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Rape is not less frequent during the ovulatory phase of the menstrual cycle

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Abstract

Arguing that female adaptations reduce the likelihood of rape during fertile periods, Chavanne and Gallup (1998) cite two unpublished studies as evidence that rape is less frequent during the ovulatory phase, a claim subsequently repeated by other authors. Neither of the two studies in question (Rogel 1976; Morgan 1981) supports this conclusion. Moreover, analysis of conception rates reveals that the probability of conception following rape does not differ from that following consensual coitus. There is thus no evidence that rape frequency varies across the menstrual cycle in a manner reflecting female rape avoidance mechanisms. The contrast between evidence of the latter and the absence of epidemiological support may reflect differences between contemporary and ancestral societies.

Keywords: rape, menstrual cycle, ovulation, rape avoidance

Introduction

Of the myriad forms of human aggression and cruelty, rape is one of the most troubling. Adopting an evolutionary perspective on rape, a number of investigators have recently documented the existence of psychological mechanisms that, during the high fertility phase of the menstrual cycle, lead women to alter their behaviour in ways that seem designed to reduce the risk of sexual assault. This group

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of investigators also claims that the epidemiology of rape complements the changes in female behaviour which they have documented since, it is asserted, rape is less frequent during the high fertility phase of the menstrual cycle. While the evidentiary value of their own results is high, the same is not true of these investigators' oft-repeated claim regarding the patterning of rape. This paper addresses that claim. After explicating the logic of the evolutionary approach to female rape avoidance and discussing the recent work on female behaviour, I examine the unpublished sources cited in support of the purported epidemiological pattern. Finding absolutely no evidence leading to this conclusion in these sources, I then conduct an independent test of the claim by comparing the likelihood of conception resulting from a single act of rape with that resulting from a single act of coitus. This test too fails to indicate that rape is less frequent during the high fertility phase of the menstrual cycle. Having concluded that, at present, there is no evidence that rape is less frequent during the high fertility phase, I close by discussing possible causes of the disjunction between cyclic female rape avoidance behaviour and the epidemiology of rape in modern societies.

An evolutionary approach to rape avoidance

A complex and highly over determined phenomenon, rape can be productively investigated at a variety of analytic levels. While explorations of personality, ideology, social structure, and similar proximate factors can shed light on rape, these avenues generally stand independent of attempts to discern the role played by our evolutionary heritage. Importantly, viewing rape from an evolutionary perspective does not entail endorsing any single explanation of the phenomenon, as multiple competing hypotheses can be developed within an evolutionary framework (Archer and Vaughan 2001).

Because features of our evolutionary past can frequently only be inferred indirectly, for the investigator interested in understanding contemporary sociosexuality, an evolutionary perspective is often most useful to the extent that ultimate explanations generate testable hypotheses regarding modern human behaviour. Although much of the current debate surrounding evolutionary perspectives on rape revolves around theories addressing the motives of the rapist (see Archer and Vaughan 2001 for review), an evolutionary approach can also be adopted with

regard to the need to defend against rape. At the most elementary level, for ancestral women (who lacked contraception), rape had the potential to dramatically reduce individual biological fitness by eliminating a woman's ability to choose her mate.

Mate choice can affect reproductive success via at least two avenues. First, because the offspring's genotype combines genes from each of the two parents, the health, robusticity, and attractiveness of the offspring is in part contingent on the genetic quality of the mate chosen. Second, in species capable of bi-parental care, if individuals vary with regard to their ability and willingness to invest in offspring, selecting a high-investing mate can increase the resources available to the given offspring and/or free up one's own time and energy for investment in additional offspring. The optimal level of selectivity with regard to mate choice is determined by the size of the obligate minimum biological investment in each offspring relative to total lifetime reproductive potential (Trivers 1972). Because time, energy, and nutrients are all finite, the larger the proportion of an individual's total pool of these resources that must be expended in each reproductive event, the more important it is to choose one's reproductive partners carefully.

Humans are remarkable among primates both for their high level of obligate female reproductive investment and for the degree to which males are able to provide parental investment should they choose to do so. The human neonate is larger proportionate to maternal body size than is true of other primates, and has nearly four times as much body fat; lactation is correspondingly energetically expensive, constituting a 26% increase over the demands of the non-reproductive state (reviewed in Dufour and Sauther 2002). Despite the high costs of human gestation and lactation, in contemporary foraging societies (a crude window into the circumstances thought to characterize ancestral *Homo sapiens* populations), compared to chimpanzees, human infants are weaned at an earlier age in both absolute and developmental terms, and interbirth intervals are shorter, patterns that are in part explained by provisioning and protection offered by men (Kaplan et al. 2000) particularly during the early years of life (Marlowe 2003).

