
Male Sexual Jealousy: Lost Paternity Opportunities?

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**John E. Edlund**

Rochester Institute of Technology, NY, USA

David J. Buller and Brad J. Sagarin

Northern Illinois University, DeKalb, IL, USA

Jeremy D. HeiderSoutheast Missouri State University, Cape Girardeau,
MO, USA**Cory R. Scherer**

Pennsylvania State University—Schuylkill, PA, USA

Maria-Magdalena Farc

McHenry County College, Crystal Lake, IL, USA

Oluyinka Ojedokun

Adekunle Ajasin University, Akungba-Akoko, Nigeria

Abstract

Numerous studies have shown that men experience relatively greater levels of jealousy in response to the sexual aspects of an infidelity (relative to women), whereas women experience relatively greater levels of jealousy in response to the emotional aspects of an infidelity (relative to men). The traditional explanation for this relationship suggests that men experience this greater level of jealousy due to threats of a loss of paternal certainty. In this article, we present three studies that demonstrate

Corresponding Author:

John E. Edlund, Department of Psychology, Rochester Institute of Technology, 18 Lomb Memorial Drive,
Rochester, NY 14623, USA.

Email: jeegsh@rit.edu

that men's differentially greater jealousy occurs in response to situations that threaten paternity *opportunities*. These results suggest that a loss of perceived paternity opportunities is the ultimate origin of men's increased jealousy in response to sexual infidelity.

Keywords

Sex differences, jealousy, paternity opportunities, paternal uncertainty

Introduction

According to traditional accounts of the theory of evolved sex differences in jealousy, ancestral women's challenge of ensuring paternal investment exerted selective pressures that increased women's jealousy in response to emotional infidelity, whereas ancestral men's challenge of paternal uncertainty exerted selective pressures that increased men's jealousy in response to sexual infidelity (Buss, Larsen, Westen, & Semmelroth, 1992; Daly, Wilson, & Weghorst, 1982; Symons, 1979). Following Buss et al.'s seminal study, numerous studies have attempted to refute or support this basic finding. Meta-analyses have established that the sex difference in jealousy replicates when using forced-choice measures (Harris, 2003) and continuous measures (Sagarin et al., 2012). Although there have been some challenges to this finding (e.g., the double shot hypothesis: DeSteno & Salovey, 1996; attenuation of the effect under cognitive load: DeSteno, Bartlett, Braverman, & Salovey, 2002), none of these challenges has significantly changed the way that evolutionary psychologists approach the sex difference in jealousy (as all of these initial challenges were addressed in subsequent studies).

In contrast to these challenges, Buller (2005) has issued a fundamental challenge to the evolutionary hypothesis regarding the sex difference in jealousy. Buller begins by noting that ancestral women's willingness to pair bond implies that men were offering them something of sufficient value to justify eschewing (for the most part) other men. Similarly, ancestral men's willingness to pair bond implies that women were offering them something of sufficient value to justify eschewing (for the most part) other women. According to Buller, the traditional evolutionary psychological view defines the exchange as follows: Men offer women paternal investment, and women offer men paternal certainty. From this, the sex difference in jealousy can be seen as stemming from perceived breaches of this exchange (emotional infidelity threatening paternal investment; sexual infidelity threatening paternal certainty).¹

Buller's (2005) challenge concerns half of the exchange. Buller concurs with the view that men's offer of paternal investment was sufficient to motivate

women to enter into pair bonds. But Buller argues that women's offer of increased paternal certainty was insufficient to motivate men to enter pair bonds. Buller cites two pieces of evidence in support of his argument. First, Buller cites Hawkes, Rogers, and Charnov's (1995) game-theoretic models that demonstrate

even in a model of a pair-bonded population in which males are assured of paternity, and hence assured that their parental care isn't misspent, males still allocate very little effort to parental care and the vast majority of their effort to promiscuous mating. (p. 266)

Ultimately, even in models where men were assured of their paternity, the models could not account for the observed levels of care of children found in humans. Thus, assurance of increased paternal certainty is insufficient to motivate men to provide paternal investment.

