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5 Heightens During the Fertile Window: Evidence for the Cycle Shift Hypothesis

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Abstract

Previous research suggests that women may alter their behaviour during the fertile window of the menstrual cycle to attract a mate who has traits that indicate high quality genes. We tested whether fertile women demonstrate greater behavioural engagement with a masculine compared to a less masculine male. The test was performed using a quiz show paradigm, in which a male host asked female participants general knowledge questions. The masculinity of the host was varied between participants. Women's performance on the quiz as well as their romantic attraction to the host was examined in relation to women's estimated cycle phase and host masculinity. Fertile compared to non-fertile women were more romantically attracted to the host and were faster to answer his questions, but only when he was portrayed as masculine. The results of the study are interpreted as being in keeping with Gangestad and Thornhill's (1998) cycle shift hypothesis.

Women's Behavioural Engagement with a Masculine Male

Heightens During the Fertile Window: Evidence for the Cycle Shift Hypothesis

Estrus, or a period of heightened sexual receptivity in females, was once thought to be lost in women (see Thornhill & Gangestad, 2008 for a historical review). Physical markers of estrus are visually apparent in other animals--swelling and engorgement of the external genitalia are seen in lemurs and chimpanzees and a blistering chest patch is displayed by geldas gibbons, as examples. Accumulating evidence, however, indicates that women's behaviour also varies across the menstrual cycle. Fertile women are more likely than their counterparts to shop for items to enhance their physical attractiveness (Hill & Durante, 2009), prefer sexually provocative clothing (Durante, Li, & Haselton, 2008), and are more likely to accept a romantic overture from a man who they have just met (Gueguen, 2009a, 2009b). Findings such as these results raise the following question: What purpose do these fertility-associated behavioural changes serve?

According to the cycle shift hypothesis, women have evolved psychological tendencies to prefer, particularly during the fertile phase of the menstrual cycle, men who have traits that indicate high quality genes (Gangestad & Thornhill, 1998; Thornhill & Gangestad, 1999; also see Thornhill & Gangestad, 2008 for a review). When fertile, women should be especially attracted to men who have traits that indicate ostensibly genetic benefits for offspring. Thornhill and Gangestad (2008) maintain that extant research findings support the cycle shift hypothesis. Fertile compared to non-fertile women are more likely to prefer the scent of symmetrical men (Gangestad & Thornhill, 1998) as well as the scent of socially dominant men (Havlicek, Roberts, & Flegr, 2005). Fertile women compared to their counterparts also show stronger preferences for masculine faces (Penton-Voak & Perret, 2000), taller men

(Pawłowski & Jasierńska, 2005), and men who behave dominantly (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004; Lukaszewski & Roney, 2009). These traits may indicate genetic quality. For instance, facial symmetrical is associated with better genetic, physical, and mental health (Furlow et al., 1997; Thornhill and Møller, 1997; Yeo et al., 2000). Therefore, Thornhill and Gangestad (2008) argue, shifts in women's mate preferences across the menstrual cycle are adaptations that function to increase women's attraction to men who have traits that indicate good genetic quality.

One limitation of previous studies is that women's mate preferences have been measured using women's self-report ratings rather than their actual behaviour toward the opposite sex. The two studies that we know of that looked at women's actual behaviour in relation to menstrual cycle phase found that fertile women compared to their counterparts are more likely to comply with a romantic overture from a man (Gueguen, 2009a, 2009b). However, since the features of the male were not varied systematically in this study, it is currently not known whether fertile women behaviourally engage differently with a man depending on whether he has traits that are indicative of high quality genes.

The current study examined whether women's behavioural engagement with a male varied in relation to their fertility and the male's level of masculinity. A quiz show paradigm was employed, in which a male host asked the participant general knowledge questions. The quiz show paradigm was utilized because it enabled us to measure behavioural engagement in an unobtrusive and circumspect manner. The masculinity of the host was varied between participants. Behavioural engagement with the host was measured by determining the speed with which women responded to the host's questions and the number of answers that they got correct. If response speed indexes level of behavioural engagement with the

host, then ovulating women should answer the quiz show questions faster and more accurately than their counterparts if the host is portrayed in more masculine terms.