The combination of a high level of obligate female reproductive investment and the possibility of substantial male parental investment would have made the choice of mates critical to female fitness in ancestral human populations. Natural selection can therefore be expected

to have favoured great selectivity in human female mate choice (Buss and Schmitt 1993; Symons 1979). With regard to choosing both short- and long-term partners, women can be expected to be acutely sensitive to cues of genetic quality, while in making the latter choice they can also be expected to attend closely to indices of a man's ability and willingness to invest in his partner and her children. A wide variety of empirical findings support these predictions (cf. Buss 1998; Gangestad and Simpson 2000; Johnston et al. 2001).

By definition, rape is the antithesis of female mate choice, for the rapist uses coercive means to attain sexual access against his victim's wishes. For ancestral women, particularly in the event of conception, loss of control over mate choice would have entailed potentially profound fitness consequences (Shields and Shields 1983; Thornhill and Thornhill 1983; Thornhill and Palmer 2000:). First, rape eliminated a woman's ability to influence the genetic quality of her offspring by selecting a mate on the basis of cues of good genes. Second, because males who resorted to rape may have often provided no or very little post-coital investment, rape placed a woman at a competitive fitness disadvantage relative to women whose mates provided for and protected them and their children.

The catastrophic nature of the potential impact of rape on female fitness suggests that natural selection may have favoured the evolution of female psychological mechanisms that, at least under ancestral conditions, shaped behaviour in a manner that reduced the likelihood that the possessor would be thus victimized. However, behavioural prophylaxis against rape would necessarily have come at some cost, as attentional resources are finite. Likewise, if prophylaxis took the form of modifications of daily activities, some potentially profitable opportunities for foraging, social exchange, and so on must have been forgone. Finally, if prophylaxis took the form of increased willingness to combat a sexual assailant, rape avoidance may have entailed increased risk of injury. As a result of these costs, natural selection may have favoured mechanisms that modulate behavioural prophylaxis as a function of the expectable fitness costs of rape. Importantly, this factor varies in a predictably cyclic fashion.

Under ancestral conditions, rape would have had the greatest negative impact on female fitness if it resulted in conception. Female fertility is unequally distributed across the menstrual cycle, with the probability that a single act of coitus will result in conception increasing from 0.000% at the start of the follicular phase to nearly 0.100% in the days

immediately preceding ovulation, followed by a precipitous decline to 0.005% at the end of the cycle (Wilcox et al. 2001:213). The above reasoning suggests that any psychological mechanisms that modify a woman's behaviour in order to reduce the probability that she will be raped should operate differentially as a function of the likelihood of conception as determined by her current position in the menstrual cycle (Chavanne and Gallup 1998; Petralia and Gallup 2002). In other words, rape-avoidance mechanisms are expected to be most active during the periovulatory period, and least active during the early follicular, late luteal, and menstrual phases.

Evidence of the existence of psychological rape-avoidance mechanisms

A small group of investigators have recently documented behavioural changes across the menstrual cycle suggestive of the existence of female psychological mechanisms designed to reduce the risk of rape during periods when conception risk is highest. In the first such study, Chavanne and Gallup (1998) asked 40 U.S. undergraduate women to rate the risk of sexual assault entailed by each of 18 everyday behaviours (e.g., "go to the library", "walk in a dimly lit area", etc.). Three hundred undergraduate women were then asked to indicate in which of the 18 behaviours they had engaged during the last 24 hours, and were also asked to report the date of onset of their most recent menstrual period. Counting forward from this date, subjects were assigned to one of the following four categories: menstrual (days 1–5), postmenstrual (days 6–12), ovulatory (days 13–17), and premenstrual (days 18–28). A risk-taking score was created by summing the behaviours indicated, weighted in light of their purported riskiness. Among subjects not using oral contraceptives, risk-taking was lower during the ovulatory than premenstrual phase; no such difference occurred among subjects using oral contraceptives.

