

## Relationship satisfaction and outcome in women who meet their partner while using oral contraception

S. Craig Roberts, Katerina Klapilová, Anthony C. Little, Robert P. Burriss, Benedict C. Jones, Lisa M. DeBruine, Marion Petrie and Jan Havlíček

*Proc. R. Soc. B* published online 12 October 2011  
doi: 10.1098/rspb.2011.1647

---

- Supplementary data** ["Data Supplement"](http://rspb.royalsocietypublishing.org/content/suppl/2011/10/10/rspb.2011.1647.DC1.html)  
<http://rspb.royalsocietypublishing.org/content/suppl/2011/10/10/rspb.2011.1647.DC1.html>
- References** [This article cites 29 articles, 8 of which can be accessed free](http://rspb.royalsocietypublishing.org/content/early/2011/10/10/rspb.2011.1647.full.html#ref-list-1)  
<http://rspb.royalsocietypublishing.org/content/early/2011/10/10/rspb.2011.1647.full.html#ref-list-1>
- P<P** Published online 12 October 2011 in advance of the print journal.
- Subject collections** Articles on similar topics can be found in the following collections  
[behaviour](#) (713 articles)
- Email alerting service** Receive free email alerts when new articles cite this article - sign up in the box at the top right-hand corner of the article or click [here](#)
- 

Advance online articles have been peer reviewed and accepted for publication but have not yet appeared in the paper journal (edited, typeset versions may be posted when available prior to final publication). Advance online articles are citable and establish publication priority; they are indexed by PubMed from initial publication. Citations to Advance online articles must include the digital object identifier (DOIs) and date of initial publication.

---

To subscribe to *Proc. R. Soc. B* go to: <http://rspb.royalsocietypublishing.org/subscriptions>

---

# Relationship satisfaction and outcome in women who meet their partner while using oral contraception

S. Craig Roberts<sup>1,\*</sup>, Kateřina Klapilová<sup>2</sup>, Anthony C. Little<sup>1</sup>,  
Robert P. Burriss<sup>1</sup>, Benedict C. Jones<sup>3</sup>, Lisa M. DeBruine<sup>3</sup>,  
Marion Petrie<sup>4</sup> and Jan Havlíček<sup>2</sup>

<sup>1</sup>*School of Natural Sciences, University of Stirling, Stirling FK9 4LA, UK*

<sup>2</sup>*Department of Anthropology, Charles University, Husnikova 2075, 158 00 Prague 13, Czech Republic*

<sup>3</sup>*School of Psychology, University of Aberdeen, Aberdeen AB24 3FX, UK*

<sup>4</sup>*Institute for Ageing and Health, Newcastle University, Newcastle upon Tyne NE4 5PL, UK*

Hormonal variation over the menstrual cycle alters women's preferences for phenotypic indicators of men's genetic or parental quality. Hormonal contraceptives suppress these shifts, inducing different mate preference patterns among users and non-users. This raises the possibility that women using oral contraception (OC) choose different partners than they would do otherwise but, to date, we know neither whether these laboratory-measured effects are sufficient to exert real-world consequences, nor what these consequences would be. Here, we test for differences in relationship quality and survival between women who were using or not using OC when they chose the partner who fathered their first child. Women who used OC scored lower on measures of sexual satisfaction and partner attraction, experienced increasing sexual dissatisfaction during the relationship, and were more likely to be the one to initiate an eventual separation if it occurred. However, the same women were more satisfied with their partner's paternal provision, and thus had longer relationships and were less likely to separate. These effects are congruent with evolutionary predictions based on cyclical preference shifts. Our results demonstrate that widespread use of hormonal contraception may contribute to relationship outcome, with implications for human reproductive behaviour, family cohesion and quality of life.

**Keywords:** mate choice; contraceptive pill; attractiveness; heterozygosity; relationship satisfaction; divorce

## 1. INTRODUCTION

Women express an increased periovulatory preference for traits that signal genetic quality or compatibility [1–4]. Hormonal contraceptives suppress these shifts, leading to different mate preference patterns among users and non-users [5–8] and changes in women's preferences before and after initiating use [9]. To date, this evidence comes from laboratory studies, but it suggests that hormonal contraceptive users might make different actual partner choices than they otherwise would [9–12]. Because oral contraceptives (OCs) are widely used (e.g. 82% of women in the USA have used them at some time [13] and 40–54% of women aged 16–34 currently use them in the UK [14]), such effects could be substantial and widespread.

Research on mate preferences for genetic complementarity at the major histocompatibility complex (MHC) has provided the clearest evidence for these effects. If preferences are typically for MHC-dissimilar partners [8,10], and use of OCs shifts preferences towards MHC-similarity [9], then couples who meet while the woman is using hormonal contraception may be more

likely to be relatively MHC-similar. This could have a negative impact on relationship quality because, once a partnership has formed, subsequent cessation of contraceptive use could lead to realignment of a woman's preferences and reduction in attraction to her partner. Indeed, women who are relatively MHC-similar to their partner report reduced in-pair sexual satisfaction and increased interest in extra-pair relationships [15]. Even if these effects are subtle, they could have measurable downstream consequences for relationship quality and likelihood of separation or divorce [9–12].

