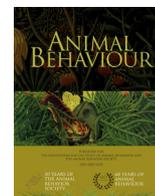


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Animal Behaviour

journal homepage: www.elsevier.com/locate/anbehav

No direct relationship between human female orgasm rate and number of offspring

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ARTICLE INFO

Article history:

Received 15 February 2013
 Initial acceptance 11 March 2013
 Final acceptance 24 April 2013
 Available online xxx
 MS. number: 13-00141

Keywords:

by-product
 children
 evolution
 fertility
 genetic correlation
 heritability
 mate choice
 orgasm
 pair bond
 sire choice

The evolutionary basis of women's orgasm is unknown, but the most favoured theory involves putative physiological processes that accompany orgasm and increase the likelihood of fertilization during intercourse. In a sample of over 8000 female twins and siblings, we show a substantial genetic basis to both orgasm rate and number of offspring. While there was a very weak but significant phenotypic correlation between the two variables, there was no corresponding genetic correlation, suggesting the involvement of environmental confounders. Controlling for relationship length and frequency of sexual intercourse eliminated the significant phenotypic correlation between orgasm rate and number of offspring, which suggests no substantive causal relationship between orgasm and fertility. These results cast doubt on the predominant functional theory of female orgasm.

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The evolutionary basis of the human female orgasm has long been intensely debated, and the intensity has increased in recent years (e.g. Judson 2005; Lloyd 2005; Puts & Dawood 2006; Wallen 2006; Amundson 2008; Lynch 2008; Wallen & Lloyd 2008; Brody et al. 2011; Zietsch & Santtila 2011, 2012; Zietsch et al. 2011; Puts et al. 2012b; Wallen et al. 2012). The debate centres on whether female orgasm has an evolutionarily adaptive function and, if so, what that function is. A recent review of the various hypotheses and accompanying evidence concluded that the most likely evolutionary explanation is that female orgasm has an adaptive function which is to increase the likelihood of conception when having sex with a mate of high genetic quality (the 'sire choice hypothesis'; Puts et al. 2012a). Consistent with this explanation, there is evidence that women are more likely to orgasm with higher quality men (Thornhill et al. 1995; Shackelford et al. 2000; Puts et al. 2012b). Puts et al. (2012a) also argued that the weight of

evidence suggests that physiological processes associated with female orgasm increase the likelihood of pregnancy by facilitating transmission of sperm to the egg (e.g. 'upsuck'; Fox et al. 1970; Baker & Bellis 1993), providing a putative mechanism for cryptic female mate choice. However, the evidence for such physiological processes is contentious (for reviews see Lloyd 2005; Levin 2011; Puts et al. 2012a), and the consequential prediction of an association between orgasm rate and fertility has not been tested. Additionally, if a relation between orgasm rate and fertility were causal, then the factors affecting orgasm rate would necessarily also affect fertility, and since genetic factors account for around 30% of the variance in female orgasm rate (Dawood et al. 2005; Dunn et al. 2005; Zietsch & Santtila 2011) we would expect the genetic (as well as environmental) factors affecting orgasm in women also to affect the number of offspring (i.e. there should be a genetic correlation (as well as environmental correlation) between the traits; see van Tienderen & de Jong 1994). We used data from a large sample of Finnish female identical and nonidentical twins to perform the first test for phenotypic and genetic correlation between orgasm rate and number of offspring.

