

The association between discontinuing hormonal contraceptives and wives' marital satisfaction depends on husbands' facial attractiveness

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How are hormonal contraceptives (HCs) related to marital well-being? Some work suggests HCs suppress biological processes associated with women's preferences for partner qualities reflective of genetic fitness, qualities that may be summarized by facial attractiveness. Given that realizing such interpersonal preferences positively predicts relationship satisfaction, any changes in women's preferences associated with changes in their HC use may interact with partner facial attractiveness to predict women's relationship satisfaction. We tested this possibility using two longitudinal studies of 118 newlywed couples. Trained observers objectively rated husbands' facial attractiveness in both studies. In study 1, wives reported their marital satisfaction every 6 mo for 4 y and then reported the history of their HC use for their relationship. In study 2, wives reported whether they were using HCs when they met their husbands and then their marital satisfaction and HC use every 4 mo for up to three waves. In both studies, and in an analysis that combined the data from both studies, wives who were using HCs when they formed their relationship with their husband were less satisfied with their marriage when they discontinued HCs if their husband had a relatively less attractive face, but more satisfied if their husband had a relatively more attractive face. Beginning HCs demonstrated no consistent associations with marital satisfaction. Incongruity between HC use at relationship formation and current HC use was negatively associated with sexual satisfaction, regardless of husbands' facial attractiveness. These findings suggest that HC use may have unintended implications for women's close relationships.

hormonal contraceptives | marriage | physical attractiveness | evolutionary psychology | human mating

The majority of women living in industrialized nations use hormonal contraceptives (HCs) at some point during their lives (1, 2). Adding to a robust literature that already documents important intrapersonal implications of HCs (3), a growing literature suggests that HCs may also have an important interpersonal implication—they may affect women's evaluations of their romantic relationships.

According to biological perspectives on human mating, women evolved to be attracted to partner qualities reflective of genetic fitness, qualities that may be summarized by facial attractiveness (4–7). However, there is some evidence that HC use weakens the hormonal processes that partially account for these preferences (8) (for exceptions, see refs. 9 and 10). Specifically, a few studies demonstrate that women using HCs show weaker cyclical shifts in preferences for cues of genetic fitness than do nonusers (11–14). Further, a few additional studies demonstrate that women using HCs demonstrate weaker overall preferences for cues of genetic fitness than do nonusers (15, 16). In one study, for example, women showed a weaker preference for facial masculinity when using HCs versus not (16).

What then are the implications of HCs for women's long-term relationships? Some women use HCs before entering a committed relationship and thus choose a long-term partner while using HCs. However, at some point during the relationship, women must discontinue using HCs to conceive, which the majority of women

eventually do (17). Other women, in contrast, may choose a partner while not using HCs and at some point during the relationship may begin using HCs as they become sexually active. It is possible that any changes in preferences for partner genetic fitness associated with changes in HC use may have implications for women's relationship satisfaction. According to interdependence theory (18, 19) and supportive research (20), having a partner who meets one's interpersonal preferences is positively associated with overall relationship satisfaction. Thus, the changes in women's preferences for cues of partner genetic fitness that may accompany corresponding changes in their HC use may interact with actual cues of their partners' genetic fitness, such as overall facial attractiveness, to predict women's relationship satisfaction. Specifically, women who form a relationship when using HCs and later discontinue using HCs may begin to prioritize cues of partner genetic fitness to a greater extent and thus experience increases in satisfaction if their partner's face contains numerous cues of genetic fitness (i.e., is relatively attractive), but decreases in satisfaction if their partner's face contains fewer cues of genetic fitness (i.e., is relatively less attractive). In contrast, women who form a relationship when not using HCs and later begin using HCs may begin to prioritize cues of partner genetic fitness to a lesser extent and thus experience decreases in satisfaction if their partner's face contains numerous cues of genetic fitness (given that such cues may become less important to them), but subsequent increases in satisfaction if their partner's face contains fewer cues of genetic fitness.

We are aware of two published studies that have examined the implications of HCs for women's established relationships. Roberts et al. (21) reported that women who used HCs when

Significance

Hormonal contraceptives (HCs) are believed to suppress biological processes associated with women's preferences for cues of partner genetic fitness, cues that may be summarized by men's facial attractiveness. Two longitudinal studies of marriage demonstrate that wives who used HCs at relationship formation became less satisfied when they discontinued HCs if their husband had a relatively less attractive face, but more satisfied if their husband had a relatively more attractive face. Incongruity between HC use at relationship formation and current HC use was negatively associated with sexual satisfaction, regardless of husbands' facial attractiveness. Practically, these findings suggest that discontinuing HCs may have critical unintended effects on women's relationships. Theoretically, they indicate that evolved mating processes have implications for established relationships.

