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RISE IN FEMALE-INITIATED SEXUAL ACTIVITY AT OVULATION AND ITS SUPPRESSION BY ORAL CONTRACEPTIVES

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Abstract This study was designed to test the hypothesis that women exhibit peaks of sexual activity at ovulation, as would be predicted from estrous effects in animals. Married women who used contraceptive devices other than oral contraceptives experienced a significant increase in their sexual behavior at the time of ovulation. This peak was statistically significant for all female-initated behavior, including both autosexual and female-initiated heterosexual behavior, but was not present for male-initiated behavior except under certain conditions of contraceptive use. Previous failures to find an ovulatory peak may be due to use of measures of sexual behavior that are primarily determined by initiation of the male partner. Women using oral contraceptives did not show a rise in female-initiated sexual activity at the corresponding time in their menstrual cycles, probably owing to the suppression of ovulatory increases in hormone secretion by the oral contraceptives. (N Engl J Med 299:1145-1150, 1978)

ON theoretical grounds one might expect a rise in human female sexual behavior around the time of ovulation, since nonhuman mammals have heightened sexual receptivity (estrus) in association with ovulatory hormone changes.[1,2] Such an effect, if hormonally produced, should be suppressed by oral contraceptives, which alter the normal fluctuations of the various hormones associated with ovulation.[3,4]

Although previous studies of human female sexual behavior have shown premenstrual and post-menstrual rises in coital frequency, they have not produced unequivocal proof that there is a midcycle peak in sexual activity. Early studies that depended upon retrospective judgment usually failed to find a midcycle peak,[5-7] although one study of women whose husbands were absent during the war did find such an effect.[8] More recent studies have used daily questionnaires or interviews, and their results have varied according to the measure of sexual activity. Studies that have measured coital rate or orgasm rate have shown no midcycle peak in these measures,[9,10] or else a slight peak[11,12] that was of dubious statistical significance.[13,14] Other studies measuring introspected sexual feelings as a part of a general test of mood[15,16] or within a psychotherapeutic context[17,18] have found positive evidence of a midcycle peak. None of these studies, however, have provided statistical analyses of the effects. In his general review, James[14] came to the conclusion that an ovulatory peak had not been demonstrated clearly and that, if present at all, it could only be a minor effect.

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The effect of oral contraceptives on sexual behavior has also been equivocal. Although some sociologic surveys find that women who take oral contraceptives have higher coital rates than other women,[19] the difference may reflect the absence of fear of pregnancy or the lack of a period of abstinence characteristic of contraceptive methods such as the rhythm method, and may not reflect direct effects on sexual desire. On the other hand, many studies have found that a certain percentage of women report loss of sexual desire after taking contraceptive pills. Early clinical claims that this was a general effect have been reviewed and criticized on methodologic grounds,[13,20] and more recent studies have found that a majority of women do not lose sexual desire after adopting oral contraception.[21-26]

We hypothesized that previous failures to find an ovulatory rise in sexual activity have been due to the predominance of male-partner initiation in the measures of female sexual activity that have been employed, and that an ovulatory peak could be found if measures determined primarily by female initiative were used. We further hypothesized that such a peak, if present, should not be found in women using oral contraception. The present study tests these hypotheses.

MATERIALS AND METHOD

Subjects

The participants were 35 white college-educated women, 21 to 37 years of age, who were recruited from among the women affiliated with the Wesleyan University community. All women who indicated an interest in participating in the project attended individual screening interviews. Only those who did not have marital or medical (especially gynecologic) problems that might affect sex-

ual activity or menstrual cyclicity were selected for participation in the study. All subjects were paid $15 a month for their participation. The complete confidentiality of their data was ensured.

It is difficult to determine how representative our sample is of white married women in this age bracket. The women in the sample were distinguished by their interest in sexuality, their commitment of a substantial amount of time to the study and their willingness to discuss their sexual activities in detail. The recruiting letter indicated a minimum commitment of three months. However, their average frequency of intercourse, as measured during the study, was virtually identical to the frequency (eight to 10 times a month) recently reported from a national sample of 100,000 women of comparable age and background, drawn from the readership of *Redbook Magazine*.[27]

Subjects were divided into three types on the basis of mode of contraception. Twelve "pill subjects" had been taking combination oral contraceptives for at least six months. The contraceptives were low-estrogen ethinyl estradiol and norgestrel (Ovral) (eight subjects), low-estrogen mestranol and norethindrone (Ortho-Novum) (two subjects) and norethindrone acetate and ethinylestradiol (Norlestrin) and mestranol and norethynodrel (Enovid) (one subject each). Eleven participants used either an intrauterine device or male vasectomy as means of contraception, methods that do not intrude into the planning or act of intercourse; these were the "nonintrusive nonpill subjects." The remaining 12 participants used a diaphragm, foam or male condom for contraception, methods which can intrude into the planning or act of intercourse; these were the "intrusive nonpill subjects." There were no statistically significant differences between these three types in background characteristics nor in overall rates of any of the sexual-activity measurements used in the data analyses.