However, other research suggests the potential for positive relationship outcomes. Under conditions characterized by high-progesterone levels and low fertility (e.g. in the luteal phase or early pregnancy), women express stronger preferences for social cues associated with direct benefits of mate choice. Because some synthetic progestins have similar effects on brain activity and reproductive behaviour to natural progesterone [16], OC users would maintain a higher level of preference for traits such as wealth and intelligence [17]. Similarly, weaker preferences for facial masculinity in OC users [4–6] could make for more stable relationships, since men with less masculine features (indicative of low testosterone levels) are perceived to be [18], and may actually be [19], less likely to be unfaithful. Thus, this body of research

\* Author for correspondence ([craig.roberts@stir.ac.uk](mailto:craig.roberts@stir.ac.uk)).

Electronic supplementary material is available at <http://dx.doi.org/10.1098/rsob.2011.1647> or via <http://rsob.royalsocietypublishing.org>.

would predict that use of hormonal contraception during partner choice would be positively associated with women's satisfaction with their partner's provision and relationship commitment.

It is not known whether these laboratory-measured effects on women's preferences are sufficiently powerful to influence actual choices that women make in the real world. Furthermore, it is not known how these two kinds of effects interact in determining the outcome of a relationship. Because this question is not easily amenable to experiment in societies in which women exercise free choice, we here address these issues using a quasi-experimental design in which we record relationship satisfaction and survival in a large sample of women who met their partner while they were either using or not using OC. We collected data from 2519 parous women about their relationship with their first child's biological father (hereafter, partner). We selected women with at least one child to standardize (as far as possible) levels of relationship commitment and experiences associated with pregnancy and childcare, and to ensure that women had experienced changes to their hormonal profiles associated with OC use cessation and/or pregnancy during their relationship. For each woman, we used established scales and items to construct composite measures of both sexual and general (non-sexual) satisfaction in the relationship with her partner.

## 2. MATERIAL AND METHODS

### (a) *Participants*

At the time of partnership formation, 1514 women used no form of hormonal contraception and 1005 used combined OC. Users of other forms of hormonal contraception (e.g. progestogen-only pill, implants and injection;  $n = 278$ ) were excluded from analyses because these represented a small proportion of the sample and because these methods differ in hormonal formulation from OCs (e.g. they usually employ only progestogens rather than an oestrogen/progestogen combination). Of the 2519 retained participants, 1761 were still in a partnership with the biological father of their first child. Of the 758 women not still together with the father, 734 had separated from him or formally divorced (we term both as separation); the remaining 24 had been bereaved and were excluded from analyses concerning relationship satisfaction and survival. Average age was 37.7 years (s.d. = 8.6). The majority of the sample was drawn from the USA (1220) and the Czech Republic/Slovakia (999); other participants were from the UK (159), Canada (98) and other countries (43). Additional analyses (see the electronic supplementary material) confirmed that reported effects were not an artefact of regional variation in behaviour.

Participants were recruited via personal contact, by advertisement on pregnancy and parenthood forum websites, and through social networking websites. Surveys were completed online. The only criteria for selection were that participants should be women with at least one biological child. Most participants from the USA were drawn from a participant research panel administered by Qualtrics.com. Czech/Slovak participants were administered the questionnaire in the Czech language. Participants were told that the study was about their experiences of pregnancy, children and their relationship satisfaction, but not the specific hypotheses under test.

### (b) *Measures*

#### (i) *Sexual satisfaction*

Measures of sexual satisfaction were based on those previously used to test effects of MHC-allele sharing on relationship quality by Garver-Apgar *et al.* [15]. To construct a composite measure of sexual satisfaction within their relationship, we recorded women's scores on (i) sexual arousal with their partner, (ii) partner's sexual adventurousness, (iii) the frequency with which they experienced orgasm with their partner during intercourse, (iv) sexual attraction to their partner, and (v) sexual responsiveness to their partner (the sexual proceptivity scale of Ellis's partner-specific Investment Inventory [20]). Scores were given on anchored 9-point rating scales (e.g. for sexual arousal, 1 = 'does not satisfy me at all', 9 = 'completely satisfied'). Correlation analysis shows high concordance among these five measures (Spearman  $\rho = 0.42$ – $0.85$ , see electronic supplementary material, table S1). Scores on each of these measures were then normalized and summed.

#### (ii) *General satisfaction*

Composite scores of general relationship satisfaction, stressing non-sexual aspects of the women's relationship with their partner, were calculated in the same way. We recorded women's scores (using 9-point rating scales, as above) to four questions used by Garver-Apgar *et al.* [15], measuring the extent to which women were satisfied with (i) their partner's provision of financial resources, (ii) faithfulness and loyalty, (iii) intelligence, and (iv) ambition. In addition, we recorded scores on (v) Brown's measure of partner support behaviour [21]. Correlation analysis demonstrated high concordance among these five measures ( $\rho = 0.40$ – $0.57$ , see electronic supplementary material, table S2). Scores for each woman were normalized and summed.

#### (iii) *Sexual rejection and compliant sex*

We recorded women's scores on these measures, also following Garver-Apgar *et al.* [15]. The sexual rejection score comprises three items (e.g. 'I rejected my partner's attempts to initiate sex') and the compliant sex score comprises two items (e.g. 'had sexual intercourse with my partner even though I didn't want to because I felt pressured by his continual arguments'). All items were scored on a 5-point scale, from 1 = 'never' to 5 = 'very often'. Although these measures are to some degree similar to those included in the sexual satisfaction composite measure, we analysed them separately because they capture negative aspects of relationship dynamics and include an element of the partner's coerciveness.