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they chose their partner and then bore children with those partners (and thus must have discontinued using HCs) were less satisfied with the sexual aspects of their relationships, but more satisfied with their partners' financial provision. Likewise, Roberts et al. (22) reported that women who discontinued using HCs during an ongoing relationship reported lower levels of sexual satisfaction and no changes in satisfaction with their partners' financial provision and intelligence. However, neither of these studies examined the role of cues of partner genetic fitness. As noted, any shifts in women's preferences for partner genetic fitness that coincide with changes in HC use should interact with such cues to predict women's relationship satisfaction.

We used data obtained from two longitudinal studies to examine whether the association between wives' HC use and their marital satisfaction depended on (i) whether wives were using HCs when they entered into their relationship with their husband and (ii) their husband's facial attractiveness. Based on the possibility that HC discontinuation leads wives to more strongly prioritize partner facial attractiveness, we expected HC discontinuation to interact with husbands' facial attractiveness to predict wives' marital satisfaction, such that HC discontinuation would be negatively associated with marital satisfaction among wives married to husbands with relatively less attractive faces but positively associated with marital satisfaction among wives married to husbands with relatively more attractive faces. We also examined whether beginning the use of HCs was positively associated with marital satisfaction among wives married to husbands with relatively less attractive faces but negatively associated with satisfaction among wives married to husbands with relatively more attractive faces. Finally, we attempted to replicate the association between changing HC use and wives' sexual satisfaction (21, 22).

Materials and Methods

Participants. The participants in study 1 were 48 couples who participated in a broader longitudinal study of 135 newlywed couples. These 48 couples were those for whom the wife provided HC data during the fourth and final year of the study. The wives who did not provide the HC data either had discontinued the study ($n = 11$), had divorced or separated ($n = 14$), or did not respond to the inquiry ($n = 62$). No wives refused to provide HC data. The couples who provided the data necessary to be included in these analyses did not differ from those who did not provide such data on any of the variables examined here ($P > 0.45$). The participants in study 2 were 70 couples participating in a broader longitudinal study of 79 newlywed couples. Nine couples were excluded because the wives had experienced menopause. See *SI Materials and Methods* for details regarding recruitment and sample characteristics.

Procedure. At baseline, couples in both studies were either mailed a packet of surveys to complete at home and bring with them to a laboratory session or emailed a link to Qualtrics.com, where they completed surveys online before their laboratory session. These surveys included a consent form approved by the University of Tennessee Institutional Review Board and the Florida State University Human Subjects Committee, measures of marital and sexual satisfaction, other measures beyond the scope of the current analyses, and a letter instructing couples to complete their questionnaires independently of one another. In study 2, wives also reported whether they were pregnant and, if not, whether they were currently using HCs and whether the couple was trying to get pregnant. During the laboratory session, each member of the couple was photographed and couples completed other tasks beyond the scope of the current analyses. Couples in study 1 were paid US\$80 and couples in study 2 were paid US\$100 for completing this baseline phase.

Subsequent to the baseline session, couples in study 1 were contacted approximately every 6 to 8 mo for ~4 y and mailed the same marital and sexual satisfaction measures, as well as other measures beyond the scope of the current analyses. Couples in study 2 were contacted every 4 mo up to three times and emailed a link to the same marital and sexual satisfaction measures, the same measure of HC use and pregnancy-related issues, and other measures beyond the scope of the current analyses. Couples in study 1 were paid US\$50 and couples in study 2 were paid US\$25 for completing these phases.

During the fourth and final year of study 1 (when the current hypotheses were developed), wives were contacted via phone or email and asked to provide information regarding their HC use over the entire course of their relationship. Wives who responded were provided a link to SurveyMonkey.com, where they were asked to provide consent to answer additional questions regarding their HC use. Participating wives were mailed US\$25.

Measures.

Wives' HC use at relationship formation. We asked wives in both studies whether they were using HCs when they began their relationship with their husband and dummy-coded their responses (0 = no, 1 = yes).

Wives' HC use during their relationship. In study 1, we asked wives to retrospectively list the types of HCs they used since they began their relationship and the start and end dates for the periods during which they used each type of HC. Although prior research has demonstrated that women are relatively accurate when reporting their HC history (23), we took two steps to increase the accuracy of their reports. First, we encouraged wives to consult their physician and/or medical records if they were unsure of the type used or the period during which they used it. Second, we verified that the type (and brand, if provided) of birth control listed was in fact hormonal. We used this information to create a dummy code indicating whether or not wives had used HCs during each phase of data collection (0 = no, 1 = yes). [Progesterone-only HC formulations may affect mate preferences differently than HC formulations containing estrogen (24). No women reported using progesterone-only formulations when they began their relationships with their husbands and one woman reported using a progesterone-only formulation during the final two assessments of the study. Notably, subsequent analyses indicated the three-way interaction remained significant when excluding the two assessments during which that wife used a progesterone-only HC; $t(219) = -2.26, P = 0.03$.]

