

BRIEF REPORT

Partner Attractiveness Moderates the Relationship Between Number of Sexual Rivals and In-Pair Copulation Frequency in Humans (*Homo sapiens*)

Michael N. Pham, Todd K. Shackelford, Christopher J. Holden, Virgil Zeigler-Hill,
Anna Hummel, and Stacy L. Memering
Oakland University

Nonhuman males attend to the number of potential sexual rivals in the local environment to assess sperm competition risk. Males of these species sometimes perform more frequent in-pair copulations to increase the likelihood of success in sperm competition. Here, we extend this research to humans, *Homo sapiens*. We secured self-report data from 393 men in a committed, sexual, heterosexual relationship. The results indicate that men whose in-pair partner has more male coworkers and friends (i.e., potential sexual rivals) also perform more frequent in-pair copulations, but *only* among men who perceive their partner to be particularly attractive relative to assessments of partners by other men in the sample. This research is the first to empirically investigate the number of potential male rivals in the local environment as a cue to sperm competition risk in humans. Discussion addresses limitations of the current research and highlights directions for future research.

Keywords: sperm competition, frequent copulation, female attractiveness, male sexual rivals, humans

Sperm competition occurs when a female copulates with two or more males within a sufficiently brief time period, with the result that the sperm of the different males simultaneously occupy the reproductive tract and compete to fertilize ova (Parker, 1970). Among paternally investing, socially monogamous species (e.g., many avian species, humans), female extrapair copulation (EPC) is the most common context for sperm competition (Birkhead & Møller, 1998; Smith, 1984). Males whose in-pair partner pursues EPCs are at risk of cuckoldry—the unwitting investment of resources in offspring to whom he is genetically unrelated.

Males evolved adaptations to increase success in sperm competition, including a “sperm competition psychology”—information-processing mechanisms that motivate males to judiciously perform sperm competition tactics: These mechanisms activate when males perceive sperm competition cues, and produce outputs that motivate sperm competition tactics (Goetz, Shackelford, Platek, Starrett, & McKibbin, 2007).

Male-initiated frequent in-pair copulations (IPCs) may be a sperm competition tactic. Males may perform frequent IPCs to place more functional sperm into competition with potential rival sperm in a partner’s reproductive tract (Birkhead, Atkin, & Møller, 1987; McKinney, Cheng, & Bruggers, 1984). Among socially

monogamous birds, males at greater sperm competition risk perform more frequent IPCs (Birkhead et al., 1987; McKinney et al., 1984; Pizzari, Cornwallis, Løvlie, Jakobsson, & Birkhead, 2003). In humans, men’s IPC frequency correlates positively with sperm competition risk (Kaighobadi & Shackelford, 2008) and with performance of “mate retention” tactics—behaviors decreasing a partner’s EPC risk (Shackelford, Goetz, Guta, & Schmitt, 2006).

Female attractiveness may cue sperm competition risk. Male fowl (*Gallus gallus*) copulating with a more attractive female ejaculate more sperm (Cornwallis & Birkhead, 2007). Human males mated to a more attractive partner also may be at greater risk. Rival males more frequently approach, and poach, more attractive women from their relationships (Schmitt & Buss, 2001). Men mated to more attractive women perform more mate retention tactics (Buss & Shackelford, 1997; Goetz et al., 2005; Haselton & Gangestad, 2006) and more behaviors interpreted as sperm competition tactics (Goetz et al., 2005; Kaighobadi & Shackelford, 2008). Research documents a positive relationship between female attractiveness and IPC frequency (Kaighobadi & Shackelford, 2008).

Across several species, nonhuman males attend to the presence and number of potential sexual rivals to assess sperm competition risk and adjust accordingly the number of sperm in their copulatory ejaculate, as well as time spent guarding their partner (Fuller, 1998; Gage & Barnard, 1996; Møller, 1985; Pilastro, Scaggianti, & Rasotto, 2002; Pizzari, Cornwallis, & Froman, 2007; Pizzari et al., 2003; Rondeau & Sainte-Marie, 2001; Schaus & Sakaluk, 2001). In humans, presence and number of potential sexual rivals also may index sperm competition risk. More sexually aroused men produce ejaculates that may be more successful in sperm

Michael N. Pham, Todd K. Shackelford, Christopher J. Holden, Virgil Zeigler-Hill, Anna Hummel, and Stacy L. Memering, Department of Psychology, Oakland University.

