Mate Retention Behavior and Ejaculate Quality in Humans

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Abstract

Males of some species use mate retention behavior and investment in ejaculate quality as anti-cuckoldry tactics concurrently while others do so in a compensatory fashion. Leivers, Rhodes, and Simmons (2014) reported that men who performed mate retention less frequently produced higher-quality ejaculates, suggesting that humans use these tactics compensatorily. We conducted a conceptual replication of this research in a sample of 41 men (18 to 33 years; M = 23.33; SD = 3.60). By self-report, participants had not had a vasectomy and had never sought infertility treatment. We controlled for several covariates known to affect ejaculate quality (e.g., abstinence duration before providing an ejaculate) and found no statistically significant relationships between mate retention behavior and four components of ejaculate quality: sperm velocity, sperm concentration, slow motility, and ejaculate volume. The present results provide little support for the hypothesis that human males deploy mate retention behavior and ejaculate quality investment compensatorily. We discuss the limitations of this study and highlight the need for research to address questions about the nature of anti-cuckoldry tactic deployment in humans, especially concerning investment in ejaculate quality.

Keywords: ejaculate quality; mate retention; anti-cuckoldry tactics; sperm competition

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Sperm competition occurs when sperm from two or more males simultaneously occupy a female's reproductive tract and compete to fertilize ova (Parker, 1970). In species that practice social monogamy but also occasionally engage in extra-pair copulations, sperm competition can lead males to invest unwittingly in offspring to whom they are not genetically related (i.e., cuckoldry; Parker, 1970). Sperm competition is known to occur – or has been inferred to occur – in many species, including humans (Baker & Bellis, 1993; Birkhead & Møller, 1998; Gomendio & Roldan, 1991; Parker, 1970; Smith, 1984). Scelza and colleagues (2020) found that 48% of children in a sample of the indigenous Himba in Northern Namibia were genetically unrelated to their social father. Research with Western samples suggests much lower (but non-zero) rates of non-paternity in humans. For example, a meta-analysis reported a non-paternity rate of 3.1% across 32 studies (Voracek, Haubner, & Fisher, 2008). To avoid the costs of cuckoldry, human males may deploy anti-cuckoldry tactics such as engaging in more frequent copulation after spending longer periods of time apart from their partner (Shackelford et al., 2002).

Anti-cuckoldry tactics include the use of mate retention behavior and the production of a high-quality ejaculate (Kelly & Jennions, 2011; Kilgallon & Simmons, 2005; Shackelford, Goetz, Guta, & Schmitt, 2006; Simmons & Fitzpatrick, 2012). The frequent use of mate retention behavior (e.g., vigilance about a partner's whereabouts, buying gifts for a partner) reduces the likelihood that a man's partner will be sexually unfaithful (Buss & Shackelford, 1997). Another anti-cuckoldry tactic is increased investment in ejaculate quality, with the result that a higher-quality ejaculate increases the likelihood of success in sperm competition if the partner has been (or may soon be) sexually unfaithful (Goetz et al., 2005). Similarly, human males produce higher-quality ejaculates when they have spent less time with their partner since the couple's last copulation and, therefore, face a greater sperm competition risk (Baker & Bellis, 1993, 1995). This higher ejaculate quality under conditions of greater sperm competition risk in humans is similar to findings in other mammals. Norway rats (*Rattus norvegicus*), for example, produce higher-quality ejaculates with greater risk of sperm competition (e.g., when copulating in the presence of a rival male; Pound & Gage, 2004).

There is debate about the use of different anti-cuckoldry tactics, notably whether these tactics are deployed compensatorily or concurrently (see Shackelford, Goetz, Guta, & Schmitt, 2006, for an extended discussion). Male Mediterranean wrasses (*Symphodus ocellatus*) engage in the compensatory deployment of anti-cuckoldry tactics, with nesting males' guarding their mates to thwart cuckoldry and sneaker males relying on sperm competition to achieve paternity (Alonzo & Warner, 2000). Male sand lizards (*Lacerta agilis*), especially those of greater genetic quality, deploy anti-cuckoldry tactics concurrently, as they both mate-guard and invest in ejaculate quality in conditions of greater risk of sperm competition (Gullberg, Olsson, & Tegelström, 1996). In humans, Leivers and colleagues (2014) reported that men's deployment of mate retention behavior correlates negatively with ejaculate quality (in terms of sperm concentration, motility, and swimming velocity). Thus, men of lower phenotypic quality (as indexed by lower ejaculate quality) may face a greater risk of sperm competition than higher-quality men and address this greater risk with more frequent performance of mate retention behavior (i.e., deploying compensatory anti-cuckoldry tactics).