In study 2, we asked wives at each assessment whether they were using HCs. We then formed a dummy code indicating whether they were using HCs at the time they completed the assessment (0 = no, 1 = yes).

Facial attractiveness. According to some perspectives, facial attractiveness summarizes overall genetic fitness (4–7). Given that our predictions regard overall genetic fitness, rather than any specific cue of genetic fitness (e.g., masculinity, symmetry, MHC heterogeneity), a group of trained research assistants ($n = 5$ in study 1; $n = 4$ in study 2) rated the facial attractiveness of each spouse from the photographs that were taken at baseline, using a scale ranging from 1 to 10, where higher ratings indicated more physically attractive faces. In both studies, participants stood in front of a blank, white wall and were told to maintain a comfortable expression while their photograph was taken. The photographs used in study 1 depicted the spouses' faces from the shoulders up, and all judges were instructed to rate the facial attractiveness only. The photographs used in study 2 were similar, except they were additionally cropped so that only the spouses' faces were shown. To further ensure that ratings of husbands' facial attractiveness were not confounded with ratings of their body attractiveness, which may be less indicative of genetic fitness, judges also rated separate photographs that depicted the bodies of husbands in both studies, and we controlled for these ratings in supplemental analyses. Coders rated each spouse independently. The reliability of our coders was adequate [in study 1, interclass correlation (ICC) = 0.78 for husbands and ICC = 0.92 for wives; in study 2, ICC = 0.85 for husbands and ICC = 0.88 for wives]. We used the mean attractiveness ratings across judges as our measure of each spouse's facial attractiveness.

Marital satisfaction. Although prior work examining the role of HCs for women's satisfaction with nonsexual aspects of their relationship (21, 22) has examined their satisfaction with specific aspects of the relationship (e.g., partners' financial provision, intelligence), we used a global measure of marital satisfaction to capture the extent to which wives were generally satisfied with their marriages because we believed such a global evaluation would be most likely to capture the extent to which wives were susceptible to the interactive effects of their shifting preferences for cues of genetic fitness and their husbands' facial attractiveness. Indeed, relationship scholars (25, 26) have pointed out that examining the effects of specific processes (e.g., behavior, cognition, preferences) on evaluations of a relationship requires assessing global evaluations of the marriage. We assessed marital satisfaction in both studies with the Quality Marriage Index (27), a measure that requires spouses to report their agreement with six general statements regarding their marital satisfaction (e.g., "My relationship with my partner makes me happy"). Five items use a seven-point scale and one item uses a 10-point scale. All items were summed for each participant. Internal consistency was acceptable (in study 1, $\alpha > 0.85$ for husbands and 0.88 for wives at each assessment; in study 2, $\alpha > 0.95$ for husbands and 0.92 for wives at each assessment).

Sexual satisfaction. In study 1, sexual satisfaction was assessed with the Index of Sexual Satisfaction (28), a measure that requires spouses to report their agreement with 25 statements regarding their satisfaction with the sexual relationship with their spouse using a seven-point scale (sample items include, "Sex is fun for my partner and me"). All items were summed for each participant. Internal consistency was acceptable ($\alpha > 0.94$ for husbands and wives at each assessment). In study 2, sexual satisfaction was assessed with one item (i.e., "How satisfied are you with the quality of the sex you have had with your spouse over the past 4 mo?") using a seven-point scale.

Results

Sixteen (33%) of the 48 wives in study 1 and 37 (53%) of the 70 wives in study 2 reported using HCs at relationship formation. Ten (63%) of these wives in study 1 and 17 (46%) of these wives in study 2 reported discontinuing HCs at some point during their relationship. Ratings of husbands' facial attractiveness were normally distributed in both studies (in study 1, skewness = 0.12, kurtosis = -0.42; in study 2, skewness = 0.43, kurtosis = 0.20). Growth curve analyses indicated that these wives experienced declines in their satisfaction over time [in study 1, $b = -0.17$, $SE = 0.05$, $t(234) = -3.23$, $P < 0.01$; in study 2, $b = -0.21$, $SE = 0.06$, $t(156) = -3.40$, $P < 0.01$]. Although partial correlations between wives' HC use at relationship formation and husbands' facial attractiveness, controlling for wives' facial attractiveness, did not reach significance in study 1 ($r = -0.15$, $P = 0.31$) or study 2 ($r = -0.09$, $P = 0.47$), this correlation was marginally significant in an analysis that combined the data from both studies ($r = -0.16$, $P = 0.09$), providing some evidence that wives who used HCs at relationship formation chose less attractive husbands. Husbands' facial attractiveness was not significantly associated with whether or not wives discontinued HCs [in study 1, $b = -0.09$, $SE = 0.13$, $t(44) = -0.71$, $P = 0.48$; in study 2, $b = 0.09$, $SE = 0.09$, $t(66) = 0.88$, $P = 0.32$]. Descriptive statistics and bivariate correlations for each study appear in Table S1.