Chavanne and Gallup's study suffers a number of limitations. The risk-taking measure conflates activity level with risk exposure, as women who reported engaging in many low-risk activities were assigned the same score as participants who reported engaging in a few high-risk activities. In addition, the forward-counting method is a crude means of determining position in the menstrual cycle. Recently, Bröder and Hohmann (2003) rectified these shortcomings somewhat by asking German male and female university students to rate the danger of sexual

assault entailed by 20 risky and 20 non-risky behaviours. The authors then employed a longitudinal design to record the frequency of risky and non-risky behaviours at four points during the menstrual cycles of 51 German women, determined on the basis of the onset of menstruation. This improved method produced an even stronger result, revealing that women engage in activities that place them at risk less frequently during the ovulatory phase than during other phases of the menstrual cycle, while no changes are evident with regard to non-risky activities.

Petralia and Gallup (2002) hypothesized that resistance to sexual assault should vary as a function of position in the menstrual cycle. Using both the forward-counting method and a urinary test for luteinising hormone (a marker of the onset of ovulation), the authors categorized 192 U.S. undergraduates into four menstrual cycle phases. Participants were given a test of handgrip strength, then read essays depicting either a woman walking to her car late at night while being pursued by a strange man, or a woman walking to her car during the day with other people around; a second handgrip strength measure was taken immediately thereafter. For women in the ovulatory phase who were not taking oral contraceptives, handgrip strength increased significantly following the sexual assault essay, but not following the control essay. No effect of either essay was found for women in other phases of the cycle or for those using oral contraceptives. Although the literature is mixed with regard to the effects of menstrual cycle phase on a variety of measures of athletic performance, a recent well-designed study revealed no effect of phase on handgrip strength (Friden et al. 2003). Moreover, the evidentiary value of Petralia and Gallup's positive finding is increased by the fact that women in the ovulatory phase category who read the control essay did not evince an increase in handgrip strength relative to the pre-test. While a four-category discrimination is not ideal given that conception risk varies in a continuous fashion across the menstrual cycle (Wilcox et al. 2001), the use of luteinising hormone detectors adds weight to the authors' conclusion that the period of peak fertility is accompanied by distinct behavioural changes.

Claims regarding the frequency of rape across the menstrual cycle

Taken together, the work of Chavanne and Gallup, Petralia and Gallup, and Bröder and Hohmann provides preliminary evidence of the existence

of psychological mechanisms that operate to reduce the probability that rape will occur during the period when the likelihood of conception is highest, a pattern explicable in terms of the relationship between conception and the negative fitness consequences that rape entailed for women in the ancestral past. In light of the noteworthy nature of these contributions to our understanding of rape-related phenomena, it is profoundly unfortunate that these investigators erroneously take as one of their starting points the claim that the epidemiology of rape in contemporary societies reflects active avoidance of sexual victimization as a function of conception risk. As Chavanne and Gallup put it:

> [W]omen are actually less likely to be raped at about the time they are ovulating as opposed to other points in the menstrual cycle. Rogel (1976) examined the distribution of rapes during different phases of the menstrual cycle among 785 victims of sexual assault. She discovered that proportionately fewer women were raped during the mid-portion of the menstrual cycle (days 10–22), and this effect appeared most pronounced for victims who were in their late teens and early twenties. Based on a sample of 123 rape victims, Morgan (1981) also noted that women who were in the ovulatory phase at the time of the encounter were underrepresented among victims of sexual assault (1998: 27–28).

The Chavanne and Gallup paper has received considerable attention, and has inspired a growing corpus of research on phase-dependent female rape-avoidance mechanisms (see Bröder and Hohmann 2003; Garver-Apgar 2003). Given its pioneering position in this field of research, it is likely that the Chavanne and Gallup paper will serve as a model for many future publications. Recently, Simkin and Roychowdhury (2002) demonstrated that authors frequently repeat citations without reading the work in question, and this would seem to be particularly likely when unpublished material is cited in a seminal paper, as in the case of the Rogel and Morgan dissertations summarized in the above passage. Indeed, in introducing their replication of the Chavanne and Gallup study, Bröder and Hohmann state '. . .Rogel (1976) and Morgan (1981) reported that women were less likely to be raped during the fertile (ovulatory) phase of their menstrual cycle than at other times (cited in Chavanne and Gallup 1998)', (2003: 392). Likewise, Petralia and Gallup support their conclusions by noting the existence of 'work showing that women in the ovulatory phase are

less likely to be raped (Morgan 1981; Rogel 1976)', (2002: 6–7). Finally, in their widely read (and much debated) book on rape, immediately following a synopsis of the Chavanne and Gallup study, Thornhill and Palmer state:

> Rogel (1976) found that, among about 800 victims of sexual assault, proportionately fewer women were raped during the middle portion of the cycle, and this was especially the case for women who were in their late teens and early twenties. Morgan (1981) got a similar result using a smaller but still substantial sample (123) of female sexual-assault victims (2000: 101–102).