We also tested whether women demonstrated higher levels of behavioural engagement when they were romantically attracted to the host, regardless of cycle phase. Towards this end, women rated their romantic attraction to the host following the quiz show. When women are ovulating they should be more romantically attracted to the host if he is portrayed as masculine rather than less masculine.

1. Method

1.1 Participants

Prior to their enrolment in the study, women were pre-screened using an online questionnaire, which contained items for measuring menstrual cycle phase (please see below). Participants were told that the purpose of the pre-screening questionnaire was to obtain information about their “general health and well-being” to generate questions for a quiz show that would be hosted by the University. The real purpose of the pre-screening, however, was to ensure that there would be an adequate number of fertile women across the experimental conditions. To support the cover story that participants were told, the questionnaire had 10 filler items (e.g., How many hours a night on average do you sleep?, Do you ever have headaches?, How often do you feel stressed?). When feasible, given the experimenters’ and participant’s schedules, women were scheduled to complete the study during the fertile phase of their cycle. Women who reported irregular menstrual cycles or who were using hormone-based contraceptives were not enrolled.

The recruitment procedure resulted in a total of 106 female students (age $M = 20.32$ years) from the University of Leicester. They participated for course credit. Of these women, 42.5% were in the fertile phase of their menstrual cycle.

1.2 Stimuli and Procedure

The participant was told that the University was auditioning a male actor to host a quiz show to promote student health and safety awareness. Her role was to help the University select the show's host. The participant was randomly assigned to read one of two curriculum vitas (CV) that had been purportedly submitted by the male actor as part of his audition. The 'Hobbies and Personal Interests' section was used to describe the host in more or less masculine terms, and this section varied between the two versions of the CV. In the masculine version, the male actor played rugby, lifted weights, and danced for a male dance troupe. In the less masculine version, the male actor played the flute, designed clothes, and danced for a male ballet company. The two CVs were otherwise identical, listing the male actor's education and acting experience. There were 25 fertile and 32 non-fertile women randomly assigned to the masculine host condition, and 20 fertile and 29 non-fertile women randomly assigned to the less masculine host condition.

The participant was then shown a video of the actor auditioning for the role of host. The host's behaviour was standardized via video presentation because previous research suggests that men's behaviour toward women may be influenced by women's fertility status (Haselton & Gangestad, 2006; Miller, Tybur, & Jordan, 2007). Participants were told that they would be playing the quiz show and rating his performance. The actor read 20 general

knowledge questions. (Examples of questions included: True or False: Keratin is present in your mouth and helps you break to down food.; What is your body's largest organ?; What organ produces insulin?) After each question was read, the participant rang a bell when she knew the answer and then answered the question out loud. Her response latency was automatically recorded. If she got the answer correct, a point was assigned under her name, which was written on a white board that was displayed in front of her.

Women completed a post quiz questionnaire. As a check on the masculinity manipulation, one question asked participants to rate the host's masculinity (Do you think the host is masculine?). The questionnaire also contained items asking the participant to rate her romantic attraction to the host (Do you think you and the presenter would make a good couple?, Would you say that you and the male presenter would generally be compatible?, Could you see yourself in a romantic relationship with the male presenter?). Additionally, women rated the likeability of the host as well as how attractive they found his physical appearance. All ratings were all made on a 5-point scale (anchored at 1, 'strongly disagree', and 5, 'strongly agree').