Second, Buller (2005) cites Smuts and Gubernick's (1992) mating effort hypothesis, which considers male parental care as mating effort, not parenting effort. Smuts and Gubernick note that, across species, paternity certainty is unrelated to males' willingness to provide care. Further, in some species with male care (e.g., savanna baboons, vervet monkeys, and gelada), males frequently provide care to a female's offspring prior to mating with the female, with the female often providing subsequent paternity opportunities, presumably in response to the male's willingness to provide care (van Schaik & Paul, 1996). This suggests an alternative model for pair bonding: Men offer women paternal investment, and women offer men paternity opportunities (indeed, these ideas have previously been suggested, but not tested, by Daly et al., 1982 and Buss, 2000). This, in turn, suggests an alternative model for the sex difference in jealousy: Women have evolved an increase in jealousy in response to threats to paternal investment, whereas men have evolved an increase in jealousy in response to threats to paternity opportunities.

Ultimately, this lost opportunities theory proposes that men will show an increase in jealousy in responses to any situation where the man believes that he has lost a perceived paternity opportunity. These types of situations include the typical scenarios used in the sex difference in jealousy research where the cheating partner actually has sex with an interloper (and a possible pregnancy could result); however, the lost opportunities theory proposes that men will also show an increase in jealousy in response to scenarios where there is simply a perceived loss in paternity opportunities even when paternity certainty is not an issue (e.g., the couple has been dating but has never had sex). It is worth noting that all scenarios that threaten paternal certainty also threaten paternity opportunities (because a woman who becomes pregnant from a rival cannot conceive with her partner during the pregnancy and is less likely to conceive with her partner during lactation). Thus, paternity uncertainty scenarios represent a subset of

lost paternity opportunity scenarios. The key test, then, is whether men's unique increase in jealousy (relative to women) occurs only for paternity uncertainty scenarios (which would support the traditional paternity uncertainty account of the male side of evolved sex differences in jealousy) or whether men's unique increase in jealousy (relative to women) occurs for the larger set of lost paternity opportunity scenarios (which would support the alternate account of the male side of evolved sex differences in jealousy).

More specifically, support for the lost paternity opportunities explanation would be found if men show a greater increase in jealousy than women in the lost opportunities scenarios compared to the control scenarios, whereas support for the paternity uncertainty explanation would be found if men show a greater increase in jealousy than women in the paternity uncertainty scenarios compared to the control scenarios. Furthermore, we realize that all the jealousy scenarios we use in the present studies confound other factors along with the critical manipulated variables (just as the standard sexual infidelity and emotional infidelity scenarios used across numerous studies on sex differences in jealousy confound other factors: see Edlund & Sagarin, 2009 for a detailed exposition on this issue). It is due to this that the critical test is not simply whether lost paternity opportunity scenarios provoke greater jealousy in men than do other types of jealousy scenarios—a difference that could be easily attributed to confounding factors. The critical test is whether lost paternity opportunity scenarios provoke disproportionately greater jealousy in men compared to women than do other types of jealousy scenarios—an interaction between scenario type and sex that would be more difficult to attribute to confounding factors (see Edlund & Sagarin, 2009 or Edlund & Sagarin, 2017 for further explanation of these factors).

We present three studies that provide the first test of these competing explanations in humans. These studies pit the paternal certainty explanation against the paternity opportunities explanation by examining women's and men's reactions to a series of jealousy-provoking situations. In line with prior theorizing and numerous prior studies, women are expected to show an increase in jealousy in response to situations that threaten paternal investment (e.g., emotional infidelity), and men are expected to show an increase in jealousy in response to situations that threaten paternal certainty (e.g., sexual infidelity). This latter prediction emerges from both explanations, straightforwardly from the paternal certainty explanation, but also from the paternity opportunities explanation, as the pregnancy and subsequent lactation potentially caused by a sexual infidelity reduces a man's paternity opportunities. The theories make different predictions, for scenarios in which there is a perceived loss in paternity opportunities where there is no loss of paternal certainty. Support for the paternal certainty explanation would be found if these scenarios produce similar increases in women's and men's jealousy compared to control scenarios (e.g., there is no difference between men's and women's responses relative to the control

scenarios). Support for the paternity opportunities explanation would be found if these scenarios produce a significantly greater increase in men's jealousy over women's jealousy compared to the control scenarios (e.g., men show an increase in jealousy in response to these scenarios that women do not) .

