



Sexual and emotional jealousy in relation to the facial sexual dimorphism of a potential rival

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Keywords: jealousy; feminine; masculine; face; emotional infidelity; sexual infidelity

Received March 5, 2021
Revised February 1, 2023
Accepted February 1, 2023

Abstract

Background and purpose: Previous studies have shown that men are more sensitive to sexual infidelity, while women are more sensitive to emotional infidelity. Studies have also shown that jealousy is evoked by the rival's desirable characteristics. Therefore, it was assumed that women would be more jealous of a woman with a feminine face, while men would report greater levels of jealousy when presented with a rival with a masculine face. It was also predicted that these expected differences would depend on the infidelity type – sexual and emotional. Based on this, the aim of this study was to investigate differences in jealousy in relation to participants' sex, the type of infidelity and the rival's facial sexual dimorphism.

Materials and methods: The study included 401 (164 men and 237 women) participants, aged between 18 and 35. Jealousy was assessed by using hypothetical scenarios of a partner's emotional and sexual infidelity that involved rivals with a masculine and feminine face. Participants reported the intensity of jealousy on a 7-point scale.

Results and conclusions: As predicted, men reported higher levels of jealousy over sexual, whereas women were more upset over emotional infidelity. Moreover, while there was no difference in jealousy among men in relation to the rival's facial sexual dimorphism, women reported a higher intensity of jealousy toward a rival with a feminine face, regardless of the infidelity type. These results are interpreted by different adaptive mechanisms in men and women.

INTRODUCTION

Jealousy is a complex emotion defined as a response to a perceived threat to an important romantic relationship (1). Once evoked, jealousy motivates behaviors aimed at deterring a potential threat and maintaining a valued relationship. From an evolutionary perspective, this represents an adaptive reaction that evolved as a response to an adaptive mating problem faced by our ancestors (2).

However, men and women have been faced with different adaptive mating problems (3), so they differ in their reactions to different types of infidelity. First, men have been faced with the problem of paternity uncertainty because fertilization occurs in a woman's body. Paternity probability decreases if a man's mate has engaged in sexual intercourse with another man. In this case, man is at higher risk of investing time and resources in biologically unrelated offspring. Therefore, men should report greater sensitivity to sexual infidelity.

On the other hand, women's reproductive success is not affected by partners' sexual infidelity (2). Instead, women have been faced with the problem of losing partner's resources and support. The probability of losing a partner's resources increases in case of emotional infidelity, assuming that a man would invest in a woman with whom he is emotionally involved. Considering this, women should be more sensitive to signs of emotional infidelity.

The described sex differences in jealousy have been documented in numerous previous studies conducted in different cultures and with different methods (forced-choice methods, continuous scales, physiological measurement, etc.) (4–24). Recent findings suggest that the same sex difference in response to sexual and emotional infidelity exists in the case of online infidelity (25,26). Furthermore, men (compared to women) were found to be more reactive to the sexual components of infidelity, as assessed by a startle eyeblink response (27). In addition, sex differences were confirmed in a meta-analytic review (28) that included 40 published and unpublished papers with 209 effect sizes from 47 independent samples.

In addition to jealousy ratings depending on the infidelity type, men and women generally differ in the characteristics they value in a potential partner. The mechanism underlying these differences includes sex differences in parental investment (3). Parental investment can be defined as time, energy, and resources that a parent invests in the offspring to increase its chance of survival (29). Sex differences in parental investment, i.e., larger investment by women than men, is largely due to the higher metabolic energy expenditure in producing eggs versus producing sperm, fertilization that occurs in a female body, and pregnancy that lasts for nine months which makes further reproduction during that time impossible. Also, women have to go through childbirth, after which they usually spend time breastfeeding for up to several years. On the contrary, after fertilization, men's minimal obligatory parental investment is almost zero (29). However, to increase the survival of the offspring men provided food and protection, hence allocating direct resources to their offspring (30).

