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Blood pressure reactivity to stress is better for people who recently had penile–vaginal intercourse than for people who had other or no sexual activity

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Abstract

Penile–vaginal intercourse (PVI) but not other sexual behavior is associated with better psychological and physiological function. I examined the relationship of sexual behavior patterns to blood pressure (BP) and its reactivity to stress (public speaking and verbal arithmetic). For a fortnight, 24 women and 22 men used daily diaries to record PVI, masturbation, and partnered sexual behavior in the absence of PVI. Persons who reported PVI (but no other sexual activities) had better stress response (less reactivity and/or lower baseline levels) than persons reporting other or no sexual behaviors. Persons who only masturbated or had partnered sex without PVI had 14 mmHg more systolic BP reactivity than those who had PVI but not the other behaviors. Many variables were examined but failed to confound the observed relationships. The magnitude of the sexual behavior effect on BP reactivity is greater than of other factors in the literature. These findings add to the research corpus on the benefits of PVI (differentiated from other sexual activities).

Keywords: Blood pressure; Stress; Sexual behavior; Trials

1. Introduction

Blood pressure reactivity to stress can predict the development of higher resting blood pressure levels (Matthews et al., 2003) and left ventricular hypertrophy as well as (in patients with cardiovascular disease) risk of myocardial infarction (Treiber et al., 2003).

Greater rates of sexual intercourse have been associated longitudinally with lower risk of mortality (Davey Smith et al., 1997). The present study considers one mechanism (blood pressure stress reactivity) by which sexual activity might affect cardiovascular risk, and differentiates between sexual behaviors.

There are several theoretical reasons why specifically penile–vaginal intercourse frequency would be expected to be associated with better physical and psychological health. First, if psychosexual development goes awry, the resulting ''pre-genital'' sexual behavior (inhibition of frequency or quality of intercourse in favor of noncoital activities) might be associated with both less psychological maturity and the psychophysiological effects thereof (Freud, 1953). Freud conjectured that noncoital sexual activity is ''incomplete'', and hence its tension ''disburdening'' function is inadequate (p. 124). A lessened ability to discharge tension might manifest itself in many ways, including heightened stress reactivity. Second, there is the evolutionary preeminence of the lone potentially reproductive sexual endeavor. Selection advantages might be conferred on intercourse, including perhaps enhanced health and emotional function. Third, intercourse is more of a synchronized sensorimotor and emotional interaction than other sexual behaviors, which might lead to avoidance of intercourse by persons who prefer less emotionally intimate sexual interactions (Brody, 2003). Fourth, intercourse requires more complex brain activity than other sexual behavior. Lesions of the male primate medial preoptic area severely reduce intercourse frequency but do not alter masturbation or social interaction (Slimp

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et al., 1978). Fifth, there are afferent neuronal and psychoneuroendocrine differences between intercourse and other sexual behaviors. Manual or oral manipulation of the clitoris stimulates the pudendal nerve, but the vaginocervical stimulation provided by intercourse additionally stimulates the pelvic, hypogastric, and vagal nerves (Komisaruk and Whipple, 1998; Peters et al., 1987; Whipple and Komisaruk, 2002). It is the pelvic nerve that appears essential for some of the behavioral actions of oxytocin (Komisaruk and Whipple, 1998). Both oxytocin and improved vagal tone might be among the mechanisms involved in intercourse but not other sexual behaviors being associated with better psychophysiological function (Brody and Preut, 2003; Brody et al., 2000).

Frequency of penile–vaginal intercourse but not of other sexual behaviors is associated with indices of better emotional awareness (less alexithymia; Brody, 2003) and better cardiovascular autonomic tone (greater resting heart rate variability and lesser resting blood pressure; Brody and Preut, 2003; Brody et al., 2000).