While the arguments in favour of the existence of evolved rape-avoidance mechanisms are both theoretically cogent and supported by preliminary evidence, in light of the problem of re-citation identified by Simkin and Roychowdhury, it is important to set the record straight. As I will demonstrate in the remainder of this paper, *to date there is no evidence to support the claim that rape is less frequent during the periovulatory period than chance alone would predict.*

Evidence bearing on the distribution of rape across the menstrual cycle

Direct evidence: the Rogel and Morgan dissertations

The two unpublished dissertations cited by Chavanne and Gallup, and subsequently re-cited by others, have much in common with each other. Working in the early years of evolutionary approaches to human sexual behaviour, neither Rogel (1976) nor Morgan (1981) presents a well-formulated hypothesis concerning the ultimate determinants of the frequency of rape.[1] Rather, both authors are intrigued by the possibility that ovulation is advertised in humans, and both identify pheromones as a probable medium for such communication (Rogel 1976: 20–29; Morgan 1981: 8–9). While describing evidence of increased copulatory frequency during the periovulatory period as suggestive of such a phenomenon, both Rogel and Morgan note that such changes may be due to increases in proceptive sexual behaviour during the fertile phase. Both authors accordingly present their studies of the frequency of rape across the menstrual cycle as a means of investigating the possibility that men can detect the fertile phase in women independent of enhanced

proceptivity, since rape victims presumably do not solicit their assailants. Below I examine each of the dissertations in detail.

In introducing her dissertation, Rogel states 'The primary question to be examined in this study is whether or not the frequency of rape varies non-randomly over the menstrual cycle' (1976: 1), precisely the point at issue in contemporary investigators' citations of Rogel's work. Specifically, Rogel sets out to explore the possibility that rape is *more frequent* during periods of high conception risk, a pattern consistent with her hypothesis that pheromones advertise a woman's position in the menstrual cycle.

Rogel examined medical records concerning 785 reports of rape filed in 1973 at the Emergency Rooms of the University of Chicago Hospitals and Clinics, of which 497 were ultimately employed by Rogel (reasons for exclusion are not provided). Using a date described somewhat vaguely as that of 'last menstrual period' (a figure subject to errors of recall), Rogel counted forward to the date of the rape. Recognizing that cycle length, which was not recorded in the reports, varies both between and within women, in order to determine whether the resulting distribution differed from that expected by chance, Rogel then put existing data to a novel use. Chiazze et al. (1968) had studied the length of at least 10 menstrual cycles in each of over 2,000 women. Ninety-five percent of the cycles reported by Chiazze et al. were between 15 and 45 days in length. For each cycle length within this range (e.g., 15 days, 16 days, 17 days, etc.), Rogel used the figures reported by Chiazze et al. to calculate the expected frequency of the given cycle length in any large random sample of women. Assigning equal probability to each day within a cycle of a given length, Rogel then calculated the probability that victims would occupy each day from 1 to 45 by summing the contributions of cycles of differing lengths, each contribution being weighted in light of the expected frequency of the given cycle length. The combined result constitutes the expected frequency of the number of rape victims on each day from 1 to 45 if rapes were distributed at random with respect to the menstrual cycle.

Summarizing her findings after comparing the observed and expected frequencies of rape on each of the 45 days, Rogel does indeed state, as claimed by Chavanne and Gallup, that her study indicates that rape is less frequent than expected during days 10–22. However, contrary to the impression given by Chavanne and Gallup's characterization of Rogel's results, this distribution does not resemble the pattern predicted by Chavanne and Gallup's hypothesis that women possess evolved

mechanisms that reduce the likelihood of sexual assault as a function of conception risk. The complete quote from the conclusion of Rogel's dissertation reads '[The frequency of rape was] higher than expected around days 6–9, lower than expected days 10–22, *particularly days 10–11 and 19–20*, and higher than expected days 29–32' (1976: 56, bracketed material and emphasis added). This pattern is profoundly incongruent with the interpretation offered by Chavanne and Gallup. Based on a thorough, well-designed longitudinal study of 221 U.S. women who planned to become pregnant, Wilcox et al. (2001) determined the probability of conception following a single act of coitus for each of 40 days following the onset of menstruation, conditional on reaching that day. The periods of markedly reduced rape frequency observed by Rogel, days 10–11 and 19–20, do not include days 12–14, the three-day period that captures the greatest likelihood of conception following a single act of intercourse (Wilcox et al. 2001: 213). Indeed, these periods do not even include days 13–17, the span selected by Chavanne and Gallup as the high conception risk phase. Clearly, a closer look at Rogel's results is merited.

