

Original Article

Human sperm competition in postindustrial ecologies: sperm competition cues predict adult DVD sales

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Sperm competition theory has been used to generate the hypothesis that men prefer to view pornographic images suggesting the presence of a rival male, over images which do not. The current research uses a new methodology to address conflicting evidence about men's preferences for pornographic images. Raters coded a random sample of 166 pornographic DVDs (from a population of 49 493), which were then analyzed using multiple regression. Consistent with the hypothesis generated from sperm competition theory, the number of images on a DVD cover and screenshots depicting 2 or more men interacting with 1 woman (suggesting the presence of sperm competition) predicts DVD sales rank, whereas the number of images on a DVD cover and screenshots depicting 2 or more women interacting with 1 man (suggesting the absence of sperm competition) does not predict DVD sales rank. Discussion addresses limitations and future directions, including using penile plethysmography to avoid relying on correlational analyses.

Key words: evolutionary psychology, humans, pornography, sperm competition. [*Behav Ecol*]

INTRODUCTION

Sperm competition occurs when the sperm of 2 or more males simultaneously occupy the female reproductive tract and compete to fertilize the ova (Parker 1970). Among socially monogamous species, sperm competition most commonly occurs when the female engages in extrapair copulations (EPCs; Smith 1984; Baker and Bellis 1993; Birkhead and Møller 1998; Shackelford et al. 2002, 2007). Males whose partner pursues EPCs are at risk of cuckoldry—the unwitting investment of resources into genetically unrelated offspring.

Cuckoldry may have imposed selection pressures over human evolution. Several studies have demonstrated nonzero rates of discrepant social and biological fatherhood (Bellis et al. 2005; Anderson 2006; Voracek et al. 2008; Wolf et al. 2012). Voracek et al. (2008) conducted a meta-analysis of 32 published samples (9 countries; $N = 24\ 117$) and concluded that 3.1% of children were genetically unrelated to their social father.

Anticuckoldry behaviors—including tactics that males perform to increase their success in sperm competition—may have been

an evolutionarily recurrent feature of socially monogamous, paternally investing species. Parallel responses to cuckoldry risk are seen by males in both humans and socially monogamous birds. For example, when the risk of their partner's EPC is higher, males perform frequent in-pair copulations (birds: McKinney et al. 1984; Birkhead et al. 1987; humans: Shackelford et al. 2006), forced in-pair copulations (birds: Goodwin 1955; Barash 1977; Bailey et al. 1978; McKinney and Stolen 1982; Cheng et al. 1983; McKinney et al. 1984; Birkhead et al. 1989; humans: Goetz and Shackelford 2006), and adjust the number of sperm they ejaculate during their next in-pair copulation (birds: Nicholls et al. 2001; Pizzari et al. 2003; humans: Baker and Bellis 1993). These male behaviors are designed, in part, to place their sperm into their partner's reproductive tract to compete against rival male sperm to fertilize ova.

“Sperm competition psychology” refers to a set of information-processing or cognitive mechanisms that, when activated, produce physiological and psychological outputs that increase the likelihood of success in sperm competition (e.g., sexual arousal, motivation for in-pair copulation; Shackelford et al. 2002, 2007; Shackelford 2003; McKibbin 2012; Shackelford and Goetz 2012). These mechanisms are activated when men perceive cues to sperm competition, such as female promiscuity and infidelity (Pound 2002; Shackelford et al. 2002, 2007; Camilleri and Quinsey 2009, 2012).

The study of pornographic material provides insight into men's sexual psychology (Kingston et al. 2009). The video pornography

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industry is considerable, with sales and rentals in the United States alone yielding \$3.6 billion in 2006 (AVN Media Network ... [updated 2009]). Pornographic materials are produced largely to facilitate or enhance sexual arousal in men (Mosher 1988) and men are the primary consumers of these materials (Malamuth 1996). Because these materials are designed to appeal to men, the content of videos reflects male sexual interests (Malamuth 1996). For example, men pursuing a short-term mating strategy must identify fertile women with whom to copulate (Buss and Schmitt 1993) and, therefore, show interest in pornography that presents youthful women who display cues of fertility (Malamuth 1996). Pound (2002) extended this work, suggesting that men's sexual arousal when viewing some themes in male-consumed pornography is produced by evolved mechanisms activated by cues to sperm competition risk.

