

We conducted our study online and used the backward counting method to estimate each woman's cycle day (see Puts, 2006). To achieve a medium effect ($d = 0.50$) of cycle phase on competitive responses using the backward counting method ($r = .70$) with 80% power, we aimed for a final sample of at least 456 participants (Gangestad et al., 2016, Table 4).

Women completed our survey in response to ads on social media, introductory psychology classes, or Prolific (https://app.prolific.com). Following consent, demographic, health, and menstrual cycle questionnaires, giving contact information, and completing 6 personality questionnaires, participants responded to individual composite faces (see below) presented in random order, followed by the same faces, presented in pairs. After the survey, all participants were contacted near their estimated next cycle start date, by email, to confirm cycle onset. Inclusion criteria were premenopausal status, not pregnant, not using hormonal birth control, not using hormone medication, and no self-reported hormonal condition (e.g., congenital adrenal hyperplasia). Women using birth control were redirected and unable to proceed in the survey. Participants providing insufficient information and suspected bots were also not included (detailed in Supplementary Materials).

Five hundred seventy-one women completed the study. We subsequently excluded 63 for menstrual and/or hormonal deviations (e.g., menopausal, abnormal uterine bleeding, giving birth in past 6 months), illegal drug use, self-reported psychological disorders, not being of consenting age, and providing invalid cycle information (e.g., same dates for current and next cycle onset) (detailed in Supplementary Materials). An additional 3 were excluded for cycles lasting <17 days and 41 for cycles lasting >38 days. We retained data from 10 women who reported being on days 1–4 and currently menstruating despite cycles lasting <17 or > 38 days.

Our final sample included 464 women ($M = 25.34$ years, range $=$ 17–53 years, $SD = 6.60$). Most were from social media (67%) and reported being Caucasian (65%), exclusively heterosexual (82%), and living in Canada or the US (70%). Approximately half were in a romantic relationship (56%).

2.1.1. Menstrual cycle phase

We used the backward counting method (Blake et al., 2016; Gangestad et al., 2016; Puts, 2006) to estimate each participant's cycle day at testing, and then standardized that cycle day to a 28-day cycle. This method assumes ovulation 14 days prior to next menstrual cycle onset, and controls for actual cycle length in estimating cycle day. Actual cycle length was obtained for all participants by confirming their next cycle onset (i.e., first day of menstrual bleeding) by email. For women within 14 days of the end of their cycle at testing, we placed them on a 28-day cycle by subtracting the number of days left in their cycle from 28. For women more than 14 days from the end of their cycle, we placed them on a 28-day cycle by calculating how far into their follicular phase they were and multiplying that proportion by 14 (e.g., day 8 of a 26-day cycle is 67% in to an estimated 12-day follicular phase; this equals day 9 of a 28-day cycle with a 14-day follicular phase). All calculations were rounded to the nearest day.

We then classified participants by cycle phase depending on calculated cycle day and relative hormone levels (reviewed in Hampson, 2020; Schmalenberger et al., 2021): early follicular/late luteal (days 1–8 and 26–28; low E2/low P; $N = 195$), late follicular/ovulatory (days 9–15; high E2/low P; $N = 116$), and mid-luteal (days 16–25; low E2/high P; $N = 153$). There were no significant differences between groups in age ($F(2, 461) = 1.60, p = .204, \eta_p^2 < 0.01$), ethnicity ($\chi^2(16) = 13.98$, $p = .600$, $V = 0.17$), country of permanent residence ($\chi^2(4) = 1.18$, $p =$ .869, $V = 0.05$), relationship status ($\chi^2(2) = 2.49$, $p = .288$, $V = 0.07$), or sexual orientation ($\chi^2(6) = 8.13$, $p = .229$, $V = 0.09$).