Based on this, it is assumed that women evolved to pay attention to signs of the ability of the potential partners to provide resources. It has been proposed that the ability to provide food and protection, as well as genetic benefits to their offspring, is related to physical masculinity and dominance (30). Moreover, physical masculinity may provide information about reproductive maturity, health, and social status (31), making it a desirable characteristic women seek in a potential partner. In line with this, studies have shown that women prefer men who are more muscular (32) and have more masculine voices (33). Jones *et al.* (34) recently published the largest-ever longitudinal study of women's preferences for facial masculinity in

men's faces and reported that women generally preferred masculinized over feminized versions of men's faces. Men's facial masculinity was found to be negatively associated with the frequency of respiratory diseases and antibiotic use (35), suggesting it can be an indicator of good health.

It is noteworthy that some studies failed to support the finding that women prefer masculine over feminine faces (36), possibly because this preference is context-dependent (short- vs. long-term relationship contexts) and can vary as a function of women's individual differences, such as sexual orientation, self-rated attractiveness, and pathogen disgust sensitivity (37). Nevertheless, it seems that women are accurate in estimating physical strength by inspecting only male faces (38) and that they perceive masculine faces as more dominant (36).

Furthermore, it is assumed that men evolved to seek signs of reproductive health in potential partners and the ability to provide direct physiological resources to offspring and carry out the pregnancy. Signs of reproductive health are related to physical attractiveness and femininity. In line with this, men prefer women with feminine voices (39–42) and faces (43–46). Studies have also shown that facial femininity is positively related to estrogen levels (47) and negatively related to respiratory disease number and duration (35). This suggests that, just like male masculine features, feminine features in women's faces may signal good (reproductive) health.

In general, men and women value sexually dimorphic facial features when evaluating the physical appearance of an opposite-sex partner. These sexually dimorphic characteristics that men and women value in potential partners correspond to those of potential rivals that evoke more intense jealousy. This means that a rival with desirable physical characteristics (masculine men and feminine women) should elicit greater levels of jealousy. For example, studies have shown that men were more upset by a physically stronger rival, whereas women were more jealous of a rival with a more attractive face (6, 48). In a similar vein, it has been found that men reported greater jealousy when a rival was high in social and physical dominance, while women reported more jealousy when a rival was more physically attractive (49).

The aim of the present study was to replicate previous results regarding sex differences in jealousy with respect to two different infidelity types and to extend previous findings regarding the role of rival's facial characteristics on jealousy ratings. For this purpose, feminine and masculine prototype faces of potential rivals in hypothetical situations of emotional and sexual infidelity were used. We assumed that men would report greater distress over sexual, whereas women would report greater distress over emotional infidelity. Also, we expected that a same-sex rival with high sexually dimorphic facial features (i.e., masculine man and feminine woman) would provoke

greater jealousy in both sexes. This was especially expected in the hypothetical situation of sexual, compared to emotional infidelity, because some evidence suggests that partners' physical appearance is more important in sexual (short-term) than in emotional (long-term) relationships (50,51).

MATERIALS AND METHODS

Participants

Heterosexual participants ($N=401$) volunteered to take part in this research (164 men and 237 women). All of the participants in the sample were of early adult age and from various faculties and professions in the Republic of Croatia. Participants' age range was from 18 to 34 years. The mean age of women ($M=22.20$, $SD=2.65$) did not differ significantly from the mean age of men ($M=22.15$, $SD=3.26$, $t(399)=0.12$, $p=0.91$). Using convenience sampling, participants were recruited via Facebook by sharing the experimental procedure within groups with members who are heterogeneous by sex, age, occupation, and area of residence within the Republic of Croatia.

Jealousy assessment

Jealousy in relation to the two infidelity types was assessed by using an original procedure developed by Buss et al. (4), which includes hypothetical scenarios of sexual and emotional infidelity. Participants were presented with the instruction to "think of a committed romantic relationship that you have had in the past, that you currently have, or that you would like to have. Now imagine that the person with whom you are in this relationship is interested in another person of the opposite sex." Next, participants were told that they will be presented with the image of a person (see detailed description below) that got involved with their partner. They estimated the level of jealousy using 7-point scale (from 0 – the absence of jealousy to 6 – maximum jealousy) in hypothetical situations of sexual ("partner had sexual intercourse with the person in the image but with no emotional involvement") and emotional infidelity ("partner formed deep emotional relationship with the person in the image, but with no sexual involvement").