Those empirical studies correlated sexual behavior frequency with psychological and physiological variables. The present study uses a different approach, by comparing the blood pressure responses of persons who engaged at all in penile–vaginal intercourse but not other sexual behavior (in one analysis, masturbation, in the other analysis partnered sexual behavior in the absence of penile–vaginal intercourse) with those of persons who engaged in other combinations of sexual behaviors (including none) during a 2-week recording period. This approach has the advantage of allowing comparisons of various qualitative patterns of recent sexual behavior, with an emphasis placed on engaging and not engaging in the behaviors, rather than assuming linear or independent effects of the behaviors.

2. Methods

2.1. Participants

Participants were recruited from advertisements posted at universities, shops and sports centers for a randomized trial of high-dose ascorbic acid on stress reactivity (Brody et al., 2002). Because the ascorbic acid group demonstrated both decreased stress reactivity (Brody et al., 2002) and increased frequency (Brody, 2002b) of penile–vaginal intercourse (but not other sexual behavior), only subjects from the placebo arm are examined in the present analyses. Because of their risk of misreporting "sensitive" behaviors, the eight subjects scoring above the 87th percentile on the Lie Scale of the Eysenck Personality Questionnaire were excluded (Eysenck and Eysenck, 1975). Six additional subjects were excluded for other reasons, including noncompliance and knowing one of the stressor administrators (Brody et al., 2002). Data from 24 women and 22 men (age mean 24.5, range 19–37) were analyzed. Subjects were White Europeans and had at least a high school education. They received a medical examination and were judged to be in good health (among the exclusion criteria was a body mass index > 32). Subjects provided informed consent, and were made aware of data confidentiality, anonymous data coding, and their ability to discontinue participation in the study at any time. The study was approved by the State Medical Ethics Committee.

2.2. Materials and procedure

2.2.1. Sexual behavior

For the 14 days before the stressor, subjects completed a daily diary in which they recorded whether that day they engaged in: (1) penile–vaginal intercourse (henceforth "intercourse"), (2) masturbation, or (3) partnered sexual behavior in the absence of penile–vaginal intercourse (subjects were told to include oral sex, anal sex, and partner masturbation in this category). For each of the two analyses, subjects were allocated to one of four groups based on their sexual behavior.

For the intercourse/masturbation analysis, the groups are: (a) one or more masturbation days but no intercourse days ($N = 17$), (b) no days of either masturbation or intercourse ($N = 10$), (c) at least 1 day each of masturbation and intercourse ($N = 11$), and (d) one or more intercourse days but no masturbation days ($N = 8$). For the intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse analysis, the groups are: (a) one or more days of partnered sexual behavior in the absence of penile–vaginal intercourse, but no intercourse days ($N = 11$), (b) no days of partnered sexual behavior in the absence of penile–vaginal intercourse and no days of intercourse ($N = 16$), (c) at least 1 day of partnered sexual behavior in the absence of penile–vaginal intercourse plus at least 1 day of intercourse ($N = 12$), and (d) one or more intercourse days but no days of partnered sexual behavior in the absence of penile–vaginal intercourse ($N = 7$).

2.2.2. Stressor

At least 20 min after arriving at the laboratory, subjects underwent the Trier Social Stress Test (Kirschbaum et al., 1993). The test consists of being informed (following the *Baseline* blood pressure measurement) that the task is to give a speech to an unknown panel on suitability for a job in the subjects' field of interest, followed by verbal arithmetic. After solitary preparation for ten minutes, the *Preparation* measurement is taken, and the subject enters the test room and begins the speech to an unsupportive panel. After 5 min, the subject is instructed to perform serial subtractions aloud for 5 min. Immediately afterwards, the *Stress* measurement is taken, and the subject leaves to a waiting area, where ten minutes later the *Recovery* measurement is taken.

2.2.3. Physiological recording

Systolic (SBP) and diastolic blood pressure (DBP) were measured oscillometrically with an automatic self-inflating

sphygmomanometer (Boso Medicus PC, Bosch + Sohn, Jungingen, Germany). The cuff was placed on the upper left arm, and the device was activated by the experimenter at the prescribed times (measurements were stored in the device's memory). An earlier version of this device had 4-year intraclass reliabilities of .87 for systolic, and .80 for diastolic blood pressure (Brody et al., 1999).

