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Hormonal contraceptive use and mate retention behavior in women and their male partners

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ABSTRACT

Female hormonal contraceptive use has been associated with a variety of physical and psychological side effects. Women who use hormonal contraceptives report more intense affective responses to partner infidelity and greater overall sexual jealousy than women not using hormonal contraceptives. Recently, researchers have found that using hormonal contraceptives with higher levels of synthetic estradiol, but not progestin, is associated with significantly higher levels of self-reported jealousy in women. Here, we extend these findings by examining the relationship between mate retention behavior in heterosexual women and their male partners and women's use of hormonal contraceptives. We find that women using hormonal contraceptives report more frequent use of mate retention tactics, specifically behaviors directed toward their partners (i.e., intersexual manipulations). Men partnered with women using hormonal contraceptives also report more frequent mate retention behavior, although this relationship may be confounded by relationship satisfaction. Additionally, among women using hormonal contraceptives, the dose of synthetic estradiol, but not of synthetic progesterone, positively predicts mate retention behavior frequency. These findings demonstrate how hormonal contraceptive use may influence behavior that directly affects the quality of romantic relationships as perceived by both female and male partners.

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Introduction

Since their introduction over 50 years ago, hormonal contraceptives have become established as a popular and effective method of avoiding unintended pregnancy. From 2006 to 2008, the number of US women who had ever used the most popular form of hormonal contraceptive, the oral contraceptive pill, stood at 82% (Mosher and Jones, 2010). In 2007, 8.8% of reproductive age women (15–49 years) worldwide used an oral contraceptive and a further 3.7% used other forms of hormonal contraceptive, such as injectables or implants; in more developed regions these proportions were greater (oral contraceptive, 18.1%; other hormonal contraceptive, 1.3%) (United Nations, 2009). The popularity of hormonal contraceptives crosses political and religious boundaries, with high proportions of users not only evident in developed nations such as Germany (oral contraceptive, 52.6%, other hormonal contraceptive, 0%) and Belgium (oral contraceptive, 44.8%, other hormonal contraceptive, 1.1%), but also in emerging and developing economies such as Bangladesh (oral contraceptive, 28.5%, other hormonal contraceptive, 7.7%), and Iran (oral contraceptive, 25.1%, other hormonal contraceptive, 2.7%) (United Nations, 2009). As well as providing women with control over their fertility, hormonal contraceptive use is thought to be associated with several non-contraceptive health benefits, including reduced risk of ovarian (Lurie et al., 2007) and endometrial cancer (Hannaford and Kay, 1998). However, hormonal contraceptive use is also associated with a variety of negative physical side-effects, such as an increased risk of myocardial infarction, venous thromboembolism, and ischemic stroke (e.g., Cole et al., 2007).

Recently, researchers have investigated the psychological side-effects of hormonal contraceptive use, documenting effects on mood and psychological well-being (see, e.g., DeSoto et al., 2003; Roberts et al., in press; Sanders et al., 2001). Hormonal contraceptives may also influence sexual interest and behavior. For example, Guillermo et al. (2010) found that women using hormonal contraceptives expressed significantly greater interest in engaging in short-term sexual relationships across all phases of the menstrual cycle compared to naturally cycling women, and Little et al. (2002) found that oral contraceptive use was associated with a greater number of reported sexual partners. Hormonal contraceptive users also report reduced sexual functioning (Wallwiener et al., 2010) and higher rates of depression (Kulkarni, 2007) than normally cycling women. While it is possible that some other, unmeasured difference between women who choose to use or not use hormonal contraceptives may be driving these findings, these studies suggest a possible influence of synthetic hormones on behavior.

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There is mounting evidence for potentially adaptive variation over the ovulatory cycle in women's preferences for men's traits, including facial masculinity (Johnston et al., 2001; Little et al., 2008; Penton-Voak and Perrett, 2000; Penton-Voak, et al., 1999), masculine body shape (Little et al., 2007), the odor of masculine men (Grammer, 1993; Havlicek et al., 2005), voices with masculine characteristics (e.g., lower pitch) (Feinberg et al., 2006; Puts, 2005), and various non-physical traits, such as dominant and intrasexually competitive behavior (Gangestad et al., 2004; Gangestad et al., 2007; Lukaszewski and Roney, 2009). During the luteal phase when conception risk is low and progesterone levels are high, preferences increase for apparent health in faces (Jones et al., 2005a; 2005b) and facial self-resemblance (DeBruine et al., 2005). Such preference shifts may represent by-products of adaptations that promote affiliation with healthy individuals (Jones et al., 2005a; 2005b) and kin (DeBruine et al., 2005) prior to and during pregnancy. Given that these preference shifts are likely governed by natural variation in hormone levels (e.g., Jones et al., 2008; Little et al., 2008; Welling et al., 2007), it is perhaps unsurprising that many such effects are absent in those reporting hormonal contraceptive use (Gangestad et al., 2007; Haselton and Miller, 2006; Johnston et al., 2001; Jones et al., 2005b; Little et al., 2007; Pawłowski and Jasienska, 2005; Penton-Voak et al., 1999; Puts, 2006; Rosen and López, 2009); one study has even shown that hormonal contraceptive use results in an absence of shifts in face perception among women's male partners (Burriss and Little, 2006).