Images of the rivals

In order to examine changes in jealousy depending on the level of rival's facial sexual dimorphism, standardized images of male and female prototype face from previous research (52) were used with the permission of the authors. Each prototype face was created from ten passport-style photographs randomly selected from a pool of 60 male ($M_{age}=20.54$, $SD_{age}=2.07$) and 60 female ($M_{age}=20.48$, $SD_{age}=2.30$) individual photographs taken for previous studies (53-55) (for more information on the photographic procedure, see (53)).



Figure 1. Male prototype face in two versions – high facial sexual dimorphism (masculine, left) and low facial sexual dimorphism (feminine, right).



Figure 2. Female prototype face in two versions – high facial sexual dimorphism (feminine, right) and low facial sexual dimorphism (masculine, left).

For the purpose of previous study (52) each prototype was transformed by $\pm 50\%$ of the shape differences between symmetrical male and female prototypes in order to appear more feminine and more masculine using standard computer graphics methods (56). In this way, four prototype faces were created: masculine woman (low facial sexual dimorphism), feminine woman (high facial sexual dimorphism), masculine man (high facial sexual dimorphism), and feminine man (low facial sexual dimorphism) (for more information on the transformation procedure, see 51). These prototype faces, presented in Figures 1 and 2, were then used in the present study as a same-sex rivals in hypothetical situations of partner's emotional and sexual infidelity.

Procedure

Ethical approval for this research was obtained from the Committee for ethical issues and research at the University of Zadar. The research procedure was set online and was conducted by using *Psytoolkit*, a free web-based app for demonstrating, programming, and running experiments and surveys. After being given an assurance guaranteeing anonymity of their answers, participants were asked an initial set of questions about their age, gender,

sexual orientation (heterosexual, homosexual, bisexual, or other) and relationship status (single, in a committed relationship, married, or other).

Next, participants were presented with combinations of infidelity scenarios (emotional/sexual) that involved rivals presented in the images. Each participant rated his/her level of jealousy in four different situations: emotional and sexual infidelity that involved same-sex rivals high and low in facial sexual dimorphism. All four trials were presented in a randomized order.

RESULTS

All analyses were conducted using a programming language for statistical computing *R* v.6.6.0 (57) with packages, *lme4* v.1.1-21 (58) and *emmeans* v.1.4.3.01 (59). Descriptive statistics, means and standard deviations, of jealousy ratings for different infidelity scenarios that involved rival high and low in facial sexual dimorphism are presented in Table 1. Furthermore, distributions of jealousy ratings in different situations did not deviate greatly from the normal since all skewness (< 3) and kurtosis (< 8) indices were below the proposed thresholds (60).

Differences in jealousy ratings were examined using a linear mixed-effects model with crossed random effects of participants and stimuli (images of the rivals). Considering participants as a sample from the population of participants, and images of the potential rivals as a sample from the population of potential rivals, we specified two random effects structures: one for the participants and one for the stimuli. We assessed fixed effects of participants' gender (man and women), level of rival's facial sexual dimorphism (high and low) and infidelity type (sexual and emotional) to jealousy ratings.

Models with crossed random factors have two sampling units, hence fixed factors are not solely considered as being "between" or "within". Therefore, models need to be spec-

ified by having both sampling from the populations of participants and stimuli in mind (61). Here, we can consider rival's facial dimorphism and infidelity type as within-subjects and between items factors, and participant's gender as between subjects and within items factor. Accordingly, we defined random effects structure by specifying random intercepts for subjects allowing for random slopes of rival's facial sexual dimorphism and infidelity type, and by specifying random intercepts for stimuli and allowing for random slopes of participant's gender.