2.3. Design

Two repeated measures multiple analyses of covariance (MANOVA) models were used, with the within-subjects variable Time, the between-subjects variables biological sex and one of the two sexual behavior group variables, and the covariate age (on an a priori basis). The dependent variables were SBP and DBP. The *p*-values are Greenhouse–Geisser corrected for lack of sphericity. Greenhouse–Geisser corrected degrees of freedom are presented.

3. Results

3.1. Penile–vaginal intercourse versus masturbation

MANOVA revealed multivariate within-subjects effects on blood pressure of time interacting with intercourse/masturbation group ($F(18, 91) = 1.8$, $p < .05$, $\eta^2 = .25$, Wilks' $\lambda = .43$), and a main effect of time ($F(6, 32) = 3.8$, $p < .01$, $\eta^2 = .41$, Wilks' $\lambda = .58$); as well as between subjects effects for intercourse/masturbation group ($F(6, 72) = 2.4$, $p < .05$, $\eta^2 = .17$, Wilks' $\lambda = .69$), biological sex ($F(2, 36) = 16.4$, $p < .001$, $\eta^2 = .48$, Wilks' $\lambda = .52$), and age ($F(2, 36) = 6.7$, $p < .005$, $\eta^2 = .27$, Wilks' $\lambda = .73$). Male biological sex and older age were both associated with more blood pressure reactivity.

Examination of SBP and DBP separately indicated that within subjects, the interaction of Time with intercourse/masturbation group was not significant for overall SBP responses, but was for DBP responses ($F(8, 100) = 2.4$, $p < .05$). However, there was a main between-subjects effect of intercourse/masturbation group on both SBP ($F(3, 37) = 3.4$, $p < .05$) and DBP ($F(3, 37) = 4.5$, $p < .01$). The Greenhouse–Geisser epsilon was .89 for SBP, and .91 for DBP.

Fig. 1 and Table 1 depict the baseline, preparation, stress, and recovery means and standard errors of SBP and DBP. People who engaged in penile–vaginal intercourse but not masturbation had lower SBP and DBP than persons in the other groups across the four times with some reactivity and recovery differences as well.

3.2. Penile–vaginal intercourse versus partnered sexual behavior in the absence of penile–vaginal intercourse

MANOVA revealed within-subjects effects of time interacting with intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse group ($F(18, 91) = 2.0$, $p < .05$, $\eta^2 = .27$, Wilks' $\lambda = .39$); as well as a main effect of time ($F(6, 32) = 3.7$, $p < .01$, $\eta^2 = .41$, Wilks' $\lambda = .59$). Between subjects, there were blood pressure effects for intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse group ($F(6, 72) = 2.2$, $p < .05$, $\eta^2 = .15$, Wilks' $\lambda = .72$), biological sex ($F(2, 36) = 23.1$, $p < .001$, $\eta^2 = .56$, Wilks' $\lambda = .44$), and age ($F(2, 36) = 8.5$, $p < .001$, $\eta^2 = .32$, Wilks' $\lambda = .68$). Male biological sex and older age were both associated with more blood pressure reactivity.

Examination of SBP and DBP responses separately indicated that within subjects, the interaction of Time with intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse group was significant for SBP ($F(8, 101) = 2.8$, $p < .01$), but only marginally for DBP ($F(9, 108) = 1.9$, $.10 > p > .05$). There were no significant between-subjects effects for intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse group membership. The Greenhouse–Geisser epsilon was .92 for SBP, and .97 for DBP.

People who engaged in intercourse but not partnered sexual behavior in the absence of penile–vaginal intercourse had less SBP reactivity (and faster recovery) than persons in the other groups.

