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Human Female Orgasm as Evolved Signal: A Test of Two Hypotheses

Ryan M. Ellsworth · Drew H. Bailey

Abstract We present the results of a study designed to empirically test predictions derived from two hypotheses regarding human female orgasm behavior as an evolved communicative trait or signal. One hypothesis tested was the female fidelity hypothesis, which posits that human female orgasm signals a woman's sexual satisfaction and therefore her likelihood of future fidelity to a partner. The other was sire choice hypothesis, which posits that women's orgasm behavior signals increased chances of fertilization. To test the two hypotheses of human female orgasm, we administered a questionnaire to 138 females and 121 males who reported that they were currently in a romantic relationship. Key predictions of the female fidelity hypothesis were not supported. In particular, orgasm was not associated with female sexual fidelity nor was orgasm associated with male perceptions of partner sexual fidelity. However, faked orgasm was associated with female sexual infidelity and lower male relationship satisfaction. Overall, results were in greater support of the sire choice signaling hypothesis than the female fidelity hypothesis. Results also suggest that male satisfaction with, investment in, and sexual fidelity to a mate are benefits that favored the selection of orgasmic signaling in ancestral females.

Keywords Female orgasm · Interpersonal relationships · Evolutionary psychology · Infidelity

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Introduction

The question of whether the human female orgasm is an adaptation or a by-product of selection has been a perennial topic of debate among evolutionary scientists ever since Morris (1967) proposed the first formal hypothesis of the function of women's orgasm. While several hypotheses on the evolved role of female orgasm have been formulated and some have been tested since that time (e.g., Alcock, 1980, 1987; Baker & Bellis, 1993; Bernds & Barash, 1979; Eschler, 2004; Hrdy, 1981; Jones, 2007; Puts, 2007; Puts, Dawood, & Welling, 2012; Shackelford et al., 2000; Smith, 1984; Thornhill & Gangestad, 1996; Thornhill, Gangestad, & Comer, 1995), empirical investigation of one hypothesis has long been neglected. This is what we refer to as the female fidelity hypothesis proposed by Alexander (1979; see also Alexander & Noonan, 1979). This article presents the results of a study designed to test some predictions of both Alexander's and an alternative hypothesis of a signaling function of human female orgasm. In the following section, we briefly describe signaling theory and its application to a hypothesized communicative role of female orgasm behavior.

Signaling Theory and Female Orgasm

According to Maynard Smith and Harper (2003), a signal is defined as "any act or structure which alters the behavior of other organisms, which evolved because of that effect, and which is effective because the receiver's response has also evolved" (p. 3). As this definition makes clear, a signal is not merely any trait that carries information or influences receivers, but one that was naturally selected to do so. To apply principles of signaling theory (see Maynard Smith & Harper, 2003; Searcy & Nowicki, 2005) to the view of female orgasmic behavior, we note first that, if it evolved as a signal, it must have influenced male behavior in a manner that, on average, benefited the reproductive success of

ancestral females. Second, for female orgasmic behavior to have been selected for a signaling function, and for males to have been selected to respond to the signal in ways beneficial to females, it must have, on average, communicated reliable information about some attribute of the female. Although it is a requirement of an evolutionarily stable signaling system that signals be, on average, reliable, this does not preclude some degree of deception. Indeed, it is precisely because of the prevalence of honest signals that some individuals can gain by signaling deceptively. In this case, feigning orgasm would be a deceptive signal, conveying dishonest information about the female.

It is important to note that the present study was primarily concerned with human female orgasmic behavior and not necessarily with those aspects of orgasm not readily observable to a mate during (copulatory and non-copulatory) sexual behavior. Recent attention to the physiology of female orgasm (see Lloyd, 2005; Puts et al., 2012) appears to have overshadowed investigation of possible functional significance of overt behavioral manifestations of female sexual climax. In our view, overlooking a behavior pattern in favor of its physiological underpinnings is a shortcoming in need of correction: both warrant investigation.

It is also important to point out that a hypothesis of human female orgasmic behavior as a signal does not necessarily entail the assumption that orgasm or orgasm-like behavior in nonhuman female primate has a similar (analogous or homologous) function. Comparative studies of primate sexuality can yield insight into the evolutionary history (phylogeny) and taxonomic distribution of traits, but cannot themselves identify human adaptation. As pointed out by Thornhill and Gangestad (2008, p. 31), "Women-specific adaptations were designed functionally to solve sexual problems in the hominin lineage," and thus "demonstration that a trait functions in a particular manner in humans requires adaptationist study of humans."

