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**Male Sexual Attractiveness Predicts Differential Ovulatory Shifts
in Female Extra-Pair Attraction and Male Mate Retention Efforts**

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In press: *Evolution and Human Behavior*

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October 11, 2005

30

Abstract

31 Because ancestral women faced trade-offs in choosing mates, they may have evolved to pursue a
32 dual-mating strategy in which they secured investment through one partner and obtained good
33 genes through others. The dual-mating theory predicts that women will display greater interest in
34 extra-pair sex near ovulation, especially if they are mated to a primary male partner who is low
35 in sexual attractiveness. Forty-three normally-ovulating women rated their partner's sexual
36 attractiveness and separately reported their own desires and their partner's mate retention
37 behaviors at high and low fertility (confirmed using luteinizing hormone tests). In the high
38 fertility session relative to the low, women who assessed their partners as being lower in sexual
39 attractiveness reported greater extra-pair desires and more expressed love and attention from
40 their male partners. Women's desire for their own partners did not differ significantly between
41 high and low fertility sessions.

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43 Key Words: Ovulatory Cycle, Mate Guarding, Sexual Conflict, Conception, Sexual Desire,
44 Female Sexuality

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46 **in Female Extra-Pair Attraction and Male Mate Retention Efforts**

47 **1. Introduction**

48 Females can benefit by selecting mates who offer material benefits to offspring, such as
49 parental care and food resources (Trivers, 1972), and by selecting mates who offer benefits that
50 can be genetically transmitted to offspring (Jennions & Petrie, 2000; Kokko, Brooks, Jennions,
51 & Morley, 2003; Møller & Alatalo, 1999). In principle, women could benefit from both material
52 and heritable benefits conferred by male partners, but both sets of features may be difficult to
53 find in the same mate. Men who display indicators of good genes are highly attractive as sex
54 partners; hence they can, and often do, pursue a short-term mating strategy that tends to be
55 associated with reduced investment (Gangestad & Simpson, 2000; Gangestad & Thornhill,
56 1997). Therefore, women may often be forced to make strategic tradeoffs by selecting long-term
57 social partners who are higher in investment attractiveness than sexual attractiveness (Gangestad
58 & Simpson, 2000).

59 These trade-offs may have selected for a psychology of dual-mating, which leads women
60 to seek primary partners who provide investment while seeking good genes through extra-pair
61 mating. Indeed, rates of human extra-pair paternity are substantial, with current estimates
62 ranging from lows around 1% to highs of more than 55% in some populations (Anderson, 2005).
63 In sum, there are conditions under which a dual-mating strategy may have evolved, and there is
64 evidence that human extra-pair mating occurs.

65 **1.1 Predictions**

66 *Shifts in Extra-Pair Desire.* A key prediction of the dual mating hypothesis is that
67 attraction to extra-pair mates should increase as women near ovulation. Results from previous

68 studies have been somewhat mixed, with most documenting greater attraction to extra-pair mates
69 when women are in the ovulatory phase of their cycles (Gangestad, Thornhill, & Garver, 2002;
70 Haselton & Gangestad, 2005) and one suggesting that women are more attracted to their primary
71 partner at peak fertility within the cycle (Pillsworth, Haselton, & Buss, 2004). In light of these
72 conflicting findings, Pillsworth et al. (2004) suggested that future research should explicitly
73 examine male sexual attractiveness to test the hypothesis that a woman's pursuit of an extra-pair
74 versus an in-pair conceptive strategy is conditional on how sexually attractive her partner is
75 relative to other men. Consistent with this proposal, in a daily diary study, Haselton and
76 Gangestad (2005) found that increases in extra-pair desires at high fertility were greatest for
77 women who rated their partners as low in sexual vs. investment attractiveness. Similarly,
78 Gangestad et al. (2005) found that women with partners high in fluctuating asymmetry reported
79 greater attraction to extra-pair men, and less attraction to their own partners, when near
80 ovulation. In the current study, we further examined this hypothesis by seeking to replicate the
81 finding of Haselton and Gangestad (2005) using a more rigorous luteinizing-hormone method of
82 fertility assessment. We also advanced two additional predictions, which follow.

83 *Shifts in In-Pair Desire.* According to the good genes model, women whose long-term
84 partners display indicators of good genes do not benefit from engaging in a dual-mating strategy;
85 thus we predicted that women's reported desire for their primary partner would also result from
86 the interaction of fertility and partner sexual attractiveness, such that ovulatory increases in in-
87 pair desires will be reported more by women with partners who are high in sexual attractiveness.