It is important to note that many factors beyond the evolutionary influence may impact a particular person's response to a particular jealousy-producing situation (for instance, in many studies of jealousy, women report higher levels of jealousy in response to all aspects of an infidelity; Edlund & Sagarin, 2009). These social (or other) factors do certainly play an important role in how a person evaluates the situation, but these factors in no way negate the influence of the evolutionary forces. However, due to the impact of these factors, the critical test of the evolutionary hypothesis is the interaction between gender and scenario type (see Edlund & Sagarin, 2017 for a detailed exposition on this issue). It is also worth noting that we are concerned with the ultimate origins of human behavior; the proximate reasons for a particular behavior might *appear* completely disconnected from the ultimate origin. For instance, sexual intercourse has the ultimate origin of procreation (this is a biological certainty). However, evolution has influenced this so significantly that most sex that occurs in the United States has an explicit goal to avoid procreation (Davis, Shaver, & Vernon, 2004). That does not negate the importance of procreation in the origins of sexual behavior, even if the specific acts are not done for the purposes of procreation.

Hypotheses

1. When participants imagine a scenario where there is both a loss of paternal certainty and opportunity, we expect men and women to show increased jealousy relative to control scenarios.
2. When participants imagine a scenario where there is a loss of perceived opportunities but no loss of certainty, we expect that men will show a greater increase in jealousy (relative to women) compared to the control scenarios.

Study one

Method

Participants. Ninety-one randomly selected undergraduate students in an introduction to psychology subject pool based in the United States participated in this experiment (33 men, 58 women, $M_{age} = 18.95$ years, $SD = 1.87$).² The gender breakdown was representative of the subject pool from which the participants were drawn. Four participants who did not identify as heterosexual (1 gay/lesbian, 1 bisexual, 2 non-respondents) were excluded from the analyses.

This research (and the subsequent studies) was institutional review board approved.

Procedure. Students completed a seven-page survey in class for extra credit. The first six pages contained three non-romantic jealousy scenarios (e.g., “Imagine that you just returned from Christmas vacation from your first year at college. You discover that your best friend from high school has a new friend and that they are spending all their time together.”), three lost paternity opportunity scenarios (e.g., “Imagine that before you had ever had sex, your partner has broken off the relationship. This partner then becomes involved with someone else whom you have never met.”), and three paternity uncertainty scenarios (e.g., “Imagine that you are in a sexual relationship with your partner. Your partner confesses that he or she recently had a one-night stand, which they assure you was a one-time occurrence and will never happen again.”); see Appendix for the full list of scenarios. Participants rated their levels of jealousy, hurt, and anger to these scenarios on a scale of 1 to 9 (although in this article, we only report the results of the jealousy items).³ Demographic information was collected at the end of the survey.

Results and discussion

Preliminary evaluation. Before analyzing the data, we inspected the data for suitability for analyses. The means on the component items were somewhat skewed (ranging from -1.47 to $.30$) and somewhat variable kurtoses (ranging from -1.41 to 2.00). Given analysis of variance’s robustness against moderate violations of normality (Olson, 1974), this suggests that the data were suitable for parametric analyses.

Confirmatory factor analysis. The first analysis of interest was to investigate whether the scenarios were interpreted by the participants as different categories of jealousy responses. We tested three models: a one-factor model that considered all items to be reflective of jealousy, a two-factor model that viewed the paternity uncertainty items as separate from the other items, and a three-factor model that treated all three classes separately. The one- and two-factor models exhibited poor fit (Non-normed fit index, comparative fit index, incremental fit index $< .85$; root mean square error of approximation $> .09$). The three-factor model exhibited characteristics evident of good fit (although the χ^2 statistic for the three-factor model ($\chi^2 = 43.51$, $p < .01$) was significant, the χ^2/df ratio (1.89) is considered excellent (Kline, 2005)). The values of the comparative fit index (0.93) and incremental fit index (0.93) also meet the threshold (.90) for good model fit. Last, the root mean square error of approximation statistic (.084) is also considered to be acceptable. As this model appeared to best fit the data, we moved onto an analysis collapsing across the three scenarios in each category

Table 1. Average means by condition in study one.