Because ovulatory cycle preference shifts are potentially adaptive (Gangestad and Thornhill, 2008), hormonal contraceptives that alter them may detrimentally influence mate preferences and mate choice (see Alvergne and Lummaa, 2009; Havlicek and Roberts, 2009; Roberts et al., 2008; Wedekind and Füri, 1997). If so, we might expect to see links between hormonal contraceptive use and negative relationship properties, such as indicators of relationship satisfaction and stability. This indeed appears to be the case, with women who use hormonal contraceptives reporting more intense affective responses to partner infidelity and greater overall sexual jealousy (Geary et al., 2001). Recently, Cobey et al. (2011) extended these findings by examining whether feelings of jealousy vary with the dose of synthetic estradiol and progestin in combined oral contraceptives. They found that higher doses of synthetic estradiol, but not progestin, were associated with significantly higher levels of self-reported jealousy. These findings suggest that hormonal contraceptives may influence emotional states, such as jealousy, and not merely that more jealous women tend to use hormonal contraceptives. However, to our knowledge there is currently no evidence that hormonal contraceptive use is associated with changes in actual behavior among romantic partners.

Jealousy generates behaviors that may function to maintain relationships by reducing the likelihood of a partner straying or being poached by a rival (e.g., Buss, 1988; Daly et al., 1982; Shackelford et al., 2005b; Shackelford et al., 2008). The Mate Retention Inventory (MRI, Buss, 1988; Buss et al., 2008) is used to assess the incidence of these mate retention behaviors, which range from appearance enhancement and expressions of love to physical abuse. Scores on the MRI are linked to marital satisfaction and relationship aggression (as discussed in Buss et al., 2008). Therefore, we aimed to test three hypotheses regarding mate retention behaviors and hormonal contraceptive use among heterosexual couples. First, because hormonal contraceptive use may alter mate preferences (Alvergne and Lummaa, 2009; Havlicek and Roberts, 2009; Roberts et al., 2008; Wedekind and Füri, 1997), potentially leading to relationship conflict and increased jealousy (Cobey et al., 2011; Geary et al., 2001), we hypothesized that women using hormonal contraceptives would express more frequent mate retention behaviors than women not using hormonal contraceptives. Second, because female hormonal contraceptive use is associated with a greater interest in short-term sexual encounters (Guillermo et al., 2010; Little et al., 2002), we hypothesized that male partners of women who use hormonal contraceptives, in an effort to limit the increased likelihood of their partner straying, would exhibit more frequent mate retention behaviors than men whose partners do not use hormonal contraceptives. Finally, we predicted that the dose of synthetic estradiol, but not of progestin, would be positively correlated with the frequency of mate retention behavior, extending the findings of Cobey et al. (2011).

Methods

Participants

Participants were recruited via the psychology department subject pool at a university in the north-eastern United States. Interested parties were instructed prior to signing up for the study that all participants had to have been in a committed heterosexual relationship for at least one month (mean relationship length = 16.52 months, SD = 17.95, Range = 2–106 months) and that their partner must be willing to participate with them. One or both members of 8 different couples opted to withdraw from this study, leaving 109 heterosexual women (mean age = 20.1 years, SD = 1.89) and their male partners (mean age = 20.7 years, SD = 3.32) who participated. Of these women, five did not respond to the question "Do you currently use a hormonal contraceptive?" so they and their partners were excluded from further analysis. Of the remaining women, 35 reported not using a hormonal contraceptive and 69 reported that they were using a hormonal contraceptive. We also asked women to indicate the brand of hormonal contraceptives that they used, if applicable. All participants received either $7 USD (non-subject pool participants) or course credit (subject pool participants) in exchange for participating.

Procedure

Couples visited the laboratory together, but men and women were segregated and completed all tasks at private computer workstations. This meant that it was not possible for a participant to view their partner's responses, thereby promoting honesty. Each participant completed a demographics questionnaire, the female version of which contained items relating to hormonal contraceptive use. Participants also completed a self-report short-form MRI (MRI-SF, Buss et al., 2008), a partner-report MRI-SF (i.e., where they reported on the mate retention tactics their partner uses, see Shackelford et al., 2005a), the Sociosexual Orientation Inventory-Revised (SOI-R, Penke and Asendorpf, 2008; see also Simpson and Gangestad, 1991), and the Relationship Assessment Scale (RAS, Hendrick et al., 1998). Due to a coding error, the SOI-R and RAS data for 19 couples were not saved. Participants also rated their commitment to their partner on a 1 (not at all committed) to 10 (completely committed) scale. All tests and questionnaires were completed in a random order.