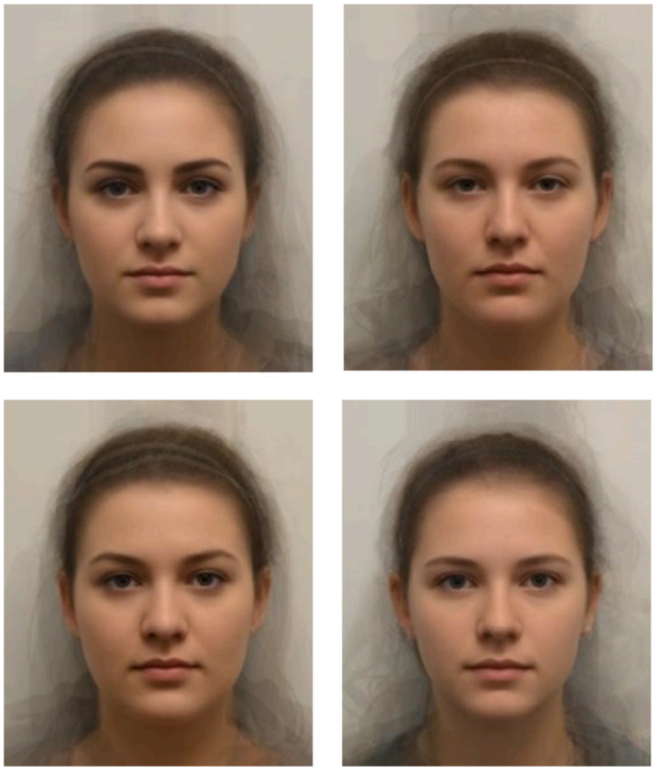

Fig. 1. Composite female faces used in the mating context (high attractiveness, top left; low attractiveness, top right) and social context (high social threat, bottom left; low social threat, bottom right).

2.2. Materials

2.2.1. Composite faces

We used Psychomorph (http://users.aber.ac.uk/bpt/jpsychomorph/) (Tiddeman, Burt, & Perrett, 2001) to construct 4 composite faces of same sex "competitors" (Fig. 1). Each composite comprised photos from an existing database of female faces rated for attractiveness and social threat (see Palmer-Hague & Geniole, 2022). For mating, we used 12 faces rated highest (*M* (*SD*) = 5.16 (0.20)) and lowest (*M* (*SD*) = 2.68 (0.35)) in attractiveness to make 2 composites (strong and weak mating competitors, respectively). For social competitors, we used 12 faces rated highest (*M* (*SD*) = 52.33 (7.92)) and 12 faces rated lowest (*M* (*SD*) = 26.75 (1.14)) on the Indirect Aggression Scale (Forrest, Eatough, & Shevlin, 2005). Naïve raters accurately perceived social threat in these faces (Palmer-Hague & Geniole, 2022), demonstrating their validity for this method.

2.2.2. Competitive behavior

Women rated mating competitors individually for attractiveness, likelihood of introducing the target to their boyfriend (reverse scored), comfort with the target spending time with their boyfriend (reverse scored), and likelihood of gossiping about the target on 7-point Likert scales. They rated social competitors for popularity, likelihood of introducing the target to their best friend (reverse scored), comfort with the target spending time with their best friend (reverse scored), and likelihood of gossiping about the target. See Supplementary Materials for item details.

Women were then shown each set of composite faces in pairs, side by side, in random order. They rated which of the two was more likely to receive attention from men (mating context pair) and more likely to get what they want from others (social context pair) on a 7-point Likert scale (1 = woman on left, 4 = neither, 7 = woman on right). Scores were reversed where necessary; ratings >4 indicated stronger competitor.

2.2.3. Personality

To examine the robustness of potential hormonal effects, we controlled for various personality variables, including dominance, competitiveness, friendliness, and self-esteem. For dominance, we used the Simple Adjective Test (SAT; Grant, 1998) (α = .98) and two dominance subscales of the International Personality Item Pool (IPIP) (CAT-PD:Dom (α = .92) and CPI-Nar (α = .87), respectively; Goldberg et al., 2006). For competitiveness, we used the General Competitiveness Measure (GC; Faer, Hendriks, Abed, & Figueredo, 2005) (α = .74) and Intrasexual Competition Scale (IC; Buunk & Fisher, 2009) (α = .90). For friendliness and self-esteem, we used the NEO-EI (α = .89) and self-esteem (α = .88) subscales of the IPIP, respectively (Goldberg et al., 2006). We also assessed self-reported attractiveness by having participants rate their own physical attractiveness compared to that of their peers on a 7-point Likert scale. Descriptives are shown in Table S15.