A signaling hypothesis does not imply that all aspects of human female orgasm were favored by selection or that the signaling aspect is the only function. It is possible that features of women's orgasm other than conspicuous behaviors, such as affective and hormonal consequences, have been selected for other functions. Indeed, the sire choice signaling hypothesis described below relies on the assumption that the hormonal and physiological correlates of orgasm increase the chances of fertilization. However, our study does not directly speak to this issue (for a comprehensive discussion of adaptation and by-product hypotheses of female orgasm, see Lloyd, 2005; see also reviews by Barash, 2005; Puts, 2006; Puts & Dawood, 2006).

The Female Fidelity Hypothesis

Alexander's (1979) argument for female orgasm as a signal posits that, through displays of intense arousal during orgasm, females signal sexual satisfaction with their partner and hence decreased probability to seek sexual satiation with extra-pair

males. These signals act to influence a male's perception of a partner's sexual fidelity. Confidence in the sexual fidelity of a mate would have increased a male's paternity confidence in any resulting offspring of the female, thus increasing his willingness to invest in those offspring. Alexander (1979) stated that the female orgasm might be:

> [P]rincipally a communicative device that tends to reassure a male that a female is disinclined to seek sexual satisfaction with other males. If this interpretation is correct, female orgasm should (1) be characterized by obvious outward signs; (2) mimic male orgasms in regard to outward signs; (3) frequently involve deception, with females pretending to have orgasms when they do not; (4) occur most frequently (a) in deeply satisfying or long-term interactions with males committed to the female and her offspring, and (b) with dominant males or males with obviously superior ability to deliver parental benefits; and (5) occur least frequently in brief or casual encounters, and in copulation with a partner unsatisfactory in the above regards. (p. 87)

The current test of Alexander's hypothesis addressed the following predictions: female orgasmic behavior should be salient to a male mate (i.e., males should be able to report on the behaviors associated with a partner's orgasm, and the frequency of a partner's orgasms); female frequency of orgasm should be associated with female satisfaction with her current relationship and with a partner who is committed (operationalized in the present study by measures of fidelity) and investing; and orgasm should be less frequent with male partners who are less committed and less investing.

The female fidelity hypothesis additionally predicted positive relations among female orgasm, male confidence in a mate's sexual fidelity, and actual female sexual fidelity. Negative relations were predicted between male detection or perceptions of faked orgasm and confidence in a mate's sexual fidelity, as well as between frequency of faked orgasm and actual sexual fidelity of females.

The Sire Choice Signaling Hypothesis

In some species with internal fertilization, females can bias the paternity of their offspring by regulating which male's sperm reaches her egg(s) (Birkhead & Møller, 1993; Eberhard, 1996). Recently, Puts et al. (2012) reviewed evidence that orgasm in women serves as a mechanism of post-copulatory cryptic sire choice, citing evidence for female orgasm's dependence on indicators of genetic quality (Garver-Apgar, Gangestad, Thornhill, Miller, & Olp, 2006; Puts, Welling, Burriss, & Dawood, 2011; Shackelford et al., 2000; Thornhill et al., 1995); the roles of brain areas activated during female orgasm (Beyer, Anguiano, & Mena, 1961; Setekleiv, 1964; Zervomanolakis et al., 2007, 2009); the physiological correlates of orgasm, most notably the surge of the hormone oxytocin (Knaus, 1950; Wildt, Kissler, Licht, &

Becker, 1998), released during female orgasm, which facilitates uterine contractions responsible for sperm transportation through the reproductive tract; and increased faked orgasm by women with more sexual partners (Darling & Davidson, 1986; Wiederman, 1997).

If it is correct that female orgasm increases the likelihood of conception, it might still be predicted that women may benefit from signaling the occurrence of orgasm and men to be sensitive to these behaviors. Therefore, the female fidelity hypothesis and the sire choice signaling hypothesis both predict that men will adjust their relationship psychology in response to partner orgasm in ways consistent with increased paternity certainty and that women will employ orgasm signals strategically in ways that would have ancestrally led to reproductive benefits through influences on male behavior.

Both the female fidelity and sire choice hypotheses maintain that female orgasm increases a male's paternity confidence, although through different proximate routes. Key data that allow for the current study to discriminate between support for the sire choice signaling hypothesis and the female fidelity signaling hypothesis are the relations between orgasm and female sexual fidelity. If orgasm is a signal of fidelity, then orgasm frequency should be positively related to the likelihood of female fidelity. If orgasm is a signal of female sire choice, orgasm frequency need not be related to the likelihood of fidelity. However, both hypotheses predict the frequency of faked female orgasm to be positively related to the likelihood of female infidelity.