Correspondence concerning this article should be addressed to Michael N. Pham, Department of Psychology, Oakland University, 110 Pryale Hall, Rochester, MI 48309. E-mail: mnpham@oakland.edu

competition (e.g., higher percentage of motile sperm, Kilgallon & Simmons, 2005; higher sperm concentration, higher concentration of motile sperm, and more motile and more total sperm, Pound, Javed, Ruberto, Shaikh, & Del Valle, 2002; greater semen volume, van Rouen et al., 1996), and male sexual arousal is greater when viewing pornography depicting one woman interacting with two men (cueing sperm competition risk) than during pornography depicting two women interacting with one man (cueing absence of sperm competition risk; McKibbin, Pham, & Shackelford, 2013; Pound, 2002). Kilgallon and Simmons (2005) documented that men produce masturbatory ejaculates with a higher percentage of motile sperm when viewing pornography depicting one woman interacting with two men than during pornography depicting three women interacting without any men. Additionally, men whose in-pair partner spends more time with her male friends (i.e., potential sexual rivals) report greater IPC interest (Pham & Shackelford, 2013).

In the current research, we investigate two classes of potential sexual rivals: women's male coworkers and male friends. The workplace is a common environment in which partnered women identify and secure EPC partners (McKinnish, 2007; Treas & Giesen, 2000; Wiggins & Lederer, 1984). Across several samples, 46% to 62% of partnered women who report EPCs share a workplace with their EPC partner (Treas & Giesen, 2000; Wiggins & Lederer, 1984). Partnered women may also pursue EPCs with their male friends. Men sometimes befriend partnered women with the intention of luring them into an extrapair sexual relationship (Schmitt & Buss, 2001). The majority of men, and some women, are sexually attracted to opposite-sex friends (Kaplan & Keys, 1997), and report uncertainty about sexual boundaries with those friends (Swain, 1992). Because men may estimate sperm competition risk from their partner's attractiveness and the number of her male coworkers and male friends, and because male-initiated frequent IPC may be a sperm competition tactic, we hypothesize that men who perceive a partner to have more male coworkers and friends (i.e., potential sexual rivals) will also perform more frequent IPCs, but *only* if they perceive their partner to be particularly attractive relative to assessments of partners by other men in the sample. Because human in-pair sexual activity declines over the course of a relationship (Klusmann, 2002, 2006), we control statistically for relationship length in testing our hypothesis.

Method

We recruited from the community and university campuses 393 men in a committed, sexual, heterosexual relationship. The mean participant age was 23.7 years ($SD = 7.5$), and the mean relationship length was 35.9 months ($SD = 56.2$).

Materials

Participants reported their age (in years) and the length of their relationship (in months). Following previous research (Goetz et al., 2005; Kaighobadi & Shackelford, 2008), participants answered four questions about their partner's attractiveness on a 10-point Likert-type scale (0 = *not at all*, 9 = *extremely*): How (a) physically and (b) sexually attractive do you currently find your partner? How (c) physically and (d) sexually attractive do other men currently find your partner? Participants reported how many (a)

male friends and (b) male coworkers their partner currently had. Participants reported the number of times they had sex with their partner in the past week.

Procedures

Potential participants were asked if they were at least 18 years of age and in a committed, sexual, heterosexual relationship. Those qualifying were asked to read and sign a consent form and to complete a questionnaire. Participants placed completed questionnaires in envelopes they then sealed, and placed the consent form in separate envelopes, to retain anonymity.

Results

Following previous research (Goetz et al., 2005; Kaighobadi & Shackelford, 2008), we constructed a *partner attractiveness* measure ($\alpha = .85$, $M = 7.08$, $SD = 1.33$) from the mean of responses to four questions: how (a) sexually and (b) physically attractive the participant views his partner, and how (c) sexually and (d) physically attractive the participant believes other men view his partner. We constructed a *potential sexual rivals* measure from the sum of participant's reports of the number of their partner's male friends and male coworkers. We recorded IPC frequency as men's reports of the number of times they had sex with their partner in the past week.