88 *Shifts in Partner Mate Guarding and Positive Inducements to Fidelity.* Female affairs
89 can be extremely costly to male partners, and men are therefore expected to possess evolved
90 counter-strategies designed to protect them from cuckoldry. Mate retention strategies may be

91 either prohibitive—such as restricting a partner’s movements—or persuasive—such as engaging
92 in attentive and solicitous behavior toward the partner. Gangestad et al. (2002) found that women
93 reported increases in both their partners’ proprietary behaviors and attentiveness as a function of
94 fertility. In the current study, we predicted that women’s reports of their partners’ mate-guarding
95 tactics would increase during the fertile phase of the cycle, and that this effect would be stronger
96 for women who rated their partners as less sexually attractive, as these are the women most
97 likely to pursue a dual-mating strategy.

98 **2. Methods**

99 ***2.1 Participants***

100 Participants were 43 women recruited from a large university in the Southwestern United
101 States who either satisfied a research requirement or were paid for their participation, and who
102 reported that they were currently involved in a romantic relationship. None had used hormonal
103 contraceptives in the three months prior to participation, and all reported having regular
104 menstrual cycles between 24 and 36 days in length ($M = 29.56$, $SD = 2.95$). Using a nationally-
105 marketed ovulation test (ClearBlue™), all participants were assessed to have a luteinizing
106 hormone (LH) surge between 2 days prior and 4 days following one of their lab sessions (see
107 below). Tests such as these that measure LH levels in urine are 97% concordant with ovulation
108 as confirmed by ultrasonography (Guermendi et al., 2001). Low fertility sessions were scheduled
109 to occur after the likely day of ovulation, excluding menstrual days and the three days preceding
110 menstruation (to avoid premenstrual effects). Eighty women were originally recruited for the
111 study, but 37 were ineligible for inclusion in analyses either because they failed to complete the
112 multisession study ($n = 22$), showed no evidence of an LH surge within six testing days ($n=5$),
113 participated in the high fertility session more than four days before a surge in LH was detected

114 (n=1), were scheduled inaccurately for low fertility sessions (with that session falling either
115 within the three days prior to menstruation or within what might have been an ovulatory phase;
116 n=9). In sum, of the women who completed all parts of the study, 74.1% were eligible for
117 inclusion in analyses. This retention rate is comparable to those of previous studies with similar
118 methods (e.g., Gangestad et al., 2002 reported a 61.4% retention rate).

119 The mean age of participants in the sample was 21.43 years (SD=5.35, range 18-46);
120 59.0% identified themselves as Asian-American, 25.6% as Caucasian, 7.7% as Hispanic, 2.6% as
121 African American, 2.6% as Middle Eastern, and 2.5% as another ethnicity. All women in the
122 sample identified themselves as “currently in a romantic relationship,” with a median
123 relationship length of 15.55 months (Mean = 28.34 months, SD = 35.77, range .1 month-144
124 months). Twenty-six (60.46%) women had engaged in sexual intercourse with their current
125 partner; of those who had not, 15 (34.88% of the sample) were virgins. On average, women had
126 a total of 2.45 sex partners to date (SD = 4.94, range =0-25). Four out of 43 women (9.30%) had
127 engaged in sexual intercourse with someone other than their current partner while involved in the
128 current relationship.

129 **2.2 Procedure**

130 Participants came to the lab for three sessions: an initial session and two follow-up
131 sessions. The follow-up sessions were scheduled according to each participant’s menstrual cycle,
132 with one session occurring during the ovulatory phase of her cycle, and the other occurring
133 during the luteal phase (see below for information on phase scheduling).

134 *Initial Session.* Participants answered questions about their health (e.g., medications they
135 were taking), cycle regularity, cycle length, and anticipated next date of menstrual onset.
136 Participants then completed several computer-based questionnaires that included basic

137 demographic information, relationship and sexual histories, and several items concerning their
138 assessments of their relationship and current partner.