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METHODS

Participants and Measures

Female identical and nonidentical twins and siblings ($N = 8447$ individuals, age 18–49, mean \pm SD = 29.12 \pm 6.87) completed a questionnaire in which they responded to the item: ‘Over the past 4 weeks, when you had sexual stimulation or intercourse, how often did you reach orgasm?’ (almost always; usually; sometimes; every now and then; rarely or never; no sexual activity [coded as missing]) and ‘Over the past 4 weeks, when you had sexual stimulation or intercourse, how difficult was it for you to reach orgasm?’ (extremely difficult or impossible; very difficult; difficult; slightly difficult; not difficult; no sexual activity [coded as missing]) (reverse scored). For both items, 3% of women did not respond at all. The two items ($r = 0.75$) were summed to yield a measure of orgasm rate. Data collection proceeded in two waves (nonoverlapping subsamples); the questionnaires used in the two waves comprised largely the same items, including those described above. However, items differed between the two questionnaires on other variables of interest. Participants in the first wave ($N = 2245$) were asked ‘How many children do you have?’, while participants in the second wave ($N = 6202$) were asked ‘How many biological children do you have?’ as well as ‘How many other (nonbiological) children do you have?’. We are only interested in biological children here, but only 1% of participants in the second wave reported having any nonbiological children; as such, we used the generic ‘number of children’ item for participants in the first wave with the knowledge that it would include a very small degree of error owing to the inclusion of nonbiological children. Participants in the second wave were additionally asked if they had a current partner (‘Are you in a steady relationship?’ Yes/No) and if so how long they had been in this relationship (response categories: less than a month; more than a month but less than 6 months; 7–12 months; 1–3 years; 4–10 years; more than 10 years); they were also asked how often they engaged in vaginal intercourse (not at all; less than once a month; once or twice a month; once a week; two or three times a week; four to six times a week; once a day; two or three times a day; more than four times a day).

Ethical clearance for the first wave was given by the Ethics Committee of the Department of Psychology at Abo Akademi University and for the second wave by the Ethics Committee of the Abo Akademi University. Further details of the samples and data collection are described elsewhere (Johansson et al. 2013).

Statistical Analysis

The classic twin design partitions variance in traits, and covariance between traits, into genetic, shared environmental (i.e. shared within twin pairs) and residual (e.g. unshared environment and measurement error) sources. This can be achieved because each of these sources of variance predicts different patterns of identical and nonidentical twin pair correlations. Identical twins share all their genes, while nonidentical twins share on average only half their segregating genes. As such, if genetic factors were the only source of variance in a trait we would expect a twin correlation of 1 for identical pairs and 0.5 for nonidentical pairs. If shared environmental factors were the only source of variance in a trait, we would expect a twin correlation of 1 for both identical and nonidentical pairs. Residual variance is uncorrelated in both identical and nonidentical pairs. In reality, observed identical and nonidentical twin correlations generally reflect a combination of these sources of variance, and structural equation modelling determines the combination that best matches the observed data. Cross-twin cross-trait correlations enable us to partition covariance

between traits into genetic and environmental sources in the same way as we do for variance in a single trait.

Standard biometrical analysis (Neale & Cardon 1992; Posthuma et al. 2003) was conducted in the matrix algebra program Mx (Neale et al. 2004), which uses maximum-likelihood modelling to determine the model that best fits the data, incorporating age as a covariate (controls for mean effect) so as not to inflate the correlations between twins (since they are the same age). In maximum-likelihood modelling, the goodness-of-fit of a model to the observed data is distributed as chi-square, and the number of unknown parameters (those to be estimated) is reflected by the degrees of freedom. By testing the change in chi-square ($\Delta\chi^2$) against the change in degrees of freedom (Δdf), we can test whether dropping model parameters, or constraining them to be equal, significantly worsens the model fit (i.e. a likelihood ratio test).

RESULTS

Table 1 shows intraclass twin pair correlations for each trait, as well as the cross-twin cross-trait correlations for the full sample, all controlling for age. Intraclass correlations were greater in identical twin pairs than in nonidentical twin and sibling pairs for both orgasm rate ($\chi^2_1 = 20.91$, $P < 0.001$) and number of offspring ($\chi^2_1 = 13.45$, $P < 0.001$), indicating genetic influences on both traits. Biometrical modelling showed that genetic factors accounted for 26% and 30% of the variance in orgasm rate and number of offspring, respectively, while shared environment accounted for no variance in orgasm rate and 11% of the variance in number of offspring.

Orgasm rate and number of offspring were weakly but significantly correlated within individuals ($r = 0.06$, $P < 0.001$). Cross-twin cross-trait correlations (Table 1) were nonsignificant and weaker in identical twins than in nonidentical twins, the opposite of what would be expected in the presence of a genetic correlation between the two variables. This suggests that higher orgasm rate does not cause a greater number of offspring (in which case a genetic correlation would be expected, because both the genetic and environmental influences on orgasm would necessarily influence number of offspring); it instead suggests that the weak association may instead be caused by environmental factors.