#### (iv) *Attractiveness of partner*

We also calculated a composite score of women's assessment of their partner's attractiveness. We recorded scores (7-point rating scales, from 1 = 'much less than average' to 7 = 'much more than average') on two measures of attractiveness used by DeBruine *et al.* [22] ('compared to other men, how attractive do you consider your partner's [face/body] to be?', Spearman  $\rho = 0.62$ ), and Garver-Apgar *et al.*'s [15] question 'how satisfied are you with your partner's physical attractiveness?' ( $\rho = 0.50$  and  $0.57$ , respectively).

#### (v) *Ratings of ex-partners*

For those couples who had separated, we altered the wording of questions to reflect this; for example, in place of obtaining

Table 1. Differences in partner ratings according to oral contraceptive use during partner choice. Statistically significant comparisons are highlighted in bold.

measure	non-users <sup>a</sup>	OC users <sup>a</sup>	sample size <sup>b</sup>		<i>Z</i> <sup>c</sup>	<i>p</i>
			<i>non-users</i>	<i>OC users</i>		
<i>sexual satisfaction</i>						
sexual arousal	6.07 ± 0.062	5.91 ± 0.068	991	766	2.34	<b>0.020</b>
sexual adventurousness	5.82 ± 0.064	5.62 ± 0.071	990	765	2.52	<b>0.012</b>
sexual proceptivity	3.80 ± 0.026	3.72 ± 0.028	993	766	2.84	<b>0.005</b>
sexual attraction	3.35 ± 0.034	3.20 ± 0.037	990	765	3.20	<b>0.001</b>
orgasm with partner	3.82 ± 0.040	3.79 ± 0.044	991	762	0.99	0.32
<i>general satisfaction</i>						
financial provision	5.74 ± 0.064	6.02 ± 0.067	991	766	2.60	<b>0.009</b>
faithfulness/loyalty	6.79 ± 0.051	6.84 ± 0.058	992	765	0.46	0.64
intelligence	6.80 ± 0.046	6.96 ± 0.047	992	766	1.95	0.051
ambition	5.89 ± 0.059	5.87 ± 0.064	991	764	0.80	0.42
support	4.51 ± 0.035	4.45 ± 0.037	993	766	1.89	0.058
<i>other measures</i>						
partner rejection	2.03 ± 0.030	2.02 ± 0.032	992	765	0.53	0.59
compliant sex	1.46 ± 0.026	1.40 ± 0.027	993	765	0.92	0.36
facial attractiveness	5.01 ± 0.038	4.98 ± 0.038	992	767	0.41	0.68
body attractiveness	4.69 ± 0.043	4.53 ± 0.047	991	765	2.46	<b>0.014</b>

<sup>a</sup>In this table, oral contraceptive (OC) use is at time of meeting partner, irrespective of current usage (in-text additional analyses control for current usage).

<sup>b</sup>Note that sample sizes vary slightly across measures as a small number of women refrained from answering certain questions.

<sup>c</sup>Statistical analyses used non-parametric Mann–Whitney tests; mean rating scores (± s.e.) are shown for ease of interpretation.

levels of agreement with the statement ‘I feel strong sexual attraction toward my partner’ from Garver-Apgar *et al.*’s [15] attraction to partner scale, we used the wording ‘Thinking back about my ex-partner, I felt strong sexual attraction towards him’.

#### (vi) Experience and attitudes towards extra-pair sex

To control for individual differences in the participant’s attitudes towards, desire for, and engagement in extra-pair sex, we used a standard tool, the sociosexual orientation inventory—revised (SOI-R) [23]. This comprises three subscales dealing with past behavioural experiences (e.g. ‘With how many different partners have you had sex within the past twelve months?’), attitude towards uncommitted sex (participants indicate level of agreement with statements such as ‘I can imagine myself being comfortable and enjoying ‘casual’ sex with different partners’), and sociosexual desire (e.g. ‘How often do you have fantasies about having sex with someone with whom you do *not* have a committed romantic relationship?’). Each subscale contains three items that are summed to yield an overall score.

#### (c) Data analysis

##### (i) Relationship satisfaction

Differences in individual measures were first assessed using Mann–Whitney tests. In order to control for possible confounding differences between groups of women (those who were using OCs when they met their partner and those who were not), we used ANOVA, with dependent variables being measures of relationship satisfaction. Between-group factors were the use of OC (versus non-use of any hormonal contraception) when couples met and relationship duration (split by the median relationship length because of skew in this variable). In addition, sociosexuality (SOI-R score) was included in the model as a covariate. Sample sizes vary because some women did not respond to all items.

##### (ii) Relationship outcome

We first used  $\chi^2$ -tests to test for associations between outcome measures (women’s responsibility for initiation of separation and absolute rates of separation) and women’s use of OC when couples met. Subsequently, we used logistic regression to check that associations were robust to key potential confounds (see below).

### 3. RESULTS

#### (a) Relationship satisfaction

Among women whose relationship was ongoing ( $n = 1761$ ), initial analysis revealed several statistically significant differences between women who were using or not using OC when they met their partner (table 1). Women who used OC during partner choice (compared with non-users) scored lower on sexual arousal with their partner, on satisfaction with his sexual adventurousness, and on sexual proceptivity and attraction towards him. They also rated their partner’s body lower in attractiveness compared with non-users. By contrast, these women appeared more satisfied with general (non-sexual) aspects of their partner: they were significantly more satisfied with his financial provision compared with women who were not using OC during partner choice.