To test the hypothesis, we conducted a moderation analysis (controlling statistically for relationship length) to assess whether men who perceived more potential sexual rivals also performed more frequent IPCs, but *only* among men who perceived their partner to be more attractive. We entered into a regression analysis predicting IPC frequency from the number of potential sexual rivals and partner attractiveness (both centered), an interaction term for these two variables, and relationship length. There was a main effect of relationship length ($\beta = -.13$, $t = -2.60$, $p = .01$), partner attractiveness ($\beta = .20$, $t = 4.03$, $p < .001$), no main effect of number of potential sexual rivals ($\beta = .01$, $t = 0.17$, $p = .87$), and an interaction effect between partner attractiveness and number of potential sexual rivals ($\beta = .15$, $t = 2.47$, $p = .01$). Predicted values for this interaction are shown in the Figure 1. We conducted simple slopes analyses, recommended by Aiken and West (1991), to describe the interaction of continuous variables. These simple slopes tests were conducted using values one standard deviation above the mean to represent men who perceived their partners to be relatively high in attractiveness ($M = 8.41$), and one standard deviation below the mean to represent men who perceived their partner to be relatively low in attractiveness ($M = 5.75$). Consistent with the hypothesis, the slope of the line representing the association between the number of potential sexual rivals and IPC frequency was significant for men who perceived their partner to be more attractive ($\beta = .25$, $t = 3.06$, $p = .002$), but not for men who perceived their partner to be less attractive ($\beta = -.23$, $t = -1.66$, $p = .10$).

Discussion

Consistent with our hypothesis, men whose in-pair partner had more male coworkers and friends (i.e., potential sexual rivals) also performed more frequent IPCs, but *only* among men who per-

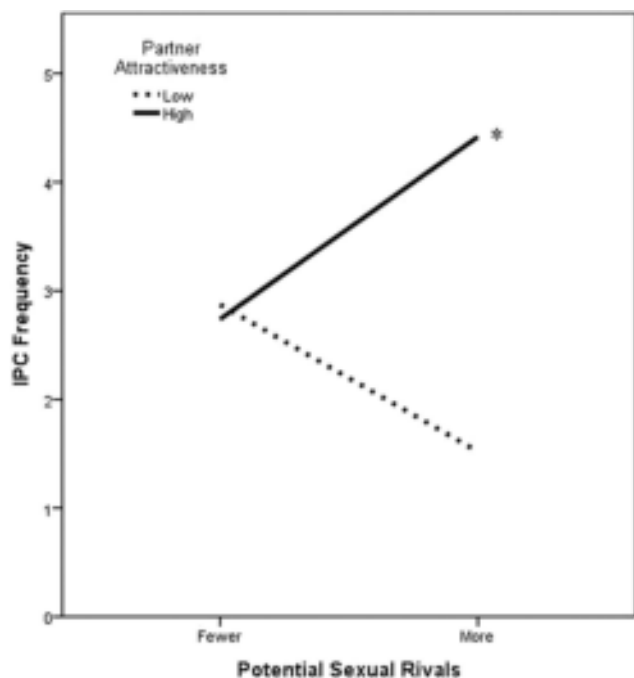


Figure 1. Simple slopes graph for predicting men's IPC frequency from the number of potential sexual rivals at low and high levels (i.e., 1 SD below and above the mean) of partner attractiveness, controlling statistically for relationship length. * $p < .01$.

ceived their partner to be particularly attractive relative to assessments of partners by other men in the sample. This research is the first to investigate the number of potential male rivals in the local environment as a cue to sperm competition risk in humans.

A limitation of the current research is that we do not know whether men or their partner initiated copulations. Male-initiated, but not female-initiated, IPC frequency is hypothesized to be a male sperm competition tactic. However, excluding forced copulation, this distinction is not simple. For example, female nonhuman primates express copulatory interest by presenting their genitals to males; males assess female visual, olfactory, and behavioral signals before "initiating" copulation (Beach, 1976). Similarly, both men and women typically exchange copulatory interest signals with partners before copulation (i.e., flirting and seduction; Moore, 2010). Attractive women might receive more attention from male coworkers and male friends, thereby "priming" sexual desire to perform female-initiated frequent IPCs. Future research could assess the frequency with which men (or their partner) refuse IPCs—an indirect measure of who initiates IPCs.