The current study presents a conceptual replication of Leivers et al. (2014). We expected to detect a negative association between the deployment of mate retention behavior and ejaculate quality. We secured two ejaculates per participant instead of one ejaculate per participant as in Leivers et al., affording statistical control of within-subject ejaculate variability (Gerris, 1999; Mallidis, Howard, & Baker, 1991; Schwartz, Laplanche, Jouannet, & David, 1979). We operationalized ejaculate quality as four composite components constructed from 17 ejaculate parameters (i.e., sperm velocity, sperm concentration, slow motility, and ejaculate volume) and assessed mate retention behavior with the Mate Retention Inventory–Short Form (MRI-SF; Buss, Shackelford, & McKibbin, 2008). Specifically, we investigated whether ejaculate quality was associated with the performance of (i) overall mate retention, (ii) benefit-provisioning and cost-inflicting mate retention domains, and (iii) the categories within the benefit-provisioning and cost-inflicting mate retention domains (e.g., positive inducements, intrasexual negative inducements; Holden et al., 2014). Additionally, we assessed and controlled for the covariates of age, abstinence duration, and body-mass-index (BMI), each of which is known to affect ejaculate quality (see Measures).

Method

Participants

The current study reports the results of novel analyses for a subset of data from a larger project (Pham et al., 2018). The sample included 41 men attending a Midwestern university in the US, with ages ranging from 18 to 33 years (*M* = 23.30; *SD* = 3.60; 71.1% of the sample was Caucasian, with Asian representing the second-most commonly reported ethnicity at 6.7%; see DeLecce, Fink, Shackelford, & Abed, 2020; DeLecce, Shackelford, Fink, & Abed, 2020; Pham et al., 2018). By self-report, participants had not had a vasectomy and had never sought infertility treatment. They were currently in a committed, heterosexual, sexually active relationship for at least six months (range 6 to 123 months; *M* = 35.50; *SD* = 26.80).

Measures

Mate retention behavior. Mate retention behavior was measured using the Mate Retention Inventory–Short Form (MRI-SF; Buss, Shackelford, & McKibbin, 2008). This inventory provides assessments of the total performance frequency of 38 acts of mate retention, along with assessments of performance frequency on five categories of mate retention (i.e., direct guarding, intersexual negative inducements, intrasexual negative inducements, positive inducements, and public signals of possession). The MRI-SF also affords assessments on two broad domains of mate retention: benefit-provisioning, which is marked by efforts to make remaining in the relationship more appealing than defecting or committing infidelity (e.g., “Bought my partner an expensive gift”); and cost-inflicting, which is marked by efforts to intimidate the partner into remaining in the relationship through abuse or manipulation (e.g., “Insisted that my partner spend all her free time with me”; see Holden et al., 2014). MRI-SF scores were obtained by averaging the relevant items (for overall mate retention and each category and domain). Reliabilities (Cronbach’s alpha) are displayed in Table 1.

Ejaculate quality. Ejaculate quality was assessed using the Semen Quality Analyzer (SQA-V; Medical Electronic Systems, Los Angeles, California, US), a fully automated machine that analyzes ejaculates on several clinical measures (see Pham et al., 2018, for details) and has previously demonstrated greater precision than both manual analysis and Computer Assisted Semen Analysis (CASA; Lammers, Splingart, Barrière, Jean, & Fréour, 2014). Participants produced ejaculates at home via masturbation using only the materials we provided and then they delivered the samples to the lab (see Procedures for more details). The ejaculate was syringed into a proprietary measurement capillary, which was inserted into a chamber in the SQA-V for automatic analysis. After completion of the automated analysis, all materials that directly contacted the ejaculate were discarded in a biohazard waste container.