Two candidates for such environmental factors are relationship length and frequency of sexual intercourse; if one or both of these were associated with both orgasm rate and number of children, they could drive the association between the latter two traits. To test this, we used the subsample of women who were in relationships and reported relationship length and frequency of sexual intercourse ($N = 3916$). Both relationship length ($r = 0.05$, $P = 0.001$) and frequency of sexual intercourse ($r = 0.09$, $P < 0.001$) were weakly but significantly correlated with orgasm rate, controlling for age. In this subsample, the correlation between orgasm rate and number of offspring was again weak but significant when controlling only for age ($r = 0.04$, $P = 0.006$), but when relationship length was also controlled the correlation became even weaker and

Table 1
Intraclass Pearson correlations for orgasm rate and number of children, and cross-twin cross-trait intraclass Pearson correlations

	Intraclass correlations		
	Orgasm	No. of children	Cross-twin cross-trait
Identical twins (645 pairs)	0.25	0.41	–0.01
Nonidentical twins/siblings (1751 pairs)	0.09	0.26	0.04

Number of identical and nonidentical twin/sibling pairs are included in parentheses.

nonsignificant ($r = 0.024$, $P = 0.13$), and was further reduced when we also controlled for frequency of intercourse ($r = 0.017$, $P = 0.28$). Given that controlling for just these two factors eliminated much of the already tiny correlation and that there was no genetic correlation, our results suggest it is unlikely there is any substantive causal link between female orgasm rate and number of offspring.

DISCUSSION

To inform the debate on the evolutionary basis of female orgasm, we investigated the putative link between orgasm and fertility. Our findings suggest it unlikely that female orgasm substantively increases the probability of fertilization, casting doubt on cryptic female choice explanations of female orgasm that depend on such a phenomenon.

While physiological processes promoting conception are the most commonly cited mechanism for how orgasm might facilitate female sire choice, another possibility is that orgasm simply functions as a reward for sexual intercourse with high-quality men. However, the very weak correlation between orgasm rate and frequency of intercourse does not provide much support for the idea that orgasm is important in encouraging intercourse. Our results have no impact on other evolutionary explanations. The findings are not inconsistent with the pair-bonding hypothesis that female orgasm facilitates long-lasting relationships that afford the benefits of biparental care to offspring (Morris 1967). Nor are they inconsistent with the by-product theory (Lloyd 2005), whereby female orgasm is not adaptive and is maintained as a by-product of ongoing selection on the male orgasm–ejaculation system. However, it should be noted that other recent evidence casts doubt on each of the possibilities just mentioned (Zietsch & Santtila 2011; Zietsch et al. 2011).

One caveat of the present findings is that modern contraception and family planning might reduce any correlation between orgasm rate and number of offspring. However, unplanned pregnancies and difficulty or inability to conceive are both commonplace and, respectively, would be more and less common in orgasmic women if orgasms during sex were associated with processes facilitating fertilization; that is, we should still have expected to see more orgasmic women tending to having children earlier and more often than less orgasmic women, which would have created a correlation between orgasm rate and number of children after controlling for age. None the less, future research would benefit by asking about timing and duration of birth control use, and orgasm rates within the associated time periods and with specific partners, so that these factors could be accounted for when testing for any orgasm–fertility link.

Another limitation is that women's orgasm rate was assessed generically with regard to type of sexual activity. Future studies should assess orgasm rate with specific reference to different types of sexual activity (e.g. during copulatory and noncopulatory sex; Baker & Bellis 1993), and different types of orgasm (e.g. clitoral and vaginal orgasm; Costa et al. 2012), since these have been hypothesized to affect fertility differentially. Furthermore, Puts et al. (2012a) raised the possibility that female orgasm could serve both fertilization and pair-bonding functions during the fertile and nonfertile phases of the menstrual cycle, respectively; to test such complex hypotheses would require further details including cycle information and temporally specific information on orgasm rates.

Clearly, the evolutionary basis of female orgasm is still mysterious, and the aforementioned limitations prevent the present results from being definitive; but the simplest explanation of these findings is that orgasm does not substantively affect women's fertility, which reduces the likelihood of certain prominent evolutionary accounts.

Acknowledgments

Thanks go to the twins who participated, and to Patrik Jern for assistance with the data. Brendan Zietsch is supported by a Discovery Early Career Research Award from the Australian Research Council.

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