Another limitation is that we assessed the number of men's partner's male coworkers and friends using men's rather than their partner's reports. Men's reports may be less accurate than direct reports from their partner, but the current research investigates men's perceived sperm competition risk and, therefore, men's reports assess more validly perceived sperm competition risk. Nevertheless, future research could secure men's partner's reports to assess whether men over- or underestimate the number of potential sexual rivals in the local environment.

Male-initiated frequent IPCs also may be part of a broader anticuckoldry strategy. Men may be performing frequent IPCs to

sexually satisfy their partner, thereby minimizing her desire to pursue EPCs. Consistent with this explanation, previous research documents that men's IPC frequency is correlated with the frequency with which they perform other mate retention behaviors (Kaighobadi & Shackelford, 2008; Shackelford et al., 2006).

A notable portion of our sample likely used modern contraceptives (e.g., hormonal contraceptives, diaphragms), which prevent copulations from resulting in sperm competition (e.g., condoms prevent sperm from entering the female reproductive tract). Such evolutionarily novel features, however, are not expected to substantively change the function of evolved sperm competition psychology. "Adaptive mismatches" have also been seen in nonhuman species. For example, male Houbara bustards (*Chlamydotis undulata*) copulate with artificial paper mache females (Saint Jalme, Gaucher, & Paillat, 1994), although such copulations will not produce offspring. Similarly, modern contraceptive use will not necessarily affect men's frequent IPCs as a sperm competition tactic.

In sum, research on nonhuman sperm competition cues can heuristically guide research on human sperm competition cues. Both human and nonhuman males functionally estimate sperm competition risk from the proportion of time spent apart from an in-pair partner since the couple's last copulation (Baker & Bellis, 1993; Shackelford et al., 2002; Shackelford, Goetz, McKibbin, & Starratt, 2007), their partner's attractiveness (Cornwallis & Birkhead, 2007; Goetz et al., 2005; Kaighobadi & Shackelford, 2008), and the presence of potential sexual rivals (Birkhead, Johnson, & Nettleship, 1985; Pham & Shackelford, 2013). The current research adds to this literature by documenting that the number of potential sexual rivals in the local environment affects human males' assessments of sperm competition risk.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage.
- Baker, R. R., & Bellis, M. A. (1993). Human sperm competition: Ejaculate adjustment by males and the function of masturbation. *Animal Behaviour*, 46, 861–885. doi:10.1006/anbe.1993.1271
- Beach, F. A. (1976). Sexual attractivity, proceptivity, and receptivity in female mammals. *Hormones and Behavior*, 7, 105–138. doi:10.1016/0018-506X(76)90008-8
- Birkhead, T. R., Atkin, L., & Møller, A. P. (1987). Copulation behavior of birds. *Behaviour*, 101, 101–138. doi:10.1163/156853987X00396
- Birkhead, T. R., Johnson, S. D., & Nettleship, D. N. (1985). Extra-pair matings and mate guarding in the common murre *Uria aalge*. *Animal Behaviour*, 33, 608–619. doi:10.1016/S0003-3472(85)80085-3
- Birkhead, T. R., & Møller, A. P. (Eds.). (1998). *Sperm competition and sexual selection*. London, UK: Academic Press.
- Buss, D. M., & Shackelford, T. K. (1997). From vigilance to violence: Mate retention tactics in married couples. *Journal of Personality and Social Psychology*, 72, 346–361. doi:10.1037/0022-3514.72.2.346
- Cornwallis, C. K., & Birkhead, T. R. (2007). Changes in sperm quality and numbers in response to experimental manipulation of male social status and female attractiveness. *The American Naturalist*, 170, 758–770. doi:10.1086/521955
- Fuller, R. C. (1998). Sperm competition affects male behaviour and sperm output in the rainbow darter. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, 265, 2365–2371. doi:10.1098/rspb.1998.0585