To ease interpretation of parameter estimates, all of the following primary analyses were conducted using standardized versions of all continuous independent variables and grand-centered values of all HC variables. We first tested the main effect of wives' HC use for their marital and sexual satisfaction, without accounting for whether they were using HCs at relationship formation or their husbands' attractiveness. Using multilevel modeling, we regressed wives' reports of satisfaction at each assessment onto the dummy code indicating whether wives used HCs at each assessment. To control the influence of relationship-specific factors and changes in each type of satisfaction over time, we controlled for month of assessment and husbands' corresponding levels of satisfaction by estimating the following two-level model using the HLM 7 computer program (Scientific Software International) (Eq. 1):

$$Y_{ii}(\text{wives' satisfaction}) = b_{0i} + b_{1i}(\text{month of assessment}) + b_{2i}(\text{husbands' satisfaction}) + b_{3i}(\text{HC status}) + e_{0ii} + r_{0i}. \quad [1]$$

We estimated Eq. 1 six times: once for each type of satisfaction (marital and sexual) in each study and once for each type of satisfaction combining the data across studies, but controlling for idiosyncratic differences between studies using a dummy code. In the combined analyses, wives' sexual satisfaction was standardized before combining the data due to the different measures used in the two studies.

Results are presented in the section of Table 1 labeled as model A. HC use was unassociated with either type of satisfaction on average across all analyses except one: Among wives in study 1, HC use was negatively associated with wives' marital satisfaction, indicating that wives in study 1 were less satisfied with their marriages on average when they used HCs. This association did not reach significance in the other five analyses.

Next, we tested whether the associations between wives' HC use and satisfaction estimated in the previous analyses were moderated by whether they were using HCs at relationship formation—i.e., whether beginning or discontinuing HCs was associated with wives' marital or sexual satisfaction. To do this, we repeated the previous analyses except we also entered the dummy code indicating whether wives were using HCs at relationship formation to account for variance in the intercept and current HC status slope estimates in the second level of the model to create the current HC status \times HC status at relationship formation interaction with the following equation (Eq. 2):

$$Y_{ii}(\text{wives' satisfaction}) = b_{0i} + b_{1i}(\text{month of assessment}) + b_{2i}(\text{husbands' satisfaction}) + b_{3i}(\text{current HC status}) + b_{4i}(\text{HC status at relationship formation}) + b_{5i}(\text{current HC status} \times \text{HC status at relationship formation}) + e_{0ii} + r_{0i}. \quad [2]$$

In this model, the current HC status \times HC status at relationship formation interaction tests the effect of HC congruency (i.e., beginning or discontinuing HC use) on satisfaction. These tests are very similar to the tests conducted by Roberts et al. (22), with the exception that our measure of relationship satisfaction was intentionally more global.

Results are presented in the section of Table 1 labeled as model B. The current HC status \times HC status at relationship formation interaction was not associated with wives' marital satisfaction, indicating that HC congruency was unrelated with general relationship satisfaction, on average. Nevertheless, as can be seen in Table 1, the current HC status \times HC status at relationship formation interaction was positively associated with wives' sexual satisfaction in all three analyses, indicating that HC congruency was positively associated with wives' sexual satisfaction in both studies and the analysis that combined the two studies. Replicating prior research (21, 22), wives who were using HCs at relationship formation became less sexually satisfied when they discontinued HCs in all three analyses [in study 1, $t(188) = -2.23$, $P = 0.03$; in study 2, $t(82) = -2.07$, $P = 0.04$; in combined, $t(274) = -2.89$, $P < 0.01$]. Further, wives who were not using HCs at relationship formation also became less sexually satisfied when they began using HCs in study 1 and the combined analysis, [in study 1, $t(188) = -2.13$, $P = 0.03$; in combined, $t(274) = -1.99$, $P < 0.05$]. Although this effect did not quite reach significance in study 2 [$t(82) = -1.06$, not significant (NS)], it also did not differ statistically across the two studies [$t(272) = 0.00$, NS].