Linear mixed-effects modelling was conducted using maximum likelihood as an estimation method and the significance of the fixed effects were obtained by calculating the 95% confidence intervals, based on the parametric bootstrapping of 10,000 samples.

Table 2. Results of linear mixed-effects model examining changes in jealousy ratings in relation to participant's gender, level of rival's facial sexual dimorphism and infidelity type, by controlling for participant's age and relationship status.

Fixed effects	B	SE	95% CI	
			2.5%	97.5%
Intercept	4.03*	0.18	3.68	4.37
Age (centered)	-0.07*	0.03	-0.12	-0.004
Relationship status (ref. In a relationship)	-0.65*	0.18	-0.99	-0.31
Gender (ref. Man)	1.48*	0.19	1.11	1.84
Rival's facial sexual dimorphism (ref. High)	-0.03	0.09	-0.20	0.14
Infidelity type (ref. Emotional)	0.32*	0.12	0.08	0.55
Gender X Rival's facial sexual dimorphism	-0.21	0.12	-0.44	-0.01
Gender X Infidelity type	-0.49*	0.15	-0.80	-0.18
Rival's facial sexual dimorphism X Infidelity type	0.14*	0.12	-0.09	0.37
Gender X Rival's facial sexual dimorphism X Infidelity type	-0.25	0.15	-0.56	0.06
Random effects				
Participants				
Intercept SD	1.70			
Rival's facial sexual dimorphism SD	0.38			
Infidelity type SD	1.07			
Items				
Intercept SD	0.0002			
Gender SD	0.0006			
Residual SD	0.76			

* – significant fixed effects, *B* – unstandardized regression coefficient, *SE* – standard error of *B*, 95% *CI* – 95% confidence intervals calculated based on parametric bootstrapping of 10,000 samples

Table 1. Descriptive statistics for jealousy ratings depending on the infidelity type and the level of rival's facial sexual dimorphism.

	Facial sexual dimorphism	Infidelity			
		Emotional		Sexual	
		M	SD	M	SD
Total sample	High	4.58	2.04	4.60	2.07
	Low	4.42	2.05	4.43	2.07
Men	High	3.67	2.06	4.02	2.33
	Low	3.62	2.11	4.10	2.26
Women	High	5.22	1.74	5.07	1.70
	Low	4.97	1.82	4.72	1.87

M – mean; *SD* – standard deviation

Results showed a significant negative relationship between jealousy intensity and participants' age. Therefore, we controlled for the effect of age, which was centered around 22.22, a sample mean age. Results also suggest that participants who were in a committed relationship reported higher levels of jealousy, compared to the single participants. Hence, we controlled for the effect of the relationship status by making participants being in the relationship a reference category.

Results of the linear mixed-effects model are presented in Table 2.

Main effects of participant's gender and infidelity type were statistically significant, with women reporting greater levels of jealousy compared to men, and sexual infidelity eliciting greater jealousy responses compared to emotional infidelity. The main effect of rival's facial sexual dimorphism was not statistically significant.

Next, we examined the interactions of fixed effects in predicting jealousy ratings. Highest order, a three-way interaction between participant's gender, rival's facial sexual dimorphism and infidelity type was not statistically significant in predicting jealousy ratings, and we proceeded to interpret two-way interactions. The interaction between infidelity type and rival's facial sexual dimorphism was not significant. On the other hand, two-way interaction between participant's gender and infidelity type, and interaction between participant's gender and rival's facial sexual dimorphism were statistically significant in predicting jealousy ratings. To further understand those interactions, we plotted model-based estimated marginal means (*EMMs*) (Figure 3) and conducted post-hoc pairwise comparisons.

We conducted pairwise comparisons using *t*-test with degrees of freedom estimated by Satterthwaite method, allowing for inequality of variances in compared samples.