1.3 Measures and Data Analysis

Fertility was estimated based on women's self reported menstrual cycle data. Previous research indicates that self-reports of menstrual cycle phase can be unreliable (Small, Manatunga, & Marcus, 2007). Therefore, to assess the validity of the fertility estimates, three measures of fertility were computed in order to cross validate the results. If the results are robust, then the relationship between fertility and the outcome measures should

be consistent across the three fertility measurement methods. First, following the procedures developed by other researchers for estimating ovulation (e.g., Gangestad & Thornhill, 1998; Miller, Tyber, & Jordan, 2007), *cycle phase* was measured by counting forward from the woman's first day of her menstrual period to the day on which the woman participated in the study. Women who were on days 9-15 of their cycle were deemed to be in the fertile phase, whilst the others were deemed to be in a non-fertile phase. Second, since previous research indicates that cycle days 16-19 may not be low risk conception days (Wilcox et al., 2001), women who were on cycle days 16-19 were dropped from the non-fertile category. That is, for the second fertility estimate, women who were on days 9-15 of the cycle were deemed to be in the fertile window, whereas women on days 1-8 and days 20-28 were deemed non-fertile, and women who were on days 16-19 of the menstrual cycle were excluded from the measure ($N = 12$: $n = 7$ masculine condition and $n = 5$ less masculine condition). Third, the validity of the self-report menstrual cycle data would be strengthened if behavioural engagement with the host was found to increase along with conception risk. Therefore, conception risk ($M = .04$, $SD = .03$) was estimated based on cycle day using actuarial data from Wilcox and colleagues (2001).

Behavioural engagement was measured by averaging each woman's *response speed* across the 20 quiz questions as well as by her *response accuracy*, or the total number of correct answers given. *Romantic attraction* was measured by averaging across the items that assessed the participant's attraction to the host ($\alpha = .75$).

All of the outcome measures were found to be normally distributed. Hence, the hypotheses were tested using the general linear model. Each of the dependent variables was submitted to a 2 (fertility phase) x 2 (host masculinity) analysis of variance. Significant

interaction effects were examined further with simple effects analysis. Effects sizes were estimated using ω^2 and Cohen's d . Alpha was set to .05 in all analyses.

2. Results

Preliminary Analyses

The masculinity manipulation worked as intended. The actor was rated as significantly more masculine in the masculine host condition compared to the less masculine host condition ($M = 3.20$ and $M = 2.63$, respectively), $t(104) = 3.16$, $p < .01$, two-tailed ($d = .63$).

The masculinity manipulation, however, did not significantly affect his physical appearance ratings (masculine $M = 3.14$ and less masculine $M = 3.20$) or women's ratings regarding his likeability (the mean values were identical in the masculine and less masculine conditions: $Ms = 3.18$).

2.1 Romantic Attraction to the Host

Cycle phase and masculinity had an interactive effect on romantic attraction scores, $F(1, 102) = 14.48$, $p < .01$, $\omega^2 = .11$. A simple effects analysis indicated that when the host was masculine, women tended to report that they were more attracted to him if they were fertile rather than non-fertile ($M = 3.12$ and $M = 2.43$, respectively), $F(1, 102) = 11.55$, $p < .01$ ($d = .96$). If the host was described in less masculine terms, non-fertile women reported greater attraction to the host on average compared to fertile women ($M = 2.95$ and $M = 2.50$, respectively), $F(1, 102) = 5.25$, $p < .01$ ($d = .56$). These results provide a conceptual replication of previous work finding that fertile women prefer men who have more

masculine traits (e.g., Lukaszewski & Roney, 2009; Pawłowski & Jasieńska, 2005; Penton-
Voak & Perret, 2000).

2.2 Behavioural Engagement with the Host

The results for mean response speed as a function of cycle phase and host masculinity are presented in Figure 1. Cycle phase and host masculinity had an interactive effect on response speed, $F(1, 102) = 11.80, p < .01, \omega^2 = .09$. A simple effects analysis indicated that when the host was masculine, women in the fertile phase responded faster compared to non-fertile women ($M = 5.87$ s and $M = 6.66$ s, respectively), $F(1, 102) = 14.17, p < .01 (d = .88)$. In the less masculine condition, response speed did not significantly vary with cycle phase (fertile $M = 6.31$ and non-fertile $M = 6.00$). Therefore, fertile women compared to their counterparts appeared to be more engaged with the host, but only when he was portrayed as masculine.