Finally, we tested our primary prediction that the association between HC congruency and wives' marital satisfaction depends on husbands' facial attractiveness. To do this, we repeated the previous analyses except this time we additionally added husbands' facial attractiveness, and the HC status at relationship formation \times husbands' facial attractiveness interaction to account for variance in the intercept and current HC status slope estimates in the second level of the model to create the crucial current HC status \times HC status at relationship formation \times husbands' facial attractiveness interaction and all lower level interactions with the following model (Eq. 3):

$$Y_{ii}(\text{wives' satisfaction}) = b_{0i} + b_{1i}(\text{month of assessment}) + b_{2i}(\text{husbands' satisfaction}) + b_{3i}(\text{current HC status}) + b_{4i}(\text{HC status at relationship formation}) + b_{5i}(\text{husbands' facial attractiveness}) + b_{6i}(\text{current HC status} \times \text{HC status at relationship formation}) + b_{7i}(\text{current HC status} \times \text{husbands' facial attractiveness}) + b_{8i}(\text{HC status at relationship formation} \times \text{husbands' facial attractiveness}) + b_{9i}(\text{current HC status} \times \text{HC status at relationship formation} \times \text{husbands' facial attractiveness}) + e_{0ii} + r_{0i}. \quad [3]$$

In this model, the current HC status \times HC status at relationship formation \times husbands' facial attractiveness interaction tests

Table 1. Associations between wives' marital satisfaction and initial contraceptive status, current contraceptive status, husbands' facial attractiveness, and their interactions

Independent variables	Marital satisfaction						Sexual satisfaction					
	Study 1		Study 2		Combined		Study 1		Study 2		Combined	
	<i>b</i>	<i>r</i>	<i>b</i>	<i>r</i>	<i>b</i>	<i>r</i>	<i>b</i>	<i>r</i>	<i>b</i>	<i>r</i>	<i>b</i>	<i>r</i>
	Model A [†]											
Intercept	40.23	—	40.08	—	39.95	—	139.36	—	5.82	—	-0.02	—
Study	—	—	—	—	-1.49	0.17	—	—	—	—	-0.01	0.01
Month of assessment	-1.11**	0.24	-1.05**	0.33	-1.22**	0.24	-0.64	0.04	-0.11	0.19	-0.05	0.05
Husbands' satisfaction	1.44*	0.17	3.91**	0.45	2.57**	0.24	10.71**	0.45	0.29**	0.29	0.36**	0.35
CHCS	-1.57*	0.17	1.48	0.17	-0.37	0.04	-1.97	0.06	0.16	0.09	0.01	0.01
	Model B [‡]											
Intercept	40.23	—	40.28	—	39.95	—	139.20	—	5.77	—	-0.03	—
Study	—	—	—	—	-1.72*	0.19	—	—	—	—	-0.04	0.03
Month of assessment	-1.10**	0.24	-1.03**	0.32	-1.22**	0.24	-0.65	0.04	-0.11	0.19	-0.05	0.06
Husbands' satisfaction	1.44*	0.17	3.87**	0.47	2.55**	0.24	10.35**	0.44	0.31**	0.32	0.37**	0.36
CHCS	-1.44*	0.15	1.39	0.17	-0.46	0.05	0.26	0.01	0.11	0.06	0.08	0.06
HCRF	0.54	0.07	0.64	0.08	1.00	0.12	-2.85	0.10	0.21	0.11	0.06	0.04
CHCS × HCRF	1.19	0.07	-3.62	0.21	-0.16	0.01	15.08**	0.21	0.83*	0.23	0.64**	0.20
	Model C [§]											
Intercept	40.27	—	40.29	—	40.00	—	138.63	—	5.84	—	-0.03	—
Study	—	—	—	—	-2.00*	0.21	—	—	—	—	-0.06	0.04
Month of assessment	-1.09**	0.23	-0.96**	0.30	-1.23**	0.23	-0.57	0.04	-0.12	0.20	-0.05	0.07
Husbands' satisfaction	1.41*	0.17	4.25**	0.52	2.60**	0.25	10.65**	0.45	0.31**	0.34	0.36**	0.36
CHCS	-1.71**	0.19	1.63	0.20	-0.59	0.06	0.59	0.02	0.21	0.13	0.07	0.04
HCRF	0.59	0.07	1.20	0.15	1.21	0.14	-3.58	0.13	0.17	0.10	0.08	0.05
CHCS × HCRF	1.04	0.07	-4.52*	0.27	-0.36	0.02	17.07**	0.27	0.47	0.15	0.60**	0.18
HFA	-0.40	0.09	-0.50	0.14	-0.42	0.10	0.31	0.02	-0.05	0.07	-0.03	0.04
CHCS × HFA	-0.32	0.04	-0.67	0.09	-0.87	0.08	2.60	0.08	-0.43*	0.28	-0.13	0.08
HCRF × HFA	-0.00	0.00	1.65	0.23	0.10	0.01	-5.95	0.19	0.50*	0.30	0.00	0.00
CHCS × HCRF × HFA	-3.64*	0.17	-5.46**	0.34	-2.96*	0.14	3.79	0.04	-0.24	0.08	-0.29	0.09