In a previous study (Pham et al., 2018), two ejaculate samples from each participant were produced in experimental (more sexually arousing) and control (less sexually arousing) conditions. More specifically, participants were primed with partner infidelity in the experimental condition and were primed with the idea of sex with their partner in a context that did not involve infidelity in the control condition. This provided a means to test for evidence of ejaculate adjustment when primed with cues concerning sperm competition. However, Wilcoxon signed-rank tests revealed no significant differences for any ejaculate parameter between the two conditions. Each parameter was moderately correlated across the two ejaculates (average Spearman's $\rho = 0.44$; $p < 0.05$; see also DeLecce, Fink, Shackelford, & Abed, 2020; DeLecce, Shackelford, Fink, & Abed, 2020). We correlated ejaculate quality measures with mate retention behavior separately for each of the two ejaculates provided by participants. These results did not differ from those produced when we used calculated means for measures across the two ejaculates (see Results). For parsimony and reportorial efficiency, we retained for analyses the means estimated from the two ejaculates for each participant (produced in the experimental and control conditions in Pham et al., 2018). We verified that all ejaculate measures were within the reference values for fertile ejaculate characteristics provided by the World Health Organization (see Pham et al., 2018, for details).

The SQA-V estimates 17 ejaculate parameters (see Pham et al., 2018). Once ejaculate parameters were averaged across the two ejaculates (see above), we performed, in addition to zero-order correlations between each ejaculate parameter and mate retention behavior, a principal components analysis to reduce the number of parameters and thereby decrease the risk of false-positive findings. This analysis yielded four components. The 17 ejaculate parameters were highly correlated with one another in some cases, which is common in studies examining ejaculate quality (Argarwal, Sharma, & Nelson, 2003; Leivers, et al., 2014). Nevertheless, the first component indexed *sperm velocity*, the second component indexed *sperm concentration*, the third component indexed *slow motility*, and the fourth component indexed *ejaculate volume* (see Table 2). Standardized factor scores for each of the components were retained as a measure of ejaculate quality for the hierarchical regression analyses (see Results).

Covariates. We assessed several covariates known to affect ejaculate quality: age (in years), BMI, and abstinence duration (in days). Some ejaculate parameters vary over the lifespan—for example, the number of sperm in an ejaculate decreases with age (Cooper et al., 2010; Ng et al., 2004). Additionally, obesity is associated with infertility in men; BMI, for example, is negatively associated with sperm count (Eisenberg et al., 2013). Moreover, some ejaculate parameters are affected by abstinence duration before ejaculation; for example, rapid and repeated ejaculation reduces sperm number in subsequent ejaculates (Hopkins, Sepil, & Wigby, 2017).

Procedures

All procedures were approved by the Institutional Review Board of the university where data were collected. Participants were recruited via advertisements posted on bulletin boards on the campus of a Midwestern university in the US. Participants contacted the laboratory to schedule three in-person sessions. In Session 1, participants were escorted to a private room and completed the MRI-SF along with several additional self-report questionnaires unrelated to the current article (e.g., measures of personality and relationship satisfaction). Then, the researchers collected several anthropometric measurements, including shoulder and hip girth, height, and weight. In this session, participants were not exposed to any type of priming. After Session 1, participants received materials required to collect and transport masturbatory ejaculates in two scheduled sessions (i.e., Sessions 2 and 3). The materials included a nonlatex, non-spermicidal condom, a plastic twist-tie, a screw-top specimen container, a biohazard Ziploc bag, and aluminium foil.

Participants were instructed to abstain from ejaculating for at least 48 hours (but no longer than seven days) before each masturbatory session, following World Health Organization (2010) guidelines. The time between each masturbatory session (Sessions 2 and 3) ranged from 2 to 28 days, with an average of seven days between sessions. Participants were asked to masturbate without the help of their partner and to not use any materials that we did not provide (e.g., pornography, lubricant). Participants masturbated to ejaculation in a private location while wearing the provided condom. After ejaculation, participants sealed the condom and delivered it (within one hour of ejaculation) to the laboratory. Participants provided written consent and were told the purpose of the study in Session 1. They received US$25 after each session.

Results

We first computed descriptive statistics for variables included in the analyses (see Table 3). Many of these variables were non-normally distributed (see Pham et al., 2018) and, therefore, we calculated Spearman's rank correlation coefficients We then calculated exploratory correlations between all mate retention categories within the benefit-provisioning domain (positive inducements and public signals of possession) and cost-inflicting domain (direct guarding, intersexual negative inducements, and intrasexual negative inducements) and the 17 ejaculate parameters. These correlations included both zero-order and partial Spearman's correlations after controlling for the covariates of age, abstinence duration, and BMI. There were a few significant positive partial correlations between benefit-provisioning categories of mate retention and ejaculate parameters, most notably those between positive inducements and the percentage of slow progressive motile sperm. These partial correlations are displayed in Table 4. The zero-order correlations are displayed in Table 5 (in the supplementary material; see also the table detailing the zero-order correlations between all 17 ejaculate parameters in the supplementary material).