	General jealousy scenarios	Lost opportunity scenarios	Paternity uncertainty scenarios
Men	4.74 (1.77)	5.49 (1.95)	6.29 (1.90)
Women	4.84 (1.80)	4.84 (2.05)	6.70 (1.86)

(indeed, a similar approach of collapsing across scenarios was taken by Sheets & Wolfe, 2001 when investigating the sex difference in jealousy).

Scenario comparisons. Our primary analysis of interest was comparing men and women and their level of jealousy across the three scenario classes (see Table 1). We ran a mixed model repeated measures analysis of variance where sex was between subjects and the responses to scenarios were within subjects. Sex interacted with scenario type, $F_{interaction} (2, 84) = 4.84, p = .01, \text{partial } \eta^2 = 0.04$. Additionally, there was a main effect of scenario type, $F_{maineffect} (2, 84) = 42.81, p < .01, \text{partial } \eta^2 = 0.49$. Sex was not a significant predictor in this analysis, $F_{maineffect} (2, 84) = .02, p > .05, \text{partial } \eta^2 = 0.00$.

Consistent with much of the literature (e.g., Sagarin et al., 2012), we found that women ($M = 6.70$) reported more jealousy than did men ($M = 6.29$) in the lost paternity certainty scenarios. However, consistent with the lost paternity opportunities theory and inconsistent with the paternity uncertainty theory, we found that men showed significantly higher levels of jealousy in response to the lost opportunities scenarios than did women (men = 5.49, women = 4.84). This suggests that men are particularly sensitive to the perception of lost paternity opportunities and they experience increased jealousy in response to these scenarios.

Study two

Our initial investigation suggests that men are sensitive to lost paternity opportunities as a broad classification; however, Buller (2005) suggests that there would likely be three separate potential triggers of male jealousy in response to lost perceived mating opportunities: (1) that jealousy could be provoked prior to a full-blown relationship being formed; (2) the jealousy could be provoked when an existing relationship ends and the woman begins a new sexual relationship with another man; or (3) the jealousy could be provoked when a man is the extra-dyadic partner who is poaching access to the female partner. Although Buller (2005) suggests that jealousy could be provoked in the extra-dyadic condition, we wondered whether this type of situation might actually cause men to show lower levels of jealousy due to two separate contributing factors: (1) The man would continue to have mating access (although it would not be exclusive

access) and (2) because men in this situation might coopt their lover's partner, this type of situation might be a conditional mating strategy, which would have been advantageous for men to pursue if it were available, and as such, it could have suppressed the normal jealousy response.

The purpose of this study was to investigate whether the three subtypes of lost paternity opportunities would provoke a higher level of jealousy in men. In addition to investigating these three subtypes of lost opportunity driven jealousy, we also added scenarios that would assess reactions to a purely emotional betrayal and a purely sexual betrayal (similar to the scenarios used in Buss et al., 1999). These additional items help establish the similarity of our research paradigm by using similar measures to the ones previously published.

Method

Participants. One hundred eighty-seven randomly selected undergraduate students in an introduction to psychology subject pool based in the United States participated in this experiment (52 men, 135 women, $M_{age} = 22.87$ years, $SD = 1.87$). The gender breakdown was representative of the subject pool from which the participants were drawn. Twelve participants who did not identify as heterosexual (5 homosexual, 6 bisexual, 1 non-respondent) and nine participants who did not fully complete the packet were excluded from the analyses.

Procedure. Students completed a 13-page survey in class for extra credit. The first 12 pages contained the three non-romantic jealousy scenarios, two lost paternity opportunity scenarios where the individuals had never had sex, two lost paternity opportunity scenarios where there was a clean break in a formerly sexual relationship, two lost paternity scenarios where the respondent is the extra-dyadic partner, the three paternity uncertainty scenarios, three sexual betrayal only scenarios, and three emotional betrayal only scenarios; nine of these scenarios had previously been featured in study one (and additional items were created for this study); see Appendix for the full list of scenarios. Participants rated their levels of jealousy, hurt, and anger to these scenarios on a scale of 1 to 9. Demographic information was collected at the end of the survey.

Results and discussion

Preliminary evaluation. As in study one, we conducted a preliminary evaluation of the data. The means on the component items were somewhat skewed (ranging from -1.30 to $.31$) and possessed somewhat variable kurtoses (ranging from $-.128$ to $.91$). As such, the data were suitable for analysis.