3.3. Additional analyses

As detailed in Table 2, separate ANOVA models indicated that the sexual behavior groups did not differ with regard to a range of psychological, social, behavioral, and physiological variables (that some readers might conjecture to confound the observed relationship between blood pressure reactivity and sexual behavior). The groups did differ by biological sex ratio (for the intercourse/masturbation analysis: $F(3, 42) = 3.1$, $p < .05$; for the intercourse/partnered sexual behavior in the absence of penile–vaginal intercourse analysis the difference was not quite significant: $F(3, 42) = 2.4$, $.10 > p > .05$). In both analyses, the groups also differed by the proportion in an ongoing partnership: both $F(3, 42) = 3.0$–3.2, $p < .05$ (post hoc tests revealed this was due to the no intercourse/no masturbation group and the no intercourse/no partnered sexual behavior in the absence of penile–vaginal intercourse group having a lower proportion of persons in such a partnership than the groups who did have intercourse). Follow-up analyses indicated that: (1) in univariate analyses, having such a partnership was not significantly associated with blood pressure reactivity; (2) in MANOVA models, partnership status was not significant (so the partnership variable was not retained). Most participants in each subgroup were students or graduate students, and the groups did not differ with regard to the remaining occupations (which were primarily teachers, manual labor, and unemployed).