Initial processing of data

Scores on the SOI-R are calculated by summing responses to the nine items, with higher scores indicating an unrestricted sociosexual orientation (i.e., an overall more promiscuous behavioral tendency) and lower scores indicating a more restricted sociosexual orientation (Penke and Asendorpf, 2008; see also Simpson and Gangestad, 1991). Scores on the RAS are calculated by summing responses to the seven relationship constructs, each of which is rated on a 0 (very dissatisfied) to 6 (very satisfied) scale. High scores on the RAS indicate high relationship satisfaction (Hendrick et al., 1998). The MRI-SF involves participants assigning a number from 0 (never performed this act) to 3 (often performed this act) to 38 items. By summing the numbers assigned to each statement for the self-report MRI-SF and the partner-report MRI-SF, we obtained a self-report mate retention score (self-MRI) and a partner-report mate retention score (partner-MRI) for each participant. For conciseness, women's reports of their partner's use of mate retention tactics are hereafter referred to

as 'female partner-MRI' and men's reports of their partner's use of mate retention tactics are hereafter referred to as 'male partner-MRI'. Items in the MRI-SF can be grouped into two domains: inter- and intra-sexually directed mate retention behaviors. We also calculated self-MRI and partner-MRI scores for these two domains for each participant in order to conduct further exploratory analyses.

Kolmogorov–Smirnov tests showed that female self-MRI ($D_{102}=0.082$, $p=.088$), female partner-MRI ($D_{102}=0.083$, $p=.080$), and male self-MRI ($D_{102}=0.060$, $p=.20$) were normally distributed. Male partner-MRI was significantly non-normal ($D_{102}=0.090$, $p=.042$), hence we used non-parametric Mann–Whitney U-tests to test for relationships between MRI and hormonal contraceptive use. However, we note that the effects of hormonal contraceptive use on total mate retention scores reported below are equivalent to those obtained using independent samples *t*-tests. We also investigated the effects of hormonal contraceptive use on the domains of reported mate retention behavior using a univariate ANOVA. Finally, we tested whether the potential confounds of reported age, relationship length, SOI-R scores, RAS scores, and reported relationship commitment were influencing our findings. All reported statistics are two-tailed unless otherwise indicated.

Results

Women's self-MRI and men's partner-MRI were significantly positively correlated ($r=.448$, $p<.001$), as were men's self-MRI and women's partner-MRI ($r=.367$, $p<.001$). There was a significant effect of hormonal contraceptive use on women's self-MRI ($U=834$, $Z=2.57$, $p=.010$, $r=0.25$), with women who used a hormonal contraceptive reporting more frequent mate retention behaviors than other women (see Fig. 1). There was no significant effect of contraceptive use on women's partner-MRI ($U=945.5$, $Z=1.50$, $p=.14$, $r=0.15$), although the direction was consistent with that of the effect for women's self-ratings. However, despite men's self-MRI and women's partner-MRI being positively correlated, a paired-samples *t*-test revealed that men's self-MRI was significantly higher ($M=39.52$, $SD=13.58$) than women's partner-MRI ($M=34.17$, $SD=13.91$; $t_{102}=3.758$, $p<.001$). There were also significant effects of partner hormonal contraceptive use on men's self-MRI ($U=742.5$, $Z=2.83$, $p=.005$, $r=0.28$) and men's partner-MRI ($U=667$, $Z=2.92$, $p=.003$, $r=0.29$). In both cases, men whose partners used a hormonal contraceptive had higher MRI scores.

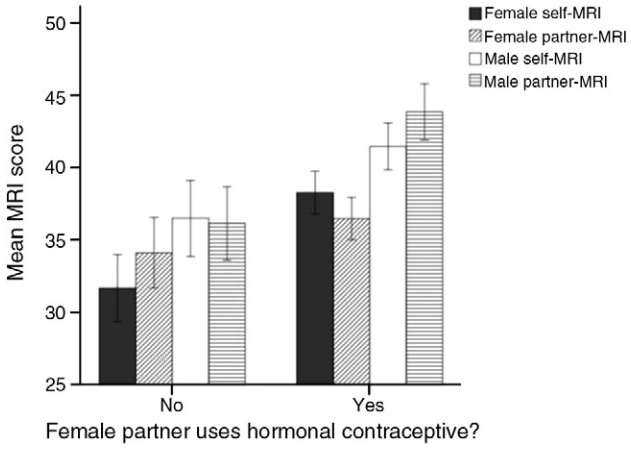

Fig. 1. Male and female mean MRI responses grouped by female hormonal contraception use. Women who reported using a hormonal contraceptive reported more frequent mate retention behaviors than women who did not. There was no significant effect of contraceptive use on women's reported partner-MRI. Men whose partners used a hormonal contraceptive reported both higher self- and partner-MRI scores. Note that the Y-axis begins at 25.