Although the results of this initial analysis are consistent with predictions generated by a body of laboratory studies (reviewed above) that suggest that OC use might alter mate preferences, it is possible that some or all of these effects could alternatively arise as a result of between-group differences that are unrelated to mate choice and any disruptive effects of OC. For example, lower sexual satisfaction associated with OC use could instead be due to differences in attitudes towards, or willingness to engage in, uncommitted, short-term

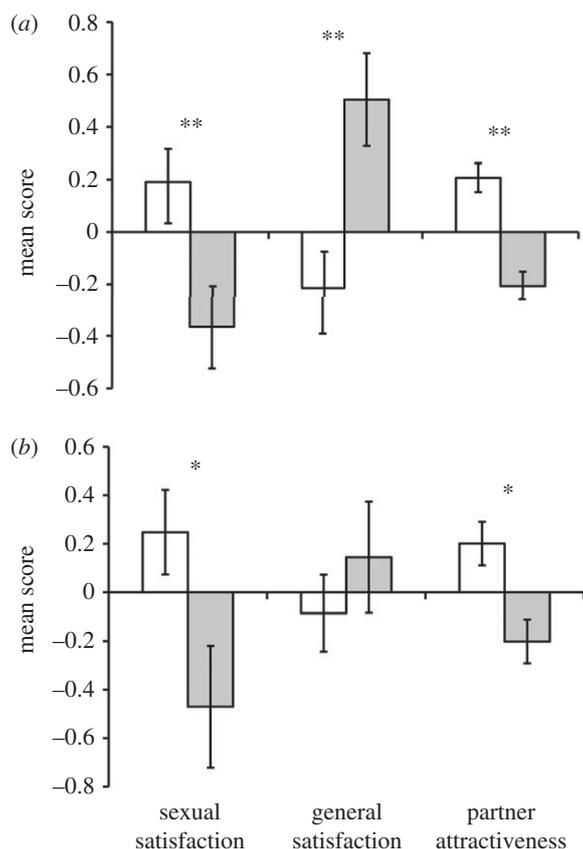


Figure 1. Measures of relationship satisfaction in women who met their partner while either using (grey bars) or not using (white bars) oral contraceptives (OCs). Data show estimated marginal means of standardized scores ( $\pm$  s.e.m), adjusted for SOI-R score, relationship duration and current hormonal condition. Estimates of sexual satisfaction and partner attractiveness also control for general (non-sexual) relationship satisfaction. (a) Women still in a relationship with the biological father of their first child (749 were non-users and 462 were OC users at time of meeting). (b) Retrospective scores of women no longer in a relationship with the father of their first child (492 were non-users and 236 were OC users at time when couples met). Significant differences are indicated by \* $p < 0.05$  and \*\* $p < 0.01$ .

relationships (sociosexuality). Time since partnership formation is also likely to influence relationship satisfaction [24]. Responses to satisfaction measures might also be influenced by hormonal condition. We therefore carried out additional confirmatory analyses using ANOVA to control for these variables. We included SOI-R scores as a covariate, relationship duration as a factor (split by the median) and we accounted for the possibility that current hormonal condition contributes to women's perception of their partner by excluding women who were pregnant or using hormonal contraception during data collection (the corresponding analysis, including only current OC users, retained too few individuals to generate sufficient statistical power). In the analysis of sexual satisfaction and partner attractiveness, we also included general relationship satisfaction as a covariate since this could influence within-couple sexual satisfaction and capture further unspecified aspects of partnership satisfaction that might vary between groups (sexual and general satisfaction were positively correlated:  $r = 0.600$ ,  $p < 0.0001$ ). In this analysis (figure 1a), we again found significantly

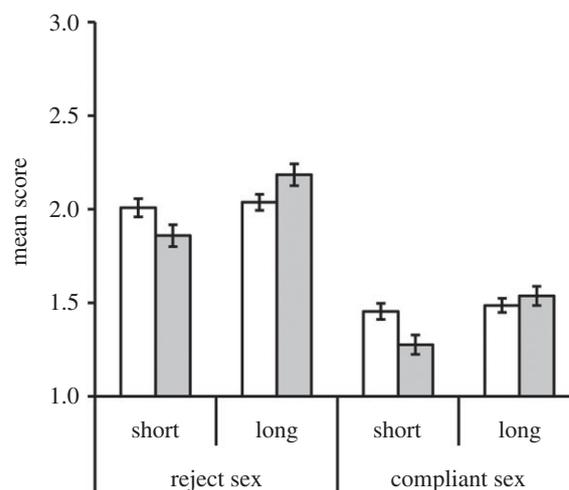


Figure 2. Relative frequency with which women rejected sex with their partner, or undertook compliant sex with him, in still-partnered women who met their partner while either using OC (grey bars,  $n = 461$ ) or not (white bars,  $n = 749$ ). Data are estimated as marginal means ( $\pm$  s.e.m), adjusted for SOI-R score, general relationship satisfaction and current hormonal condition. Both interactions are statistically significant (sexual rejection:  $p = 0.005$ ; compliant sex:  $p = 0.014$ ). Short and long refer to current relationship duration, split by the median relationship length of 142 months.

lower sexual satisfaction in women who were using OC when they met their partner ( $F_{1,1200} = 7.57$ ,  $p = 0.006$ ), despite scoring higher in terms of general satisfaction ( $F_{1,1206} = 10.07$ ,  $p = 0.002$ ). Women also scored their partner as less attractive ( $F_{1,1203} = 13.98$ ,  $p < 0.001$ ) if they met while using OC.