Men's sexual arousal to pornography is a consequence of an "adaptive mismatch" between an evolved sperm competition psychology and evolutionarily novel stimuli; that is, whereas men's sexual psychology evolved over deep time, pornography is an evolutionarily novel product of postindustrial human ecologies (Malamuth 1996). Men can be sexually aroused by stimuli that were not present in the human ancestral environment (e.g., computer images) but which strongly resemble evolutionarily recurrent cues to sperm competition (i.e., female promiscuity). Adaptive mismatches have been documented in other species. For example, male rhesus macaques (*Macaca mulatta*) forfeit resources to view computer images of female perinea (Deaner et al. 2005), and male Houbara bustards (*Chlamydotis undulata*) copulate with artificially constructed "dummy" females (Saint Jalme et al. 1994).

Pound (2002) measured men's preferences for pornographic materials as indicators of sexual arousal. When asked to report which types of scenes they preferred when reading erotic stories, viewing photographs of sexual activity, and watching videos of sexual activity, men report preferring depictions of polyandrous sexual activity (one woman interacting with multiple men) to depictions of polygynous sexual activity (one man interacting with multiple women; Pound 2002). Additionally, men express a preference for depictions of polyandrous sexual activity when asked to choose the type of image they would like to view (Pound 2002). Pound also examined the prevalence of polyandrous and polygynous sexual activities in photographs and in adult videos. In both instances, polyandrous sexual activities were more frequently represented than polygynous sexual activities. Pound's research was the first to document that men are sexually aroused by cues indicating the presence of rival males, a cue of the risk of sperm competition.

More recent results using a different methodology appear to conflict with Pound's (2002) results. Hald (2006) sent questionnaires to men that included a list of 31 pornographic themes. The participants were asked to select the 3 themes that they watched most. A higher percentage of men selected group sex featuring one man with more women than selected group sex featuring one woman with more men as 1 of their 3 most-watched themes. Thus, the results of Hald contradict predictions from sperm competition theory and the results of Pound. The results of Hald, however, rely solely on the honesty of men's reports and their ability to recall accurately how often they view materials with particular themes. Men may be less likely to report viewing pornographic materials that are considered socially undesirable or may be unable to recall and rank accurately what they have seen.

The sales rank of a pornographic DVD is an indication of its popularity as evidenced by its sales figures. Guided by sperm competition theory (see also Pound 2002), we hypothesize

that the frequency of scenes on the DVD front cover, back cover, and screenshots that contain 1 woman interacting with 2 or more men will predict the sales rank of the DVD, but that the frequency of scenes that contain 2 or more women interacting with 1 man will not predict the sales rank of the DVD.

The total time a DVD is available for sale may affect its cumulative sales figures and consequent sales rank. Consumers also consider the price of a DVD in their purchasing decision. We assess and statistically control for these potential confounds in tests of the hypotheses.

METHODS

Adult DVD Empire

We collected images and sales information for DVDs from Adult DVD Empire, which at the time of initial data collection was the largest online retailer of pornographic DVDs and has been named the Best Retail Website by the Adult Video Network from 2004 to 2008 (Arthur 2008). As of 2008, Adult DVD Empire had over 83 000 products for sale (Arthur 2008). Adult DVD Empire received over 300 000 unique visitors to the site during March 2009 (Compete ... [updated 2009]). Estimates of the demographics of visitors to the site suggest that 75% of visitors are men, 40% are between 18 and 34 years of age, 47% are between 35 and 49 years of age, and 12% are 50 years of age or older (Quantcast ... [updated 2009]).

DVD selection for inclusion in main database

To identify DVD listings for further study, we used the Web site's advanced search feature. Because the unit of analysis was movie, we excluded from our search DVDs that were compilations of multiple movies. Because high-definition DVD and Blu-ray disc players were not widely available until 2006 ("Players" 2006), these types of disc were excluded from our search at the time. This search generated 49 493 DVDs. Each DVD listing could be identified uniquely with a 5-digit number assigned by the search engine. To construct a practically sized database of DVD listings, we used a random number generator to select 6 sets of 100 specific DVD listings for potential inclusion in the final database. Two research assistants saved images of these listings to disk.