We next conducted hierarchical regression analyses to predict each of the four ejaculate quality components (i.e., sperm velocity, sperm concentration, slow motility, and ejaculate volume) from benefit-provisioning mate retention and cost-inflicting mate retention while controlling for the covariates of age, abstinence duration, and BMI. The results revealed that none of these four overall regression models was significant. The only significant findings from these regression analyses were that the length of abstinence period before producing the ejaculate positively predicted the components of sperm concentration and ejaculate volume. Additional details are displayed in Table 6.

Lastly, we performed separate hierarchical regression analyses in which each of the four components was predicted from just one mate retention category. In other words, one predicting ejaculate quality from total mate retention behavior, another predicting ejaculate quality from benefit-provisioning behavior, and another predicting ejaculate quality from cost-inflicting behavior. The only set of these analyses that produced significant effects were those predicting the fourth ejaculate quality component, which indexed ejaculate volume. Specifically, total mate retention behavior, benefit-provisioning mate retention behavior, and cost-inflicting mate retention behavior each positively predicted ejaculate volume. Table 7 displays additional details.

Discussion

We investigated whether the deployment of mate retention behavior by human males is negatively associated with ejaculate quality, to replicate the results reported by Leivers et al. (2014). Overall, this conceptual replication was not successful because we did not identify statistically significant associations between the deployment of mate retention behavior (overall or along the domains of benefit-provisioning or cost-inflicting) and (most assessments of) ejaculate quality. When no adjustments were made to correct for multiple testing with exploratory correlations, a significant positive correlation between ejaculate volume and total mate retention was revealed, with or without controlling for the relevant covariates of abstinence period, age, and BMI. This relationship also held when using mate retention behavior to predict the four components (i.e., sperm velocity, sperm concentration, slow motility, and ejaculate volume) identified by Principal Components Aanlysis of the 17 ejaculate parameters. However, once corrections for multiple tests were introduced, no significant associations emerged from the analyses. Taken together, the current results provide little support for the hypothesis that men deploy compensatorily the anti-cuckoldry tactics of mate retention and ejaculate quality investment.

There are methodological and theoretical reasons that may explain why the current research failed to replicate the results reported by Leivers et al. (2014), who documented the use of compensatory anti-cuckoldry tactics in humans. Leivers et al. secured a single ejaculate from each participant, whereas we secured two ejaculates from each participant. Because ejaculate measures are known to exhibit within-individual variability (Mallidis, Howard, & Baker, 1991; Schwartz, Laplanche, Jouannet, & David, 1979), the use of average values in tests of relationships with mate retention behavior may be more representative than relationships using single ejaculate measures.

It is also possible that humans do not adhere to the dichotomous concurrent versus compensatory deployment of anti-cuckoldry tactics, despite the results reported by Leivers et al. (2014). Given greater cognitive complexity relative to other species (e.g., Norway rats; Gage & Pound, 2004), human males may engage in both compensatory and concurrent anti-cuckoldry tactic deployment depending on context or individual differences. When using the four-component structure as the measure of ejaculate quality, the component that approximated ejaculate volume (i.e., the fourth component) was positively predicted by mate retention behavior. Perhaps this finding suggests that men who perform mate retention more frequently produce larger ejaculates, but that does not mean their ejaculates are of any better quality in terms of, for example, sperm motility. Instead, perhaps there are other components in the ejaculate (e.g., seminal proteins) that in a larger volume would reduce female receptivity to other males and thus prevent sperm competition (Moschilla, Tomkins, & Simmons, 2020). It should be noted, however, that this suggestion is speculative given the lack of research on the effects of seminal proteins on female sexual receptivity in humans.

An important limitation of the current research is the small sample of 41 men, which increases the risk of both false positive and false negative findings. Our analyses may have lacked sufficient power to detect small effects. However, our sample was larger than that assessed by Leivers et al. (2014; n = 34) and used a repeated-measures design, which affords more power to detect effects. Nevertheless, future research should investigate the relationships between mate retention behavior and ejaculate quality using sufficiently large samples. To be able to detect medium effect sizes (ρ = .25) using bivariate correlations, a sample size of at least 97 would be required for 80% power.