Data Collection

All participants filled out daily questionnaire sheets on which they recorded all sexual experiences, including data on the following: intercourse, caressing (defined as a session of lovemaking that did not involve intercourse), masturbation, fantasy, arousal due to books, films, magazines or dreams, initiator of each heterosexual session (mutual, self or partner), whether the participant rejected an initiation by the partner or vice-versa, and presence or absence of mittelschmerz (defined as a pain in the abdomen near the right or left ovary). The interviewer worked out a definition of "session initiator" and "rejected advances" with each subject during screening interviews. Participants deposited completed questionnaires with the experimenter at the end of each week, when they received additional questionnaires for the next week. One of the researchers called all subjects several times during the first month of participation to make sure they were completing their forms correctly and to answer any questions that might have arisen. She also spoke with many subjects when they deposited their completed questionnaires each week, as a further check.

The 35 participants completed data for 171 menstrual cycles. The median number of cycles completed per subject was 4.2, with a mode of three. Cycle lengths ranged from 23 to 36 days. There was great variability of cycle length within each subject. Individual subjects had cycle lengths that varied from shortest to longest by up to seven days (median variation of 4.0 days); in no subject with data from at least three cycles was the variation in cycle length less than two days. Six cycles longer than 36 days were not included in the analysis because we thought they might be indicative of anovulation.

Most participants began recording data on the first day of a cycle and continued until the last day of a later cycle. Seven women began recording after their first cycle had begun, but they were able to inform us of the date of the onset of their preceding menstrual flow so that the length of their first cycle could be determined. One woman did not complete her last cycle. However, she provided us with the date of her next menstruation, enabling us to estimate her ovulation as with the other subjects (see data-analysis section below).

Data Analysis

Female-initiated sexual activites were calculated separately from activites initiated exclusively by the male. They were divided into two mutually exclusive categories: heterosexual and autosexual. The measure of female-initiated heterosexual activities was calculated as the simple sum of female-initiated and mutually initiated intercourse and caressing sessions and female advances rejected by the partner. Out of the total 1266 sessions of female-initiated heterosexual activity, 852 consisted of intercourse, and 240 of caressing without intercourse, and 174 were advances rejected by the partner. The measure of autosexual behavior was calculated as the simple sum of masturbation sessions, sexually arousing fantasies and dreams, and reports of arousal from books, magazines or films. Calculations for both heterosexual and autosexual activitives are based on the mean frequency of activity per day.

As in all questionnaire data, there was opportunity for error and bias in the recording of data, such as session initiator and rejected advances. We considered the possibility of requiring the partners of the subjects to fill out separate questionnaires but rejected it on the grounds that it would have greatly increased an already considerable intrusion into the subjects' privacy. As it turned out, most subjects seem to have adopted rather similar criteria. Of the 35 subjects, 31 reported that mutual initiation of heterosexual activity constituted between 10 per cent and 50 per cent of the total, and that female-initiated sexual activity (including mutually initiated) made up between 33 per cent and 80 per cent of the total. The exceptions included two pill subjects with low proportions of mutual and female initiation and two other subjects, one a pill subject and one a non-intrusive nonpill subject with relatively high proportions of mutual initiation and high proportions of female initiation as a consequence. It is unlikely that the three exceptional pill subjects had any undue weight in the major findings of the study, since their rates of female-initiated heterosexual activity declined like those of other pill subjects during ovulation. On a more general level, there is no reason to expect that any error or bias in the recording of session initiator by the majority of subjects should have affected one segment of the menstrual cycle more than another. It is also unlikely that error or bias in the recording of rejected advances could have affected the major findings of the study to any great extent. This category constituted more than 14 per cent of the female-initiated heterosexual activity for only two subjects, and, in both cases, the ovulatory effects were similar in direction and degree for both rejected advances and other female-initiated heterosexual activity.