Primary analysis. As in study one, our primary analysis of interest compared men and women and their levels of jealousy across the scenario classes. Sex interacted with scenario type, $F_{interaction}(6, 157) = 2.79$, $p < .01$, partial $\eta^2 = 0.03$. There was

Table 2. Average means by condition in study two (United States sample).

	General jealousy scenarios	Lost opportunity (with no sex) scenarios	Lost opportunity (with sex) scenarios	Lost opportunity as the other scenarios	Paternity uncertainty scenarios	Sexual betrayal only scenarios	Emotional betrayal only scenarios
Men	3.77 (1.66)	4.51 (2.03)	5.21 (1.88)	4.00 (2.24)	6.38 (1.73)	6.06 (2.05)	6.10 (1.59)
Women	5.32 (1.63)	5.32 (1.81)	5.81 (1.97)	5.32 (2.17)	6.85 (1.68)	6.38 (1.86)	7.13 (1.47)

a significant difference between men and women in the general jealousy condition, $F(1, 163) = 9.10$, $p < .01$; see Table 2 for all of the means and standard deviations.

Additionally, we were interested in replicating the basic pattern of results found in the traditional sex difference in jealousy literature; we compared the sexual- and emotional-betrayal only scenarios. The interaction between men's and women's responses to the scenarios was significant, $F_{contrast}(1, 164) = 8.76$, $p < .01$, partial $\eta^2 = 0.05$. This suggests that the basic pattern that has been demonstrated in the literature (where men, relative to women, show higher levels of jealousy in response to the sexual components of the infidelity) is present in these data as well.

As in study one, we found that women reported more jealousy than did men in the lost paternity certainty scenarios (which neither uniquely supports the lost opportunities or the paternity uncertainty theories, nor does it provide refutation evidence for either). However, consistent with the lost paternity opportunities theory and inconsistent with the paternity uncertainty theory, we found that men (relative to women) showed higher levels of jealousy in response to the lost opportunities scenarios where the individuals had sex but a definitive break had occurred, along with the scenarios where the individuals had never had sex. This reinforces the idea that men are particularly sensitive to the perception of lost paternity opportunities.

Study three

Studies one and two have provided initial evidence suggesting that the sex difference in jealousy can better be explained by the lost opportunities theory (more so than the theory of paternal uncertainty). In study three, we sought to replicate the results from studies one and two while looking at a cross-cultural sample of students and working adults.

Method

Participants. Three hundred twenty undergraduate students and working adults based in Nigeria participated in this experiment (155 men, 165 women,

Table 3. Average means by condition in study three (Nigeria sample).

	General jealousy scenarios	Lost opportunity (with no sex) scenarios	Lost opportunity (with sex) scenarios	Lost opportunity as the other scenarios	Paternity uncertainty scenarios	Sexual betrayal only scenarios	Emotional betrayal only scenarios
Men	4.42 (1.93)	4.40 (2.19)	5.19 (2.17)	4.03 (2.38)	5.03 (1.87)	4.86 (1.49)	4.90 (1.79)
Women	4.67 (2.06)	4.52 (2.53)	4.77 (2.13)	4.27 (2.88)	5.95 (2.19)	5.01 (2.21)	5.39 (1.70)

$M_{age} = 23.42$ years, $SD = 3.08$). Participants were randomly drawn from a university subject pool as well as working adults collected through a snowball data collection technique. Twelve participants who did not identify as heterosexual (12 homosexual) and two participants who did not fully complete the packet were excluded from the analyses. The Nigerian sample was selected based on availability of the participants along with the desire to expand the validity of studies one and two by doing a replication in a collectivistic and less WEIRD context (Western, Educated, Industrialized, Rich, Democratic; Henrich, Heine, & Norenzayan, 2010).

Procedure. Participants completed an adapted survey from study two. These adaptations were minor (bachelor/bachelorette party was re-termed bachelor/spinster/matric night party; see Appendix for the scenarios along with their modifications) as English is the official language of Nigeria (eliminating the need for a true translation). As in studies one and two, participants rated their levels of jealousy, hurt, and anger to these scenarios on a scale of 1 to 9. Demographic information was collected at the end of the survey.