Inspection of Rogel's compiled data (1976: 74) indicates that the frequency of rape among women not using oral contraceptives ($n = 414$) is at chance on day 14 and *above* chance on days 12 and 13, the two days with the highest conception risk in the entire cycle (Wilcox et al. 2001: 213). Moreover, the pattern touted by Chavanne and Gallup is driven almost entirely by women age 17–20 ($n = 135$) (Rogel 1976: 48–50); those outside of this age range who were not using oral contraceptives ($n = 213$) exhibit less of a dip in frequency on days 10 and 11, are at chance on days 12 and 15, and are substantially above chance on days 13 and 14 (Rogel 1976: 76). Given that ovulation typically occurs on day 14, not a single one of these patterns is consistent with Chavanne and Gallup's interpretation that 'women are actually less likely to be raped at about the time they are ovulating'.[2,3] Hence, at best, Chavanne and Gallup have grossly misunderstood Rogel's results and her conclusions; at worst, they have intentionally misrepresented Rogel's work.

The second unpublished dissertation cited by Chavanne and Gallup is that of Morgan (1981). Morgan employed emergency room records from an unidentified large metropolitan hospital, collecting information on a considerably smaller sample consisting of 99 rape cases among women not taking oral contraceptives. Records included the somewhat ambiguous question 'date of last menses' (again, a figure subject to errors

of recall), which Morgan interpreted as the date of onset of the most recent menstrual period. Morgan augmented the existing rape reporting form, adding the question 'Beginning date of next-to-last menses'. However, Morgan notes that the question was rarely answered, and, equally problematic, Morgan does not specify the proportion of the sample collected prior to the addition of this question. For cases in which this information was not available (presumably the vast majority), Morgan assumed a 28-day menstrual cycle length (a potentially problematic step given the known variation in cycle length, Chiazze et al. 1968). Counting forward from the date of last menses, the day of rape was categorized using the following conventions: the ovulatory phase was defined as the two days prior to the midpoint of the cycle and the two days after the midpoint; the para-menstrual phase was defined as the last four days of the cycle plus the first four days of the next menses; and the remainder of the cycle (encompassing 15 days) was defined as 'other days'.

The observed frequencies of rape were as follows: 15 ovulatory phase cases, 33 para-menstrual phase cases, and 51 'other days' cases (1981: 28). As Morgan explicitly points out (1981: 27), given the division of the 28-day cycle into three segments with durations of 5, 8 and 15 days, respectively, a chi square test indicates that this distribution does not even remotely differ from that predicted by chance. Morgan also divides his sample on the basis of whether the victim had interacted with her assailant prior to the assault, a factor of potential relevance given Chavanne and Gallup's (1998) and Bröder and Hohmann's (2003) findings that women avoid situations that place them at risk of rape during periods of high conception risk. However, neither the 'unknown' condition ($n = 63$; distribution: 10, 22, 31) nor the 'known' condition ($n = 36$; distribution: 5, 11, 20) reveals a distribution different from that which chance alone would predict. Hence, contrary to Chavanne and Gallup's statement, Morgan never 'noted that women who were in the ovulatory phase at the time of the encounter were underrepresented among victims of sexual assault' (Chavvane and Gallup 1998: 28), nor do his data support such a claim. Rather, clearly disappointed in his failure to find any patterns of interest whatsoever, Morgan summarizes the results of his numerous tests of the patterning of rape across the menstrual cycle by concluding that 'More than anything else, the observed frequencies appear to represent normal [i.e., random] distribution [sic],' (1981: 50, bracketed material added). It is unclear how Chavanne and Gallup could possibly have viewed Morgan's work

as supporting their assertion that rape is less frequent during periods of high conception risk given that both Morgan's results and his explicit statements indicate that the distribution of rape across the menstrual cycle does not differ from that predicted by chance alone.

Indirect evidence: Comparing the probability of conception following rape with the probability of conception following consensual coitus

Neither the work of Rogel (1976) nor that of Morgan (1981) supports the claim that rape is less frequent during periods of high conception risk. However, although the Rogel and Morgan dissertations clearly do not fit the characterizations offered by Chavanne and Gallup, the limitations of these studies indicate that additional research is in order if we are to settle the question of the incidence of rape in contemporary society as a function of the victim's position in the menstrual cycle.