CHCS, current HC status; HCRF, HC status at relationship formation; HFA, husbands' facial attractiveness; *r*, effect size *r*.

P* < 0.05; *P* < 0.01.

[†]Study 1, *df* = 179 for marital satisfaction and *df* = 189 for sexual satisfaction; study 2, *df* = 82 for all other effects in marital satisfaction model and *df* = 83 for all other effects in sexual satisfaction model; combined, *df* = 116 for study, *df* = 264 for all other effects in marital satisfaction model, and *df* = 275 for all other effects in sexual satisfaction model.

[‡]Study 1, *df* = 46 for HCRF, *df* = 178 for all other effects in marital satisfaction model, and *df* = 188 for all other effects in sexual satisfaction model; study 2, *df* = 68 for HCRF, *df* = 81 for all other effects in marital satisfaction model, and *df* = 82 for all other effects in sexual satisfaction model; combined, *df* = 115 for study and HCRF, *df* = 263 for all other effects in marital satisfaction model, and *df* = 274 for all other effects in sexual satisfaction model.

[§]Study 1, *df* = 44 for HFA, HCRF, and HFA × HCRF, *df* = 176 for all other effects in marital satisfaction model, and *df* = 186 for all other effects in sexual satisfaction model; study 2, *df* = 66 for HFA, HCRF, and HFA × HCRF, *df* = 79 for all other effects in marital satisfaction model and *df* = 80 for all other effects in sexual satisfaction model; combined, *df* = 113 for study, HFA, HCRF, and HFA × HCRF, *df* = 261 for all other effects in marital satisfaction model, and *df* = 272 for all other effects in sexual satisfaction model. Wives' sexual satisfaction was standardized in the combined analyses.

whether the association between HC congruency and satisfaction depends on husbands' facial attractiveness.

Results are presented in the section of Table 1 labeled as model C. The current HC status × HC status at relationship formation × husbands' facial attractiveness interaction was not associated with wives' sexual satisfaction in any of the analyses. Nevertheless, the current HC status × HC status at relationship formation × husbands' facial attractiveness interaction was negatively associated with wives' marital satisfaction in all three analyses. Notably, this interaction remained significant when controlling for wives' facial attractiveness and husbands' body attractiveness in study 1 [*t*(176) = -2.34, *P* = 0.02] and the combined analysis [*t*(261) = -2.41, *P* = 0.02], and wives' facial attractiveness, husbands' body attractiveness, whether wives were pregnant, and whether the couple was trying to get pregnant in study 2 [*t*(75) = -3.41, *P* < 0.01].

Tests of the simple two-way interactions among wives not using HCs when they formed their relationships revealed that husbands' facial attractiveness did not moderate the effects of HC use in any of the three analyses, although it was marginally significant in study 2 [in study 1, *t*(176) = 1.17, NS; in study 2, *t*(79) = 1.98, *P* = 0.05; in combined, *t*(261) = 0.58, NS]. Further,

the pattern of main effects of HC use among wives not using HCs at relationship formation was inconsistent across studies 1 and 2 [in study 1, *t*(176) = -3.11, *P* < 0.01; in study 2, *t*(79) = 3.01, *P* < 0.01] and nonsignificant in the analysis that combined the data from the two studies [*t*(261) = -0.53, NS]. In other words, beginning HC use did not have consistent effects on wives' marital satisfaction and the effects that did emerge did not reliably depend on husbands' attractiveness.