Results and discussion

Preliminary evaluation. As in study one, we conducted a preliminary evaluation of the data. The means on the component items were minimally skewed (ranging from $-.26$ to $.70$) and somewhat variable kurtoses (ranging from $-.1.62$ to $-.82$). As such, the data were suitable for analysis.

Primary analysis. As in studies one and two, our primary analysis of interest was comparing men and women and their levels of jealousy across the scenario classes. Sex interacted with scenario type, $F_{interaction} (6, 299) = 18.04$, $p < .01$, partial $\eta^2 = 0.10$; see Table 3 for all of the means and standard deviations. Sex was not a significant predictor in this analysis, $F_{maineffect} (1, 299) = 2.53$, $p > .05$, partial $\eta^2 = 0.01$.

Additionally, we were interested in replicating the basic pattern of results found in the traditional sex difference in jealousy literature (as done in study

two); we compared the sexual- and emotional-betrayal only scenarios. The interaction between men's and women's responses to the scenarios was marginally significant, $F_{contrast}(1, 305) = 3.75, p = .054$, partial $\eta^2 = 0.03$. This suggests that the basic pattern that has been demonstrated in the literature in cross-cultural samples (where men, relative to women, show higher levels of jealousy in response to the sexual components of the infidelity) is present in these data as well.

As in studies one and two, we found that women reported more jealousy than did men in the lost paternity certainty scenarios. However, consistent with the lost paternity opportunities theory and inconsistent with the paternity uncertainty theory, we found that men (relative to women) showed a significantly greater jealousy in response to the lost opportunities scenarios where the individuals had never had sex. This further reinforces the idea that men are particularly sensitive to the perception of lost paternity opportunities.

General discussion

Across three separate studies, we investigated whether the sex difference in jealousy could best be explained by the lost paternity opportunities theory in samples collected in the United States and in Nigeria. The critical test of the paternity opportunities theory would be found in scenarios where there is a perceived loss of paternity opportunities but no loss of paternal certainty; support for the paternity opportunities explanation would be found if these scenarios produce a significantly greater increase in men's jealousy over women's jealousy compared to the control scenarios, whereas support for the paternal certainty explanation would be found if these scenarios produce similar increases in women's and men's jealousy compared to control scenarios. Both theories would predict an increase in jealousy in response to situations that threatened paternal certainty (as by definition there would also be a loss of paternal opportunities).

In study one, we found that men showed an increase in jealous responses to scenarios where there was a perceived loss of paternity opportunities (whereas women did not show a sensitivity to those scenarios); both men and women showed a high level of jealousy in response to the paternal uncertainty scenarios. In study two, men again showed an increase in jealousy in response to the perceived loss of paternity opportunities scenarios where the couple has never had sex and scenarios where there was a clear end to the relationships. In study three, men showed an increase in jealousy in response to the scenarios where the couple had sex but there was a clear end to the relationship. In addition, we replicated the traditional sex difference in jealousy using items that focused on the sexual and emotional components separated. Finally, both men and women showed an increase in jealousy in response to the scenarios where there is both a loss of paternity opportunities and a loss of paternity certainty.

Taken together, these studies argue for a change in our understanding of the sex difference in jealousy. We suggest that the best explanation for the *male* side of the sex difference in jealousy is that men are sensitive to a perceived loss in paternity opportunities (rather than a loss of paternal certainty). Ultimately, the lost opportunities theory allows for the prediction of differences in jealousy under a wider variety of circumstances (such as a relationship where the partners have never had sex) than are predicted by the paternal uncertainty hypothesis. Further, as we demonstrated this effect in a non-Western sample, we believe that this is not an artifact of culture but, rather, represents an evolved predisposition.

This conclusion opens the door to additional avenues for research investigating the sex difference in jealousy. For instance, it stands to reason that men might be sensitive to other cues related to their paternity opportunities such as a woman's fertility status. This research also has potential ramifications for other areas of evolutionary psychology. For instance, the mate guarding literature (Buss & Shackelford, 1997) has been premised on the idea of men responding to cues that might challenge their paternity certainty. Our research would suggest that this literature would benefit from a critical evaluation of other factors related to paternity opportunities that might show sensitivity towards mate guarding. It is important to note that we are not arguing that the existing findings are wrong (i.e., that men, relative to women, are more upset about the sexual components of an infidelity, whereas women, relative to men, are more upset about the emotional components of the infidelity)—rather, we are arguing that the theoretical explanation needs expansion from looking only at paternity uncertainty to looking at lost paternity opportunities.