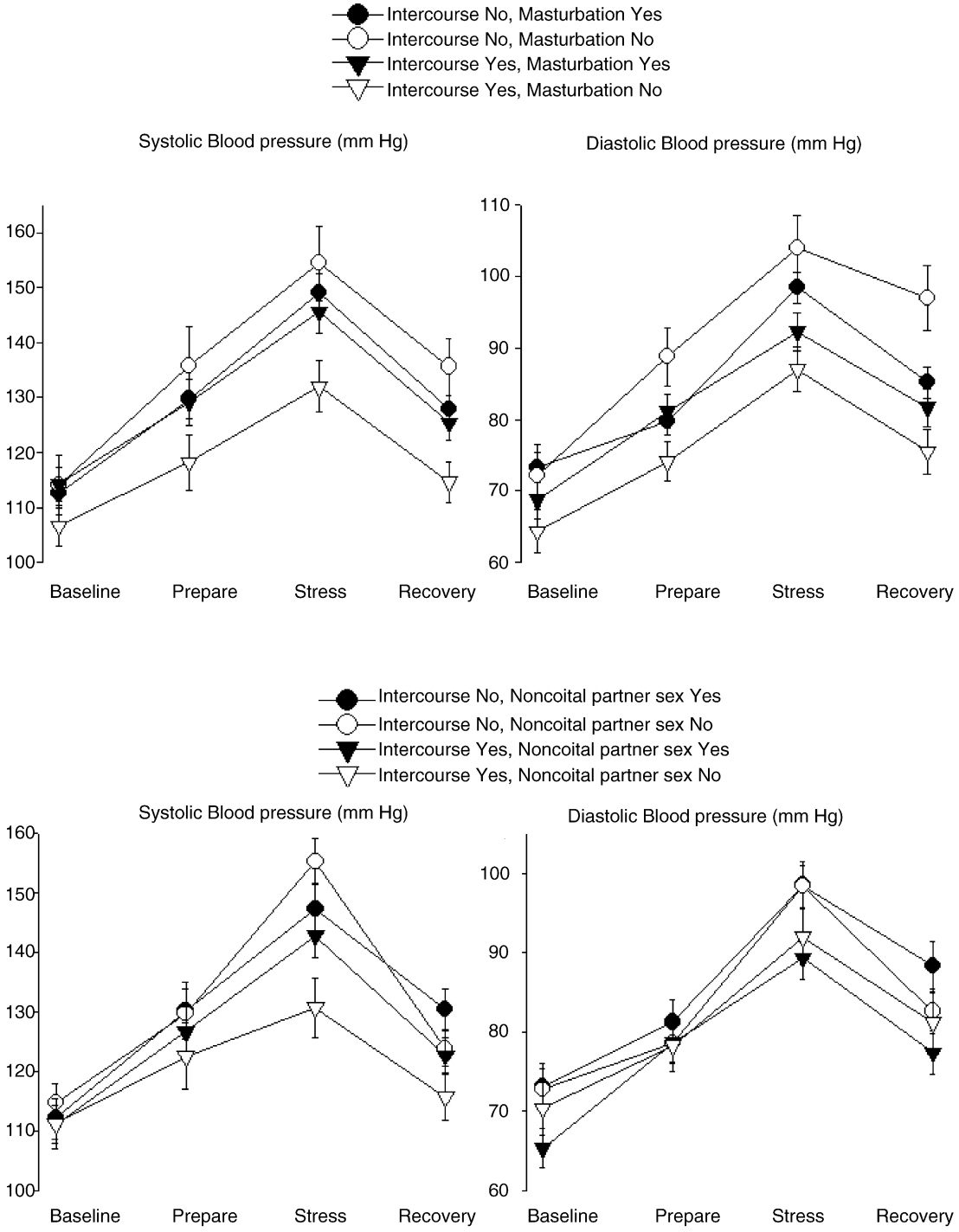

Fig. 1. Means and standard error bars for stress responses of systolic and diastolic blood pressure as a function of combinations of intercourse and (above) masturbation or (below) "noncoital partner sex" (partnered sexual behavior in the absence of penile–vaginal intercourse).

As one exploratory analysis, the relationship between SBP reactivity and number of days (frequency) of intercourse, masturbation and partnered sexual behavior in the absence of penile–vaginal intercourse was examined with a partial correlation procedure controlling for age and biological sex. Within the limits of the 14-day recording period, neither intercourse nor partnered sexual behavior in the absence of penile–vaginal intercourse were significantly associated with reactivity, but masturbation frequency was associated with more reactivity ($r = .35$, $p < .05$).

As a second exploratory analysis, the relationship between SBP reactivity and days since last intercourse was examined with a partial correlation procedure controlling for age and biological sex. When a value of 31 days was assigned to persons reporting no intercourse in the 14 day period, days since intercourse correlated ($r = .31$, $p < .05$)

Table 1
Blood pressure responses to stress as a function of recent sexual behaviors[a]

Measure	Time	Sexual behavior	Mean	S.E.	Sexual behavior	Mean	S.E.
SBP	Baseline	Intercourse: no, masturbation: yes	112.6	2.6	Intercourse: no, noncoital partner sex: yes	112.2	3.6
	Prepare		129.7	3.5		130.3	4.9
	Stress		149.2	3.3		147.2	4.3
	Recover		127.8	2.5		130.5	3.5
	Baseline	Intercourse: no, masturbation: no	114.1	5.4	Intercourse: no, noncoital partner sex: no	114.8	3.1
	Prepare		135.7	7.2		129.7	4.3
	Stress		154.5	6.8		155.3	3.8
	Recover		135.6	5.2		123.9	3.1
	Baseline	Intercourse: yes, masturbation: yes	114.2	3.1	Intercourse: yes, noncoital partner sex: yes	111.2	3.1
	Prepare		129.2	4.2		126.8	4.2
	Stress		145.6	3.9		142.8	3.8
	Recover		125.3	3.0		122.7	3.1
	Baseline	Intercourse: yes, masturbation: no	106.7	3.7	Intercourse: yes, noncoital partner sex: no	111.3	4.1
	Prepare		118.2	5.0		122.6	5.6
	Stress		132.0	4.7		130.8	5.0
	Recover		114.6	3.6		115.8	4.1
DBP	Baseline	Intercourse: no, masturbation: yes	73.3	2.1	Intercourse: no, noncoital partner sex: yes	73.1	2.9
	Prepare		79.7	1.9		81.3	2.8
	Stress		98.4	2.2		98.5	3.1
	Recover		85.2	2.2		88.3	3.2
	Baseline	Intercourse: no, masturbation: no	72.2	4.4	Intercourse: no, noncoital partner sex: no	72.8	2.5
	Prepare		88.8	4.0		78.6	2.5
	Stress		104.0	4.5		98.3	2.7
	Recover		96.9	4.5		82.6	2.8
	Baseline	Intercourse: yes, masturbation: yes	68.7	2.6	Intercourse: yes, noncoital partner sex: yes	65.3	2.5
	Prepare		81.2	2.3		78.7	2.5
	Stress		92.3	2.6		89.3	2.7
	Recover		81.7	2.6		77.4	2.8
	Baseline	Intercourse: Yes, masturbation: no	64.4	3.1	Intercourse: yes, noncoital partner sex: no	70.4	3.3
	Prepare		74.1	2.8		78.3	3.3
	Stress		87.0	3.2		92.0	3.5
	Recover		75.5	3.2		81.1	3.7