3. Results

3.1. Mating competition

3.1.1. Manipulation check

Women rated the strong competitor's face (*M (SD)* = 5.49 (1.05)) significantly more attractive than the weak competitor's face (*M (SD)* = 4.64 (1.12), $F(1, 460) = 299.82$, $p < .001$, $\eta_p^2 = 0.40$, $MD = 0.848$, *95 % CI* = [0.752, 0.944]) regardless of cycle phase (main effect: $F(2, 460) = 0.45$, $p = .636$, $\eta_p^2 < 0.01$; interaction: $F(2, 460) = 0.436$, $p = .647$, $\eta_p^2 < 0.01$). When shown together, they also rated the strong competitor's face significantly more likely to receive attention from men (*M (SD)* = 6.17 (1.22), $t(463) = 38.44$, $p < .001$, $d = 1.78$, *95% CI* = [1.64, 1.93], $MD = 2.17$, *95% CI* = [2.06, 2.28]).

3.1.2. Competitive responses

Likelihood of introducing the woman to a current or future boyfriend, comfort with the woman spending time alone with a current or future boyfriend, and likelihood of gossiping about the woman to friends (strong: α = .63, weak: α = .58) were all positively correlated for both the strong and weak competitors (Table 1), so we used the average responses for each face for all further analyses.[1]

Correlations between personality variables and competitive responses for both faces are shown in Table 2. IC, CAT-PD: Dom, and CPI-Nar were positively correlated with competitive responses for both faces (except CAT-PD: Dom and weak competitor's face). Age, NEO-EI, and self-esteem were negatively correlated with competitive responses to both faces. No other relationships were significant.

3.1.3. Effects of cycle phase

Women were more competitive toward the strong compared to the weak competitor, but there was no significant effect of cycle phase or the competitor X cycle phase interaction (Table 3)

3.1.4. E_2, P, age, and personality

Next, we explored effects of estimated E_2 and P on competitive responses to the strong versus weak competitors. In lieu of direct hormone measurements, we used previously published estimates for each cycle day (Garver-Apgar, Gangestad, & Thornhill, 2008). We included age, IC, CPI-Nar, CAT-PD: Dom, friendliness, and self-esteem in the model. There were no significant effects of E_2 ($p = .452$) or P ($p = .498$), but IC positively predicted ($p < .001$), and age negatively predicted ($p = .013$),

[1] Subsequent results using each item separately did not qualitatively differ from those of the composite. Full mixed ANOVA results for separate items are available in Tables S1-S6.

Table 1
Correlations between competitive response items for strong (above diagonal) and weak (below diagonal) mating competitor faces.

	Likelihood of introducing woman to boyfriend (reverse scored)	Comfort with woman spending time with boyfriend (reverse scored)	Likelihood of gossiping about woman
Likelihood of introducing woman to boyfriend (reverse scored)	*	.54 [.48, .60]	.24 [.15, .33]
Comfort with woman spending time with boyfriend (reverse scored)	.50 [.43, .57]	*	.28 [.20, .37]
Likelihood of gossiping about woman	.23 [.14, .31]	.20 [.12, .29]	*

All correlations are significant, $p < .001$. Brackets contain 95% confidence intervals.

Table 2
Correlations for personality characteristics and average competitive response to strong and weak mating competitor faces.

	Correlation with Average Response			
	Strong Competitor	p	Weak Competitor	p
Participant Age	**−.23 [−.31, −.14]**	**.000**	**−.17 [−.26, −.08]**	**.000**
General Competitiveness	.07 [−.02, .16]	.111	.07 [−.03, .16]	.159
Intrasexual Competitiveness (IC)	**.32 [.24, .40]**	**.000**	**.24 [.15, .32]**	**.000**
Self-perceived Attractiveness	.04 [−.05, .13]	.419	.02 [−.07, .11]	.664
Dominance (CPI-Nar)	**.10 [.00, .18]**	**.042**	**.10 [.01, .19]**	**.029**
Dominance (CAT-PD: Dom)	**.10 [.01, .19]**	**.034**	.08 [−.01, .17]	.078
Dominance (SAT)	−.08 [−.17, .02]	.101	−.05 [−.14, .04]	.257
Friendliness (NEO-EI)	**−.12 [-.21, −.03]**	**.009**	**−.17 [−.26, −.08]**	**.000**
Self-esteem	**−.16 [−.25, −.07]**	**.000**	**−.17 [−.26, −.08]**	**.000**

Brackets contain 95% confidence intervals. Correlations significant at $p < .05$ are in bold.