In conclusion, the present study found little support for the hypothesis that mate retention behavior and ejaculate quality investment are deployed compensatorily. We are therefore reluctant to advance firm conclusions about the relationships between the deployment of mate retention behavior and ejaculate quality in humans and recommend further research, using larger sample sizes as a first step, addressing the nature and deployment of human anti-cuckoldry tactics, particularly as they relate to ejaculate quality.

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Table 1. Cronbach's alpha reliability values for assessments of mate retention categories and domains.

Mate retention domain	**Mate retention category**	**Cronbach's alpha**
Total mate retention		.82
Benefit-provisioning		.73
	Positive inducements	.66
	Public signals of possession	.65
Cost-inflicting		.79
	Direct guarding	.75
	Intersexual negative inducements	.62
	Intrasexual negative inducements	.65

Note: n = 41. See text for definitions of variables.

Table 2. Principal component analysis of the 17 ejaculate parameters yielding 4 components (sperm velocity, sperm concentration, slow motility, and ejaculate volume) and each parameter's loading on each of the four components.

	Component Loading			
Ejaculate parameters	PC1 (Velocity)	PC2 (Sperm concentration)	PC3 (Slow motility)	PC4 (Ejaculate volume)
Concentration of progressive sperm that are shaped normally	.657	.676	.055	.188
Quantity of progressive sperm that are shaped normally	.465	.569	.191	.573
Percentage of progressive sperm that are shaped normally	.699	.390	.325	.307
Concentration of rapid progressive motile sperm	.892	.264	-.104	.029
Percentage of rapid progressive motile sperm	.966	-.031	.105	-.003
Concentration of slow progressive motile sperm	.088	.938	.221	.120
Percentage of slow progressive motile sperm	-.083	.495	.714	.301
Quantity of progressive motile sperm	.370	.691	.195	.551
Percentage of nonprogressive motile sperm	-.424	-.221	.788	.038
Concentration of motile sperm	.465	.842	.140	.097
Quantity of motile sperm	.242	.708	.271	.558
Percentage of motile sperm	.540	.223	.734	.241
Percentage of dead sperm	-.513	-.176	-.809	-.188

Sperm Motility Index	.886	.292	-.003	.034
Sperm concentration within the sample	.246	.886	-.176	-.153
Sperm velocity	.842	.376	.046	.102
Semen sample volume	-.042	-.011	.194	.937
% variance in ejaculate quality explained	56.28	17.25	11.50	6.02

Table 3. Mean, standard deviation (*SD*), skewness, and kurtosis for target variables.

Mate retention	**Mean**	***SD***	**Skew**	**Kurtosis**
Direct guarding	0.41	0.44	3.45	1.88
Intersexual negative inducements	0.71	0.41	1.19	0.59
Intrasexual negative inducements	0.44	0.42	2.00	-0.85
Public signals of possession	1.55	0.50	1.81	0.25
Positive inducements	2.03	0.35	-0.53	0.07
Benefit-provisioning tactics	1.79	0.36	1.69	0.66
Cost-inflicting tactics	0.52	0.34	1.97	0.46
Total mate retention	1.10	0.28	2.31	-0.02
Ejaculate quality measures				
Functional sperm concentration (M/ml)	10.25	10.57	4.08	2.80
Quantity of functional sperm (M)	23.02	24.87	4.11	2.00
Percentage of normal morphology	29.62	9.86	2.48	0.49
Rapid progressive sperm concentration (M/ml)	7.02	8.19	3.96	1.54
Percentage of rapid progressive sperm (a)	14.68	12.57	3.70	1.92
Slow progressive sperm concentration (M/ml)	9.11	8.23	3.22	1.53
Percentage of slow progressive sperm (b)	16.22	9.66	1.23	-0.62
Quantity of progressive motile sperm (a + b)	40.94	40.86	4.22	2.83
Percentage of non-progressive motile sperm (c)	14.45	6.64	1.77	-0.27
Motile sperm concentration (a + b + c)	23.13	17.99	0.003	1.22
Quantity of motile sperm (a + b + c)	58.88	54.03	4.28	3.74
Percentage of motile sperm (a + b + c)	42.83	18.40	-0.79	-0.95
Percentage of immotile sperm (d)	54.66	16.61	0.78	-0.97
Sperm motility index (SMI)	85.90	76.97	3.03	0.05

Sperm concentration within the sample (M/ml)	55.74	34.34	0.82	-1.13
Sperm velocity (microns/sec)	8.77	3.12	0.55	-0.85
Semen volume (ml)	2.55	1.23	3.24	2.55
Covariates				
Age	23.33	3.60	2.41	0.32
Abstinence days	3.28	5.37	14.91	44.77
Body mass index	27.18	5.12	3.57	5.02

Note: *n* = 41. See text for definitions of variables.