[a] SBP = systolic blood pressure, DBP = diastolic blood pressure, noncoital partner sex = partnered sexual behavior in the absence of penile–vaginal intercourse the same day.

with reactivity. When the zero value subjects were deleted, the correlation was not significant. As implied by those results, visual inspection of the plot of days since last intercourse versus reactivity suggested that much of the effect was due to subjects with a zero value.

4. Discussion

People who had intercourse but did not masturbate or even have partnered sexual behavior in the absence of penile–vaginal intercourse in the two-week period had blood pressure values that were lower than persons who did not engage in any sexual activity, as well as those who only masturbated or only had partnered sexual behavior in the absence of penile–vaginal intercourse. The intercourse-only group also had lower blood pressure values than subjects who had intercourse but also had one or more days of masturbation and/or partnered sexual behavior in the absence of penile–vaginal intercourse. This pattern of results has several implications. First, there are important differences between intercourse and other sexual behaviors, with only intercourse being associated with indices of better physical and mental health (Brody, 1997, 2002b, 2003). Second, differences are not simply due to some social effect (sexual activity with another person versus in the absence of another person), because the blood pressure reactivity difference between intercourse and masturbation was comparable to the difference between intercourse and partnered sexual behavior in the absence of penile–vaginal intercourse. Third, engaging in masturbation or even partnered sexual behavior in the absence of penile–vaginal intercourse on some days might detract from the benefits of intercourse.

As noted in Section 1, mechanisms connecting specifically penile–vaginal intercourse to better physical and psychological health include: the benefits of relatively successful psychosexual development, and the activation and adequate function of the central and peripheral neuronal pathways involved in intercourse (as compared to those involved in other sexual behaviors). Another possible mechanism might involve oxytocin. Oxytocin (a hormone which appears to be involved in pair-bonding, among other roles) has been shown to reduce physiological indices of

Table 2
Characteristics of different sexual behavior groups[a,b]