Cycle standardization was accomplished by the following method that standardized cycles to 28 days without using "fractionated" days. Since previous research had indicated that the best estimate of ovulation is the 14th day, counting backward from the succeeding menstruation,[28] days were plotted on a daily basis counting backward in "reverse-cycle days" for 18 days, a time well before the estimated time of ovulation. Because the data in the early part of the cycle are clearly influenced by menstruation, the days at the beginning of the cycle were plotted separately by counting forward until day 11 or, for cycles of fewer than 28 days, until reverse-cycle day 18. These two separate curves, one counting backward and one counting forward, are presented as a single graph in Figures 1 and 2. The marked peak in reports of mittelschmerz by nonpill subjects on reverse-cycle day 14, as shown in Figure 1, supports the accuracy of this procedure for estimating ovulation. Mittelschmerz was rarely reported by pill subjects — in all only six times by three women, of which three times were at midcycle.

To test for the statistical significance of the ovulation effect, comparisons were made of nonpill subjects' and pill subjects' mean levels of female-initiated heterosexual activity and of autosexual activity during ovulation days (estimated as reverse-cycle days 13 to 15) and non-ovulation days of the menstrual cycle. Similar tests were also conducted for components of these measures: masturbation and fantasy-like autosexual activity, exclusively female-initiated heterosexual activity and mutually initiated heterosexual activity, as well as for exclusively male-initiated heterosexual activity.

Subjects were the unit of statistical analysis. For each statistical analysis (i.e., for each measure of sexual behavior), two data entries per subject were calculated by averaging of the number of sexual activities the participant had engaged in each day during all her cycles, for ovulatory (reverse cycle days 13 to 15) and nonovulatory days separately. Although the number of days upon which these entries are based vary from subject to subject because of differences in cycle lengths and number of cycles completed, the two entries are conceptually equivalent for all subjects. They represent the sub-

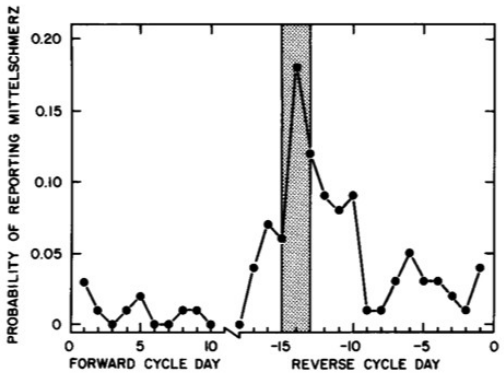

Figure 1. Cyclic Fluctuations in Mean Probability of Reporting Mittelschmerz per Day.

Data are derived from the 19 nonpill respondents who reported at least one occurrence of mittelschmerz. Number of cases per cycle day is 94, except for forward counting days seven to 10, which contain somewhat fewer cases because of cycles shorter than 28 days.

ject's average frequency of sexual activity at ovulation and at all other times during the cycle. With these data, 3-×-2 analysis of variance (linear model) was calculated for each measure, with contraceptive type and segment of the cycle as the two variables. Two variances were partitioned: a subject within-type variance for testing the effect of contraceptive type and a cycle segment × subject within-type variance for testing the effect of cycle segment and the interaction of contraceptive type with cycle segment. An unweighted means solution for unbalanced analysis of variance designs was followed.[29] The results of these analyses are shown in Table 1.

Because the error variance of the data was not uniform, it was necessary to account for this discrepancy in the analysis of variance procedure. The nonuniformity of variance may be seen in Table 2, in which it will be noted that the standard deviation of data from ovulation days is usually greater than that from non-ovulation days, and that the size of the mean and the size of the standard deviation are positively correlated. It was found empirically that when a square-root transformation of the data was made, the nonuniformity of variance was greatly reduced, and the variances of the transformed data were not significantly heterogeneous at the 0.10 probability level by use of an F max statistic.[29] To transform the data, zero scores were converted to the value 1/2n, where n is the number of observations on which the particular frequency determination was based. The transformed data for female-initiated heterosexual activity and for autosexual activity were reanalyzed with use of the unweighted means solution for unbalanced analysis of variance designs as before. Results of analyses on the transformed data were similar to those on the original data; all F ratios were at least as significant as in the original analyses.