Additionally, and crucially for distinguishing between the two signaling hypotheses, the female fidelity hypothesis predicts that men's reports of the likelihood of a partner's infidelity should be related to orgasm, while the sire choice hypothesis makes no predictions on the association between orgasm and male perceptions of partner fidelity, as orgasm is not predicted to be related to female commitment to a mate (see Table 1 in Puts et al., 2012). However, like the female fidelity hypothesis, the sire choice hypothesis predicts a male ability to scrutinize the authenticity of female orgasm. See Table 1 for a summary of predictions of each hypothesis.

Table 1 Summary of tested predictions for each hypothesis

Prediction	Female fidelity	Sire choice	Supported?	Findings
Female orgasm will be associated with female relationship satisfaction	✔	✔	Yes	Relationship satisfaction positively correlated with orgasm intensity and orgasm frequency
Female orgasm will be related to partner investment	✔	✔	Yes	Partner investment positively correlated with orgasm intensity and orgasm frequency
Female orgasm frequency will be associated with female sexual fidelity in the current relationship.	✔		No	Past infidelity positively correlated with orgasm frequency; Future infidelity positively correlated with orgasm intensity and orgasm frequency
Fake orgasm will be associated with female sexual infidelity in the current relationship	✔	✔	Yes	Past infidelity positively correlated with fake orgasm frequency; Future infidelity positively correlated with fake orgasm frequency
Men's perception of female orgasm frequency will be associated with men's relationship satisfaction.	✔	✔	Yes	Partner orgasm frequency and intensity positively correlated with male relationship satisfaction; Partner fake orgasm frequency negatively correlated with male relationship satisfaction
Men's perception of female orgasm frequency will be associated with men's fidelity in their current relationship.	✔		Yes	Partner orgasm frequency negatively correlated with past male infidelity
Men's perception of female orgasm frequency will be related to perceptions of female sexual fidelity in the current relationship.	✔		No	Partner orgasm intensity positively correlated with likelihood of partner past infidelity; Partner orgasm frequency unrelated to likelihood of partner past infidelity; Partner orgasm intensity and frequency unrelated to likelihood of partner future infidelity
Male detection of fake orgasm will be associated with lower confidence in the sexual fidelity of a partner.	✔		No	Partner fake orgasm frequency unrelated to likelihood of partner past infidelity; Partner fake orgasm frequency unrelated to likelihood of partner future infidelity

Method

Participants

To test the predictions of the two hypotheses of human female orgasm, a computer-based questionnaire was administered to 138 females and 121 males reported to be currently in a romantic relationship (participants were not in romantic relationships with each other). All participants in the sample were undergraduate students enrolled in introductory psychology courses at a Midwestern university. Participants were recruited from the introductory psychology participant pool at a large Midwestern university. Participants received course credit for participation. Participant information is shown in Table 2.

Procedure

Participants entered a computer room separated into halves by a room divider. Only one participant completed the survey in a room half during any given time, and the participants in the room halves were always of the same sex. Participants signed a consent form, completed the computer-based questionnaire, which took approximately 30 min, and exited the testing room, at which point they were debriefed.

Measures

Relationship Satisfaction

Relationship satisfaction was measured by the Relationship Assessment Scale (Hendrick, 1988), which consists of seven questions answered on 7-point Likert scales, about participants' relationship satisfaction. This scale was reliable in the current sample ($\alpha = .87$), consistent with previously reported reliability ($\alpha = .86$) (Hendrick, 1988). An example of an item from this scale is "How good is your relationship compared to most?" We also added two items emphasizing the participants' recent relationship satisfaction ("How would you rate your overall satisfaction with your current relationship over the past four weeks?") and participants' relationship satisfaction before this ("Compared to the past four weeks, how would you rate your overall satisfaction with your relationship before this time?").

Partner Investment

Participants' partners' investment was assessed by the Partner-Specific Investment Inventory (Ellis, 1998), which consists of 62 items answered on a 5-point Likert scale with anchor points "Strongly disagree" and "Strongly agree," belonging to 11 subscales. The subscales, along with example items and internal consistencies from the current sample, were (1) Expressive/Nurturing (12 items; e.g., "He/she shares his/her feelings with me"; $\alpha = .86$), (2) Tolerant/Permissive/Agreeable (10 items; e.g., "He/she doesn't become jealous when I spend my time with other people"; $\alpha = .80$), (3) Future-Oriented (8 items; e.g., "When he/she talks about the future, I'm always in it"; $\alpha = .80$), (4) Giving of Time (six items; e.g., "He/she spends a lot of time with me"; $\alpha = .75$), (5) Sexually Proceptive (6 items; e.g., "He/she wants to have sex with me"; $\alpha = .77$), (6) Monetarily Investing (five items; e.g., "He/she pays for our evening entertainment"; $\alpha = .76$), (7) Honest (three items; e.g., "He/she tries to deceive me" (reverse scored); $\alpha = .80$), (8) Physically Protective (three items; e.g., "He/she makes sure I don't have to go out alone at night"; $\alpha = .56$), (9) Socially Attentive (three items; e.g., "He/she deserts me at parties" (reverse scored); $\alpha = .59$), (10) Good Relationship with Partner's Family (three items; e.g., "He/she enjoys my family gatherings"; $\alpha = .38$), and (11) Not Sexualizing of Others (three items; e.g., "He/she talks about the attractiveness of other women/men in my presence" (reverse scored); $\alpha = .62$). When these dimensions were assessed as separate measures of partner investment, they showed good internal consistency ($\alpha = .80$).