Limitations

Of course, one could raise the challenge (common to many of the studies that have investigated sex differences in jealousy) that our studies looked at hypothetical responses to scenarios and that people's actual responses might differ. It is worth noting, however, that when this challenge has been offered in the past, researchers looking at retrospective reports of actual infidelity have found that the sex difference in jealousy replicates in adult samples that have personally experienced an infidelity (Edlund, Heider, Scherer, Farc, & Sagarin, 2006). However, we believe that future research should look at retrospective reports of jealousy in response to a wider variety of circumstances (ones where there is a loss of paternity opportunities without a loss of paternal certainty).

Another challenge could be raised that the paternity uncertainty scenarios yielded higher jealousy scores for men than the lost opportunity scenarios (which some might take as evidence to support the paternity uncertainty hypothesis). However, Buller (2005) addresses this possibility in noting that paternal uncertainty could have boosted men's jealousy in such scenarios, but that it was insufficient as the *ultimate* origin of men's increased jealousy in

response to sexual infidelity. As such, paternity uncertainty can add to the influence of lost paternity opportunities.

A final challenge worth discussing is the modern tool of genetic testing. Certainly, the powerful tool of genetic testing has radically changed medicine and human interactions (for instance, the Golden State Killer was caught in part by using commercial genetic testing). Indeed, today, with genetic testing, there does not ever need to be paternal uncertainty. However, given that the availability of genetic testing is an extremely recent development, we would not expect this to influence our underlying evolved predispositions. However, this certainly presents an avenue for exploring the research question broached in this article.

Conclusion

We believe that this research extends and refines the work on sex differences in jealousy. Ultimately, men are distally interested in procreation opportunities (despite the fact that the proximate reasons for their responses might be different); any challenge to those opportunities will likely cause a jealousy response (which of course will vary based on the investment in the relationship, the type of challenge, etc.). As such, men's differing responses (relative to women) to the traditional sex difference in jealousy scenario are driven not by paternity uncertainty but by a perceived loss in paternity opportunities.

Appendix

Scenarios used in studies 1 to 3

General jealousy scenarios

* Imagine that you are working at a job. You are your boss' favorite worker. However, your boss recently hired a new worker that seems eager to succeed. The new worker seems to be trying to gain favor with your boss, perhaps to try to gain a promotion.

* Imagine that you just returned from Christmas vacation from your first year at college. You discover that your best friend from high school has a new friend and that they are spending all their time together.

* Imagine that you have a favorite teacher and you are the teacher's favorite student. A new student joins the class and the teacher is paying a lot of attention to this new individual. You fear that this individual will become your teacher's new favorite student.

Lost opportunity (with no sex) scenarios

Imagine that you desire a sexual relationship with someone. However, you find out that this person has begun a sexual relationship with someone else.

* Imagine that before you ever had sex with your romantic partner, he or she breaks off the relationship. This partner then becomes involved with someone else whom you have never met.

Lost opportunity (with sex) scenarios

* Imagine that your partner, with whom you have had an ongoing sexual relationship, breaks up with you. Your partner conveys to you in no uncertain terms that your relationship is over, and that it can never take place again because he or she is now in another relationship.

* Imagine that you are in a romantic relationship that is sexual. Your partner confesses that they have had a homosexual affair, and then breaks up with you to begin a relationship with the affair partner.

Lost opportunity as the other scenarios

Imagine that a married individual is having an affair with you (in other words, you are not married, and your romantic partner is married to someone else). This partner has said that they are planning on leaving their spouse for you. However, they have not broken off the relationship yet.

Imagine that a married individual is having an affair with you (in other words, you are not married, and your romantic partner is married to someone else). This partner says he or she is planning on supporting you, and they have already demonstrated this by purchasing you a house among other items. However, they have not broken off their relationship with their spouse.

Paternity uncertainty scenarios

* Imagine that you and your romantic partner have a sexual relationship. You discover that your romantic partner has been having a sexual affair with someone else and they recently informed you that they are in love with the other person.