Results

There was a pronounced peak for both autosexual and female-initiated heterosexual activities among both intrusive and non-intrusive nonpill groups on reverse-cycle days 13 to 15 — i.e., the days corresponding to the best estimate of ovulation. These peaks are evident in Figure 2, in which all the data from the study are summed without regard to relative contributions of each subject. For three of the four nonpill curves, the peak on reverse-cycle days 13 to 15 represents the highest rate of the entire cycle. Heterosexual activity in the intrusive nonpill group was the one exception, the ovulatory peak being somewhat lower than a post-menstrual one. As expected, the group using oral contraceptives showed no peak at midcycle; in fact, their female-initiated heterosexual activity was unexpectedly low.

We also found both premenstrual and post-menstrual peaks in female-initiated heterosexual activity for all three contraceptive types, as well as increases in autosexual behavior during menstruation (Fig. 2). Unlike the midcycle peaks, these peaks were evident in pill as well as nonpill subjects.

A more detailed examination of the ovulatory effects is presented in Tables 1 and 2. Table 2 presents the analyses of variance cell means (based on the nontransformed data). Table 1 shows the results of the analyses. It may be noted that by testing the ovulatory portion of the cycle against all other days, we are using a somewhat conservative statistical procedure. Although the nonovulatory cycle days include the menstrual drop in heterosexual activity, they also include both premenstrual and post-menstrual peaks in heterosexual activity and the menstrual increase in autosexual activity.

Confirming the peaks shown in Figure 2, the data in Tables 1 and 2 show that rates of autosexual activity and female-initiated heterosexual activity were

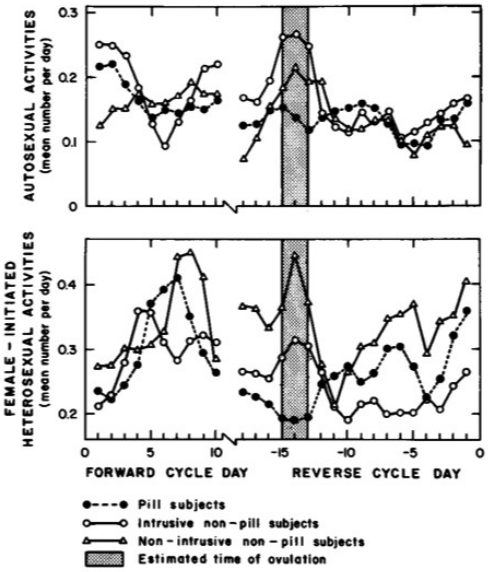

Figure 2. Cyclic Fluctuations in Mean Number of Autosexual Activities per Day (Above) and in Mean Number of Female-Initiated Heterosexual Activities per Day (Below).

The three contraceptive groups are plotted separately. Points on the graph are calculated from three-day running means to reduce variability of the curves. Number of cases per cycle day for autosexual data are 56, 67 and 42 for pill, intrusive nonpill and non-intrusive nonpill groups respectively, except for forward counting days seven to 10, as explained in Figure 1. Number of cases per cycle day for heterosexual data are slightly less owing to occasional absence of the partner, in which case no heterosexual behavior could occur.

Table 1. Results of Analyses of Variance Data for Data in Table 2.

Source	Heterosexual Activity											
	All Female Initiation			Female (Only) Initiation			Mutual Initiation			Male (Only) Initiation		
	*MS**	*F*	*P*	*MS*	*F*	*P*	*MS*	*F*	*P*	*MS*	*F*	*P*
Contraceptive type (2)†	0.268	5.06	<0.025	0.035	1.69	NS‡	0.076	3.62	<0.05	0.146	2.92	NS
Subject within type (32)	0.053			0.021			0.021			0.050		
Cycle segment (1)	0	0	NS	0	0	NS	0.011	1.00	NS	0.035	2.69	NS
Contraceptive × segment (2)	0.064	4.38	<0.05	0.018	3.21	NS	0.024	2.18	NS	0.123	9.46	<0.01
Segment × subject within type (32)	0.015			0.006			0.011			0.013		

	Autosexual Activity								
	All Autosexual			Masturbation			Fantasy, Other		
	MS	*F*	*P*	*MS*	*F*	*P*	*MS*	*F*	*P*
Contraceptive type (2)	0.041	0.92	NS	0	0	NS	0.038	1.29	NS
Subject within type (32)	0.044			0.007			0.028		
Cycle segment (1)	0.048	6.21	<0.025	0.002	2.65	NS	0.070	7.78	<0.01
Contraceptive × segment (2)	0.029	3.79	<0.05	0.003	4.10	<0.05	0.013	1.44	NS
Segment × subject within type (32)	0.008			0.0008			0.009		