Sexual Behavior and Orgasm

To assess sexual behaviors, participants were asked about their frequency of copulatory and non-copulatory sexual behavior (times per week). Female participants were asked about frequency of orgasm during copulatory and non-copulatory sexual behavior (from 0 % of copulations to 100 %, in intervals of 10 %, and from 0 % of non-copulatory sexual interactions to 100 %); frequency of faked orgasm during copulatory and non-copulatory sexual behavior; and behaviors exhibited during orgasm, rating on a 9-point scale the extent to which each of muscle spasms/contractions, muscle tension/rigidity, clutching one's partner, increased respiration, and vocalizations characterized their behaviors during orgasm. The particular behaviors given as options were chosen because they commonly appear in the descriptive literature on female orgasm (e.g., Fisher, 1973; Hamilton & Arrowood, 1978; Hite, 1987; Masters & Johnson,

Table 2 Sample statistics

Variable	Female M (SD)	Male M (SD)
Age (years)	18.82 (1.35)	18.84 (1.03)
Partner age (years)	19.61 (2.27)	18.65 (1.49)
Relationship length (months)	16.61 (14.55)	14.69 (12.98)
Ever had sex with current partner	82 % (39 %)	83 % (37 %)
Female orgasm frequency	61 % (31 %)	70 % (26 %)
Fake female orgasm frequency	18 % (22 %)	5 % (11 %)
Sex frequency (times per week)	2.86 (1.97)	3.00 (1.99)
Currently cheating	2 % (15 %)	4 % (20 %)
Has cheated	16 % (37 %)	26 % (44 %)
Has fallen in love with other	5 % (22 %)	3 % (18 %)

1966), and appear in Table 3. This measure of orgasm behavioral intensity showed an acceptable level of reliability (for this sample, female $\alpha = .71$). Male participants rated their partners' orgasm and faked orgasm frequencies, along with the extent to which the behaviors above characterized their partners during orgasm (for this sample, male $\alpha = .77$). Orgasm frequency and intensity measures are only reported for individuals in the current study who reported having had sexual intercourse with their current partner (101 males; 113 females).

Sexual Fidelity

To measure fidelity related behaviors, participants were administered a series of questions measuring their past sexual and emotional infidelity in their current relationship, current sexual and emotional infidelity, their perceptions of the likelihood of future infidelity in their current relationship, and their perceptions of their partner's scores on all of these variables. The scale, shown in Table 4, was reliable for self reports ($\alpha = .85$, .84 for men and women, respectively) and reports on partners' ($\alpha = .90$, .90 for men and women, respectively) likelihoods of future infidelity.

Participants also completed the Sociosexual Orientation Inventory (SOI) (Simpson & Gangestad, 1991), which measures attitudes and behaviors concerning uncommitted sex. Webster and Bryan (2007) demonstrated that sociosexual attitudes (e.g., "I can imagine myself being comfortable and enjoying 'casual' sex with different partners") and sociosexual behaviors (e.g., "With how many different partners have you had sex in the last year?") are different latent constructs with acceptable internal consistencies ($\alpha = .82$, .78, respectively; in the current sample, $\alpha = .80$, .75, respectively); thus, the SOI was scored accordingly.

Data Analysis

Women's ratings of their orgasmic behaviors, men's ratings of their partners' orgasmic behaviors, and men's and women's ratings of their and their partners' likelihood of future sexual infidelity were each entered into separate principal component analyses (six total PCAs) to determine the amount of unique information conveyed in these measures. To determine the number of components to maintain, Horn's (1965) parallel analysis was employed, using the "paran" function (Dinno, 2009, R version) in R (Ihaka & Gentleman, 1996). The method involves performing principal component analyses on a large number of random data sets (500 in the current study) with the same numbers of variables and observations as the current one, and then comparing the eigenvalues from the random-data factors to factors identified from the current dataset (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Hayton, Allen, & Scarpello, 2004). Components with eigenvalues larger than the average eigenvalues of the corresponding random-data components were retained.