	Age	Female proportion	Ongoing partnership proportion	Spielberger trait anxiety score	Eysenck extraversion score	Eysenck neuroticism score	TICS work overload score[c]	Smoker proportion	Body mass index (kg/m^2)	Waist to hip ratio	Diary exercise minutes (14 days)	Partnership satisfaction score[d]	Diary alcohol units (14 days)
Intercourse vs. noncoital partner sex													
Intercourse: no, noncoital partner sex: yes ($N = 11$)													
Mean	23.9	.27	.64	39.1	13.5	10.5	20.5	.45	24.6	.81	358.2	2.6	28.3
S.D.	2.0	.47	.50	7.0	3.3	4.9	6.3	.52	3.6	.06	372.6	.79	29.7
Intercourse: no, noncoital partner sex: no ($N = 16$)													
Mean	25.5	.75	.38	37.1	12.8	9.4	21.3	.50	22.1	.78	405.3	2.2	15.4
S.D.	5.4	.45	.50	8.2	5.3	4.1	5.0	.52	2.7	.07	358.9	1.2	12.3
Intercourse: yes, noncoital partner sex: yes ($N = 12$)													
Mean	25.3	.42	.83	33.9	13.6	7.4	18.6	.25	22.6	.82	370.8	2.4	19.7
S.D.	4.5	.51	.39	5.5	3.1	4.6	7.4	.45	2.8	.04	358.6	.70	14.5
Intercourse: yes, noncoital partner sex: no ($N = 7$)													
Mean	22.0	.57	.86	37.0	13.7	7.7	23.3	.43	22.3	.81	153.6	2.7	13.4
S.D.	2.9	.53	.38	5.7	2.9	5.0	8.8	.53	1.7	.08	164.8	.52	9.4
Intercourse vs. masturbation													
Intercourse: no, masturbation: yes ($N = 17$)													
Mean	24.2	.35	.59	38.0	13.2	9.5	19.8	.47	24.3	.80	337.9	2.5	23.5
S.D.	3.7	.49	.51	7.7	4.3	4.0	5.4	.51	3.4	.08	322.7	.71	24.1
Intercourse: no, masturbation: no ($N = 10$)													
Mean	25.9	.90	.30	37.8	12.9	10.5	22.9	.50	21.2	.79	468.0	2.0	14.8
S.D.	5.4	.32	.48	8.0	5.3	5.1	5.2	.53	2.0	.06	416.6	1.7	13.9
Intercourse: yes, masturbation: yes ($N = 11$)													
Mean	22.9	.55	.82	35.4	13.9	8.6	20.5	.27	22.5	.80	387.3	2.3	19.0
S.D.	3.0	.52	.40	6.6	3.3	5.3	8.4	.47	2.7	.06	334.5	.71	15.0
Intercourse: yes, masturbation: no ($N = 8$)													
Mean	25.6	.38	.88	34.5	13.3	6.0	20.0	.50	22.6	.84	158.1	2.7	15.1
S.D.	5.3	.52	.35	4.2	2.7	3.3	8.2	.53	2.1	.05	246.3	.50	9.9

[a] All comparisons are nonsignificant except proportion of females/biological sex ratio (as described in the text).
[b] Noncoital partner sex = partnered sexual behavior in the absence of penile–vaginal intercourse the same day.
[c] Schulz and Schlotz (1999).
[d] Brody (2002b).

stress (Heinrichs et al., 2003), and it is also released during sexual activity, particularly at orgasm. It might be that in addition to physiological triggers, the greater (and unique) intimacy afforded by intercourse (compared to other sexual activities) leads to greater or more effective oxytocin activity. For women, intercourse (but not clitorally focused masturbation or cunnilingus) stimulates the pelvic nerve, which appears essential for some of the behavioral actions of oxytocin (Komisaruk and Whipple, 1998). Future research might compare the orgasmic oxytocin response triggered by intercourse to the oxytocin response triggered by other sexual activities. Another possible mechanism linking intercourse to better function involves vagal nerve activity. Stimulation of the vagina and cervix (but apparently not the clitoris) stimulates the vagal nerve. A brain imaging study revealed that vaginocervical stimulation increases activity in the nucleus of the solitary tract, which is the brain region to which vagus nerve information is sent (Whipple and Komisaruk, 2002). Resting heart rate variability (which is associated with vagal activity) is greater among persons who have more frequent intercourse, but is not related to frequency of other sexual activities (Brody and Preut, 2003; Brody et al., 2000). Such greater vagal tone may serve to limit the degree of reactivity to at least mild to moderate stressors (Jiang et al., 1993; Lane et al., 1992).

Why would engaging in masturbation or even partnered sexual behavior in the absence of penile–vaginal intercourse on some days detract from the benefits of intercourse on other days? One possibility is that intercourse is approached in essentially the same spirit as the other sexual activities, leading to less psychological and physiological benefit from intercourse. It might be that there is a process of psychological and autonomic ‘‘tuning’’ (having a lingering effect) which is associated with certain patterns and pathways of sexual stimulation (as noted, one example of a difference in pathways is that the manual or oral manipulation of the clitoris characteristic of masturbation or female non-coital partnered sexual activity stimulates the pudendal nerve, but the vaginocervical stimulation provided by intercourse additionally stimulates the pelvic, hypogastric, and, most intriguingly, the vagal nerves (Komisaruk and Whipple, 1998; Peters et al., 1987; Whipple and Komisaruk, 2002)). This would be a specific variation on the general autonomic tuning process (Gellhorn, 1967). Another possibility is that intercourse is being avoided on some but not all occasions (by substituting other sexual activities), which might be due to a subtler psychosexual dysregulation than complete avoidance of intercourse. Choosing to engage in other sexual behaviors might indicate some limitation in the capacity to fully appreciate intercourse.