139 Items assessing partner mate value (after Haselton, 2003) varied along two primary
140 dimensions: sexual attractiveness and investment attractiveness. Sexual attractiveness ($\alpha = .83$)
141 was the aggregate of the following: “Compared with most men, how attractive is your partner’s
142 body to women?” “Compared with most men, how attractive is your partner’s face to women?”
143 “Compared with most men, how sexy would women say your partner is?” Investment
144 attractiveness ($\alpha = .71$) was the aggregate of the following: “Compared with most men, what is
145 your partner’s present financial status?” “Compared with most men, what is your partner’s
146 estimated future financial status?” “Compared with most men, how high is your partner in social
147 status at the present time?” “Compared with most men, what is your partner’s estimated future
148 social status?” and “How intelligent would women say your partner is, compared to most men?”
149 Each of the items was rated on a scale of 1-9 (1 = “Extremely Low,” or “Not at all
150 sexy/intelligent/etc;” 5 = “Average;” and 9 = “Extremely High,” or “Extremely
151 sexy/intelligent/etc.”). Intelligence has been argued to be a sexually selected fitness indicator
152 (Furlow, Armijo-Prewitt, Gangestad, & Thornhill, 1997; Miller, 2000) and it is also linked with
153 financial success (Neisser et al., 1996). Because intelligence was correlated more strongly with
154 the investment attractiveness items than with the sexual attractiveness items, and its inclusion in
155 the investment attractiveness composite increased the reliability of the investment attractiveness
156 measure, we included it in the investment attractiveness composite (dropping it from the
157 composite did not affect the patterning of results reported below).

158 Sexual satisfaction was assessed with five items created for the purpose of this study.
159 Each item asked women to assess their primary partner relative to other men with whom they

160 had sexual experience ($\alpha=.91$): “Relative to sex with other men, how enjoyable is sex with your
161 current partner?,” “... how passionate is sex with your current partner?,” “... how attentive to
162 your needs is your partner during sex?,” “...how satisfying is sex with your current partner?,”
163 and “...how much closeness do you feel during sex with your partner?” Women were directed to
164 answer these questions with regard to all sexual activity (including kissing, touching, etc),
165 whether or not they had ever engaged in sexual intercourse. Items were rated on a 1-7 scale
166 (1=Not at all enjoyable/etc., 4=Average, 7=Extremely enjoyable/etc.).

167 *Scheduling and LH testing.* We followed the methods of Gangestad et al. (2002). In the
168 initial session, if a participant was currently in the follicular phase of her cycle (more than 17
169 days prior to the anticipated start of her next menstruation), she was scheduled for a high fertility
170 session; if she was in the luteal phase of her cycle (between four and 17 days before
171 menstruation) she was scheduled for a low fertility session. Women expecting menstrual onset
172 within three days were scheduled for high fertility sessions. About half of the participants
173 completed their high-fertility session first ($n = 23, 53.49\%$) and about half completed their low-
174 fertility session first ($n = 20, 46.51\%$).

175 High fertility sessions were scheduled to occur between 16 and 19 days prior to the
176 expected end of the cycle, with the expectation that ovulation normally occurs 14-15 days prior
177 to the onset of menses (Weinberg, Gladen, & Wilcox, 1994; Wilcox, Weinberg, & Baird, 1995).
178 Women were scheduled to complete urine tests beginning two days before their high fertility
179 session and continuing for at least five days, or until a surge was detected; on these days
180 participants reported to the lab and were given an unlabeled mid-stream urine test designed to
181 detect the presence of luteinizing hormone in the urine. Participants were blind to the purpose of
182 the tests. An LH surge usually occurs 24-48 hours prior to ovulation; thus it was expected that a

183 surge would be observed for most women on or shortly following their scheduled high fertility
184 session. LH surge was observed, on average, 0.98 days following the scheduled high fertility
185 session (SD = 1.42, range 2 days prior to 4 days following). Conception may occur as a result of
186 intercourse up to 5-7 days prior to ovulation (Jochle, 1973; Wilcox et al., 1995); hence all of the
187 women included in this study are presumed to have been in a fertile state at the time of their
188 high-fertility session. Because the probability of conception increases as ovulation nears, the
189 estimated number of days prior to ovulation (days-to-LH-surge minus 2) was included as a
190 control variable in analyses. Inclusion of this variable (with day of ovulation = 0) allowed us to
191 estimate high vs. low fertility effects at the day of ovulation.

192 Low-fertility sessions were scheduled to occur 3-10 days prior to the next expected
193 menstrual onset. On average, women were tested 6.61 days prior to the end of their menstrual
194 cycle (SD=1.93), excluding one woman whose low fertility sessions was conducted during the
195 follicular rather than the luteal phase (23 days before expected menstruation, or nine days before
196 estimated day of ovulation). This session was far enough from the predicted date of ovulation to
197 be non-fertile (Wilcox et al., 1995) and was thus retained in the analyses.