For each analysis, only one component was retained. Therefore, the products of the scores and their component loadings of women's reported and men's reports of partners' orgasmic behaviors were summed to create the variables orgasm behavior intensity and partner orgasm intensity, and the products of participants' reports of their and their partners' future infidelity likelihood variables and their factor loadings were summed to create self and partner future infidelity scores.

Results

Male and Female Reports of Orgasm and Faking Orgasm

We compared women's and men's reports of female orgasm to validate the self-reported frequencies of orgasm and faking orgasm. Women reported achieving orgasm 61 % of the time during sexual intercourse with their current partners ($SD = 31$ %). Orgasm behavior intensity was significantly positively correlated with orgasm frequency ($r = .30$, df $= 111$, $p = .001$). On average, women reported faking orgasm 18 % of the time during sex with their current partners ($SD = 22$ %). Out of the 113 women who reported that they had engaged in sexual intercourse with their current partner, 66 (58 %) reported faking at least sometimes. Men reported that their partners faked orgasm during sex 5 % of the time ($SD = 11$ %), which was significantly less than the mean for women's self reports $t(168.40) = 5.62$, $p < .0001$. Of the 101 men who reported that they engaged in sexual intercourse with their current partner, 21 (21 %) reported that their partners faked orgasm during sex at least sometimes. Frequency of women's self-reported faked orgasms was negatively correlated with their frequency of self-reported orgasms ($r = -.30$, df $= 111$, $p = .001$), but not significantly correlated with orgasm behavior intensity ($r = .13$, df $= 111$).

Table 3 Orgasm Intensity scale

Note Instructions read "Please indicate any of the following behaviors that best characterizes your/your partner's behavior during orgasm." Anchor points were 1 (not at all or N/A) and 9 (very much)

Item	Average correlation (females)	Average correlation (males)	M (SD) (females)	M (SD) (Males)
Muscle spasms/contractions	.30	.43	6.4 (2.4)	6.5 (2.9)
Muscle tension/rigidity	.32	.45	5.7 (2.4)	6.0 (2.1)
Clutching partner	.30	.37	7.4 (2.2)	7.8 (1.6)
Increased respiration	.39	.44	7.0 (2.1)	7.5 (1.6)
Vocalizations	.34	.44	6.1 (2.3)	6.4 (2.4)

Table 4 Future Infidelity scale

	Item	Average correlation (females)	Average correlation (males)	M (SD) (females)	M (SD) (males)
Self report	Q1: How likely do you think it is that you will engage in sexual intercourse or stimulation of the genitals without sexual intercourse with someone other than your current partner while in your current relationship?	.51	.48	.56 (1.4)	1.6 (2.5)
	Q2: How likely do you think it is that you will fall in love with someone other than your current partner while in your current relationship?	.59	.61	.87 (1.6)	1.0 (1.9)
	Q3: Please indicate your agreement with the following statement. "I will probably be sexually unfaithful to my partner"	.54	.57	.49 (1.5)	1.6 (2.6)
	Q4: Have you ever seriously considered having sexual intercourse with someone other than your current partner while in your current relationship?	.46	.46	.89 (1.9)	2.8 (3.0)
	Q5: Did you ever really want to have sexual intercourse with someone other than your current partner while in your current relationship?	.46	.52	.99 (2.1)	2.9 (3.0)
Report on partner	Q1	.61	.64	.60 (1.3)	1.8 (2.5)
	Q2	.68	.72	.56 (1.2)	1.9 (1.9)
	Q3	.74	.67	.55 (1.4)	2.1 (2.6)
	Q4	.61	.62	.56 (1.3)	1.7 (3.0)
	Q5	.66	.67	.72 (1.6)	1.7 (3.0)

Note Anchor points were 0 and 9. Wording was changed slightly in the second five items to clarify that the questions were about the participant's partner, rather than the participant

Female Fidelity and Orgasm

Inconsistent with the female fidelity hypothesis, one-predictor logistic regressions yielded no significant effect for orgasm frequency on women's reports of past sexual infidelity in their current relationship (log odds = .07, model df = 111, z = .78), and a non-significant trend toward a positive relation between past sexual infidelity and orgasm behavior intensity (log odds = .19, model df = 111, z = 1.82, p = .07. Women's reported likelihood of future infidelity was also not correlated with orgasm behavior intensity (r = −.02, df = 111) or with orgasm frequency (r = −.15, df = 111, p = .10).

Female Infidelity and Faked Orgasm

Confirming predictions of the female fidelity and sire choice hypotheses, there was a significant positive relation between faked orgasm frequency and past infidelity in a woman's current relationship (log odds = .21, z = 1.99, p = .047; model df = 111). Orgasm behavior intensity and real and faked orgasm frequencies were unrelated to whether the woman reported having fallen in love with another individual while with her current

partner (log odds = −.01, .19, .15; zs = −.20, 1.15, .95; all model df = 111). Also consistent with predictions of the female fidelity and sire choice hypotheses, women's reported likelihood of future infidelity was significantly positively correlated with frequency of faked orgasm (r = .27, df = 111, p = .004).