- Gage, A. R., & Barnard, C. J. (1996). Male crickets increase sperm number in relation to competition and female size. *Behavioral Ecology and Sociobiology*, 38, 349–353. doi:10.1007/s002650050251
- Goetz, A. T., Shackelford, T. K., Platek, S. M., Starratt, V. G., & McKibbin, W. F. (2007). Sperm competition in humans: Implications for male sexual psychology, physiology, anatomy, and behavior. *Annual Review of Sex Research*, 18, 1–22.
- Goetz, A. T., Shackelford, T. K., Weekes-Shackelford, V. A., Euler, H. A., Hoier, S., Schmitt, D. P., & LaMunyon, C. W. (2005). Mate retention, semen displacement, and human sperm competition: A preliminary investigation of tactics to prevent and correct female infidelity. *Personality and Individual Differences*, 38, 749–763. doi:10.1016/j.paid.2004.05.028
- Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior*, 49, 509–518. doi:10.1016/j.yhbeh.2005.10.006
- Kaighobadi, F., & Shackelford, T. K. (2008). Female attractiveness mediates the relationship between in-pair copulation frequency and men's mate retention behaviors. *Personality and Individual Differences*, 45, 293–295. doi:10.1016/j.paid.2008.04.013
- Kaplan, D. L., & Keys, C. B. (1997). Sex and relationship variables as predictors of sexual attraction in cross-sex platonic friendships between young heterosexual adults. *Journal of Social and Personal Relationships*, 14, 191–206. doi:10.1177/0265407597142003
- Kilgallon, S. J., & Simmons, L. W. (2005). Image content influences men's semen quality. *Biology Letters*, 1, 253–255. doi:10.1098/rsbl.2005.0324
- Klusmann, D. (2002). Sexual motivation and the duration of partnership. *Archives of Sexual Behavior*, 31, 275–287. doi:10.1023/A:1015205020769
- Klusmann, D. (2006). Sperm competition and female procurement of male resources. *Human Nature*, 17, 283–300. doi:10.1007/s12110-006-1010-2
- McKibbin, W. F., Pham, M. N., & Shackelford, T. K. (2013). Human sperm competition in postindustrial ecologies: Sperm competition cues predict adult DVD sales. *Behavioral Ecology*, 24, 819–823. doi:10.1093/beheco/art031
- McKinney, F., Cheng, K. M., & Bruggers, D. J. (1984). Sperm competition in apparently monogamous birds. In R. L. Smith (Ed.), *Sperm competition and evolution of animal mating systems* (pp. 523–545). New York, NY: Academic Press.
- McKinnish, T. G. (2007). Sexually integrated workplaces and divorce: Another form of on-the-job search. *Journal of Human Resources*, 42, 331–352.
- Møller, A. P. (1985). Mixed reproductive strategy and mate guarding in a semi-colonial passerine, the swallow *Hirundo rustica*. *Behavioral Ecology and Sociobiology*, 17, 401–408. doi:10.1007/BF00293220
- Moore, M. M. (2010). Human nonverbal courtship behavior—a brief historical review. *Journal of Sex Research*, 47, 171–180. doi:10.1080/00224490903402520
- Parker, G. G. (1970). Sperm competition and its evolutionary consequences in the insects. *Biological Reviews*, 45, 525–567. doi:10.1111/j.1469-185X.1970.tb01176.x
- Pham, M. N., & Shackelford, T. K. (2013). The relationship between objective sperm competition risk and men's copulatory interest is moderated by partner's time spent with other men. *Human Nature*, 24, 476–485. doi:10.1007/s12110-013-9181-0
- Pilastro, A., Scaggianti, M., & Rasotto, M. B. (2002). Individual adjustment of sperm expenditure accords with sperm competition theory. *PNAS Proceedings of the National Academy of Science of the United States of America*, 99, 9913–9915. doi:10.1073/pnas.152133499