Regarding the interaction between participant's gender and infidelity type (Figure 3A), within-sex comparisons revealed that men were more jealous to sexual (*EMM*=4.36) than to emotional (*EMM*=4.04) infidelity ($t(496.3)=3.79$, $p<0.01$). The opposite pattern was observed among women, who were more jealous of emotional (*EMM*=5.52) compared to sexual (*EMM*=5.34) infidelity ($t(396)=2.70$, $p<0.01$). Between-sex comparisons show that women generally reported higher levels of jealousy compared to men (see the main fixed effect of sex in Table 2). This was the case in both infidelity scenarios, emotional ($t(397.1)=7.46$, $p<0.01$) and sexual ($t(398.8)=3.82$, $p<0.01$). Since previous studies (4-27) have shown sex differences in jealousy, with men being more jealous of sexual, and women of emotional infidelity, the present finding was unexpected. We assumed that sex differences in jealousy ratings were masked by generally greater jealousy levels among women. Following previous research (16), we performed an additional analysis by introducing relative jealousy levels to test this assumption.

We first calculated the proportion of sexual jealousy in overall jealousy for each participant. In this way, calculated proportion shows whether certain participant expressed higher levels of jealousy to sexual or emotional infidelity, regardless of his/her overall jealousy level. Next, we tested sex differences in the average proportion of jealousy to sexual infidelity in overall jealousy. Results show that men ($M_p=0.52$) had significantly higher proportion compared to women ($M_q=0.48$, $t(275)=3.35$, $p<0.01$). The opposite pattern was observed for the average proportion of emotional jealousy in total jealousy, which was higher among women (*t*-test value was the same but in the opposite direction).

Lastly, we conducted post-hoc analysis of group *EMMs* following the significant participant's gender by rival's facial

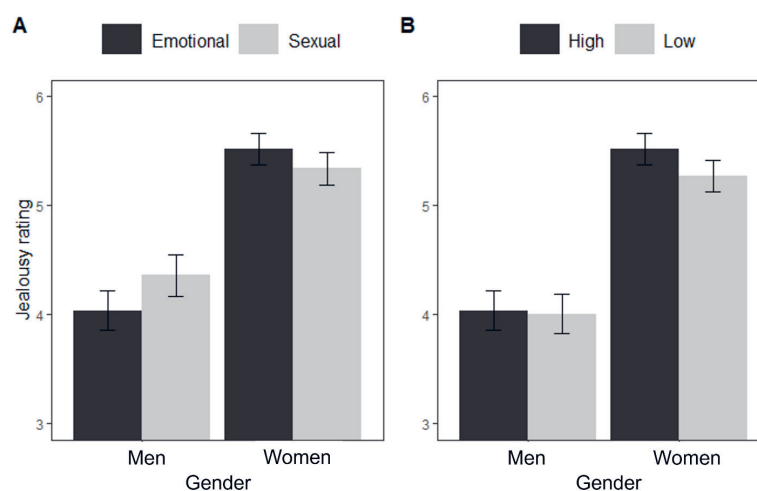


Figure 3. Bar plots of estimated marginal means and their standard errors showing two-way interactions in predicting jealousy ratings: A) interaction between participant's gender and infidelity type, with bar colors representing different infidelity scenarios; B) interaction between participant's gender and rival's facial sexual dimorphism, with bar colors representing different levels of facial sexual dimorphism.

sexual dimorphism interaction (Figure 3B). Results show that men did not differ in their jealousy ratings in relation to rival's facial characteristics ($t(395.9)=0.56$, $p > 0.05$). On the contrary, women were more jealous of rivals with high ($EMM=5.52$) compared to rivals with low facial sexual dimorphism ($EMM=5.27$, $t(395.8)=5.41$, $p<0.01$). As expected, women reported higher levels of jealousy in hypothetical situations in which their partners got sexually or emotionally involved with a feminine woman.