Inconsistent with the female fidelity hypothesis, however, women's sociosexuality related behaviors on the SOI were unrelated to real and faked orgasm frequency, as were women's sociosexuality related attitudes, except that orgasm frequency was negatively correlated with sociosexuality related attitudes (i.e., women who orgasm less during sex with their current partners were more open to the idea of casual sex) (r = −.18, df = 111, p = .052).

Female Relationship Satisfaction and Orgasm

Consistent with predictions from both hypotheses, intensity of orgasm behavior and orgasm frequency during sex were positively related to female relationship satisfaction (rs = .20, .27; df = 111; ps = .03, .004, respectively). Frequency of faking orgasm was not significantly related to relationship satisfaction, though there was a trend in favor of a negative relationship (r =

−.15, df = 111, p = .11). When orgasm behavior intensity, orgasm frequency, and faked orgasm frequency were entered as predictors of female relationship satisfaction in a regression model, none of the parameter estimates remained significant (due to collinearity between orgasm intensity and frequency), but they predicted 9 % of the variance in female relationship satisfaction, $F(3, 109) = 3.75$, p = .01. Female relationship satisfaction was not significantly correlated with the measure of frequency of sex (r = .12, df = 109).

Male Perceptions of Female Fidelity and Orgasm

Contrary to the prediction of the female fidelity hypothesis, men's ratings of the likelihood that their partners have been sexually unfaithful were slightly positively related to their ratings of their partners' orgasm behavior intensity (r = .17, df = 99, p = .08), and men's ratings of their partners' real and faked orgasm frequencies were unrelated to their ratings of the likelihood that their partners had engaged in sexual infidelity (rs = −.01, −.12, df = 99, respectively). Men's ratings of their partners' future sexual infidelity scores were also not significantly related to their ratings of their partners' orgasm behavior intensity or real and fake orgasm frequencies (rs = .05, −.16, −.03, df = 74, respectively).

Male Fidelity, Commitment, and Partner Orgasm

Inconsistent with predictions from the female fidelity hypothesis, women's frequencies of real and faked orgasm and orgasm behavior intensity were unrelated to their ratings of whether their partner was likely to be sexually unfaithful (rs = .04, .13, −.03, df = 76, respectively). However, men's reports of their partners' orgasm frequency were significantly negatively related to their reports of their own infidelity in the past (log odds = −.18, z = −2.18, p = .03; model df = 99), though men's reports of their partners' rates of faking orgasm were not (log odds = −.04, z = −.20; model df = 99). There was also a non-significant trend toward a negative relation between men's reports of their partners' orgasm behavior intensity and their reports of their own sexual infidelity in the past (log odds = −.10, z = −1.41, p = .16). Men's ratings of their own likelihoods of future sexual infidelity were not significantly correlated with their reports of their partners' rates of real and faked orgasm and orgasm behavior intensity (rs = −.19, .01, −.10; df = 98), though there was a non-significant trend toward a negative relation between partner orgasm frequency and men's self reported likelihood of sexual infidelity (p = .055). When men's reports of their partners' orgasm frequency, sex frequency, and their interaction were entered as predictors of men's likelihood of future infidelity ratings, the model yielded a non-significant trend toward an interaction between partner orgasm frequency and sex frequency, $t(96) = -1.87$, p = .064. This interaction is plotted in the second panel of Fig. 1.

Male Relationship Satisfaction and Partner Orgasm

Consistent with both hypotheses, men's reports of their partners' orgasm frequency and behavior intensity were significantly positively related to their ratings of relationship satisfaction (rs = .23, .28; df = 97; ps = .02, .005, respectively), whereas men's reports of their partners' frequency of faking orgasm were significantly negatively correlated with their ratings of relationship satisfaction (r = −.23, df = 97, p = .02). When entered simultaneously into a regression model, men's reports of their partners' real and fake orgasm frequency and orgasm behavior intensity predicted 13 % of the variance in relationship satisfaction, $F(3, 95) = 4.60$, p = .005. As with the women in our sample, the measure of men's frequency of sex, by itself, was not significantly related to relationship satisfaction (r = .14, df = 97). However, when men's reports of their partners' orgasm frequency, sex frequency, and their interaction were entered as predictors of men's relationship satisfaction, the model yielded a significant interaction between partner orgasm frequency and sex frequency, $t(95) = 2.52$, p = .01. This interaction, plotted in Fig. 1, indicates that the relation between sex frequency and relationship satisfaction was only positive for men who reported that their partners orgasm at a high rate *during sex*. For men whose partners' orgasmed at a low rate, the relation between sex frequency and relationship satisfaction was negative.