The magnitude of difference between blood pressure responses of persons engaging in different sexual behaviors is not only of impressive absolute magnitude, but also relative to other risk factors for blood pressure reactivity. Although it is challenging to compare results across studies, the magnitude of the SBP reactivity effect is numerically greater than those associated with parental history of hypertension (Clark, 2003), education (Merritt et al., 2004), effortful coping with psychosocial demands (Merritt et al., 2004), short-term suppression of ovarian hormones (Matthews et al., 1998), alexithymia (Linden et al., 1996), cynical hostility (Finney et al., 2002), marital distress (Carels et al., 1998), depression (Light et al., 1998), smoking (Straneva et al., 2000), race (Mills and Berry, 1999), or exercise training (King et al., 2002), and far greater than those of beta-blocker or ACE inhibitor antihypertensive medications (Allen et al., 2001; Mills and Dimsdale, 1991).

Although the groups differed with regard to the proportion in an ongoing partnership, partnership status did not confound the observed association of sexual behavior with blood pressure reactivity (partnership status was not significant in exploratory MANOVA models). The group difference in sex ratio along with an effect of biological sex on reactivity supports the inclusion of biological sex in the models, and both the main results and those from the exploratory partial correlation procedures support the use of the group categories. The present study used a qualitative, categorical approach (within a relatively brief time period) to examine patterns of different sexual behaviors. As noted above, other studies obtained an association of better psychological or physiological function with frequency of intercourse but not frequency of other sexual behaviors.

Men had more blood pressure reactivity than women, which was also noted in some other studies (Rose et al., 2004; Veit et al., 1997). As in any risk-factor study, there is always a possibility of unmeasured variables playing a role. However, the results were not confounded by any of the many psychological, interpersonal, vocational stress, or physiological candidate variables. The observed results could be due to some combination of having engaged in the sexual behaviors per se, as well as the characterological predispositions and aversions to the specific behaviors.

Limitations of the study include the relatively modest number of subjects and 14-day recording period. Future research might employ larger and more diverse (including older) samples, multiple dependent measures (including more specific measures of sympathetic and parasympathetic nervous system activity), more details regarding current and past intimate relationships, longer recording periods and varying frequency thresholds, and examine whether the sexual behavior resulted in orgasm. Another area to be investigated is whether condom use eliminates the blood pressure reactivity benefits of intercourse to the same extent that it eliminates the immune system enhancing (Peters et al., 2004) and mood elevating (Gallup et al., 2002) effects of intercourse.

In the present study, the stress modulating effects of different sexual behaviors are not the immediate stress reduction benefits produced by orgasm, but effects that endure for a considerable time. It appears that not having intercourse (and possibly tainting the benefits of intercourse

by engaging in sexual activity which does not include intercourse) might lead to increased stress. The stress mitigating feature of penile–vaginal intercourse is evident not only in the present study of blood pressure reactivity to stress, but also in the resting autonomic tone of people who have more frequent intercourse (Brody and Preut, 2003; Brody et al., 2000). In addition, there might be a critical period for beginning intercourse, as suggested by the finding that adult women who first had intercourse before age 17 had less severe cortisol reactivity to stress than did adult women who did not have intercourse by that age (Brody, 2002a).

In conclusion, intercourse but not other sexual behavior is associated with yet another index of better health, lower blood pressure during stress. The relationship between detailed aspects of sexual behavior and psychophysiological function (including stress reactivity) merits far more research attention. Research and advice on sexual behavior should be precise, and not dogmatically equate all sexual activities.

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