198 *Sessions 2 and 3.* During the high-fertility and low-fertility sessions, participants
199 completed a series of computer-based questionnaires about their current feelings, desires, and
200 recent experiences with their primary partners and with other men.

201 Participants were asked to rate, on a scale of -4 (Far less than usual) to +4 (Far more than
202 usual; 0 = About average) how much they had experienced certain events over the last 48 hours,
203 relative to other days. Twenty-four items of interest were interspersed with other items that were
204 not theoretically predicted to vary across the menstrual cycle, and for which few significant
205 effects emerged, with no clear pattern across like items (e.g., “Felt happy” or “Felt sad”). Table

206 1 presents items used to test our predictions with composite reliabilities at both high and low
207 fertility.

208 **3. Results**

209 *3.1 Statistical Analyses*

210 We conducted analyses using repeated general linear models (SPSS 12.0) on the
211 dependent variables of interest. Fertility status (measured as low vs. high phases of the cycle)
212 was a repeated factor in all analyses. In our focal analyses, we entered partner sexual
213 attractiveness and investment attractiveness—which were of primary interest in tests of
214 predictions—as quantitative predictor variables, along with the number of days prior to ovulation
215 in the high fertility session, and session order (high vs. low first).

216 In a second set of analyses, we added several control variables to examine whether the
217 effects of primary interest were robust to the inclusion of variables that might be confounded
218 with partner sexual attractiveness. Whether a woman had ever had sexual intercourse with her
219 partner (yes vs. no) was entered as a factor and therefore controlled. Sexual satisfaction and
220 relationship length were also added as quantitative control variables. These quantitative variables
221 were zero-centered so that the main effect of fertility status would be estimated for mean levels
222 of these predictors. Our consent procedures made it clear that women could skip items that they
223 did not wish to respond to and still remain in the study. There are, therefore, some missing data
224 for some of these added control variables, and the degrees of freedom for the reported analyses
225 vary accordingly.

226 We followed the recommendations of Rice and Gaines (1994) by implementing directed
227 tests for predicted effects. These tests allocate a probability of .04 (of a total .05) to the predicted

228 tail and .01 to the unpredicted tail. For unpredicted effects, we used two-tailed tests. Reported
229 p -values reflect these criteria.

230 One woman had an extremely low partner sexual attractiveness score (3.54 SD below the
231 mean), raising the possibility that her datum might skew estimates of effects. We therefore
232 Winzorized the data, which entailed truncating only this score to meet the next lowest score
233 (1.74 SD below the mean; Howell, 1992). Presented analyses include the truncated score. The
234 two key interactions of sexual attractiveness and cycle phase remain when the original score is
235 included in analyses.

236 ***3.2 Shifts in Extra-Pair and In-Pair Desires***

237 *Are ovulatory increases in extra-pair desires greater for women with less sexually*
238 *attractive partners?* As predicted, the effect of fertility status on extra-pair desires was
239 moderated by partner sexual attractiveness, $F(1, 38) = 5.54, p = .015$, partial $r = -.36$ (see Figure
240 1). Women who perceived their partners as low in sexual attractiveness were particularly likely
241 to report increases in extra-pair desires at high fertility. There was no interaction of phase and
242 partner investment attractiveness on extra-pair desires, $F(1, 38) = .05, ns$. Overall, women
243 tended to report greater extra-pair desires at high fertility (marginal mean = .27) than at low
244 fertility (marginal mean = -.48), but this effect was not statistically significant, $F(1, 38) = .70, ns$.
245 No other effects were significant.

246 With the other covariates added, the interaction of fertility status and partner sexual
247 attractiveness remained robust, $F(1, 30) = 6.28, p = .011$, and the main effect of fertility status
248 began to approach significance, $F(1, 30) = 1.88, p = .113$. Partner investment attractiveness had
249 a marginal main effect, such that women with more investing partners reported lower overall

250 extra-pair desires, $F(1, 30) = 3.84, p = .059$. No other main effects or interactions were
251 significant.

252 *Are there ovulatory increases in in-pair desires?* There were no significant cycle effects
253 or interactions with partner quality on in-pair desires, in either the focal analysis or in the
254 secondary analysis in which potential confounds were controlled (all p -values $> .20$).