Male Investment and Female Orgasm

Consistent with predictions of both hypotheses, women's ratings of their orgasm behavior intensity and frequency were significantly positively related to their ratings of their partners' investment in themselves (rs = .31, .22; df = 109; ps = .001, .023, respectively), but their ratings of fake orgasm frequency were not significantly related to their ratings of their partners' investment (r = −.10, df = 109). The correlations of orgasm behavior intensity and real and fake orgasm frequencies with partner investment subscales are shown in Table 5.

Discussion

A central prediction of the female fidelity hypothesis—that orgasm is related to female sexual fidelity—was not supported although, as predicted by both hypotheses, it was found that faked orgasm was positively associated with likelihood of past, present, and future sexual infidelity. The other central prediction of the female fidelity hypothesis—that male perceptions of female fidelity would be positively related to orgasm detection—was also not supported. Predictions of the hypothesis that did receive support were that orgasm was positively related to partner commitment (at least with respect to past male infidelity) and that orgasm was positively related to partner investment. However, both of these predictions concern benefits from men to the signaling female.

Fig. 1 Male relationship satisfaction by sex frequency and reported partner orgasm frequency. *Note* Sex frequency = number of times reported having sex per week
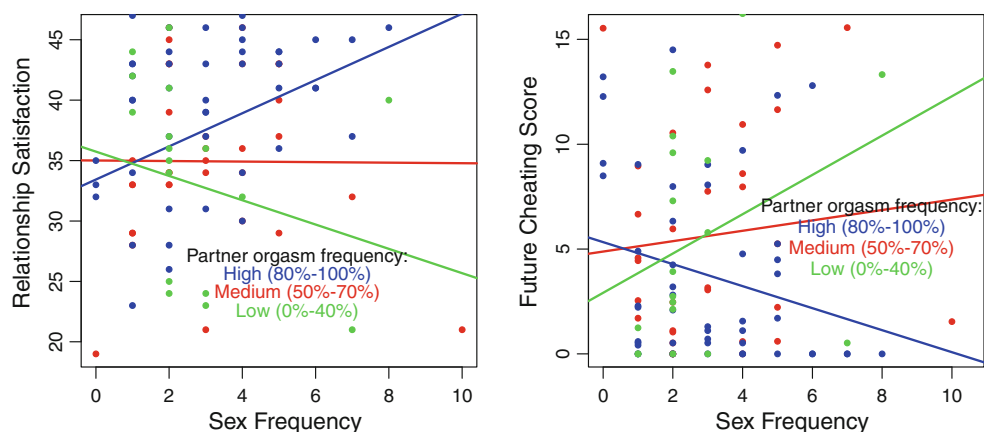
Therefore, these predictions were similarly consistent with the hypothesis that female orgasm signals something other than female fidelity, despite their initial association with the female fidelity hypothesis.

That orgasm intensity and frequency were positively related to female reports of their partners' investment could indicate that female orgasm increases investment or that high levels of investment lead to orgasm; causality and its direction could not be determined from these results. It should be noted here that while not explicitly predicted by Puts et al. (2012) (Table 1 in Puts et al., 2012), an association between orgasm and male investment was consistent with the sire choice hypothesis and was included as a prediction in the present study.

The observation of a positive association between female relationship satisfaction and orgasm was consistent with the findings

of several other studies of sexual behavior and romantic relationship evaluation (e.g., Costa & Brody, 2007; Singh, Meyer, Zambarano, & Hurlbert, 1998; Tavris & Sadd, 1977). Although our results cannot specify a direction of causality between female relationship satisfaction and orgasm, either direction is consistent with a hypothesis of orgasm as signal.

The finding that male-reported female orgasm intensity and frequency during sex were positively related to male relationship satisfaction, and the finding that men's relationship satisfaction was only positively related to their reported sex frequency for men whose partners orgasm frequently during sex, suggest that men may indeed be influenced by female orgasm in a particular way. The relationship between female orgasm and male relationship satisfaction might be explained in two ways. It may be that female orgasm increases male relationship satisfaction. Alternatively, men who are satisfied with their relationship may be more interested in their partners achieving orgasm, and make greater and more frequent effort to ensure its occurrence (McKibbon, Bates, Shackelford, Hafen, & LaMunyan, 2010). Either case is consistent with the idea that female orgasm contains information about paternity probability. The finding that male-reported frequency of their partners' faked orgasm was negatively associated with male relationship satisfaction is evidence that males assess the authenticity of female orgasm and adjust their perception of their relationship in expected ways, given that faked orgasm was associated with female infidelity. Women in low quality relationships may also fake orgasm more often.