Seeking to move beyond the Rogel and Morgan dissertations, I conducted searches of the PubMed, PsychInfo, and Biosis databases, as well as a search of the World Wide Web using the Google search engine. However, despite extensive searches, I was unable to identify any other studies that provide information on the relationship between position in the menstrual cycle and the likelihood of being sexually victimized. Nevertheless, while additional direct evidence bearing on the question at issue is as yet unavailable in the published record, indirect evidence does exist in the form of studies of the probability of conception following rape or consensual coitus. If, as Chavanne and Gallup claim, rape is less frequent during the period of highest conception risk, then an examination of the consequences of actual rapes should reveal that the overall likelihood of conception following a single act of rape is lower than the overall likelihood of conception following a single act of consensual coitus.

Holmes et al. (1996) studied 404 cases of rape in the U.S., concluding that the probability of conception following a single act of rape is 5.3% for women age 12–17 and 4.7% for those age 18–45.[4] Based on their prospective study of 221 U.S. women who planned to become pregnant, Wilcox et al. (2001) determined that the probability of conception following a single act of consensual coitus is 3.1%.[5] These figures cannot be directly compared, as fertility is age-dependent (Frank et al. 1994; Wood 1989), and it is probable that the age profiles of the rape victim samples differ from that of the consensual coitus sample given that,

in the U.S., women under age 24 are between five and seven times more likely to be raped then those age 25–49 (United States Department of Justice 2003: 16). Wilcox et al. indicate that the mean age in the latter is 30, the range 21–42; Holmes et al. do not supply equivalent information, merely bifurcating the rape sample at age 18. Modification of the respective results is therefore necessary if we are to conduct a realistic comparison between the overall likelihood that a single rape will result in conception and the overall likelihood that a single act of consensual coitus will result in conception.

The need to modify the Holmes et al. and Wilcox et al. results in order to make them comparable creates an opportunity to bias the test in favour of the claim that rape is less frequent than chance would predict during the period of high conception risk. Such biasing is achieved by maximizing the assigned probability of conception following consensual coitus and minimizing the assigned probability of conception following rape. Accordingly, although the consensual coitus sample has a mean age of 30, in order to construct a generous test, we can treat this sample as if it were composed entirely of women *over* age 30, since fertility after 30 is only 66% of fertility for ages 21–30 (reviewed in Frank et al. 1994). Similarly, although no means are provided for the rape samples, in order to construct a generous test, we can treat the 18–45 category as if it were composed entirely of women *under* age 30. These assumptions bias the test in favour of the predicted result because, in order to compare the probabilities from the two samples, we must boost the probability from the consensual coitus sample so as to compensate for the reduction in fertility entailed by the presumption that the subjects are over age 30. Specifically, since fertility after age 30 is reduced by 34% compared to fertility prior to age 30, in order to make the probabilities comparable the consensual coitus figure must be adjusted by a factor of 0.34, a change that boosts the probability of conception from a single act of consensual coitus from 3.1% to 4.2%; no such adjustment is applied to the rape sample, since we have assumed that all of the victims are under age 30.

Because the risk of conception drops off precipitously as the timing of intercourse moves outside of the periovulatory phase (Colombo and Masarotto 2000; Wilcox et al. 2001), if rape were less common during the periovulatory period than chance alone would predict, the overall probability of conception following a single act of rape would be lower than the overall probability of conception following a single act of consensual coitus. However, despite configuring the test in a manner

biased toward this outcome, the probability of conception from a single act of consensual coitus, 4.2%, clearly fails to exceed the probability of conception from a single act of rape, 4.7%. It is therefore very unlikely that, in modern societies, rapes are disproportionately rare during the period of maximum conception risk.

Conclusion

In contrast to descriptions of their work by Chavanne and Gallup and subsequent authors, neither the dissertation of Rogel nor that of Morgan supports the claim that the epidemiology of rape reveals evidence of varying behavioural prophylaxis against sexual assault as a function of conception risk across the menstrual cycle. An indirect test of this proposition comparing empirically-derived probabilities of conception following rape and conception following consensual coitus similarly fails to support this claim.