Table 4. Partial Spearman correlations between the 17 ejaculate parameters and the mate retention categories within the benefit-provisioning and cost-inflicting domains as well as total mate retention after controlling for the covariates of abstinence period, body mass index, and age.

Benefit-provisioning categories and total mate retention				
Ejaculate parameters	Benefit-provisioning total	Positive inducements	Public signals of possession	Total mate retention
Concentration of progressive sperm that are shaped normally	.07	.19	.05	-.04
Quantity of progressive sperm that are shaped normally	.15	.21	.15	.02
Percentage of progressive sperm that are shaped normally	.10	.14	.16	.02
Concentration of rapid progressive motile sperm	-.01	.02	.03	-.04
Percentage of rapid progressive motile sperm	-.24	-.24	-.08	-.12
Concentration of slow progressive motile sperm	.17	.28	.11	-.02
Percentage of slow progressive motile sperm	.36*	.39*	.31	.14
Quantity of progressive motile sperm	.17	.21	.16	.07
Percentage of nonprogressive motile sperm	.24	.23	.23	.23
Concentration of motile sperm	.10	.25	.04	.01
Quantity of motile sperm	.27	.34*	.22	.16
Percentage of motile sperm	.12	.20	.19	.08
Percentage of dead sperm	-.11	-.12	-.22	-.07

Sperm Motility Index	-.05	.12	-.06	-.10
Sperm concentration within the sample	-.08	.12	-.17	-.19
Sperm velocity	.03	.06	.09	.01
Semen sample volume	.27	.11	.32	.34*

Cost-inflicting categories

Ejaculate parameters	Cost-infliction total	Direct guarding	Intersexual negative inducements	Intrasexual negative inducements
Concentration of progressive sperm that are shaped normally	-.16	-.07	-.10	-.13
Quantity of progressive sperm that are shaped normally	-.12	-.06	-.03	-.11
Percentage of progressive sperm that are shaped normally	-.06	-.07	-.03	.02
Concentration of rapid progressive motile sperm	-.09	.01	-.12	-.11
Percentage of rapid progressive motile sperm	.02	.03	-.17	.12
Concentration of slow progressive motile sperm	-.22	-.07	.04	-.32
Percentage of slow progressive motile sperm	-.11	-.01	.24	-.24
Quantity of progressive motile sperm	-.07	.01	.04	-.10
Percentage of nonprogressive motile sperm	.18	.14	.25	.10
Concentration of motile sperm	-.11	.01	-.06	-.15
Quantity of motile sperm	-.02	.04	.08	-.08
Percentage of motile sperm	.03	.01	.06	.04

Percentage of dead sperm	-.03	-.01	-.10	-.03
Sperm Motility Index	-.16	-.10	-.19	-.11
Sperm concentration within the sample	-.26	-.16	-.19	-.26
Sperm velocity	-.04	.05	-.10	-.06
Semen sample volume	.28	.16	.32*	.32

Notes: * = $p < .05$; ** = $p < .01$; *** = $p < .001$; No corrections for multiple testing were made for these exploratory correlations.

Table 5. Zero-order Spearman correlations between the 17 ejaculate parameters and the mate retention categories within the benefit-provisioning and cost-inflicting domain as well as total mate retention.

Benefit-provisioning categories and total mate retention

Ejaculate parameters	Benefit-provisioning total	Positive inducements	Public signals of possession	Total mate retention
Concentration of progressive sperm that are shaped normally	.26	.40**	.13	.09
Quantity of progressive sperm that are shaped normally	.29	.39*	.18	.13
Percentage of progressive sperm that are shaped normally	.26	.36*	.20	.13
Concentration of rapid progressive motile sperm	.17	.25	.13	.09
Percentage of rapid progressive motile sperm	-.05	.01	.02	-.01
Concentration of slow progressive motile sperm	.28	.41**	.14	.06
Percentage of slow progressive motile sperm	.38*	.42**	.27	.18
Quantity of progressive motile sperm	.30	.38*	.19	.16
Percentage of nonprogressive motile sperm	.12	.06	.15	.16
Concentration of motile sperm	.25	.42**	.11	.11
Quantity of motile sperm	.35*	.43**	.22	.22
Percentage of motile sperm	.26	.34*	.26	.19
Percentage of dead sperm	-.27	-.31*	-.29	-.20
Sperm Motility Index	.14	.33*	.05	.03