- Pizzari, T., Cornwallis, C. K., & Froman, D. P. (2007). Social competitiveness associated with rapid fluctuations in sperm quality in male fowl. *Proceedings of the Royal Society, Series B: Biological Sciences*, 274, 853–860.
- Pizzari, T., Cornwallis, C. K., Løvlie, H., Jakobsson, S., & Birkhead, T. R. (2003). Sophisticated sperm allocation in male fowl. *Nature*, 426, 70–74. doi:10.1038/nature02004
- Pound, N. (2002). Male interest in visual cues of sperm competition risk. *Evolution and Human Behavior*, 23, 443–466. doi:10.1016/S1090-5138(02)00103-4
- Pound, N., Javed, M. H., Ruberto, C., Shaikh, M. A., & Del Valle, A. P. (2002). Duration of sexual arousal predicts semen parameters for masturbatory ejaculates. *Physiology & Behavior*, 76, 685–689. doi:10.1016/S0031-9384(02)00803-X
- Rondeau, A., & Sainte-Marie, B. (2001). Variable mate-guarding time and sperm allocation by male snow crabs (*Chionoecetes opilio*) in response to sexual competition, and their impact on the mating success of females. *The Biological Bulletin*, 201, 204–217. doi:10.2307/1543335
- Saint Jalme, M., Gaucher, P., & Paillat, P. (1994). Artificial insemination in Houbara bustards (*Chlamydotis undulata*): influence of the number of spermatozoa and insemination frequency on fertility and ability to hatch. *Journal of Reproduction and Fertility*, 100, 93–103. doi:10.1530/jrf.0.1000093
- Schaus, J. M., & Sakaluk, S. K. (2001). Ejaculate expenditures of male crickets in response to varying risk and intensity of sperm competition: Not all species play games. *Behavioral Ecology*, 12, 740–745. doi:10.1093/beheco/12.6.740
- Schmitt, D. P., & Buss, D. M. (2001). Human mate poaching: Tactics and temptations for infiltrating existing mateships. *Journal of Personality and Social Psychology*, 80, 894–917. doi:10.1037/0022-3514.80.6.894
- Shackelford, T. K., Goetz, A. T., Guta, F. E., & Schmitt, D. P. (2006). Mate guarding and frequent in-pair copulation in humans. *Human Nature*, 17, 239–252. doi:10.1007/s12110-006-1007-x
- Shackelford, T. K., Goetz, A. T., McKibbin, W. F., & Starratt, V. G. (2007). Absence makes the adaptations grow fonder: Proportion of time apart from partner, male sexual psychology, and sperm competition in humans (*Homo sapiens*). *Journal of Comparative Psychology*, 121, 214–220. doi:10.1037/0735-7036.121.2.214
- Shackelford, T. K., LeBlanc, G. J., Weekes-Shackelford, V. A., Bleske-Rechek, A. L., Euler, H. A., & Hoier, S. (2002). Psychological adaptation to human sperm competition. *Evolution and Human Behavior*, 23, 123–138. doi:10.1016/S1090-5138(01)00090-3
- Smith, R. L. (Ed.). (1984). *Sperm competition and the evolution of animal mating systems*. New York, NY: Academic Press.
- Swain, S. O. (1992). Men's friendships with women: Intimacy, sexual boundaries, and the informant role. In P. M. Nardi (Ed.), *Men's friendships* (pp. 153–172). Newbury Park, CA: Sage. doi:10.4135/9781483325736.n8
- Treas, J., & Giesen, D. (2000). Sexual infidelity among married and cohabiting Americans. *Journal of Marriage and the Family*, 62, 48–60. doi:10.1111/j.1741-3737.2000.00048.x
- van Rouen, J. H., Slob, A. K., Gianotten, W. L., Dohle, G. R., van Der Zon, A. T. M., Vreeburg, J. T. M., & Weber, R. F. A. (1996). Sexual arousal and the quality of semen produced by masturbation. *Human Reproduction*, 11, 147–151. doi:10.1093/oxfordjournals.humrep.a019008
- Wiggins, J. D., & Lederer, D. A. (1984). Differential antecedents of infidelity in marriage. *American Mental Health Counselors Association Journal*, 6, 152–161.

Received August 20, 2013

Revision received February 12, 2014

Accepted February 24, 2014 ■