255 **3.3. General Sexual Desire**

256 We did not find main effects of phase or interactions with partner sexual or investment
257 attractiveness on women's reports of general sexual desire (all p -values $> .50$). In the secondary
258 analysis, we observed a significant phase by sexual satisfaction interaction, $F(1, 29) = 4.88, p =$
259 $.035$, such that women who were more sexually satisfied showed a greater increase in sexual
260 desire at high fertility than those less sexually satisfied. No other main effects or interactions
261 were significant. In sum, a generalized increase in desire at high fertility was not found in this
262 sample, nor did we find that fertility interacted with partner sexual attractiveness; hence, general
263 desire does not appear to be able to explain the target-specific shifts we have observed.

264 **3.4 Mate Retention**

265 *Do less sexually attractive men increase their mate guarding efforts more when their*
266 *partners are fertile?* There was a significant interaction of partner sexual attractiveness and
267 fertility on women's reports of their partners' expressed love and attention giving, $F(1, 34) =$
268 $5.93, p = .013$, partial $r = -.39$ (see Figure 2). Less sexually attractive partners increased their
269 mate retention efforts more at high fertility. There was also a significant main effect of partner
270 investment attractiveness on women's reports of positive attention by their partners, $F(1, 34) =$
271 $4.78, p = .036$, such that partners higher in investment attractiveness tended to engage more in
272 positive mate retention efforts. No other effects were significant.

273 With possible confounds controlled, the observed interaction of phase and partner sexual
274 attractiveness remained significant, $F(1, 26) = 3.40, p = .048.$, and the relationship between
275 partner investment attractiveness and positive mate retention dropped to non-significant $F(1, 26)$
276 $= 1.91, p = .179.$ There were no other significant main effects or interactions.

277 In contrast to these robust effects, no significant effects were observed for partner
278 jealousy and mate guarding in either the focal or the secondary analysis. Because ovulatory
279 increases in jealousy were observed in a previous study (Gangestad et al., 2002), we also
280 examined the individual items within the composite. None of these effects were significant in
281 either the focal or the secondary analyses.

282 In sum, men who were rated as less sexually attractive were reported to increase attention
283 to and expressed love for their partners near ovulation, as predicted. Jealousy, in contrast,
284 produced no such effects, suggesting that the ovulation-contingent mate-retention efforts
285 observed in this sample were limited to positive inducements to fidelity.

286 **4. Discussion**

287 According to the good genes model, a dual-mating strategy is advantageous only if a
288 woman's partner lacks cues to good genes. We therefore predicted that women with less sexually
289 attractive partners (those likely to display fewer cues to good genes) would show ovulatory
290 increases in extra-pair desires. The good-genes model predicts that this effect will be specific to
291 sexual attractiveness and will not be observed for partners lacking investment cues. This
292 differential pattern of effects is, in fact, what we found. Sexual attractiveness, but not investment
293 attractiveness, interacted with fertility status to predict extra-pair desires; women rating their
294 partners as least sexually attractive showed the greatest increases in extra-pair desires. We
295 predicted and found parallel results for partner mate retention. Less sexually attractive men—

296 those for whom female infidelity may be of greatest concern—were reported to increase their
297 mate retention efforts more at high fertility. We did not find evidence of ovulatory increases in
298 male jealousy or interactions of partner sexual attractiveness and cycle phase predicting male
299 jealousy; thus, in this study, mate retention effects were limited to positive inducements to
300 fidelity.

301 We predicted a reversed pattern for in-pair desires, such that women with sexually
302 attractive partners would show increases in attraction to partners at high fertility. We did not
303 confirm this prediction. It is possible that this effect, if it exists, is smaller in magnitude than the
304 predicted effect of sexual attractiveness on extra-pair desires (Gangestad et al., 2005), and thus
305 more difficult to detect.

306 Male sexual attractiveness is correlated with many other variables, and thus we cannot be
307 certain that our effects are driven by it. However, when we controlled for several variables that
308 may be associated with male sexual attractiveness, including female sexual satisfaction and
309 relationship length, our effects remained robust. Our results are also cross-validated by findings
310 by Gangestad et al. (2005), who documented that women mated to relatively asymmetrical
311 partners showed greater ovulatory increases in extra-pair desires than did women mated to
312 symmetrical partners.