DISCUSSION

The aim of the present study was to investigate sex differences in jealousy with respect to two different infidelity types and rival's facial sexual dimorphism. First, the results show that women generally tended to report higher levels of jealousy in comparison to men. This finding is supported by similar past research (16,62–64). A sensible explanation of this effect might be the well-observed tendency among women to be more emotionally expressive in comparison to men (65), which might make them less likely to underestimate their jealousy levels. Despite women being generally more jealous than men, additional analysis suggested that men did, in fact, report greater jealousy in the hypothetical situation of sexual infidelity, whereas women reported greater distress over emotional infidelity, thus supporting our initial hypothesis regarding sex differences in jealousy. This finding is in line with the results of previous studies (4–27) and supports the assumption that men and women differ in their sensitivity to different types of infidelity most likely because of their differential parental investment and different adaptive mating problems they have been faced with (3). While men have been faced with the problem of paternity uncertainty in case of sexual infidelity, women were at risk of losing their partners' resources and support in case of emotional infidelity.

Furthermore, it was expected that a rival with high sexually dimorphic facial features (i.e., masculine man and feminine woman) would provoke greater jealousy in both sexes, especially in the hypothetical situation of sexual infidelity. This assumption was not supported by the present results. While women did report greater jealousy when faced with a rival with a feminine face for both infidelity types, men did not differ in their responses in relation to the facial sexual dimorphism of a potential rival. This result is in line with the evolutionary explanation of asymmetrical reproductive value among men and women. Since the reproductive value of women is linked to their fertility and ability to raise and nurture offspring, men are more likely to pay attention to their level of physical attractiveness which serves as a cue of their reproductive value (66). Therefore, it is possible that the physical attractiveness of a potential rival would have an effect on jealousy among women, but not so much among men. In a similar vein, previous findings suggest that, compared

to women, men place more importance on physical appearance when seeking a potential partner (67). This again might be a reason why a rival's physical attractiveness affected jealousy ratings among women, and not men.

The current study also demonstrates that, contrary to our initial prediction, the rival's sexual dimorphism did not affect jealousy ratings differently under the conditions of sexual and emotional infidelity. Women's increased jealousy when faced with a feminine rival regardless of infidelity type, might be due to the men's general preference for feminine women, regardless of whether they are seeking a short-term (sexual) or long-term (emotional) relationship. In fact, there is evidence suggesting that men tend to consider physical attractiveness an important characteristic when looking for both short-term and long-term relationships (67).

In general, this study demonstrates the importance of a rival's physical appearance in intrasexual competition among women and suggests that some other rival's characteristics (for example, financial or social status) might be more important when it comes to eliciting jealousy among men. For example, there are other variables not included in this study, but important in mate selection, such as personality traits, earning capacity, social status, and sense of humor (67). Including these variables when describing potential rivals, together with their physical appearance, might provide additional insights into the sex differences in jealousy. Furthermore, it is worth mentioning that women's sensitivity to infidelity cues might change across the menstrual cycle. For example, a significant link between estradiol levels and jealousy in the case of sexual infidelity was found (68). Also, changes in women's intrasexual competition strategies need to be taken into an account. One of the frequently used strategies among women is derogation, which consists of decreasing a rival's value, usually aimed at physical attractiveness. There is evidence that women tend to use this strategy more often during the fertility period (69). This might lead to potential problems in investigating jealousy levels, as ovulating women might feel as jealous as usual (or even more) yet tend to underestimate it as a strategy of intrasexual competition.

In addition to discussing the methodological issues of the present study, it is worth noting another theoretical perspective on sex differences in jealousy. Specifically, it has been recently proposed that men's differentially greater jealousy occurs in response to situations that threaten paternity *opportunities*, and not paternity certainty (70). Based on this alternative account for the sex difference in jealousy, loss of perceived paternity opportunities is considered to be the ultimate origin of men's increased jealousy in response to sexual infidelity. Further investigation of the two alternative hypotheses and theoretical perspectives on the origin of men's jealousy might lead to impor-

tant and novel explanations of sex differences in jealousy and their correlates.

In conclusion, the present study shows that men and women differ in jealousy, with men being more sensitive to sexual, and women to emotional infidelity. While physical appearance of a potential rival did not alter jealousy ratings among men, women reported greater distress in hypothetical scenarios of emotional and sexual infidelity that involved a rival with high facial sexual dimorphism.

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