We observed a number of criteria for a potential DVD listing to be included in the final database. First, a listing must have indicated that the DVD was released no earlier than 2000 and no later than 2005. This date range allowed sufficient time for sales data to accumulate while eliminating newer DVDs whose sales rank may not have stabilized. Two hundred and fifty-four DVD listings of the total 600 listings were excluded based on this criterion. Second, because we did not have data indicating when a DVD became unavailable, we excluded DVDs that were not for sale at the time of data collection. One hundred and twelve DVD listings were excluded based on this criterion. Third, we excluded DVDs whose listings did not include front cover, back cover, and screenshot images. These images are likely to be important selection criteria for men interested in purchasing pornography. Men are readily aroused by visual sexual stimuli (Ellis and Symons 1990) and are likely to use these images to decide which DVD to purchase. Furthermore, numerous studies have demonstrated the efficacy of using attractive individuals in advertising, particularly opposite-sex individuals (see Saad 2004, for a review). This suggests that sexual imagery on the DVD covers and screenshots will influence the

sales rank of these products. Three DVD listings were excluded for missing images. Fourth, collection of the DVD listings took place over several days, so the number assigned to each DVD by the search engine changed slightly during data collection, creating duplicate listings within our sample. Four DVD listings were excluded for various reasons including duplicated listings. These criteria left a sample of 227 DVDs. This sample of 227 DVDs was prepared for a different project and will be referred to as the main database. The sample used in the current research, however, is the result of 3 further exclusion criteria.

DVD selection for inclusion in the current research

First, we excluded 13 of the 227 DVD listings because they did not include the all-time best-selling rank. Second, “transsexual” pornography, as it is defined by the Web site, “includes males who dress as women (transvestites) and She-Males (males who have breast augmentation)” (*Adult DVD Empire* ... [updated 2009]). We did not generate specific hypotheses about feminized men, so we excluded 10 DVD listings from analyses because the listings categorized the DVD as “transsexual.” Third, we excluded 38 DVD listings because they did not include the release date of the DVD. Using these 3 additional selection criteria, we identified a final sample of 166 DVD listings for use in the current research.

Coding system

DVD listings in the main database were coded by 2 independent raters, 1 man and 1 woman. Coders were blind to DVD sales rankings when coding cover and screenshot content. DVD listings were coded for “all-time best-seller rank,” DVD price, DVD release date, and image type. All-time best-seller rank is the sales rank of the DVD among DVDs that have been sold on the Web site. *Adult DVD Empire* provided DVD sales data in increments of 5000, stating that more specific sales data are proprietary information which, by policy, they do not share. Constrained by the data provided by the company, all-time best-seller rank was coded in increments of 5000 such that 1 = 1–5000, 2 = 5001–10 000, and so forth. Front cover, back cover, and screenshot images were coded for sex composition including 1) 2 or more women with 1 man, 2) 2 or more men with 1 woman, and 3) 2 or more men with 2 or more women. Coders examined all of these images and recorded the frequency of each type of depiction and the total number of images on each DVD.

Intercoder reliability

We were not able to test our hypotheses for each coder-specific subsample separately because the small sample sizes of each subsample did not permit interpretable statistical analyses (coder 1: $n = 69$; coder 2: $n = 97$). To address this limitation, and to verify a high level of intercoder reliability, the 2 coders coded a random subset ($n = 20$) of DVD listings in the main database and compared coding results. Occasionally, a DVD cover included images that were difficult to code. Many images contained body parts rather than full bodies. In these instances, coders coded the image according to the likely sex of the individual involved based on the body part depicted. For example, an image of 2 women interacting with a penis was coded as an image of 2 women with 1 man. The coders discussed discrepancies with the aim of reaching agreement regarding the coding of each ambiguous image. After discussion,

the coders continued to disagree on 8 of 112 images, or 7.14% of the images in the 20 listings. The coders brought the 8 images to an independent person to resolve discrepancies. We did not use the DVD listings used in this process in later calculations of inter-rater reliability. The coders used the criteria agreed on in this step for the remainder of the coding process: 1) if an image was too blurry to interpret clearly, the coders did not code it and 2) if an image contained individuals who were not clearly interacting with each other, the coders coded the image as 2 separate images. Each of the 2 coders coded a different half of the main database of 227 DVD listings.