Next, we investigated the effects of hormonal contraceptive use on the types of mate retention behavior reported. The MRI-SF is divided into two domains: intersexual manipulations (i.e., mate retention behaviors directed at one's partner) and intrasexual manipulations (i.e., mate retention behaviors directed at rivals) (Buss, 1988; Kardum et al., 2006; Shackelford et al., 2005a; Welling et al., 2011). We tested whether hormonal contraceptive use predicted men's and women's self-reported and partner-reported intersexual and intrasexual manipulations. In women, hormonal contraceptive use significantly predicted self-reported intersexual manipulations ($U=1163$, $Z=2.26$, $p=.024$, $r=0.21$), with more frequent behaviors reported among hormonal contraceptive users (see Fig. 2). Hormonal contraceptive use did not significantly predict women's self-reported intrasexual manipulations, or women's reports of their partner's intrasexual or intersexual manipulations (all $p>.36$). Repeated-measures ANOVA [within-subjects variable: female self-reported mate retention behaviors (intersexual manipulations, intrasexual manipulations); between-subjects factor: contraceptive use (yes, no)] revealed a main effect of hormonal contraceptive use on mate retention behavior ($F_{1,102}=5.873$, $p=.017$), whereby women using hormonal contraception reported more mate retention behaviors than women not using hormonal contraception. This analysis further revealed an interaction between mate retention behaviors and contraception use ($F_{1,102}=5.774$, $p=.018$), whereby women using hormonal contraception reported using intersexual manipulations ($M=27.74$, $SD=8.66$) more frequently than women not using hormonal contraception ($M=22.97$, $SD=9.92$; $t_{102}=-2.556$, $p=.012$), but did not report using intrasexual manipulations more frequently ($M=10.62$, $SD=4.33$) than women not using hormonal contraception ($M=9.22$, $SD=3.99$; $t_{102}=-1.628$, $p>.80$). In men, partner hormonal contraceptive use significantly predicted self-reported intersexual manipulations ($U=1079.5$, $Z=2.70$, $p=.007$, $r=0.25$), men's reports of their partner's intersexual manipulations ($U=988.5$, $Z=3.33$, $p=.001$, $r=0.31$), men's self-reported intrasexual manipulations ($U=1149.5$, $Z=2.30$, $p=.022$, $r=0.22$), and men's reports of their partner's intrasexual manipulations ($U=1060$, $Z=2.92$, $p=.004$, $r=0.27$). In all cases, men whose partners used a hormonal contraceptive had higher MRI scores (see Figs. 2 and 3).

Finally, we calculated the doses of synthetic estradiol and synthetic progesterone associated with each type of hormonal contraception used by our female participants (weighted averages were used for multiphasic contraceptives where the dose varies depending on the

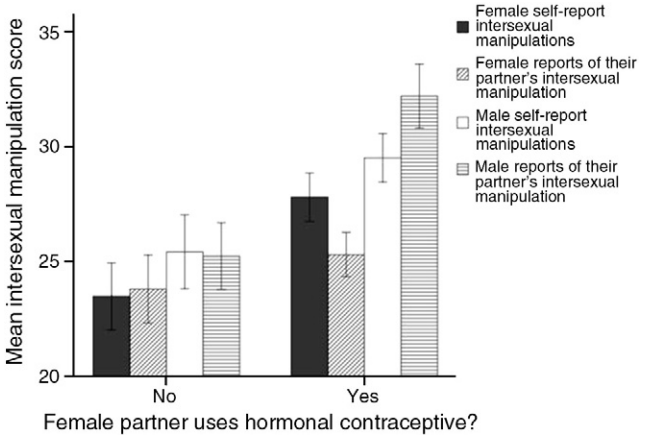

Fig. 2. Male and female mean intersexual manipulation responses grouped by female hormonal contraception use. Women who used hormonal contraceptives reported significantly higher use of intersexual manipulation tactics. There was no effect of hormonal contraceptive use on women's reports of partner intersexual manipulations. Men whose partners used a hormonal contraceptive reported both higher self-report intersexual manipulations (although this effect was no longer significant when controlling for RAS scores) and higher reported partner intersexual manipulations than men whose partners did not use a hormonal contraceptive. Note that the Y-axis begins at 20.

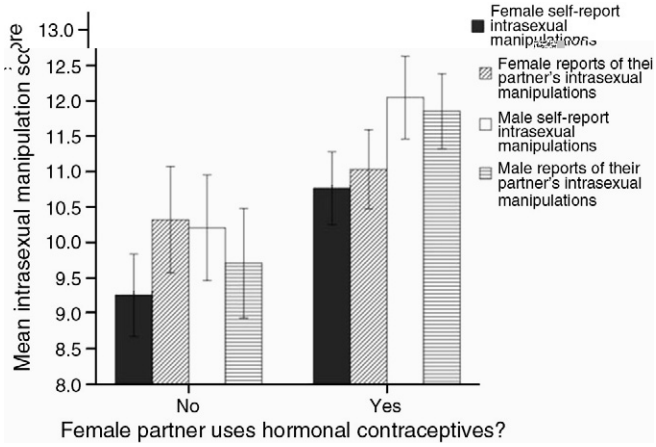

Fig. 3. Male and female mean intrasexual manipulation responses grouped by female hormonal contraception use. There was no effect of hormonal contraceptive use on women's self-report intrasexual manipulations or women's reported partner intersexual manipulations. Men whose partners used a hormonal contraceptive reported both higher self-report intrasexual manipulations (although this effect was no longer significant when controlling for RAS scores or reported commitment) and higher reported partner intrasexual manipulations than men whose partners did not use a hormonal contraceptive. Note that the Y-axis begins at 8.