Table 3
Mixed ANOVA comparing competitive behavior toward strong and weak mating competitors.

Variable	Strong		Weak		*df*	*F*	*p*	η_p^2	*MD [95% CI]*
	M	*SD*	*M*	*SD*					
Between Subjects Factors									
Cycle Phase					2	0.604	.547	0.00	
Within Subjects Factors									
Competitor	**3.06**	**1.25**	**2.85**	**1.14**	**1**	**31.175**	**.000**	**0.06**	**0.22 [0.14, 0.29]**
Competitor X Cycle Phase					2	0.417	.660	0.00	
EF/LL	**3.09**	**1.31**	**2.91**	**1.20**	**1**	**10.37**	**.001**	**0.02**	**0.19 [0.07, 0.30]**
LF/OV	**2.99**	**1.13**	**2.73**	**0.98**	**1**	**12.52**	**.000**	**0.03**	**0.27 [0.12, 0.42]**
ML	**3.06**	**1.24**	**2.87**	**1.18**	**1**	**8.54**	**.004**	**0.02**	**0.19 [0.06, 0.32]**

EF/LL = early follicular or late luteal, LF/OV = late follicular or ovulatory, and ML = mid-luteal. Statistics in menstrual cycle phase rows represent pairwise comparisons of competitive behavior between strong and weak competitors within each phase. Significant values are in bold.

greater competition toward the strong competitor.[2] This pattern remained the same after adding relationship status to the model (dummy coded 0 = No, 1 = Yes). Full results for both models are shown in Table S7. IC did not differ across cycle phases ($F(2, 461) = 0.392$, $p = .676$, $\eta_p^2 < 0.01$).

3.2. Social competition

3.2.1. Manipulation check

Women rated the strong competitor (*M (SD)* = 4.34 (1.25)) less popular than the weak competitor (*M (SD)* = 4.58 (1.19), $F(1, 461) = 16.69$, $p < .001$, $\eta_p^2 = 0.04$, $MD = -0.26$, *95% CI* = [−0.38, −0.13]), regardless of cycle phase (main effect: $F(2, 461) = 1.00$, $p = .369$, $\eta^2 < 0.01$; interaction: $F(2, 461) = 0.49$, $p = .611$, $\eta_p^2 < 0.01$). However, when shown together, they rated the strong competitor more likely to get what she wants from others (*M (SD)* = 4.36 (2.13), $t(463) = 3.59$, $p < .001$, $d = 0.17$, *95% CI* = [0.08, 0.26]), suggesting the strong competitor's face reflected someone that was less well-liked but a greater social threat.

3.2.2. Competitive responses

Likelihood of introducing the woman to their best friend, comfort with their best friend spending time with the woman, and likelihood of gossiping about the woman (strong α = .61, weak α = .54) were positively correlated for both composites (Table 4). Again, we used the average responses for each face for all further analyses.[3]

Table 5 shows that for both faces, IC, CPI-Nar, and CAT-PD: Dom were positively correlated, while age, friendliness and self-esteem were negatively correlated, with competitive responses. SAT was also negatively correlated with competitive responses to the strong competitor's face.

3.2.3. Effects of cycle phase

Again, we found the strong competitor received greater competitive responses than the weak competitor, but neither the main effect of cycle phase nor the cycle phase X competitor interaction was significant (Table 6).

3.2.4. E_2, P, age, and personality

Again, we ran multiple regression to explore effects of estimated E_2

[2] A similar pattern of results is obtained when predicting the overall competitive behavior (mean competitive behavior across both mating targets), except friendliness becomes a significant negative predictor. Full results for these models are available in Table S16.

[3] Subsequent results using each item separately did not qualitatively differ from those of the composite. Full mixed ANOVA outputs for separate items are available in Table S8-S13.

Table 4
Correlations between individual competitive response items for strong (above diagonal) and weak (below diagonal) social competitor faces.