We calculated inter-rater reliability using 19 DVDs from the main database of 227. There was an average of 12.8 images per DVD used in the calculations of inter-rater reliability (244 images total). Neither coder coded any of the images as depicting 2 or more men with 2 or more women. Thus, we were unable to calculate inter-rater reliability for 1 of the 3 possible categories. The average inter-rater correlations for depictions of 1 woman with 2 or more men, for depictions of 1 man with 2 or more women, and for the total number of scenes on the DVD were $r = 0.81, 0.88,$ and $0.95,$ respectively.

To test the hypothesis, we conducted a multiple regression analysis predicting DVD sales rank from the frequency of scenes on the DVD front cover, back cover, and screenshots that contain sperm competition cues (i.e., woman–man–man) while controlling statistically for the frequency of images that do not contain sperm competition cues (i.e., woman–woman–man, woman–woman–man–man), DVD price, and the total time a DVD was available for sale.

RESULTS

We constructed a “WMM” variable from the sum of woman–man–man images depicted on the DVD front cover, back cover, and screenshots. We repeated this process to construct a “WWM” variable (woman–woman–man images) and a “WWMM” variable (woman–woman–man–man images). We constructed a “DVD age” variable by calculating the number of months between the release date of the DVD and 5/17/08 (the middle date within our data collection period).

Zero-order correlations

Table 1 presents zero-order correlations among the target variables. Sales rank was negatively correlated with DVD age and DVD price. WWM was positively correlated with WWMM. Consistent with our hypotheses, sales rank was negatively correlated with WMM, but not with WWM or WWMM.

Multiple regression

We conducted a multiple regression analysis to identify the unique effects WMM had in predicting DVD all-time best-seller rank, after controlling for WWM, WWMM, DVD age, and DVD price (see Table 2). Sales rank remained negatively correlated with DVD age. Consistent with our hypotheses, sales rank remained negatively correlated with WMM, but not with WWM or WWMM.

DISCUSSION

The frequency of scenes on the DVD front cover, back cover, and screenshots that depict 1 woman interacting with 2 or more men

predicted the sales rank of the DVD, as hypothesized, whereas the frequency of scenes on the DVD front cover, back cover, and screenshots that depict 2 or more women interacting with 1 man did not predict the sales rank of the DVD, also as hypothesized. These results are consistent with the results of Pound (2002), who found that men preferred to view images of 1 woman with 2 men over images of 2 women with 1 man; however, these results conflict with the results of Hald (2006), who documented the opposite pattern of choice in men. The current results suggest that self-reported rankings of the frequency of viewing particular types of pornography may not accurately reflect men's patterns of consumption. That is, what men say they watch may differ from what they actually watch. The current results also are consistent with research indicating that men produce a higher percentage of motile sperm in ejaculates produced while viewing images of 2 men and 1 woman than in ejaculates produced while viewing images of 3 women (Kilgallon and Simmons 2005). Therefore, the current results provide further evidence of a sperm competition psychology in men.

Although we argue that men are more aroused by images suggesting sperm competition, we are not arguing that men preferentially place themselves in mating contexts that present high levels of sperm competition. Both in long-term (Buss 1989) and short-term (Shackelford et al. 2004) mating contexts, men prefer mating with women who present a lower risk of sperm competition. However, men are more sexually aroused if they are exposed to sperm competition cues. For example, men report greater in-pair copulatory interest when the risk of their partner's EPCs is high (Shackelford et al. 2002, 2007). This greater arousal, we argue, motivates the purchase of DVDs with covers and screenshots that depict the more sexually arousing stimuli.