cycle day). Rather than have participants self-report their doses of synthetic hormones (as in Cobey et al., 2011), we instead had participants report their contraceptive brand and used this information to determine dose, thereby minimizing participant error. Of the 69 women who reported using hormonal contraceptives, five were excluded from the following analysis because they did not report their contraceptive brand ($n=3$) or reported brands that were unidentifiable ($n=2$). Of the remaining women, synthetic estradiol dose ranged from 0 μg (e.g., *Ortho Micronor*) to 35 μg (e.g., *Necon*), while synthetic progesterone dose ranged from 20 μg (e.g., *Mirena*) to 150 mg (*Depo Provera*). Following Cobey et al. (2011), we used a median split to assign participants to either the low or high synthetic estradiol group and either the low or high synthetic progesterone group. A univariate ANOVA (dependent variable: female self-MRI; independent variables: estrogen group [low, high], progesterone group [low, high]) revealed a main effect of synthetic estradiol dose that was close to statistical significance ($F_{63}=3.918$, $p=.052$), whereby the high estrogen group tended toward higher self-MRI scores ($M=42.88$, $SD=12.46$) than the low estrogen group ($M=35.14$, $SD=11.44$). Although we used two-tailed tests throughout, we note that a one-tailed test for estradiol dose could be justified given the results of Cobey et al. (2011), and this would have been statistically significant ($p=.026$). There was no equivalent effect for synthetic progesterone ($F_{63}=.011$, $p>.91$). Repeating this analysis using female partner-MRI (estradiol: $F_{63}=.011$, $p>.90$; progesterone: $F_{63}=2.012$, $p>.16$), male self-MRI (estradiol: $F_{63}=.041$, $p>.84$; progesterone: $F_{63}=.004$, $p>.94$), or male partner-MRI (estradiol: $F_{63}=.131$, $p>.71$; progesterone: $F_{63}=1.123$, $p>.29$) as the dependent variable revealed no significant effects or effects close to significance.

Examining potential confounds

Because younger women are more likely to use hormonal contraceptives (Glei, 1999), it is possible that our results are confounded by age. We therefore analyzed correlations between women's and men's age and the four MRI measures. Neither women's nor men's age was correlated significantly with any mate retention measures (all $p>.18$), apart from the correlation between women's age and self-MRI which was close to significant ($\rho=.18$, $p=.061$). Overall, this suggests that it is unlikely that women's age accounts for the effects of contraceptive use on mate retention behavior. More directly, in this sample, women who used hormonal contraceptives (M age = 20.06 years, $SD=1.94$) and women who did not (M age = 20.25, $SD=1.96$) did not differ significantly in age ($t_{103}=0.47$, $p=.64$, $r=0.046$). In a separate study, we recruited a larger sample of partnered and non-partnered women ($N=604$, of which 267 were hormonal contraceptive users) from the same population and again found that women who used hormonal contraceptives ($M=19.04$ years, $SD=1.20$) and women who did not ($M=19.05$, $SD=2.95$) did not differ significantly in age ($t_{602}=0.64$, $p=.95$, $r=0.0026$), suggesting that our primary sample is in this respect representative of the wider population of undergraduate women at this university. Together, these analyses show that age is unlikely to be an influential factor in generating the observed relationships between contraceptive use and mate retention behavior.

It is also possible that hormonal contraceptive users differ in other ways, such as in their relationship length, sexual restrictedness/promiscuity, relationship satisfaction, or relationship commitment. We therefore tested whether our results are confounded by differences in relationship length, sexual restrictedness (i.e., SOI-R scores), relationship satisfaction (i.e., RAS scores), or reported relationship commitment between couples currently using and not using hormonal contraceptives. Couples using hormonal contraceptives (mean relationship length = 12.89 months, $SD=17.22$) did not differ from couples not using hormonal contraceptives (mean relationship length = 16.17 - months, $SD=18.02$) in relationship length ($t_{102}=.982$, $p>.32$). Women using hormonal contraceptives ($M=24.38$, $SD=9.95$) did not differ from women not using hormonal contraceptives ($M=22.03$, $SD=11.10$) in their SOI-R scores ($t_{87}=1.037$, $p>.30$), and men with partners using hormonal contraceptives ($M=34.75$, $SD=13.22$) did not differ from men with partners not using hormonal contraceptives ($M=29.82$, $SD=17.52$) in their SOI-R scores ($t_{88}=1.513$, $p>.13$). Similarly, women using hormonal contraceptives ($M=30.91$, $SD=3.81$) did not differ from women not using hormonal contraceptives ($M=31.44$, $SD=2.88$) in their RAS scores ($t_{87}=.720$, $p>.47$), and men with partners using hormonal contraceptives ($M=30.57$, $SD=4.69$) did not differ from men with partners not using hormonal contraceptives ($M=29.72$, $SD=4.32$) in their RAS scores ($t_{87}=.855$, $p>.39$). Finally, women using hormonal contraceptives ($M=9.21$, $SD=1.16$) did not differ from women not using hormonal contraceptives ($M=8.84$, $SD=1.82$) in their reported relationship commitment ($t_{102}=1.306$, $p>.19$), and men with partners using hormonal contraceptives ($M=8.74$ $SD=1.76$) did not differ from men with partners not using hormonal contraceptives ($M=8.51$, $SD=1.97$) in their reported relationship commitment ($t_{102}=.653$, $p>.51$).