Sperm concentration within the sample	.02	.22	-.14	-.13
Sperm velocity	.21	.28	.18	.13
Semen sample volume	.25	.12	.26	.32*

Cost-inflicting categories

Ejaculate parameters	Cost-infliction total	Direct guarding	Intersexual negative inducements	Intrasexual negative inducements
Concentration of progressive sperm that are shaped normally	-.12	-.02	-.11	-.06
Quantity of progressive sperm that are shaped normally	-.10	-.001	-.03	-.08
Percentage of progressive sperm that are shaped normally	-.06	-.04	-.05	.03
Concentration of rapid progressive motile sperm	-.06	.05	-.10	-.05
Percentage of rapid progressive motile sperm	.05	.08	-.17	.16
Concentration of slow progressive motile sperm	-.21	-.05	-.01	-.26
Percentage of slow progressive motile sperm	-.12	.02	.21	-.25
Quantity of progressive motile sperm	-.06	.04	.02	-.07
Percentage of nonprogressive motile sperm	.16	.14	.25	.03
Concentration of motile sperm	-.08	.04	-.08	-.07
Quantity of motile sperm	-.03	.07	.07	-.07
Percentage of motile sperm	.07	.09	.07	.04
Percentage of dead sperm	-.07	-.10	-.11	-.02

Sperm Motility Index	-.12	-.04	-.17	-.07
Sperm concentration within the sample	-.24	-.13	-.20	-.20
Sperm velocity	-.01	.10	-.08	-.01
Semen sample volume	.26	.19	.30	.26

Notes: * = $p < .05$; ** = $p < .01$; *** = $p < .001$; No corrections were made for multiple testing for these exploratory correlations.

Table 6. Hierarchical multiple regression analyses predicting the four principal components (sperm velocity, sperm concentration, slow motility, and ejaculate volume) of ejaculate quality from mate retention behavior while controlling for the covariates of abstinence period, age, and body mass index.

	PC1				PC2				PC3				PC4			
	β	*S.E.*	*t*	*Model Statistics*	*β*	*S.E.*	*t*	*Model Statistics*	*β*	*S.E.*	*t*	*Model Statistics*	*β*	*S.E.*	*t*	*Model Statistics*
Step 1				R^2 = .11 *F* = 1.47 *p* = .238				R^2 = .18 *F* = 2.54 *p* = .072				R^2 = .06 *F* = 0.80 *p* = .503				R^2 = .11 *F* = 1.45 *p* = .243
Abstinence period	0.26	0.03	1.66		0.36	0.03	2.39		-0.14	0.03	-0.85		0.27	0.03	1.72	
Age	0.02	0.04	0.12		-.11	0.04	-0.69		-0.23	0.04	-1.37		-0.15	0.04	-0.93	
BMI	-0.19	0.03	-1.17		-0.16	0.03	-1.004		-0.04	0.03	-0.22		0.05	0.03	0.34	
Step 2				R^2 = .15 *F* = 1.21 *p* = .326				R^2 = .22 *F* = 1.96 *p* = .109				R^2 = .12 *F* = 0.96 *p* = .459				R^2 = .29* *F* = 2.75* *p* = .034*
Abstinence period	0.28	0.03	1.70		0.35*	0.03*	2.25*		-0.13	0.03	-0.76		0.36*	0.03*	2.39*	
Age	-0.03	0.04	-0.15		-0.06	0.05	-0.36		-0.16	0.05	-0.94		-0.07	0.04	-0.44	
BMI	-0.28	0.03	-1.58		-0.05	0.03	-0.32		0.07	0.03	0.41		0.13	0.03	0.78	
Benefit-provisioning	-0.21	0.55	-1.11		0.23	0.56	1.30		0.29	0.57	1.54		0.32	0.53	1.86	
Cost-infliction	0.19	0.50	1.07		-0.20	0.51	-1.18		-0.12	0.52	-0.65		0.21	0.48	1.27	

Notes: * $p < .05$; $p < .01$; $p < .001$; PC1 = principal component 1 measuring sperm velocity; PC2 = principal component 2 measuring sperm concentration; PC3 = principal component 3 measuring slow motility; PC4 = principal component 4 measuring ejaculate volume

Table 7. Hierarchical multiple regression analyses predicting ejaculate quality in terms of the fourth component approximating ejaculate volume (see text) from benefit-provisioning mate retention, cost-inflicting mate retention, and total mate retention, while including covariates of age, abstinence duration, and body mass index (see text).