Other measures of sexual satisfaction [15] include the frequency of a woman's acquiescence to sex under pressure from her partner (compliant sex) or with which she rejects her partner's sexual advances. After controlling for sociosexuality, general relationship satisfaction and current hormonal condition, we found significant interactions between OC use during partner choice and relationship length (figure 2): women who used OCs rejected sex ( $F_{1,1204} = 8.08$ ,  $p = 0.005$ ) and engaged in compliant sex ( $F_{1,1204} = 6.12$ ,  $p = 0.014$ ) less frequently than non-users if the relationship was relatively new, but did so more frequently in longer relationships. This interaction appears to explain why neither of these measures approaches statistical significance in the raw dataset (table 1).

#### (b) Ex-partners and initiation of separation

Women no longer with their partner retrospectively assessed the same relationship attributes (figure 1b). Among these women, there was no relationship between OC use during partner choice and recalled general relationship satisfaction ( $p = 0.41$ ), or frequencies of compliant sex ( $p = 0.16$ ) and sexual rejection ( $p = 0.18$ ). However, women who used OCs during partner choice recalled being less sexually satisfied (again, controlling for general satisfaction;  $F_{1,724} = 5.52$ ,  $p = 0.019$ ) and rated their ex-partner as less attractive ( $F_{1,727} = 5.02$ ,  $p = 0.025$ ) compared with non-users, consistent with the women whose relationship was ongoing.

**(c) Relationship outcome**

Finally, we examined whether OC use during partner choice was associated with relationship outcome. Women who used OCs during partner choice were disproportionately likely to have initiated the separation if it occurred (84.8%: 196/231 of separations were initiated by the woman rather than the male partner, excluding six where the woman reported equal responsibility between partners) compared with non-users (73.6%: 349/474, excluding 23 women who reported equal responsibility;  $\chi^2 = 11.14$ , d.f. = 1,  $p = 0.001$ ). This effect remained significant (logistic regression:  $\exp B = 0.495$ ,  $p = 0.001$ ) after controlling for women's age ( $\exp B = 1.0$ ,  $p = 0.71$ ) and sociosexuality ( $\exp B = 1.10$ ,  $p = 0.46$ ).

However, despite this, we found that separation rate was lower if the woman was using OC during partner choice (figure 3a): 237 of 1004 such couples (23.6%) had separated, compared with 497 of 1491 couples (33.3%) in which women were not using hormonal contraception ( $\chi^2 = 27.34$ , d.f. = 1,  $p < 0.0001$ ). A logistic regression analysis, controlling for age and sociosexuality, confirmed that couples were less likely to have separated if the woman used OC during partner choice ( $\exp B = 0.62$ ,  $p < 0.0001$ ), and that this was independent of the effects of sociosexuality ( $\exp B = 2.06$ ,  $p < 0.0001$ ) and age ( $\exp B = 1.06$ ,  $p < 0.0001$ ). Furthermore, among relationships that ended in separation, partnership duration was, on average, two years longer when the woman used OC during partner choice (figure 3b;  $z = 3.39$ ,  $p = 0.001$ ; median relationship length: 60 and 84 months for non-users and users, respectively). This difference was robust to exclusion of outliers and extreme values (defined as scores of between 1.5 and 3 times the inter-quartile range, or more than 3 times the inter-quartile range), with median relationship duration then being 60 and 81 months for non-users and OC users, respectively ( $z = 3.50$ ,  $p < 0.001$ ). Confirmatory analyses (electronic supplementary material) showed that these effects are unlikely to be due to a higher rate of unplanned pregnancy among non-users.

**4. DISCUSSION**

Our results indicate that a woman's use of OC at the time when she meets her partner has measurable downstream consequences for partnership outcome. The lower satisfaction with sexual aspects of the relationship and reduced attraction to the primary partner that we report among women who met their partner while using OC are consistent with previous laboratory studies that indicate that OC might interfere with adaptive preferences, such as preference for MHC-dissimilar men. Compared with normally cycling women, OC users prefer body odours of relatively MHC-similar men [8] and initiation of OC use shifts these preferences towards MHC-similarity [9]. Furthermore, in couples who are relatively MHC-similar, women express lower sexual satisfaction with their partner and higher interest in extra-pair sex [15]. Although the possibility that disruption of preferences by OC influences relationship outcome has been the subject of considerable conjecture [9–12,25,26], our results provide the first evidence for this outside of the laboratory, in actual long-term partnerships.