How are we to reconcile the above findings with the proposition that women possess evolved psychological mechanisms that alter behaviour so as to reduce the likelihood of rape as a function of conception risk (Chavanne and Gallup 1998; Petralia and Gallup 2002; Bröder and Hohmann 2003; also Garver-Apgar 2003)? At least three possibilities exist. First, it is possible that this proposition is simply false. To date, the number of experimental studies supporting the existence of rape-avoidance mechanisms is small and, while some (e.g., Bröder and Hohmann 2003) employ relatively sound methods, others are subject to substantial limitations. However, while it is not possible to rule out the possibility that there are no conception-sensitive female rape-avoidance mechanisms, the theoretical argument in favour of their existence is cogent and, more compelling still, a growing body of evidence reveals the presence of a number of similar adaptive menstrual cycle-related psychological and behavioural changes (e.g., Johnston et al. 2001; Gangestad et al. 2002; Fessler 2003; Gangestad et al. 2004; Pillsworth et al. 2004).

A second possible explanation for the absence of the predicted menstrual cycle pattern in studies of the frequency of rape is that, although the postulated rape-avoidance mechanisms both exist and operate effectively in the modern world, methodological obstacles cloud the epidemiological portrait to such a degree as to make it difficult to discern the predicted pattern. As noted earlier, Morgan's work and, to a lesser extent, Rogel's are subject to nontrivial methodological limitations.

While the frequency-of-conception analysis that I presented is free of many of these difficulties, all of these studies are bedevilled by a number of intractable problems. First, it is likely that rape is grossly under-reported, with current reporting rates of only between 36% (Rennison 2002) and 56.6% (United States Department of Justice 2003: 106; see also Feldhaus et al. 2000) documented in the United States.[6] It is possible that if, consistent with predictions entailed by the rape-avoidance hypothesis (cf. Thornhill and Palmer 2000: 85–95), women in the periovulatory phase find rape to be more traumatizing, they may be more prone to report it. Similarly, if, as Petralia and Gallup's (2002) results suggest, periovulatory women are more likely to resist sexual assailants, they may be more likely to be injured, and hence to enter the records via admission to hospital. If such biases in reporting exist, both records of individual rapes and data on conception resulting from rapes will fail to reveal lowered victimization rates among women in the periovulatory phase.

Evolutionary disequilibrium constitutes a third possible explanation for the absence of the predicted menstrual cycle patterns in the incidence of rape. Life in a modern society differs in many important ways from the conditions under which our hunter-gatherer ancestors lived for most of our species' history. To the extent that contemporary conditions diverge from those in which psychological rape-avoidance mechanisms evolved, the behaviours produced by such mechanisms may no longer be effective in reducing the likelihood of rape during periods of maximum conception risk. While the list of potentially relevant disparities between current and ancestral conditions is long, several factors stand out. First, whereas life in most hunter-gatherer societies is markedly lacking in privacy (cf. Shostak 1981), in the modern world, buildings and cultural norms often combine to remove much behaviour from social scrutiny. This is relevant given that recent studies indicate that from 68.2% (52.1% for women in the maximally fertile age range of 20–24) (United States Department of Justice 2003: 40, 42) to 70% (Feldhaus et al. 2000) of sexual assaults against women in the U.S. are committed by a non-stranger. Such individuals likely have access to their victims behind closed doors, reducing the probability that others will come to the victim's aid. Indeed, in the U.S., 53.5% of sexual assaults occur in or near the home or at work, compared with only 33.1% that take place during a leisure activity away from home (United States Department of Justice 2003: 79–80). Hence, even though avoiding locations and situations that entailed a risk of assault by unfamiliar or poorly known

men probably greatly reduced the risk of rape in ancestral societies (Chavanne and Gallup 1998; Bröder and Hohmann 2003), such tactics may not protect a woman from rape in modern societies. Second, of equal importance, in a substantial portion of contemporary rapes victims report having been under the influence of alcohol and drugs of abuse at the time of the assault (Harrington and Leitenberg 1994; Teets 1997; Combs-Lane and Smith 2002; Wood and Sher 2002). While some similar agents were likely present in ancestral environments, their availability, strength, and addictiveness were almost certainly substantially lower in the past. As evidenced by the persistently high contribution of such substances to automobile accidents, the powerful and addictive nature of many readily-available mind-altering substances is sufficient to frequently override risk-management strategies, thus presumably reducing the effectiveness of any psychological mechanisms that evolved to decrease the extent to which women exposed themselves to the risk of rape during the periovulatory period.[7]