* Imagine that you mistakenly receive an email from your romantic partner meant for his or her coworker. It talks about the flowers and gifts that have been exchanged and how much your partner cares for the other individual. Your partner also comments on how good the sex was.

* Imagine that your current partner bumps into their old high school sweetheart on a vacation without you. You suspect something may have occurred, as your partner does not want to talk about what happened during the vacation.

Sexual only scenarios

Imagine that your romantic partner confesses to you that during a bachelor/bachelorette (bachelor/spinster), party things got out of control and they ended up having sex with one of the strippers.

Imagine that you are in a sexual relationship with your partner. Your partner confesses that he or she recently had a one-night stand, which they assure you was a one-time occurrence and will never happen again.

Imagine that your romantic partner confesses to you that he/she has been involved in a serious sexual relationship with someone else for some time now. However, he/she states that they were never in love with the other person and it will not happen again.

Emotional only scenarios

Imagine that your partner confesses that they are in love with someone else. Your partner tells you that it is not sexual, nor could it ever be, and that they simply care deeply for the other person.

Imagine that your partner confesses that they have fallen in love with someone else. Your partner assures you that nothing physical ever occurred. Furthermore, your partner tells you that this person has moved across the country for a job.

Imagine that you notice that your romantic partner has formed a deep emotional attachment to another person. You ask your partner about it, and your partner acknowledges that they care very deeply for this other person.

Note: *indicates item used in study one.

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Notes

1. This is not to say that other forces have not have influenced pair bonding as well. For instance, human infants require substantially more care than many other newborn animals. This fact has been shown to affect mate preferences (Buss, 1989) and evaluations of mate quality (Buss & Schmitt, 1993).
2. We analyzed the results for anger and hurt as well; these results had means that were in the predicted direction but were somewhat weaker. The relative weakness of these measures (relative to jealousy as an emotional term) is consistent with the established work on the sex difference in jealousy (Sagarin et al., 2012).
3. One might raise concerns about the imbalanced cell sizes between men and women in studies one and two. These samples represent the full data collected during the research and we have striven to report the truest representation of the data.

However, in light of the concerns raised about this imbalance, we performed an additional set of analyses on these data where a proportion of the women had been randomly removed from the dataset; none of the conclusions reported in the analyses section changed as a result of the removals.

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Author Biographies

John E. Edlund is an associate professor of psychology at the Rochester Institute of Technology. He studies social psychology, evolutionary psychology, along with studying how researchers employ research methods. He earned his PhD at Northern Illinois University. Edlund serves as the Psi Chi Research Director.

David J. Buller is a professor and chair in the Department of Philosophy at Northern Illinois University. He has published articles and books in the areas of cognitive science, philosophy of biology, and evolutionary psychology.

Brad J. Sagarin is a professor of social and evolutionary psychology at Northern Illinois University where he studies social influence, resistance to persuasion, deception, jealousy, infidelity, and human sexuality. Brad holds Doctorate and Master's degrees in Social Psychology from Arizona State University, and a Baccalaureate degree in Computer Science from the Massachusetts Institute of Technology.

Jeremy D. Heider is an associate professor of psychology at Southeast Missouri State University in Cape Girardeau, MO. He studies sex differences in reactions

to infidelity (e.g., emotional jealousy) and how individual difference variables such as masculinity and femininity moderate those differences.

Cory R. Scherer is an associate professor of psychology at Penn State Schuylkill. He earned his PhD at Northern Illinois University.

Maria-Magdalena Farc is a psychology instructor at McHenry County College. She earned her PhD at Northern Illinois University.

Oluyinka Ojedokun teaches psychology to both undergraduate and postgraduate students at the Department of Pure & Applied Psychology, Adekunle Ajasin University, Akungba-AKoko, Ondo State, Nigeria. He holds a PhD in Social and Personality Psychology as well as a BSc in Psychology and an MSc in Social and Personality Psychology from University of Ibadan, Nigeria. He is a recipient of a number of fellowship and grants. His main research interests are in pro-environmental behavior and attitude, psychological well-being and mental health, especially in higher education, organization, and community settings, sexual behavior research methods (particularly triangulation research), and meaning-making research.