Because age, relationship length, sexual restrictedness, relationship satisfaction, and reported relationship commitment did not differ as a function of hormonal contraceptive use, it is unlikely that these variables are influencing the observed relationships between contraceptive use and mate retention behavior. However, we further examined the relationship between hormonal contraceptive use and mate retention behaviors using univariate ANCOVAs. Controlling for age using univariate ANCOVAs [dependent variables: MRI (self, partner); fixed factor: female contraceptive use (yes, no); covariate: age] on the original data revealed results equivalent to the non-parametric statistics described earlier for both women (main effect of contraceptive use on self-MRI: $F_{1,102}=4.928$, $p<.03$; main effect of contraceptive use on partner-MRI: $F_{1,102}=.748$, $p>.38$) and men (main effect of partner contraceptive use on self-MRI: $F_{1,102}=6.755$, $p=.01$; main effect of partner contraceptive use on partner-MRI: $F_{1,102}=8.437$, $p=.004$). Repeating these analyses using relationship length, SOI-R scores, RAS scores, and reported relationship commitment as covariates did not alter these findings in men (main effect of partner contraceptive use on self-MRI: all $F>4.565$, all $p<.036$; main effect of partner contraceptive use on partner-MRI: $F>3.982$, all $p<.049$), except that the main effect of partner contraceptive use on self-MRI was only marginally significant when controlling for

RAS scores ($F_{1,102}=3.392$, $p=.06$). For women, repeating the above analyses using relationship length, SOI-R scores, RAS scores, and reported relationship commitment as covariates did not alter the findings (main effect of contraceptive use on self-MRI: all $F>4.343$, all $p<.04$; main effect of contraceptive use on partner-MRI: all $F<.748$, all $p>.55$), except that the main effect of partner contraceptive use on self-MRI was only marginally significant when controlling for RAS scores ($F_{1,102}=3.062$, $p=.053$) and SOI-R scores ($F_{1,102}=2.493$, $p=.08$). We note, however, that the general pattern of results remained.

Finally, we investigated the effects of hormonal contraceptive use on the types of mate retention behavior reported while controlling for these potential confounds. Controlling for age using univariate ANCOVAs [dependent variables: intersexual manipulations (self, partner), intrasexual manipulations (self, partner); fixed factor: female contraceptive use (yes, no); covariate: age] revealed results in line with the above non-parametric statistics for women's intersexual manipulations (self-reported: $F_{1,102}=6.464$, $p=.013$; reports on partner: $F_{1,102}=.853$, $p>.35$), women's intrasexual manipulations (self-reported: $F_{1,102}=2.290$, $p>.13$; reports on partner: $F_{1,102}=.219$, $p>.64$), men's intersexual manipulations (self-reported: $F_{1,102}=3.859$, $p=.052$; reports on partner: $F_{1,102}=7.001$, $p=.01$), and men's reports on partner intrasexual manipulations ($F_{1,102}=3.595$, $p=.06$), but not for men's self-report intrasexual manipulations ($F_{1,102}=2.717$, $p=.103$). For women, repeating these analyses controlling for relationship length, SOI-R scores, RAS scores, and reported relationship commitment as covariates revealed results in line with the above-mentioned non-parametric statistics for self-reported intersexual manipulations (relationship length: $F_{1,102}=6.289$, $p=.014$; SOI-R: $F_{1,102}=4.769$, $p=.032$; RAS: $F_{1,102}=2.864$, $p=.09$; commitment: $F_{1,102}=5.916$, $p=.017$), self-reported intrasexual manipulations (all $F<2..489$, all $p>.11$), reports of partner intersexual manipulations (all $F<.867$, all $p>.32$), and reports of partner intrasexual manipulations (all $F<.343$, all $p>.55$). For men, repeating these analyses with relationship length, SOI-R scores, RAS scores, and reported relationship commitment as covariates also revealed results in line with the non-parametric statistics described above for self-reported intersexual manipulations (relationship length: $F_{1,102}=5.171$, $p=.025$; SOI-R: $F_{1,102}=3.772$, $p=.056$; commitment: $F_{1,102}=3.987$, $p=.049$), self-reported intrasexual manipulations (relationship length: $F_{1,102}=4.674$, $p=.033$; SOI-R: $F_{1,102}=2.842$, $p=.096$), reports of partner intersexual manipulations (relationship length: $F_{1,102}=9.864$, $p=.002$; SOI-R: $F_{1,102}=8.825$, $p=.004$; RAS: $F_{1,102}=8.119$, $p=.006$; commitment: $F_{1,102}=7.330$, $p=.008$), and reports of partner intrasexual manipulations (relationship length: $F_{1,102}=8.423$, $p=.005$; SOI-R: $F_{1,102}=6.971$, $p=.01$; RAS: $F_{1,102}=5.279$, $p=.024$; commitment: $F_{1,102}=3.994$, $p=.048$), except for men's self-reported intersexual manipulations when controlling for RAS scores ($F_{1,102}=2.374$, $p=.13$) and men's self-reported intrasexual manipulations when controlling for RAS scores ($F_{1,102}=2.143$, $p=.15$) or reported commitment ($F_{1,102}=2.385$, $p=.13$).