313 Like Gangestad et al. (2002) and Haselton and Gangestad (2005), we did not observe a
314 main effect of fertility on general sexual desire, nor did we find an interaction of partner sexual
315 attractiveness and fertility in predicting generalized desire. This is noteworthy, as it helps to rule
316 out the alternative explanation that target-specific cycle shifts are produced by generally elevated
317 sexual desire. This does not appear to be the case in any of these studies. We did observe an
318 interaction of sexual satisfaction and fertility on general desire. Given the number of tests we

319 conducted by virtue of controls for confounds, this effect could be spurious. If robust, it may
320 reflect a greater sensitivity in sexually satisfied women to changes in sexual functioning near
321 ovulation (e.g., increases in the frequency of orgasms) relative to the luteal phase (Clayton,
322 Clavet, McGarvey, Warnock, & Weiss, 1999).

323 A limitation of this study is that reports of male mate retention are made by female
324 partners rather than by male partners themselves. Other studies have demonstrated that male and
325 female partners' reports of male mate retention behaviors tend to agree (Dobash, Dobash,
326 Cavanagh, & Lewis, 1998; Gangestad et al., 2002). Nonetheless, this is a clear avenue for future
327 research. In addition, although there was considerable range in the ages of the women in our
328 sample, and in the length of their relationships, our participants were, on average, relatively
329 young and their relationships were relatively new. It is possible that shifting relationship
330 dynamics across the cycle vary depending on female age or relationship length, and a systematic
331 investigation of this question may also be fruitful.

332 In sum, this study provides additional evidence for the good genes hypothesis of female
333 extra-pair mating. This study also provides evidence for the texture and subtlety of adaptations
334 underlying partner choice and relationship dynamics—not only do women's desires and men's
335 mate retention efforts vary across the cycle (Gangestad et al., 2002), but the degree to which they
336 change varies with theoretically-relevant characteristics of male partners.

337

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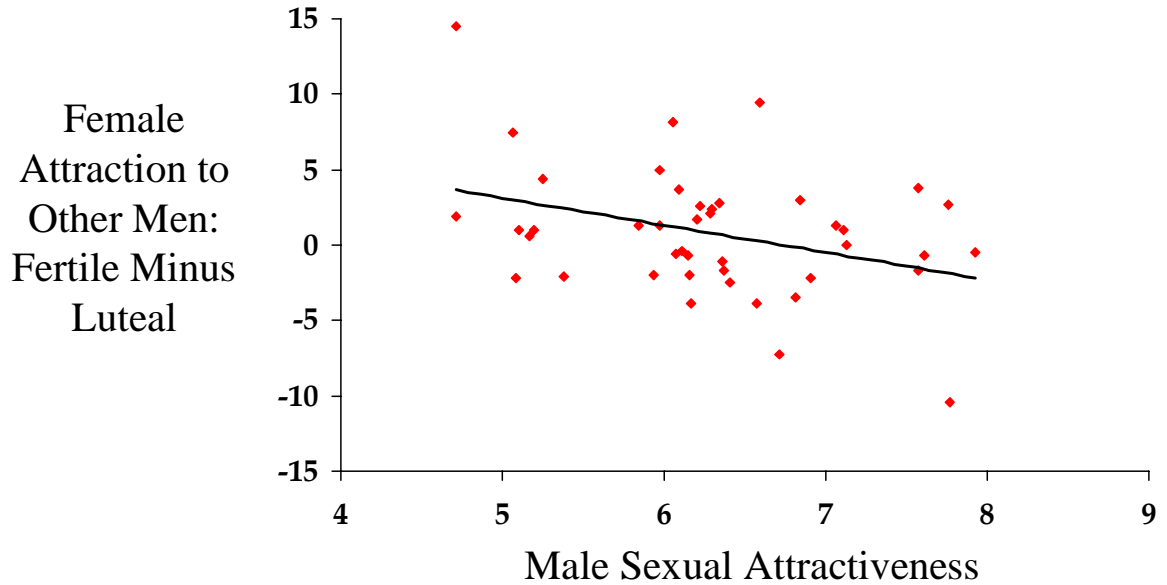
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392

Table 1: Measures in surveys administered at high and low fertility.