	Likelihood of introducing woman to best friend (reverse scored)	Comfort with woman spending time with best friend (reverse scored)	Likelihood of gossiping about woman
Likelihood of introducing woman to best friend (reverse scored)	*	.53 [.46, .60]	.23 [.15, .32]
Comfort with woman spending time with best friend (reverse scored)	.43 [.35, .50]	*	.27 [.18, .35]
Likelihood of gossiping about woman	.17 [.08, .26]	.26 [.17, .34]	*

All correlations are significant, $p < .001$. Brackets contain 95% confidence intervals.

Table 5
Correlations and confidence intervals for personality characteristics and average competitive response to high and low social threat faces.

	Correlation with Average Response			
	High Social Threat	*p*	Low Social Threat	*p*
Participant Age	**−.15 [−.23, −.05]**	**.002**	**−.10 [−.19, −.01]**	**.039**
General Competitiveness	.04 [−.06, .13]	.455	−.03 [−.12, .06]	.502
Intrasexual Competitiveness (IC)	**.18 [.09, .26]**	**.000**	**.15 [.057, .236]**	**.001**
Self-perceived Attractiveness	−.07 [−.16, .02]	.113	−.03 [−.12, .06]	.482
Dominance (CPI-Nar)	**.12 [.03, .21]**	**.008**	**.11 [.02, .20]**	**.022**
Dominance (CAT-PD: Dom)	**.15 [.05, .23]**	**.002**	**.13 [.04, .22]**	**.006**
Dominance (SAT)	**−.12 [−.21, −.03]**	**.010**	−.05 [−.14, .04]	.290
Friendliness (NEO-EI)	**−.17 [−.25, −.08]**	**.000**	**−.16 [−.25, −.07]**	**.000**
Self-esteem	**−.16 [−.24, −.07]**	**.001**	**−.09 [−.18, −.00]**	**.047**

Brackets contain 95% confidence intervals. Correlations significant at $p < .05$ are in bold.

Table 6
Mixed ANOVA comparing competitive behavior toward strong and weak social competitors.

Variable	Strong		Weak		*df*	*F*	*p*	η_p^2	*MD [95% CI]*
	M	*SD*	*M*	*SD*					
Between Subjects Factors									
Cycle Phase					2	0.25	.782	0.00	
Within Subjects Factors									
Competitor	**2.53**	**1.09**	**2.35**	**1.00**	**1**	**25.84**	**.000**	**0.05**	**0.19 [0.11, 0.26]**
Competitor X Cycle Phase					2	1.15	.316	0.01	
EF/LL	**2.49**	**1.09**	**2.37**	**1.04**	**1**	**4.39**	**.037**	**0.01**	**0.12 [0.01, 0.22]**
LF/OV	**2.53**	**0.99**	**2.28**	**0.89**	**1**	**11.98**	**.001**	**0.03**	**0.25 [0.12, 0.39]**
ML	**2.58**	**1.16**	**2.39**	**0.99**	**1**	**9.76**	**.002**	**0.02**	**0.19 [0.07, 0.31]**

EF/LL = early follicular or late luteal, LF/OV = late follicular or ovulatory, and ML = mid-luteal. Statistics in menstrual cycle phase rows represent pairwise comparisons of competitive behavior between strong and weak competitors within each phase. Significant values are in bold.

and P (as above) on difference in women's competition toward the strong and weak competitors. We included age, IC, CPI-Nar, CAT-PD: Dom, friendliness, and self-esteem in the model. We also included SAT as it was correlated with responses to the strong competitor. No predictors were significant (all $p > .05$). Adding relationship status to the model did not change these results. For full model results, see Table S14.[4]

4. Discussion

Together, our results show that neither competition for mates nor social alliances varied with women's menstrual cycle phase. While self-reported levels of intrasexual competitiveness predicted greater competition toward a highly attractive competitor compared to a less attractive competitor, we found no effect of fertility or E_2. Similarly, although intrasexual competitiveness correlated with competitive behavior toward potential social rivals, this was not targeted to either the high or low dominance rival, nor dependent on fertility or P. These findings suggest a functional difference between competitive contexts where women's motivation for competition dictates the selection and strength of competitive strategies; however, competition may not align with reproductive function as previously demonstrated.