Since cycle phase was estimated from self-report data, we checked whether the interactive effect of cycle phase and host masculinity on response speed was robust across the other measures of masculinity. First, the interaction between cycle phase and host masculinity should remain significant if women who are on cycle days 16 to 19 are removed from the analysis. Indeed, the interaction between cycle phase and host masculinity remained statistically significant when these women were removed, $(F(1, 90) = 9.32, p < .01, \omega^2 = .08)$ and a simple effects analysis again indicated that when the host was masculine, the average response speed was faster for fertile compared to non-fertile women ($F(1, 90) = 9.87, p < .01, d = .82$); when the host was less masculine, response speed did not vary

depending on cycle phase ($F < 1$). Second, if fertility is influencing behavioural engagement, then women should demonstrate greater behavioural engagement as their risk of conception increases. In keeping with this, response speed significantly decreased as conception risk increased in the masculine host condition, $r = -.35, p < .01$, two-tailed. In the less masculine condition, response speed was not significantly associated with conception risk, $r = .18, p = .22$, two-tailed. Taken together, these findings provide strong support for the assertion that women's behavioural engagement was co-varying with their fertility and host masculinity.

Response accuracy was separately analysed with a 2 (phase) x 2 (masculinity of host) between subjects ANOVA. Results indicated that the number of correct answers ($M = 16.52, SD = 2.16$) did not vary significantly across conditions.

2.3 Mediated Moderation Analysis

To determine whether the interactive effects of fertility and host masculinity on behavioural engagement were mediated by romantic attraction, we tested for mediated moderation by following the procedures recommended by Muller, Judd, and Yzerbyt (2005). The results indicated that romantic attraction did not mediate the interactive effect of fertility and host masculinity on behavioural engagement, and thereby suggest that fertility status combined with host masculinity were directly affecting behavioural engagement level. The analysis is presented in the Appendix.

3. Discussion

Previous research has found that women's preferences for masculine features co-vary with menstrual cycle phase. However, this past research has relied on women's self-reported preferences rather than their actual behaviour toward the opposite sex. Consistent with previous research, the present study found that fertile compared to non-fertile women viewed themselves as more romantically attracted to the host, but only if he was portrayed as masculine.

The obtained results are in keeping with Gangestad and Thornhill's (1998) cycle shift hypothesis. Women were not simply more engaged with the host when they were more romantically attracted to him. Rather, masculine traits on the part of the male elicited behavioural engagement, and this result occurred only in fertile women. The pattern of results suggests that fertility-associated behavioural shifts arise as adaptations for finding a mate who possesses good genes during the fertile window. There are other possible explanations for the results, however. Women's mate preferences have been shown to fluctuate with estrogen level, both within cycle and between cycles (Lukaszewski & Roney, 2009; Roney, 2009; Roney & Simmons, 2008). It has been argued that within and between cycle shifts in estrogen function to indicate when effort should be preferentially allocated to mate selection over solving other survival problems, such as foraging for food, avoiding predators, finding shelter, and the like (Roney, 2009). As such, women in early ancestral environments evolved to experience downregulated sexual attraction via reduced estrogen levels during periods when it was more crucial to solve other adaptive problems. One could argue based on this perspective that the results we obtained might be moderated by variables that previous research has linked to reduced estrogen levels, such as reductions in

1 caloric intake and engaging in moderate to high exercise (Lager & Ellison, 1990). Another
2 possible explanation for our results is that behavioural engagement is a by-product of fertile
3 women having an increased sex drive around ovulation. Therefore, perhaps the fertile
4 women in our study were more sexually aroused, and hence, they were more motivated to
5 behaviourally engage with the male. However, as others have pointed out, there is ample
6 evidence to indicate that women are not just interested in engaging with any male. Rather,
7 women seem to target specific types of partners during the fertile window, namely, men
8 who demonstrate traits that are associated with good genes (see Gangestad, Thornhill, &
9 Garver-Apgar, 2010). Additionally, research regarding variation in sex drive across the
10 menstrual cycle has produced mixed findings (see Thornhill & Gangestad, 2008 for a review
11 of this literature).