Tests of the simple two-way interactions among wives who were using HCs at relationship formation, in contrast, revealed that husbands' facial attractiveness did moderate the effects of HC use in all three analyses [in study 1, *t*(176) = -2.01, *P* < 0.05; in study 2, *t*(79) = -2.56, *P* = 0.01; in combined, *t*(261) = -2.45, *P* = 0.02]. These significant interactions are plotted in Fig. 1. Given that husbands' facial attractiveness was a continuous variable, we followed the recommendation of Preacher et al. (29) to use the Johnson–Neyman method to identify one-tailed regions of significance of the simple effects of HC use among these wives—i.e., the exact levels of husbands' attractiveness at which HC discontinuation demonstrated significant associations with wives' marital satisfaction. Consistent with predictions, discontinuing HCs was positively associated with marital satisfaction among wives

with husbands who had faces relatively more attractive than the mean (>0.46 SDs in study 1, >0.53 SDs in study 2, and >0.25 SDs in the combined analysis), but negatively associated with marital satisfaction among wives with husbands who had faces relatively less attractive than the mean (<1.80 SDs in study 1, <1.16 SDs in study 2, and <1.34 SDs in the combined analysis).

Although our primary focus regarded the moderating role of husbands' attractiveness, we also examined the simple associations between husbands' attractiveness and wives' marital satisfaction for wives who did versus did not discontinue HCs. Consistent with expectations, husbands' facial attractiveness trended toward being positively associated with marital satisfaction among wives who discontinued HCs [in study 1, $t(44) = 1.73$, $P = 0.09$; in study 2, $t(66) = 1.97$, $P = 0.05$; in combined, $t(113) = 1.69$, $P = 0.09$]. In contrast, husbands' facial attractiveness was unassociated with marital satisfaction among wives who continued using HCs in studies 1 and 2 [in study 1, $t(44) = -0.93$, $P = 0.36$; in study 2, $t(66) = 1.61$, $P = 0.11$], although it was marginally negatively associated with marital satisfaction among such wives in the combined analysis [$t(113) = -1.731$, $P = 0.09$].

Discussion

A growing body of research demonstrates that evolved processes have implications for established relationships (30–36). In one set of studies, naturally cycling women who described their partners as more physically desirable experienced increased satisfaction with those partners while fertile, whereas such women who described their partners as less physically desirable experienced decreased satisfaction with those partners while fertile (36).

However, HCs are believed to suppress the biological processes that account for these effects and thus may have unintended consequences for relationships (8). Providing some initial evidence for such effects, Roberts et al. (21, 22) demonstrated that women who began or discontinued HCs during their relationships were less satisfied with sexual aspects of their relationships. The current research provided a valuable independent replication of that research by revealing that beginning or discontinuing HCs was negatively associated with women's sexual satisfaction in two longitudinal studies of marriage. However, these two studies also extended this prior work by revealing that the association between discontinuing HCs and women's marital satisfaction depended on their husbands' facial attractiveness; whereas discontinuing HCs was associated with greater marital satisfaction among wives with relatively more attractive husbands, it was associated with lower satisfaction among wives with relatively less attractive husbands. Likewise, husbands' attractiveness was positively associated with satisfaction among wives who discontinued using HCs. Partner attractiveness was unassociated with wives' satisfaction among wives who continued using HCs in each study, but negatively associated with wives' satisfaction in the analysis that combined the data from the two studies. Husbands' facial attractiveness did not moderate the effects of wives' HC use on sexual satisfaction.

The fact that husbands' facial attractiveness moderated the association between HC use and wives' marital but not sexual satisfaction suggests that HC congruency may be associated with marital and sexual satisfaction for different reasons. As others have argued (30, 37, 38), global relationship satisfaction may serve as a barometer of the extent to which the relationship meets evolved preferences and needs. If so, the hormonal fluctuations that coincide with ovulation may be an important circuitry through which this link emerges. Given that HCs are thought to disrupt this circuitry, it makes sense that they would weaken the extent to which relationship satisfaction is sensitive to any cues of partner genetic fitness, including facial attractiveness. Discontinuing HCs may interact with husbands' facial attractiveness because it recalibrates women's relationship satisfaction to be more sensitive to such cues. Sexual satisfaction as measured here (28), in contrast, captures the extent to which partners derive physical pleasure from their sexual activities. In this light, any changes in sexual satisfaction should be due to