*Mean square. †Degrees of freedom. ‡Not significant.

significantly higher for nonpill subjects in the ovulatory than in the nonovulatory portion of the menstrual cycle. Autosexual frequency was 0.278 and 0.156 for intrusive and non-intrusive nonpill subjects in the ovulatory portion, as compared to 0.147 and 0.123, respectively, for the nonovulatory portion of the cycle. There was no comparable difference for pill subjects. The interaction between contraceptive type and segment of cycle was significant ($F = 3.79$, with 2,32 degrees of freedom, $P<0.05$). Female-initiated heterosexual frequency was 0.332 and 0.428 for intrusive and non-intrusive nonpill subjects in the ovulatory portion, compared to 0.265 and 0.321 respectively for the nonovulatory portion of the cycle. Among pill subjects there was an opposite effect, with female-initiated heterosexual frequency being lower during the ovulatory portion of the cycle. The interaction between contraceptive group and cycle segment was significant ($F = 4.38$, with 2,32 degrees of freedom, $P<0.05$).

We have further subdivided the data in Table 2 to show relative contributions of major components of female sexual activity. Female-initiated heterosexual activity has been separated into sessions initiated only by the female and those initiated mutually — i.e., by both female and male. Both these components contributed equally to the overall female-initiation effect; however, as shown in Table 1, the interaction of contraceptive by cycle segment for each component was not statistically significant. Autosexual activity has also been separated into two components: masturbation (i.e., consummatory activity) and other autosexual behavior (i.e., fantasy-like activity). In this case, the two components made different contributions to the overall effect. Fantasy-like activity was significantly increased during the ovulatory portion of the cycle for all groups, although the increase was greater for nonpill than for pill subjects. Masturbation increased during the ovulatory segment for intrusive, nonpill subjects but decreased during ovulation for other subjects. When the components were considered separately, only the cycle-segment effect for the fantasy measure and the interaction of contraceptive and cycle segment for masturbation were significant. When they were combined there was a significant interaction of cycle time with contraceptive, as described above.

Sessions of heterosexual activity initiated solely by the male have been presented in Tables 1 and 2 for comparison purposes. These sessions were more fre-

Table 2. Number of Sexual Activities per Day in 12 Intrusive Nonpill, 11 Non-intrusive Nonpill and 12 Pill Subjects.*

Type of Activity	Intrusive Nonpill		Non-Intrusive Nonpill		Pill	
	Reverse Cycle Days 13–15	Other Days	Reverse Cycle Days 13–15	Other Days	Reverse Cycle Days 13–15	Other Days
Heterosexual						
All female initiation	0.332 (0.222)	0.265 (0.138)	0.428 (0.196)	0.321 (0.147)	0.184 (0.181)	0.266 (0.173)
Female (only)	0.197 (0.179)	0.145 (0.100)	0.161 (0.152)	0.134 (0.110)	0.075 (0.116)	0.115 (0.084)
Mutual	0.135 (0.109)	0.120 (0.060)	0.267 (0.194)	0.187 (0.114)	0.109 (0.110)	0.151 (0.104)
Male (only) initiation	0.101 (0.093)	0.217 (0.148)	0.349 (0.245)	0.202 (0.095)	0.368 (0.242)	0.255 (0.130)
Autosexual						
All autosexual	0.278 (0.238)	0.147 (0.120)	0.156 (0.187)	0.123 (0.129)	0.137 (0.145)	0.144 (0.112)
Masturbation	0.049 (0.065)	0.033 (0.041)	0.030 (0.066)	0.048 (0.069)	0.023 (0.034)	0.055 (0.060)
Fantasy, other	0.228 (0.232)	0.114 (0.089)	0.126 (0.135)	0.075 (0.080)	0.115 (0.103)	0.089 (0.071)

*Values without parentheses represent means of subject means for no. of sexual activities/day, & values within parentheses SD of subject means.

quent on reverse-cycle days 13 to 15 for pill and for non-intrusive nonpill subjects, and were less frequent on those days for intrusive pill subjects than on other days of the menstrual cycle. The interaction between cycle segment and contraceptive group was significant ($F = 9.46$, with 2,32 degrees of freedom, $P<0.01$).