12 Previous research has found that women rate traits that are indicative of good genes as
13 more valuable when they are fertile, whereas their preferences for traits that would
14 characterise a mate as a good long-term partner (e.g., successful financially, intelligent, or
15 kind and warm) do not fluctuate across the course of the menstrual cycle (Gangestad et al.,
16 2007). If romantic attraction as measured in the current study reflected women's interest in
17 the host in the short-term, then it is not surprising that increased levels of romantic
18 attraction were associated with greater behavioural engagement in fertile but not non-
19 fertile women when the host was masculine. On the other hand, we did not directly
20 measure women's interest in the host as a short versus long term partner; therefore,
21 additional research on the issue is warranted.

22 The research reported here suggests that women's behaviour toward a male in a
23 relatively mundane context (i.e., one that is devoid of overt romantic attraction cues) can be

influenced by menstrual cycle phase. The topic of romantic attraction was not raised (via questionnaire) until after the quiz show; hence, women were not primed by the researchers to evaluate the suitability of the host as a romantic prospect whilst playing the quiz. Nevertheless, women differentially engaged with the host depending on cycle phase and the masculinity of the host. In our view, these results suggest that masculinity cues elicit in fertile women a psychological readiness to engage with a prospective mate. The functional significance of the behavioural engagement that we observed is yet to be determined. On the one hand, behavioural engagement may be used to indicate to a prospective partner that one is potentially interested in mating. Alternatively, increased engagement may encourage the prospective partner to notice her or to pay increased attention to her. Further research is needed to examine these and other possibilities.

As with any study, there are a number of potential limitations. First, menstrual cycle phase was estimated using self-report data, which raises the possibility that the phase estimates were not reliable. The reliability of the reports, however, is strengthened by the fact that we replicated previous research that has found that women's overt (i.e., self-reported) preference for masculine features is heightened during the fertile window. Additionally, women with irregular menstrual cycles were not included in the sample, which should have reduced the error of the estimates. Moreover, the pattern of results was consistent across the three fertility estimates that we computed. The association between conception risk and behavioural engagement that we found would not be expected unless women's menstrual cycle self-reports were reliable. Taken together, the results strongly suggest that the variation seen in behavioural engagement was fluctuating in relation to women's fertility. Second, another limitation concerns that manner in which masculinity

1 was varied. Masculinity was operationalized by controlling women's expectations, and
2 hence their perceptions, of the host by providing participants with stereotypic information
3 about his interests and hobbies. The behavioural engagement effects that were obtained in
4 relation to the predictors may have been larger had the physical appearance of the host
5 been altered as a means of varying masculinity. Third, accuracy on the quiz, which was
6 another measure of behavioural engagement, did not vary in relation to any of the
7 predictors. Perhaps the sensitivity of the measure was weak, as women were fairly accurate,
8 typically answering about 16 of the 20 questions correctly. Finally, additional research is
9 needed to determine whether women consciously regulate their behaviour. The masculine
10 host could have elicited the observed differences in behavioural engagement without
11 women having been aware that their behaviour was being affected by the masculinity of the
12 host.

13 In sum, the results of the present study suggest that women's behavioural engagement
14 with a male varies in relation to the fertile window and the masculinity level of the male. We
15 found that women were more likely to behaviourally engage with a male if they were fertile
16 and he was masculine, thereby lending support to the notion that there are fertility-
17 associated behavioural changes in women that may function to enable women to find a
18 mate with strong genetic potential.

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Appendix

Mediated moderation analysis was undertaken to test whether masculinity moderated the association between fertility and behavioural engagement through romantic attraction. Muller, Judd, and Yzerbyt (2005) specify that four criteria must be met in order to establish that a significant interaction effect is mediated by another variable. The first regression model must establish a significant interaction between the predictor and a moderator (in this case, the interactive effect of fertility and host masculinity) on the outcome variable (in this case, behavioural engagement). The second model must establish that the predictor and the moderator have an interactive effect on the mediating variable (in this case, romantic attraction). The third model must establish that the mediator has a significant effect on the outcome variable (after controlling for the interactive effect of the predictor and the moderator, and the interactive effect of the mediator and the moderator) and the relationship between the predictor and the moderator must no longer have a significant effect on the outcome variable. All four criteria must be met in order to assert that romantic attraction completely mediates the interactive effect of fertility and host masculinity on behavioural engagement. A claim of partial mediation is warranted if the magnitude of the interaction between the predictor and the moderator is significantly weakened once the mediator is taken into account (i.e., the size of the interaction effect must be reduced in the third compared to the first model).