However, as predicted, the results also reveal that women who used OCs during partner choice were more

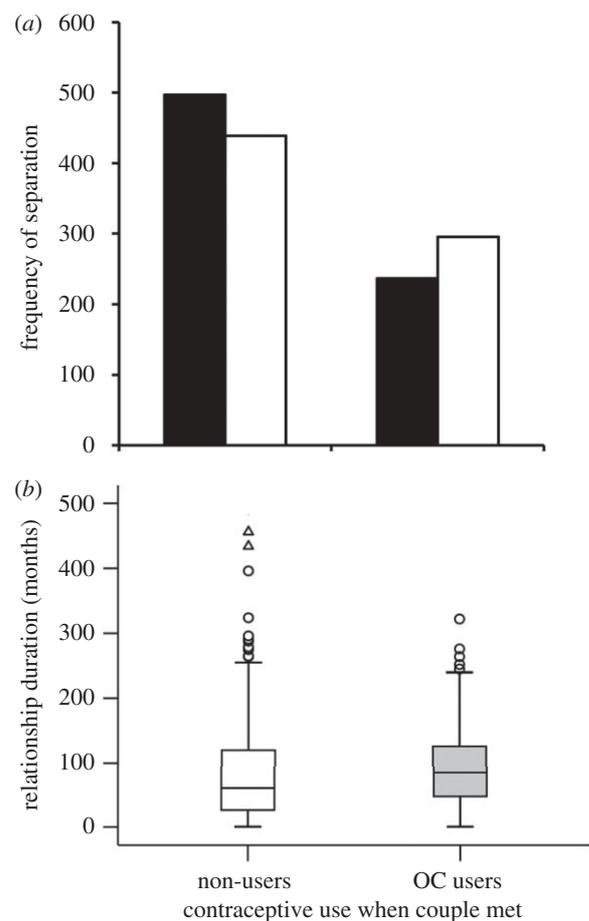


Figure 3. Effects of OC use at the time of partner choice on relationship outcome. (a) Frequency of separation is lower among women using OC when they met the biological father of their first child, compared with those who were not ( $p < 0.0001$ ). (b) Relationship duration is longer ( $p = 0.001$ ) among women who were using OCs when couples met (analysis includes only separated couples). Horizontal lines are median number of months, boxes indicate inter-quartile range. Circles and triangles represent outliers and extreme values, respectively. Both analyses control for women's age and SOI-R score. The difference in (b) was robust to exclusion of outliers (open circles) and extreme values (open triangles;  $p < 0.001$ ). (a) Black bars, observed; white bars, expected.

satisfied with non-sexual aspects of their relationship, including the partner's financial provision. Based on previous studies, we think it likely that this could arise through the suppression by OC use of periovulatory increases in preference for putative markers of good genes, such as masculinity or dominance, that are evident in women with normal menstrual cycles [1–4,27,28], thus leading to a maintained preference (during a woman's actual partner choice) for markers of high-quality paternal investment that characterizes low fertility phases of the menstrual cycle [17–19,29].

In combination, these effects mean that there may be both negative and positive associations between OC use during partner choice and subsequent relationship satisfaction. Interpreting the interplay between them, we suggest that, on average, higher general (non-sexual) relationship satisfaction in women who meet their partner while using OC might ameliorate or outweigh

the concomitant effects of reduced sexual satisfaction. Additionally, a maintained preference for traits indicating high paternal investment may mean that, on average, the men chosen by women using OC are less disposed to seek separation. Together, this could explain our finding of longer relationships in couples who met while the woman used OC.

However, as relationships progress, there may potentially come a tipping point at which a woman's sexual dissatisfaction outweighs non-sexual satisfaction. Evidence for this includes the finding that, among women using OC during partner choice, sexual dissatisfaction (compliant sex and sexual rejection) intensifies in relatively long relationships, while there was no change in non-users. Furthermore, there was a relatively small difference in recalled general satisfaction between former users and non-users who had separated compared with the large difference in those still together, indicating that sustained levels of general satisfaction may be important for relationship survival. If changes in the balance between sexual and general satisfaction contribute to the incidence of separation, women who used OC during partner choice may be more likely than non-users to be responsible for initiating eventual separation. Our results support this conjecture. While it is well-established that women (rather than their male partners) generally initiate separation [30,31], we found that women who used OC during partner choice were even more likely to initiate the separation (if it occurred) than women who had not.

We have hypothesized that the reported effects are due to influence of OC on women's partner choice, but it is also possible that OC use during relationships may also contribute to relationship satisfaction and outcome. For example, differences in contraceptive use at the point of partner choice might also reflect patterns of use after relationships are established. If so, it is possible that suppression of cyclical preference shifts by OCs could lead to stabilization of relationship satisfaction in both male and female partners during the relationship, in addition to the proposed effects on initial mate choice. Thus, women who use OCs during the relationship would not experience mid-cycle shifts in desire for attributes that might not be possessed by her partner, and men may not experience changes in concern with partner fidelity or attractiveness (for a review of such issues, see [2]). In this way, the association between OC use and initiation of relationship dissolution by women might alternatively be interpreted in terms of higher initiation by men whose partner is a non-user. The distinction between these ideas remains a point for further research.