The current research is limited by reliance on correlational data. This limitation could be addressed by using a penile plethysmograph, a device that measures objectively men's physiological, sexual arousal by measuring changes in blood flow in the penis. Previous research using penile plethysmography (e.g., Cerny and Janssen 2011) has not specifically investigated differences in arousal to heterosexual images or scenes of 2 or more women with 1 man versus heterosexual images or scenes of 2 or more men with 1 woman. Kilgallon and Simmons (2005) secured the relevant self-report ratings but not penile plethysmography data; Cerny and Janssen (2011) secured penile plethysmography data, but the multiple-male, single-female videos included homosexual intercourse and, therefore, sperm

competition risk is confounded with unknown responses to homosexual intercourse.

We found that, typically, the images that occupy the greatest proportion of surface area on the front and back covers are scenes of the leading actress(es). The attractiveness of the actress(es) largely determines who secures the lead role in a film (Saad 2004), more so than the type of scene depicted. We used DVD front and back covers, as well as screenshots, in calculating the sum of images depicting sperm competition cues. Screenshots have uniformly sized images across all screen captures, thereby mitigating the confounding effects of image size, and consumers can access DVD screenshots as readily as they can access DVD front and back covers from Adult DVD Empire. Nevertheless, future research should consider assessing and controlling statistically for the size of each image when assessing the relationship between DVD sales rank and the frequency of DVD images depicting cues to sperm competition risk.

Along with the current research, studies that employ evolutionarily novel stimuli can provide insight into evolved structure and function. Rhesus macaques (*M. mulatta*) preferentially attend to computer images of high-status macaques (Deaner et al. 2005). Nowbahari et al. (2009) trapped ants (*Cataglyphis cursor*) using plastic rings—an evolutionarily novel stimuli—to activate evolved mechanisms that facilitate their rescue behaviors (see also Dugatkin 1997). Although pornographic depictions of polyandrous sexual activity are evolutionarily novel, they nevertheless activate evolved mechanisms relevant to sperm competition in humans.

Table 1
Zero-order correlations among target variables ($n = 166$)

	Sales rank	DVD age	DVD price	WMM	WWM
Sales rank	—				
DVD age	-0.19*	—			
DVD price	0.09	-0.20**	—		
WMM	-0.23**	-0.06	-0.06	—	
WWM	-0.07	-0.11	-0.08	-0.04	—
WWMM	-0.11	0.08	0.06	0.24**	0.12

Notes. WMM = the frequency of depictions of 1 woman interacting with 2 or more men, WWM = the frequency of depictions of 2 or more women interacting with 1 man, WWMM = the frequency of depictions of 2 or more women interacting with 2 or more men, DVD Age = the number of months between the DVD release date and 5/17/08, and sales rank = all-time best-seller sales rank.

* $P < 0.05$.

** $P < 0.01$.

Table 2

Multiple regression analysis assessing relationship between WMM and sales rank, controlling for WWM, WWMM, DVD Age, and DVD price ($n = 166$)

Predictor variables

WMM		WWM		WWMM		DVD age		DVD price	
<i>B</i>	<i>t(P)</i>	<i>B</i>	<i>t(P)</i>	<i>B</i>	<i>t(P)</i>	<i>B</i>	<i>t(P)</i>	<i>B</i>	<i>t(P)</i>
-0.24	-3.08 (0.002)	-0.09	-1.19 (0.234)	-0.03	-0.33 (0.739)	-0.20	-2.62 (0.01)	0.23	0.33 (0.742)

Notes. Outcome variable = sales rank. WMM = the frequency of depictions of 1 woman interacting with 2 or more men, WWM = the frequency of depictions of 2 or more women interacting with 1 man, WWMM = the frequency of depictions of 2 or more women interacting with 2 or more men, DVD age = the number of months between the DVD release date and 5/17/08, and sales rank = all-time best-seller sales rank. *B* = standardized beta coefficient; *t* = test statistic associated with *B*; *P* = *P* value associated with test statistic.

In conclusion, the study of preferences for pornographic materials may provide insight into human sperm competition. Similar to males of other socially monogamous species, men adjust their behavioral and physiological outputs in accordance with their assessment of the risk of sperm competition (Baker and Bellis 1993; Shackelford et al. 2002, 2007; Shackelford and Goetz 2012). One such output is men's sexual arousal, which facilitates their copulatory behaviors. In the current research, we assess cues to sperm competition and sexual arousal using purchasing habits of pornography.

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