The above three models were executed using seemingly unrelated regression (SUR), which is appropriate when a series of regression analysis are carried out, and the dependent variable in one model is an independent variable in another model (Johnston, 1984). SUR

allows correlation between the regression residuals of each of the constituent models, providing improved estimates if the residuals are correlated across equations or are heteroscedastic. Dummy coding was used to analyse fertility (0 for infertile, 1 for fertile) and host masculinity (0 for less masculine, 1 for more masculine). Additionally, romantic attraction and behavioural engagement were standardized for the regression analyses, following the recommendations of Aiken and West (1991). The results of the analyses are presented in the table below.

In the first model, behavioural engagement was regressed on fertility, host masculinity, and their interaction term, and the model was found to be significant, $\chi^2(3) = 17.21, p < .001$. Consistent with the ANOVA results described previously for behavioural engagement, only the interaction term was significant (see table). In the second model, romantic attraction was regressed on fertility, host masculinity, and their interaction, and the overall model was significant, $\chi^2(3) = 16.36, p < .01$. Only the interaction between fertility and host masculinity significantly predicted romantic attraction (see table), which is a result that is consistent with the previously reported ANOVA for romantic attraction. Finally, in the third model behavioural engagement was regressed on fertility, host masculinity, the interaction of the two, romantic attraction, and the romantic attraction x host masculinity interaction, and the overall model was found to be significant, $\chi^2(5) = 1602.53, p < .0001$. Romantic attraction and the interaction between fertility and host masculinity were found to significantly predict behavioural engagement (see table). The coefficient obtained for romantic attraction ($b = -.14$) indicates that as romantic attraction increased, response speed decreased, suggesting that women were more behaviourally engaged with the host if they were romantically attracted to him. Next we examined whether romantic attraction

partially mediated the association of fertility and masculinity with response speed. Toward this end, the size of the fertility x masculinity interaction effect obtained in model 3 was compared to the size of the interaction effect obtained in model 1. A Wald test using standard errors obtained from 1000 bootstrap resamples indicated that the size of the coefficients for the fertility x masculinity interaction did not significantly differ across models, $\chi^2(1) = 2.41, p = .14$. Hence, the results indicate that romantic attraction did not mediate the interactive effect of fertility and host masculinity on behavioural engagement, and thereby suggest that fertility status combined with host masculinity were directly affecting behavioural engagement level.

Seemingly Unrelated Regression Results for the Mediated Moderation Analysis

Predictor	Model 1 DV is Response Speed		Model 2 DV is Romantic Attraction		Model 3 DV is Response Speed	
	<i>b</i> (<i>SE</i>)	<i>z</i>	<i>b</i> (<i>SE</i>)	<i>z</i>	<i>b</i> (<i>SE</i>)	<i>z</i>
X: Fertility	-.16 (.09)	-1.84	.10 (.09)	1.10	-.15 (.09)	-1.71
MO: Masculinity	.11 (.09)	1.24	-.02 (.09)	-.025	.11 (.09)	1.22
XMO: Fertility x Masculinity	-.32 (.09)	-3.5***	.35 (.09)	3.88***	.27 (.09)	-2.99*
ME: Attraction					-.14 (.01)	-39.57**
MEMO: Attraction x Masculinity					.00 (.00)	.01

Note: X = independent variable; MO = moderator; XMO = interaction between independent variable and moderator;

ME = mediator; MEMO = interaction between mediator and moderator.

p* < .001. *p* < .0001

1 Author Note

2 We are indebted to Martie Haselton and the anonymous reviewers for their invaluable
3 comments on earlier versions of this article.

4

1 Figure Caption

- 2 Figure 1: Mean response speed ($\pm 1\ SEM$) plotted as a function of cycle phase and host
3 masculinity .