Other significant differences, shown in Table 1 may be considered secondary to the interaction effects described above. Thus, for example, the significantly higher rate of autosexual behavior during the ovulatory period (main effect of cycle segment) was due exclusively to nonpill subjects, as reflected in the significant interaction term for these data. The significant differences between contraceptive groups for mutually initiated and all female-initiated heterosexual activity may be considered statistical artifacts because the ovulatory days (which account for most of the difference between groups) are weighted more heavily by the statistical procedure than by their actual contribution to the overall data.

Discussion

The presence of an ovulatory peak in both female-initiated autosexual and heterosexual activity among nonpill subjects and its absence among pill subjects suggests that the effect may be mediated by fluctuations in hormone levels associated with ovulation. In nonhuman primates, ovulation-associated female sexual initiation appears to result from an increase in production of androgenic or estrogenic hormones (or both).[30,31] In women the midcycle peak in sexual initiation is probably related to estrogens, since these hormones peak strongly at midcycle,[3,32] and since both the midcycle peak and the overall levels of estrogens are greatly reduced by oral contraceptives.[3,4] Androgens, on the other hand, peak only slightly at midcycle in women,[33,34] and overall levels of these hormones are not decreased by oral contraceptives.[4,35] The progesterone in oral contraceptives might also play a part in suppressing a midcycle peak, since they are known to suppress sexual activity in nonhuman mammals,[36] and have been suggested to suppress sexual activity in women.[37]

It is difficult to attribute the ovulatory peaks to the subjects' attempts to fulfill the expectations of the experimenters. In the first place, participants were not informed of the experimenters' hypotheses. Further checks on this point were made during the interviews before and after study when participants indicated whether they noticed cycle fluctuations in their sexual activity. During the screening interviews, only two of the 23 nonpill subjects had noticed an increase in sexual interest around the time of ovulation. After completing the study, six of the nonpill subjects had noticed such an increase, but there was no correlation between those who claimed to have noticed an ovulatory rise in sexual behavior and those whose sexual behavior, in fact, exhibited such a rise. Secondly, the large variability in cycle length within each subject would have made it difficult for subjects to anticipate time of ovulation.

An alternative explanation of the data could be hypothesized on the basis of the sharp peak in reports of mittelschmerz by many nonpill subjects on reverse-cycle days 13 to 15 (Fig. 1). Since mittelschmerz was rarely reported by pill subjects, it is possible that mittelschmerz played a part in mediating the increase in female-initiated sexual activity by nonpill subjects. This hypothesis is weakened, however, by the increased ovulatory sexual activity among several nonpill subjects who did not report mittelschmerz.

The drop in female-initiated heterosexual activity on reverse-cycle days 13 to 15 for pill subjects was a wholly unexpected finding. It was evident in both exclusively female and mutual initiation of heterosexual activity. There were also decreased rates of masturbation by pill subjects at this time. No explanation is presently available for these effects.

The data on male-initiated sessions are also difficult to interpret. The drop in male initiation by intrusive nonpill subjects that occurs at ovulation may be related to the amount of contraceptive preparation needed in this group. The male whose partner uses a diaphragm or foam may refrain from initiating because he fears that his partner may become pregnant if she does not prepare, especially around midcycle, when there is a high probability of conception. Non-intrusive nonpill subjects, on the other hand, show a substantial rise in male initiation at ovulation. It is tempting to interpret this rise in terms of hormone-dependent pheromone secretion.[38] However, such an explanation seems unlikely because pill subjects, for whom hormone levels do not cycle, show a similarly high rate of male initiation at this time.

The data in Table 2 may help explain the apparent contradictions in the previous literature concerning an ovulatory peak in female sexual activity. Most previous studies that have examined cycle fluctuations in sexuality have used coital-frequency measures from intrusive nonpill women. As may be seen from Table 2, a sum of female-initiated, mutually initiated and male-initiated heterosexual activity of intrusive nonpill subjects does not show a midcycle peak, because a fall in male-initiated heterosexual activity cancels the effect of a rise in female initiation. On the other hand, prior investigations that have assessed sexual desire from intrusive nonpill women using measures of female-initiated behavior — for example, the work of Benedek and Rubenstein on dreams[17] and Stopes'[8] work with women whose husbands were absent — have found ovulatory increases. These studies, together with our own, suggest that one can obtain consistent ovulatory effects by concentrating on measures of sexual activity that are determined by the female — i.e., autosexual activity and female-initiated heterosexual activity. As such, they clearly imply a re-evaluation of the methods used to measure human sexuality in future research.

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