Furthermore, although our results are consistent with the idea that OC may alter adaptive mate choice, with downstream consequences on relationship satisfaction and outcome, it remains possible that any of the reported effects may alternatively arise from other, as yet undetermined, associations between OC use and relationship satisfaction. However, we controlled for several likely candidates. First, there may be differences between users and non-users in attitudes towards sex and behaviour in sexual relationships, which we controlled for using the sociosexual orientation index. It is also noteworthy that the interactions between contraceptive use and

relationship duration (figure 2, showing that women using OC during partner choice were initially less likely to reject sex or acquiesce to sex under pressure from their partner, but became increasingly likely to do so, relative to non-users, as relationships progressed) demonstrate that relative sexual satisfaction cannot be simply explained by previous use or non-use of OC. Second, the assessment of current relationship satisfaction may be influenced by current hormonal state, but we controlled for this in the relevant analyses by excluding women using OC and those who were pregnant at the time of the survey. Third, in analyses probing sexual satisfaction, we controlled for the effects of non-sexual aspects of relationship quality, including financial provision. Fourth, we controlled for the duration of the relationship. Finally, we checked that the reported effects held in two different populations (the USA and the Czech/Slovak populations) and that they were not explained by between-group differences in commitment to the relationship potentially induced by a higher frequency of unplanned pregnancy among the non-users (see electronic supplementary material).

In summary, after controlling for these possible confounds, we found that women who met their partner while using OC were more satisfied in the non-sexual aspects of their relationship with their partner. This is consistent with studies showing that women express stronger preferences for social cues associated with direct benefits of mate choice at times of high progesterone levels and low fertility. However, these benefits appear to be offset by costs in terms of lower satisfaction in sexual aspects of the relationship. Women who used OC when they met their partner tended to find him less attractive, engaged in compliant sex and rejected sexual advances more frequently as the relationship progressed, and were more likely to initiate separation if it occurred. Although we do not know the relative degree of genetic similarity between couples in this study, these effects are also consistent with studies investigating mate preference for genetically complementary partners. For each kind of effect, our results suggest that these previously described mate preferences are not restricted to the laboratory, but are also expressed in actual partner choices. More importantly, our data also provide evidence that suppression of cyclical preference shifts by OC use may disrupt the expression of these adaptive preferences. We stress that the nature of this research question precludes a true experimental approach and that we therefore remain cautious about the causal link behind the associations we describe. We also recognize that the reasons for any relationship's survival or dissolution are complex and not limited to contraceptive choice at its inception. Nonetheless, our data provide important evidence in support of the proposal that the use of OC during partner choice (and possibly beyond) has the potential to profoundly influence the outcome of long-term relationships.

The study was approved by the Ethics Committee of the University of Stirling's Department of Psychology and conducted according to the principles expressed in the Declaration of Helsinki.

We are most grateful to all our participants. We also thank Marketa Londinova for help with data collection and two

anonymous reviewers for their comments. The work is supported by an Economic and Social Research Council grant (ES/I008217/1) to S.C.R. and A.C.L. A.C.L. is funded by a Royal Society University Research Fellowship, K.K. by a Czech Ministry of Education grant (MSM 0021620843), and J.H. by a Czech Science Foundation grant (GACR 406/09/0647).