	Step 1, with covariates only			
Covariates only	R^2	*F*		*P*
Overall model	.11	1.45		.243
Predictors	*β*	*SE*	*t*	*P*
Abstinence days	.27	.03	1.72	.093
Body mass index	.05	.03	0.34	.737
Age	-.15	.04	-0.93	.356
	Step 2, with mate retention and covariates			
Total mate retention	R^2	*F*		*P*
Overall model	.27	3.19		.025*
Predictors	*β*	*SE*	*t*	*p*
Abstinence days	.36	.03	2.39	.022*
Body mass index	.07	.03	0.48	.633
Age	-.08	.04	-0.55	.586
Total mate retention	.41	.55	2.76	.009**
Benefit-provisioning tactics	R^2	*F*		*P*
Overall model	.25	2.98		.032*
Predictors	*β*	*SE*	*t*	*p*
Abstinence days	.32	.03	2.19	.035*
Body mass index	.18	.03	1.18	.248
Age	-.05	.04	-0.34	.738
Benefit-provisioning tactics	.41	.49	2.62	.013*
Cost-inflicting tactics	R^2	*F*		*P*

Overall model	.22	2.40		.068
Predictors	*β*	*SE*	*t*	*p*
Abstinence days	.34	.03	2.23	.032*
Body mass index	.01	.03	0.05	.959
Age	-.14	.04	-0.92	.365
Cost-inflicting tactics	.34	.45	2.19	.036*

Note: * = $p < .05$; ** = $p < .01$; *** = $p < .001$

Supplementary Table. Zero-order Spearman's correlations between all 17 ejaculate parameters.

Parameter	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1.Concentration of progressive sperm that are shaped normally	**.93**	**.85**	**.87**	**.54**	**.80**	.49	**.92**	-.35	**.91**	**.81**	**.66**	**-.60**	**.92**	**.67**	**.84**	.09
2. Quantity of progressive sperm that are shaped normally	-	**.87**	**.78**	.47	**.79**	**.62**	**.98**	-.13	**.85**	**.92**	**.76**	**-.70**	**.86**	**.55**	**.79**	.35
3. Percentage of progressive sperm that are shaped normally		-	**.76**	**.68**	**.61**	**.58**	**.82**	-.04	**.72**	**.73**	**.84**	**-.85**	**.80**	.34	**.78**	.19
4. Concentration of rapid progressive motile sperm			-	**.74**	**.56**	.23	**.77**	**-.53**	**.76**	**.62**	**.55**	**-.51**	**.94**	**.55**	**.94**	.01
5. Percentage of rapid progressive motile sperm				-	.11	-.05	.42	-.31	.39	.27	**.54**	**-.56**	**.67**	.10	**.76**	.05
6. Concentration of slow progressive motile sperm					-	**.75**	**.85**	-.08	**.87**	**.83**	**.53**	-.47	**.65**	**.76**	**.54**	.10
7. Percentage of slow progressive motile sperm						-	**.65**	.45	**.53**	**.69**	**.65**	**-.68**	.33	.27	.25	.24
8. Quantity of progressive motile sperm							-	-.14	**.89**	**.95**	**.72**	**-.66**	**.84**	**.61**	**.77**	.37
9. Percentage of nonprogressive motile sperm								-	-.20	.03	.27	-.33	-.41	-.42	-.46	.25

10. Concentration of motile sperm	-	**.88**	**.64**	**-.54**	**.83**	**.78**	**.76**	.04
11. Quantity of motile sperm		-	**.69**	**-.63**	**.71**	**.61**	**.68**	.44
12. Percentage of motile sperm			-	**-.94**	**.69**	.13	**.60**	.24
13. Percentage of dead sperm				-	**-.57**	-.07	**-.56**	-.26
14. Sperm Motility Index					-	**.57**	**.88**	-.02
15. Sperm concentration within the sample						-	**.53**	-.13
16. Sperm velocity							-	.09
17. Semen sample volume								-

Note: All correlation coefficients with *p*-values < .001 are in bold.