In conclusion, Chavanne and Gallup and those who have followed in their footsteps are wholly incorrect in claiming that rape is less frequent during the ovulatory phase of the menstrual cycle. However, this error does not undermine the legitimacy of these authors' experimental demonstrations of the existence of psychological mechanisms that, during periods of high conception risk, alter women's behaviour in ways that would have reduced the likelihood of rape in ancestral environments. The contrast between the experimental evidence and the lack of menstrual cycle-related patterning in the epidemiology of contemporary rape may be due to either biases in the reporting of rape, evolutionary disequilibrium, or both. Given that formidable methodological obstacles likely preclude clarifying the causes for the lack of cyclic effects in contemporary rape, investigators may do well to simply leave the epidemiological question behind, concentrating their efforts instead on examining psychological and behavioural changes that, under ancestral conditions, would have contributed to rape avoidance as a function of conception risk.

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Notes

1 Although neither Rogel nor Morgan explore how natural selection may have acted on the psychology of rapists, their interest in indices of fertility is congruent with some evolutionary approaches to rape. Because rape exposes the rapist to an immediate risk of injury and, later, possible retribution, an evolutionary perspective suggests that, if rape constituted a viable reproductive strategy in ancestral populations (a contested possibility, Archer and Vaughan 2001), natural selection may have favoured the evolution of mechanisms that would have led rapists to maximize the likelihood that rape would result in conception, as it is only thus that the rapist would have obtained fitness benefits potentially outweighing the fitness costs of rape to the rapist (Shields and Shields 1983; Thornhill and Thornhill 1983).

2 By introducing a steady dose of exogenous hormones, oral contraceptives can be expected to eliminate cyclic changes in the presumed proximate determinants of phase-dependent behaviour. Following precisely this reasoning, Chavanne and Gallup (1998), Petralia and Gallup (2002), and Bröder and Hohmann (2003) treat oral contraceptive users as a control group, finding support for their respective arguments in the observation that the behaviour of such women does not vary on the factors of interest across the menstrual cycle. It is therefore significant that the only women in Rogel's study to exhibit a reduction in rape frequency on day 14 (the probable day of ovulation in nonusers of oral contraceptives) are individuals who were taking oral contraceptives at the time of the assault (1976: 76), as this is precisely the opposite pattern from that which we would expect given Chavanne and Gallup's account of Rogel's findings.

3 The adaptive significance of even the limited reduction in frequency during days 10–11 among those not using oral contraceptives is questionable given the fact that this pattern is driven primarily by women age 17–20, yet fecundity peaks considerably later (Wood 1989).

4 Thornhill and Palmer (2000: 100) pick up without citation an argument laid out by Moore (1996), namely that, because paternity tests were not performed in the Holmes et al. study, it is possible that the probability of conception due to rape was inflated by the inclusion of pregnancies resulting from consensual coitus with another male. Moore cites Hammond et al.'s (1995) finding that 60% of pregnancies ascribed to rape were actually conceived with a consensual partner, and notes that 64% of the victims in the Holmes et al. study were married or cohabiting at the time of rape. From these figures Thornhill and Palmer conclude that the probability of conception following rape is 2%. However, Moore's argument does not result in such a drastic reduction, since 47% of the rapes that resulted in pregnancy were ascribed by the victim to a boyfriend or husband (Holmes et al. 1996: 322). Crudely, this means that only approximately 17% of the remaining victims were likely to be married or cohabiting at the time

of rape. If 60% of the pregnancies contributed by these individuals were mis-ascribed, then the gross number of rape-related pregnancies should be reduced by approximately 10%. Holmes et al. report 20 cases of pregnancy out of 404 rapes of women age 12–45; adjusting the former figure produces a total of 18 cases of pregnancy, or a 4.5% probability of pregnancy per act of rape.

5 This figure was arrived at after controlling for the distribution of copulations across the cycle, hence it is unaffected by the fact that proceptive female sexual behaviour increases as a function of conception risk (reviewed in Regan and Berscheid 1999: ;46-50; see also Clayton et al. 1999; Gangestad et al. 2002), a pattern that would otherwise bias the comparison against the prediction that the probability of conception following rape will be lower than the probability of conception following consensual coitus.

6 Although rape is still vastly underreported, reporting rates appear to be increasing; for example, one study conducted only a decade ago found that only 16% of rapes are reported (Kilpatrick et al. 1992).

7 Although Bröder and Hohmann (2003) include 'get drunk while going out' among the risky behaviours which, in aggregate, are found to occur less frequently during the periovulatory period, they do not report whether this item in particular follows the predicted pattern.

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