Discussion

We found that women using hormonal contraceptives made more use of mate retention tactics than women not using hormonal contraceptives. This is the first evidence that hormonal contraceptive use is linked with mate retention behavior in women. This work builds on that of Geary et al. (2001), who found that women who use hormonal contraceptives report more intense affective responses to partner infidelity and greater overall sexual jealousy than women not using hormonal contraceptives (see also Cobey et al., 2011). Importantly, our data demonstrate that hormonal contraceptive use may affect not only women's cognition, but also how they behave toward their partner and their rivals in a manner that is likely to influence their relationship quality and stability. Mate retention behaviors can be antisocial and include acts of physical violence and emotional manipulation, the effects of which may range from relationship disruption to dissolution (Buss, 1988; Buss and Shackelford, 1997; Buss et al., 2008). Indeed, when looking at the types of mate retention behaviors used by our participants, we found that women's self-reported frequency of mate retention tactics directed at their partners was related to their use of hormonal contraception, while their frequency of mate retention tactics directed at rivals was not (although reports from male partners suggested that women who used hormonal contraceptives perform more frequent intrasexual manipulations).

Although previous research has shown that use of both hormonal contraceptives (Glei, 1999) and mate retention tactics (Buss and Shackelford, 1997) is greater among younger persons, there was neither a relationship between hormonal contraceptive use and age in our main sample nor in a separate, larger sample of women from the same population. Additionally, controlling for age using parametric statistics did not alter our main findings with regards to effects of female contraceptive use on total mate retention scores in men and women. While the correlation between women's age and self-MRI approached significance, we note that this correlation was in the opposite direction to that which would have produced our findings. It is also possible that women who score high on the MRI-SF differ in some fundamental ways from those who score low on the MRI-SF, and that these differences affect decisions to use hormonal contraceptives. These potential attitudinal differences between women who choose to use hormonal contraception and women who choose not to use hormonal contraception could also relate to the behavior of women's mates by influencing women's choice of partner, or if women's mate retention behaviors influence those of their mates. However, we found no differences in relationship length, sociosexual orientation (as measured by the SOI-R), relationship satisfaction (as measured by the RAS), or reported relationship commitment as a function of hormonal contraception use in women, or partner's use of hormonal contraception in men. Collectively, these findings indicate that differences in age, relationship length, sociosexual orientation, relationship satisfaction, and relationship commitment between couples who use or do not use hormonal contraceptives are unlikely to explain our findings, at least in women. Furthermore, we note that our finding of a relationship between synthetic estradiol dosage and self-MRI scores among hormonal contraception users suggests that simple differences between hormonal contraceptive users and non-users are not a sufficient explanation. While it is possible that other factors not considered here influenced our results, our findings lend support to the suggestion that hormonal contraceptive use may impact mate choice (see Alvergne and Lummaa, 2009; Havlicek and Roberts, 2009; Roberts et al., 2008; Wedekind and Füri, 1997) and behavior toward one's mate.

With regard to the hormonal mechanisms that potentially underpin this change in behavior, we found that synthetic estradiol dosage was associated with the extent to which women engaged in mate retention behaviors. Although levels of synthetic progesterone dosage in hormonal contraceptives are generally higher than levels of synthetic estradiol dosage, there was no association between synthetic progesterone level and women's mate retention behaviors. This is in line with Cobey et al.'s (2011) finding that higher levels of synthetic estradiol, and not progestin, are associated with significantly higher levels of self-reported jealousy. Together, this indicates that the synthetic estradiol contained in combined oral contraceptives may account for the increased jealousy and use of mate retention tactics reported by women using hormonal contraception versus naturally cycling women. Although hormonal contraceptives actually suppress ovarian hormone production (Fleischman et al., 2010), the direct action of synthetic exogenous estradiol itself may account for these differences. However, we concede that the result of an effect of synthetic estradiol dosage on women's mate retention behaviors would be more compelling if men's reports of their partner's mate retention behaviors were significantly associated with partner estradiol dosage as

well. Alternatively, synthetic estradiol may alter other aspects of physiology that, in turn, influence mate retention behavior. Further research could also examine naturally occurring variation in women's estradiol to determine whether variation in estradiol and progestin is associated with mate retention behavior in naturally cycling women.