The findings discussed thus far regarding orgasm, male investment, and relationship satisfaction were consistent with both the female fidelity and the sire choice hypotheses. However, we did not observe a positive relationship between female orgasm and fidelity nor one between orgasm and male perceptions of female fidelity. These findings were inconsistent with the female fidelity hypothesis. Therefore, our results were overall in greater support of the sire choice signaling hypothesis.

Although Lloyd (2005) argued against drawing an analytical distinction between copulatory and non-copulatory orgasm, and what she saw as an overemphasis on copulatory orgasm in theoretical and empirical work, the distinction may indeed be

Table 5 Correlations of orgasm intensity and real and fake orgasm frequencies with Partner Investment subscales

Variable:	Orgasm intensity	Orgasm frequency	Fake orgasm frequency
Subscale			
Expressive/Nurturing	.23**	.22*	.01
Tolerant/Permissive/Agreeable	.13	.09	−.19*
Future-Oriented	.09	.13	−.05
Giving of Time	.26**	.15	−.11
Sexually Proceptive	.25**	.25**	.04
Monetarily Investing	.17*	.20*	−.05
Honest	.08	.02	−.19
Physically Protective[a]	.28**	.22*	−.01
Socially Attentive[a]	.11	.11	−.08
Good Relationship with Partner's Family[a]	.06	.01	.01
Not Sexualizing of Others[a]	.06	−.04	.05
Total Investment	.26**	.22*	−.10

* p < .05

** p < .01

[a] Subscales with questionable or unacceptable reliability

important (see, e.g., Baker & Bellis, 1993; Costa & Brody, 2007; Thornhill et al., 1995). The association found in the present study between orgasm and male and female relationship satisfaction concerned orgasm reported to occur during sex. Our results concur with those of Costa and Brody (2007) who found that perceived relationship quality for females was associated specifically with copulatory orgasm frequency. While there are many possible reasons why it is specifically orgasm reported during sex that was found to be related to relationship satisfaction that having nothing to do with its possible distinctive functional significance apart from non-copulatory orgasm, we suggest that researchers continue to assess both copulatory and non-copulatory orgasm in investigations of the evolutionary significance of human female orgasm.

Limitations and Future Directions

The current study had several limitations. First, we note that because our subjects consisted exclusively of young adult university students, our data are not representative of the population at large. Second, because of the nature of our study sample, sex frequency may not have been measured well because of the inclusion of an unknown number of subjects in long-distance relationships. Long-distance relationships also likely limit direct investment by partners and preclude physical mate-guarding and time with partner. Third, our study did not assess orgasm in the context of short-term sexual relationships and extra-pair sexual activity. To understand a generalizable pattern of female orgasm across contexts, and across the span of a relationship, a larger sample that discriminates between types of relationships, duration of relationship, and other important subject variables would be necessary. Future studies would do well to examine the possibility that men's ability to detect and discriminate a partner's real and fake orgasm improves with the duration of a relationship or cumulative sexual experience with a partner. If so, we predict interesting patterns to emerge concerning female deployment of fake orgasm behavior as it relates to relationship duration or partner familiarity. Variance in relationship duration in the present sample, however, did not yield the resolution to examine this question.

Fourth, our study did not match up and assess responses of both members of romantic relationships. Fifth, and most importantly, our methodology did not permit us to ascertain the direction of causation in the relationships found among variables. In the future, longitudinal research within couples would solve the former and at least address the latter. Understanding the exact mechanisms mediating the relations between female orgasm, relationship satisfaction, faked orgasm, and infidelity is important, as noted above. However, either causal direction (orgasm → behavior; behavior → orgasm) is consistent with a signaling hypothesis of female orgasm.

Conclusion

This study represented the first effort to gather data explicitly directed at testing predictions of Alexander's female fidelity hypothesis. Despite limitations, the present study constituted an important step in the empirical investigation of a hypothesized signaling role for human female orgasm. The key predictions of the female fidelity hypothesis in particular were not supported. It appears that female orgasm behavior does not signal fidelity *per se* nor does it appear to influence the perceptions of men in this regard. However, the present study does not rule out some signaling function of human female orgasm. Male satisfaction with, investment in, and sexual fidelity to a mate are possible benefits that may have favored the selection of orgasm behavior signaling in ancestral females. Additionally, the delivery of these benefits may have derived from manipulation of males' assessment of fertilization. We urge that future research be aimed at more thorough testing of the female fidelity hypothesis. We also encourage researchers to devote more theoretical and empirical attention to falsification of the hypothesis that female orgasm serves as a mechanism of sire choice by deriving additional predictions and conducting further tests.

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