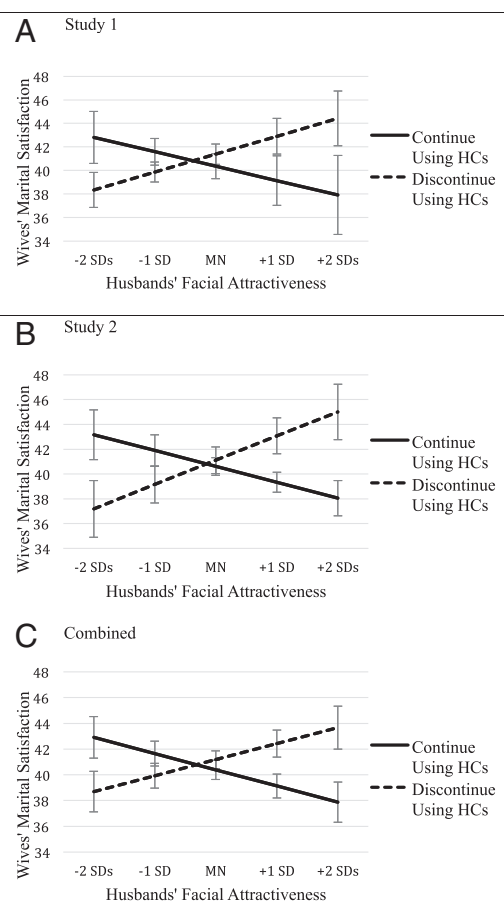


Fig. 1. Husbands' facial attractiveness moderating the association between wives' HC discontinuation and their marital satisfaction in study 1 (A), study 2 (B), and the combined analyses (C).

either changes in preferences for or attitudes toward sexual activities, or changes in sexual activities themselves. Perhaps, then, the association between changes in HC use and decreases in sexual satisfaction is due to hormonal shifts associated with changes in sexual preferences, attitudes, and/or behaviors that are independent of cues of partner genetic fitness. Future research may benefit from addressing these possibilities.

Notably, we did not find consistent evidence that beginning HCs since relationship formation was associated with wives' marital satisfaction. Interestingly, prior research (22) also failed to document consistent effects of beginning HCs for women's satisfaction with their partner's financial provision/intelligence. As others have argued (16), HCs may have their effects through partner choice; women who make such choices while not using HCs may be immune from later effects of HC use on their general satisfaction. Indeed, prior research indicates that women who used HCs at relationship formation tend to choose partners with less masculine faces (16) and there was some weak evidence that the women using HCs at relationship formation in our studies chose less attractive husbands. Future research may benefit by examining whether the null effects of beginning HCs on marital satisfaction observed here and in prior research are moderated by other factors, such as specific cues of partner genetic fitness or factors not linked to genetic fitness.

Our confidence in these findings is enhanced by several strengths. First, the key findings emerged (i) across two independent longitudinal studies, (ii) in an analysis that combined the data across both studies, and (iii) controlling for numerous potential confounds. Second, both studies relied partly on within-person changes in HCs, helping to rule out the influence

of any between-person differences associated with HC discontinuation. Third, the predicted effect remained significant controlling for wives' reports of whether couples were attempting to become pregnant in study 2, which helps rule out the possibility that it was wives' motivations to become pregnant, rather than hormonal changes associated with discontinuing HCs, that interacted with husbands' attractiveness to account for wives' satisfaction. Finally, the analyses provided evidence of a theoretical moderator of the influence of HCs on relationship satisfaction—partner facial attractiveness—strengthening the extent to which these results provide evidence that the effects emerged due to the influence of HCs on evolved preferences for cues of partner genetic fitness.

Nevertheless, several factors limit the interpretations and generalizability of these results until they can be replicated and extended. First, although the within-person design of these studies helps rule out the influence of between-person differences, and although we controlled for important within-person confounds, it remains possible that other confounding factors not controlled in our analyses account for the interactive effects of HC discontinuation. Only experimental research can definitively rule out such alternative explanations. Second, the two samples were relatively homogenous and relied on relatively modest sample sizes. Any generalizations should be made with caution until the findings can be replicated with a larger and more representative sample. Third, given that previous research suggests that estrogen may partially account for women's mate preferences (39), and given that HCs vary in the amount of estrogen they contain, it is possible that the current effects may be

stronger among women using HCs that contain lower amounts of estrogen and weaker, or even nonexistent, among women using HCs that contain higher amounts of estrogen. Of course, given that HCs contain synthetic rather than endogenous hormones, it is also possible that their effects may differ from the effects associated with endogenous hormones. Future research may benefit from examining this possibility. Likewise, future research may benefit from exploring whether the effects observed here were driven by the peaks in endogenous estrogen experienced by women once they discontinue HCs. Fourth, although some perspectives posit that facial attractiveness is a powerful predictor of genetic fitness (4–7), the current study did not examine the role of specific indicators of genetic fitness, such as symmetry, dominance, or partners' MHC dissimilarity. Future research may benefit by attempting to conceptually replicate these results using specific measures of these constructs to determine if one or multiple indicators have similar or different implications.

Finally, it is worth highlighting the potential practical implications of this research. Marital satisfaction is strongly associated with mental (40) and physical health (41); occupational outcomes (42); life satisfaction (43); and a host of physical, mental, and social outcomes for children (44). The fact that wives' HC use was linked to their marital satisfaction suggests that HCs may have far-reaching implications, both beneficial and harmful.

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