Although others have reported increased competitive mating behavior during fertile days (i.e., high E_2) of the cycle (Durante et al., 2008; Fisher, 2004; Geary et al., 2001; Parma et al., 2012; Piccoli et al., 2013), our data align with a growing body of research from studies showing no effects in women (Arslan et al., 2021; Cobey et al., 2013; Hahn et al., 2016; Stern et al., 2021; Stern et al., 2023). Studies showing null effects tend to have larger samples, suggesting that cycle shifts in mating behavior may not occur. If not, this could be because it is more beneficial for women to compete for mates throughout the cycle, increasing the likelihood of obtaining a high quality, long-term mate rather than a short-term sexual partner when fertile (see Buss & Schmitt, 1993). Indeed, one of our response items assessed mate guarding, which could imply a long-term relationship one is trying to protect. Alternatively, it could be that cycle effects are subtle, transient, and situation-dependent, making them difficult to assess. Indeed, variability in women's cycles decreases the reliability of cycle phase estimation, and direct confirmation (e.g., LH testing) is expensive and not always possible to administer (Blake et al., 2016; Gangestad et al., 2016). More research is needed to elucidate the role of cycle shifts in women's mating competition.

Similarly, given the importance of social cooperation in facilitating

[4] When predicting the overall competitive behavior toward both social targets (the arithmetic mean), a very similar pattern of results is obtained as when predicting overall competitive behavior toward mating targets. Full results are available in Table S17.

women's reproductive success (Benenson et al., 2011; Hill, 2002; Rucas, 2017; Schmitt & Buss, 1996; Sokol-Chang, Burch, & Fisher, 2017), it may be more beneficial for women to exhibit consistent vigilance in preserving existing social relationships across the menstrual cycle than to preferentially compete for them after possible fertilization. Indeed, we found no evidence of an increase in indirect competitive behavior toward social rivals during the luteal phase (i.e., high P). Others have found similar results (Arthur et al., 2024), suggesting women either do not compete for social alliances, or do so with uniform intensity throughout the cycle. Another possibility is that women maintain social alliances via prosocial behavior (e.g., being "extra nice" to alliances) rather than competitive behavior toward rivals during the luteal phase. We did not assess prosocial responses, and therefore, these hypotheses warrant further study.

Interestingly, although not hypothesized, we also found no evidence for an ovulatory (i.e., high E_2) increase in social competition during the late follicular phase. This contrasts with other studies that did find effects (Arthur & Blake, 2022; Blake, 2022; Buser, 2012; Casto et al., 2023; Eisenbruch & Roney, 2016; Lucas & Koff, 2013; Schultheiss et al., 2003; Stanton & Edelstein, 2009; Stanton & Schultheiss, 2009). One possible reason for this is that we focused on indirect aggression as competitive response to social threat rather than direct (e.g., physical, overt) competition for status or power. Additional research is needed to clarify the behavioral and hormonal mechanisms underlying women's competition for social alliances.

4.1. Limitations

Despite attempts to maximize reliability, our study is limited by reliance on backward counting methods rather than biological verification (e.g., luteinizing hormone (LH) tests) in classifying participants according to menstrual cycle phase (e.g., Blake et al., 2016; Gangestad et al., 2016). We were also unable to directly measure E_2 and P, and our use of a between-subjects design limited our ability to accurately investigate changes in individuals' behavior across time. Further, our study was only powered to detect a medium-sized effect, which precluded our ability to detect any smaller effects of cycle phase that may have been present. Our results should thus be interpreted conservatively as replication is warranted.

Although we used faces to increase the ecological validity of our manipulation, it is possible that participants did not respond in the same ways they would to actual competitors. Indeed, women may also not be aware that their competitive behavior (e.g., gossip framed as concern or disclosure of one's victimization by a target) is actually competitive (see Reynolds & Palmer-Hague, 2022), potentially minimizing their reported likelihood of behaving competitively. Similarly, our response items were brief and may not have captured the full extent of women's competitive behavior. Finally, our online convenience sample potentially biases relevant characteristics such as socioeconomic status or sociocultural norms for intrasexual relationships and behavior. These factors should be considered in future work investigating women's competition.

CRediT authorship contribution statement

Jaime L. Palmer-Hague: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jade S. Stobbart:** Writing – review & editing, Project administration, Investigation. **Benjamin J. Zubaly:** Writing – review & editing, Formal analysis.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2025.106760.

Data availability

The data associated with this research are available in Supplemental Materials.

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