Men whose partners used hormonal contraceptives reported more frequent mate retention tactics than men whose partners did not. One might predict that men whose partners use hormonal contraceptives would be less protective of their partners' fidelity because contraceptives preclude conception, meaning that these men stand a reduced chance of unknowingly investing in another man's offspring if their partner strays. It is possible that men whose partners use hormonal contraceptives are simply reacting to their partner's increased jealousy (Cobey et al., 2011; Geary et al., 2001) and use of mate retention tactics by increasing their own use of mate retention tactics. Indeed, hormonal contraceptive use also predicted men's assessments of their partner's MRI, with men reporting that their partners used more mate retention tactics if those partners used hormonal contraception, indicating that men do perceive the difference in their partner's mate retention behavior associated with hormonal contraceptive use. To test this hypothesis it would be necessary to investigate whether female mate retention behavior promotes male mate retention behavior, perhaps by collecting longitudinal data on mate retention over developing relationships. However, controlling for men's RAS scores removed the effect of partner hormonal contraceptive use on men's self-reported intersexual manipulations, and controlling for RAS scores or reported commitment removed the effect of partner hormonal contraceptive use on men's self-reported intrasexual manipulations. This indicates that the effects of partner hormonal contraceptive use on men's self-reported mate retention behaviors may be driven by other underlying factors, such as relationship satisfaction or commitment. Therefore, the effects of partner hormonal contraceptive use on men's self-reported mate retention behaviors should be interpreted cautiously.

Given that men whose partners reported using hormonal contraception reported engaging in more mate guarding behaviors, one interesting and somewhat unexpected finding was that women's partner-MRI was not related to hormonal contraceptive use (as would be expected given that men's self-MRI was related to hormonal contraceptive use, though controlling for RAS scores removed this relationship). This suggests that women using hormonal contraceptives do not perceive or interpret their partner's mate retention behaviors accurately or, perhaps less likely, that men whose partners use hormonal contraceptives over-report their own mate retention behaviors. In contrast to our null finding, past research has found that the MRI shows high congruence between self-report and spouse-report methods (Shackelford et al., 2005a), indicating that married partners can reliably describe one another's mate retention behaviors. Moreover, women's reports of partner-MRI have been used in past studies as evidence that men increase their mate guarding behaviors when their partners are fertile (Gangestad et al., 2002; Haselton and Gangestad, 2006; Pillsworth and Haselton, 2006). Alternatively, while we acknowledge that it is difficult to interpret a null finding, this could also indicate that women are not as adept at reporting their partner's mate retention tactics as previously thought, or that estimates of partner mate retention behavior are less accurate among young, perhaps comparatively less committed couples.

In addition to being in line with Geary et al.'s (2001) finding that women who use hormonal contraceptives report more intense affective responses to partner infidelity and greater overall sexual jealousy, and Cobey et al.'s (2011) finding that feelings of jealousy vary with the dose of synthetic estradiol in combined oral contraceptives, these findings also compliment other research on the effects of hormonal contraceptive use on women's behavior. Past research has found effects of hormonal contraceptive use on women's sexual behavior (Guillermo et al., 2010; Little et al., 2002), sexual desires (Wallwiener et al., 2010), and rates of depression (Kulkarni, 2007). Other studies have found that the preference shifts across the ovulatory cycle present in normally cycling women are absent in hormonal contraceptive using women (Gangestad et al., 2007; Haselton and Miller, 2006; Johnston et al., 2001; Jones et al., 2005b; Little et al., 2007; Pawłowski and Jasienska, 2005; Penton-Voak et al., 1999; Puts, 2005, 2006; Rosen and López, 2009). Similarly, Roberts et al. (2008) (see also Wedekind et al., 1995) found a significant preference shift toward MHC similarity associated with hormonal contraceptive use, suggesting that hormonal contraceptive use may disrupt potentially adaptive MHC-disassortative mate preferences. Therefore, as suggested by Cobey et al. (2011), it may be that the changes in preferences for masculinity and genetic dissimilarity that are associated with hormonal contraceptive use are mediated not just by the absence of an estrus phase but also by synthetic estradiol concentrations in hormonal contraceptives. Together with our current research, these studies suggest a possible influence of synthetic hormones on romantic and other behaviors.

Conclusions

We have shown that hormonal contraceptive use by women predicts intra-couple behavior, and that estradiol level may be the mediating factor in this relationship. This research provides converging evidence for the idea that hormonal contraceptive use impacts mate choice and relationship quality, and opens up avenues for future studies that examine the direct impact of hormonal contraceptive use on behavior and mate choice in both hormonal contraceptive users and their partners.

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