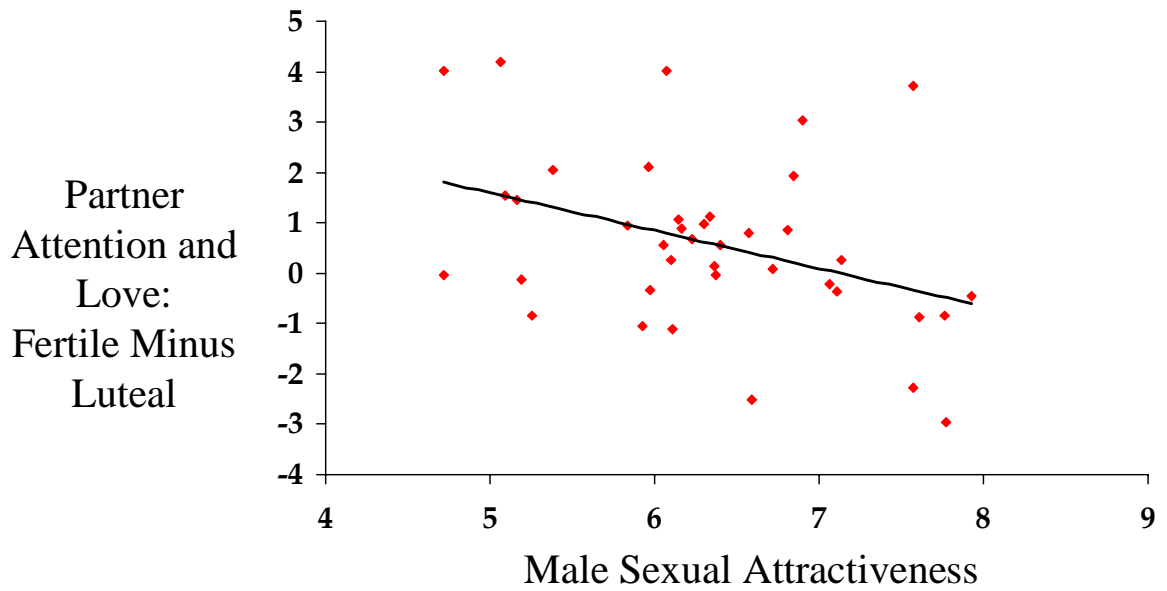
Measure	Items	α at High Fertility	α at Low Fertility
Extra-pair desire	<i>Been physically attracted to someone you did not know</i>	.70	.85
	<i>Been physically attracted to an acquaintance</i>		
	<i>Been physically attracted to a friend or coworker</i>		
In-pair desire	<i>Felt sexually attracted to your partner</i>	--	--
General desire	<i>Had persistent sexual thoughts</i>	.93	.94
	<i>Had sexual thoughts</i>		
	<i>Had sexual fantasies</i>		
	<i>Experienced sexual desire</i>		
Partner solicitousness	<i>Given you attention</i>	.94	.90
	<i>Expressed commitment to you</i>		
	<i>Expressed feelings of love to you</i>		
	<i>Expressed sexual attraction to you</i>		
Partner jealousy	<i>Acted jealous about your casual interactions with other people</i>	.80	.90
	<i>Monopolized your time</i>		
	<i>Acted possessive of you</i>		

Figure 1: Relationship between Male Sexual Attractiveness and Ovulatory Shifts in Women's Attraction to Extra-Pair Men



Note. $N = 43$ partial $r = -.36$, $p = .015$; points represent residual scores after controlling for investment attractiveness, order of session (high vs. low fertility first), and estimating effect of phase at the day of ovulation (based luteinizing hormone assay).

Figure 2: Relationship between Male Sexual Attractiveness and Ovulatory Shifts in Male Mate Retention.



Note. $N = 39$; partial $r = -.39$, $p = .02$; points represent residual scores after controlling for investment attractiveness, order of session (high vs. low fertility first), and estimating effect of phase at the day of ovulation (based luteinizing hormone assay).

Acknowledgements

We thank Dave Frederick, Sheila Allameh, Anna Berezovskaya, Lani Cante, Elizabeth Carlin, Sarah Dodd, Bahar Ebrat, Erika Forster, Lisa Marchlewicz, Lisa Newon, and Carolyn Pratt for their generous assistance in collecting the data, Paul Andrews, Steve Gangestad, and Christine Garver-Apgar for helpful advice on high and low fertility scheduling, April Bleske-Rechek, Dan Fessler, and two anonymous reviewers for comments on an earlier draft, the UCLA Experimental Biological Anthropology group for discussion of the ideas contained in this manuscript, and the UCLA Statistical Consulting Center for statistical advice. We gratefully acknowledge Unipath Diagnostics Co. for their generous donation of ClearBlue™ ovulation detection kits.