## REFERENCES

- Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K. & Minamisawa, R. 1999 Menstrual cycle alters face preference. *Nature* **399**, 741–742. (doi:10.1038/21557)
- Gangestad, S. W. & Thornhill, R. 2008 Human oestrus. *Proc. R. Soc. B* **275**, 991–1000. (doi:10.1098/rspb.2007.1425)
- Roberts, S. C. & Little, A. C. 2008 Good genes, complementary genes and human mate preferences. *Genetica* **132**, 309–321. (doi:10.1007/s10709-007-9174-1)
- Jones, B. C., DeBruine, L. M., Perrett, D. I., Little, A. C., Feinberg, D. R. & Law Smith, M. J. 2008 Effects of menstrual cycle phase on face preferences. *Arch. Sex Behav.* **37**, 78–84. (doi:10.1007/s10508-007-9268-y)
- Little, A. C., Jones, B. C., Penton-Voak, I. S., Burt, D. M. & Perrett, D. I. 2002 Partnership status and the temporal context of relationships influence human female preferences for sexual dimorphism in male face shape. *Proc. R. Soc. Lond. B* **269**, 1095–1100. (doi:10.1098/rspb.2002.1984)
- Feinberg, D. R., DeBruine, L. M., Jones, B. C. & Little, A. C. 2008 Correlated preferences for men's facial and vocal masculinity. *Evol. Hum. Behav.* **29**, 233–241. (doi:10.1016/j.evolhumbehav.2007.12.008)
- Jones, B. C. *et al.* 2005 Menstrual cycle, pregnancy and oral contraceptive use alter attraction to apparent health in faces. *Proc. R. Soc. B* **272**, 347–354. (doi:10.1098/rspb.2004.2962)
- Wedekind, C., Seebeck, T., Bettens, F. & Paepke, A. J. 1995 MHC-dependent mate preferences in humans. *Proc. R. Soc. Lond. B* **260**, 245–249. (doi:10.1098/rspb.1995.0087)
- Roberts, S. C., Gosling, L. M., Carter, V. & Petrie, M. 2008 MHC-correlated odour preferences in humans and the use of oral contraceptives. *Proc. R. Soc. B* **275**, 2715–2722. (doi:10.1098/rspb.2008.0825)
- Havlicek, J. & Roberts, S. C. 2009 MHC-correlated mate choice in humans: a review. *Psychoneuroendocrinology* **34**, 497–512. (doi:10.1016/j.psyneuen.2008.10.007)
- Roberts, S. C., Miner, E. J. & Shackelford, T. K. 2010 The future of an applied evolutionary psychology for human partnerships. *Rev. Gen. Psychol.* **14**, 318–329. (doi:10.1037/a0021253)
- Alvergne, A. & Lummaa, V. 2010 Does the contraceptive pill alter mate choice in humans? *Trend Ecol. Evol.* **25**, 171–179. (doi:10.1016/j.tree.2009.08.003)
- Mosher, W. D. & Jones, J. 2010 *Use of contraception in the United States: 1982–2008*. Hyattsville, MD: National Center for Health Statistics (Vital Health Stat).
- Lader, D. 2009 Contraception and sexual health, 2008/9. Opinions survey report no. 41, UK Office for National Statistics. See [http://www.ons.gov.uk/ons/rel/lifestyles/contraception\\_and\\_sexual\\_health/contraception\\_and\\_sexual\\_health/2008-09.pdf](http://www.ons.gov.uk/ons/rel/lifestyles/contraception_and_sexual_health/contraception_and_sexual_health/2008-09.pdf)
- Garver-Apgar, C. E., Gangestad, S. W., Thornhill, R., Miller, R. D. & Olp, J. J. 2006 Major histocompatibility complex alleles, sexual responsivity, and unfaithfulness in romantic couples. *Psychol. Sci.* **17**, 830–835. (doi:10.1111/j.1467-9280.2006.01789.x)
- Pluchino, N., Cubeddu, A., Giannini, A., Merlini, S., Cela, V., Angioni, S. & Genazzani, A. R. 2009 Progesterone and brain: an update. *Maturitas* **62**, 349–355. (doi:10.1016/j.maturitas.2008.11.023)
- Gangestad, S. W., Garver-Apgar, C. E., Simpson, J. A. & Cousins, A. J. 2007 Changes in women's mate preferences across the ovulatory cycle. *J. Pers. Soc. Psychol.* **92**, 151–163. (doi:10.1037/0022-3514.92.1.151)
- Perrett, D. I., Lee, K. J., Penton-Voak, I., Rowland, D., Yoshikawa, S., Burt, D. M., Henzi, S. P., Castles, D. L. & Akamatsu, S. 1998 Effects of sexual dimorphism on facial attractiveness. *Nature* **394**, 884–887. (doi:10.1038/29772)
- Booth, A. & Dabbs, J. M. 1993 Testosterone and men's marriage. *Soc. Forces* **72**, 463–477.
- Ellis, B. J. 1998 The partner-specific investment inventory: an evolutionary approach to individual differences in investment. *J. Pers.* **66**, 383–442. (doi:10.1111/1467-6494.00017)
- Brown, M. 1986 Social support, stress and health: a comparison of expectant mothers and fathers. *Nursing Res.* **35**, 72–76. (doi:10.1097/00006199-198601000-00002)
- DeBruine, L. M. *et al.* 2006 Correlated preferences for facial masculinity and ideal or actual partner's masculinity. *Proc. R. Soc. B* **273**, 1355–1360. (doi:10.1098/rspb.2005.3445)
- Penke, L. & Asendorpf, J. 2008 Beyond global sociosexual orientations: a more differentiated look at sociosexuality and its effects on courtship and romantic relationships. *J. Pers. Soc. Psychol.* **95**, 1113–1135. (doi:10.1037/0022-3514.95.5.1113)
- Klusmann, D. 2002 Sexual motivation and duration of the partnership. *Arch. Sex. Behav.* **31**, 275–287. (doi:10.1023/A:1015205020769)
- Vollrath, F. & Milinski, M. 1995 Fragrant genes help Damenwahl. *Trend. Ecol. Evol.* **10**, 307–308. (doi:10.1016/S0169-5347(00)89113-2)
- Boero, F. 1996 MHC and mate selection in humans? *Trend. Ecol. Evol.* **11**, 24. (doi:10.1016/0169-5347(96)80238-2)
- Havlicek, J., Roberts, S. C. & Flegr, J. 2005 Women's preference for dominant male odour: effects of menstrual cycle and relationship status. *Biol. Lett.* **1**, 256–259. (doi:10.1098/rsbl.2005.0332)
- Little, A. C., Saxton, T. K., Roberts, S. C., Jones, B. C., DeBruine, L. M., Vukovic, J., Perrett, D. I., Feinberg, D. R. & Chenore, T. 2010 Women's preferences for masculinity in male faces are highest during reproductive age range and lower around puberty and postmenopause. *Psychoneuroendocrinology* **35**, 912–920. (doi:10.1016/j.psyneuen.2009.12.006)
- Jones, B. C., Little, A. C., Boothroyd, L., DeBruine, L. M., Feinberg, D. R., Smith, M. J., Cornwell, R. E., Moore, F. R. & Perrett, D. I. 2005 Commitment to relationships and preferences for femininity and apparent health in faces are strongest on days of the menstrual cycle when progesterone level is high. *Horm. Behav.* **48**, 283–290. (doi:10.1016/j.yhbeh.2005.03.010)
- Hewitt, B., Western, M. & Baxter, J. 2006 Who decides? The social characteristics of who initiates marital separation. *J. Marriage Fam.* **68**, 1165–1177. (doi:10.1111/j.1741-3737.2006.00321.x)
- Braver, S. L., Whitely, M. & Ng, C. 1993 Who divorced whom? Methodological and theoretical issues. *J. Divorce Remarriage* **20**, 1–19. (doi:10.1300/J087v20n01\_01)