

Genital and Subjective Sexual Arousal in Postmenopausal Women: Influence of Laboratory-induced Hyperventilation

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The current study was aimed at comparing genital and subjective sexual arousal in pre- and postmenopausal women and exploring the effects of heightened sympathetic nervous system (SNS) activity on these parameters. Seventy-one women (25 young and premenopausal, 25 postmenopausal, and 21 age-matched premenopausal women) participated in two counterbalanced sessions consisting of genital arousal assessment with vaginal photoplethysmography and subjective arousal assessment with self-report questionnaires. SNS activity was enhanced using laboratory-induced hyperventilation. Results demonstrated no significant differences between pre- and postmenopausal women on genital and subjective measures of arousal in response to neutral and erotic films. SNS manipulation increased genital excitement only in young, premenopausal women. These data suggest that prior SNS enhancement can differentiate pre- from postmenopausal genital arousal. Data also revealed significant correlations between genital and subjective sexual arousal in older pre- and postmenopausal women, but not in young premenopausal women. These data are the first to directly compare genital-subjective correlations between pre- and postmenopausal women.

Research into the effects of menopause on sexuality has produced contradictory findings. For example, it has been reported that menopause both decreases sexual desire (Masters & Johnson, 1966) and subjective sexual

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arousal (Myers & Morokoff, 1986) and increases satisfaction with a sexual relationship (Hawton, Gath, & Day, 1994). Meta-analytic studies remain equivocal as to the effects of menopause on sexual activity (Myers, 1995). Moreover, age-related health problems, psychosocial stressors, and sexual dysfunction are strongly correlated in women (Laumann, Paik, & Rosen, 1999), and these health-related factors may exert more powerful effects than menopause per se on sexual functioning.

To date, there have been three published psychophysiological investigations of menopause, which have yielded conflicting findings. In the first study, a relatively small sample of young premenopausal, postmenopausal, and age-matched premenopausal women were compared (Morrell, Dixen, Carter, & Davidson, 1984). After exposure to an erotic visual stimulus, postmenopausal women displayed a significantly lower vaginal pulse amplitude (VPA) than women in both premenopausal groups, but subjective measures of arousal did not differ between the groups or correlate with VPA. Another study found that postmenopausal women receiving hormone replacement therapy did not differ in VPA to an age-matched control group (Myers & Morokoff, 1986). However, the groups differed in subjective sexual arousal, and a significant genital-subjective correlation was found. In an attempt to take a more complete inventory of climacteric symptoms associated with menopause, Laan and van Lunsen (1997) measured hormones and VPA in postmenopausal women and a small sample of younger premenopausal women (Laan & van Lunsen, 1997). Postmenopausal women had significantly lower VPA scores than premenopausal women at baseline, however, these differences disappeared after the women were exposed to an erotic stimulus. There also was a significant correlation between VPA and a woman's self-reported estimate of lubrication. No assessment was made of a potential correlation between VPA and subjective sexual arousal to the film stimulus.

A growing body of evidence reveals that increased sympathetic nervous system (SNS) activity in women may facilitate sexual arousal, which is in contrast to theories formulated from research in men. Hoon, Wincze, and Hoon (1977) were the first to demonstrate a facilitatory effect of heightened SNS activity on sexual arousal by observing that women who watched an anxiety-evoking film prior to an erotic film exhibited greater vaginal blood volume. Preexposure to an anxiety film, however, produced opposite effects on subjective sexual arousal (Palace & Gorzalka, 1990), presumably because of the women's negative cognitions in response to the film. Meston and Gorzalka (1995) demonstrated that intense, acute exercise, which facilitates SNS activity, increased VPA in response to an erotic film. These findings are corroborated in investigations that have employed medications that specifically enhance (Meston & Heiman, 1998) or inhibit (Meston, Gorzalka, & Wright, 1997) SNS activity. Although these studies provide strong evidence that moderate levels of SNS activity facilitate genital arousal in healthy young women, they have failed to demonstrate either a concurrent increase in subjective sexual arousal or a relationship between genital and subjective responses.

To date, the effects of heightened SNS activity on sexual arousal have been investigated exclusively in young, healthy, premenopausal women. Prior methodologies have precluded the participation of older women, in part because these procedures have greater risks in older women. The effects of heightened SNS activity in older postmenopausal women remain to be determined.

This study was designed to investigate the effects of menopause and heightened SNS activity through comparisons of genital and subjective responses in three groups of women: a young premenopausal group, an older postmenopausal group, and an age-matched premenopausal group. A new method of enhancing SNS activity, laboratory-induced hyperventilation (LIH), was investigated in this study. LIH involves rapid, deep breathing and is commonly used in treatment of anxiety disorders (Barlow & Craske, 1994). The physiological events that follow LIH include hypoventilation to restore CO₂ stores and a temporary state of hypoxemia that lasts approximately 7 min (Achenbach-Ng, Siao, Mavroudakos, Chiappa, & Kiers, 1994). These changes produce increased cardiac output and enhanced pulmonary, muscle, and sympathetic nerve activity (Olsen et al., 1998; St. Croix, Satoh, Morgan, Skatrud, & Dempsey, 1999) and are characterized by a marked predominance of SNS activity following LIH (George et al., 1989). This technique avoids the undesirable side effects of other modes of SNS stimulation. It may be suitable for older or nonphysically fit women and is completely safe (Barlow and Craske, 1994).

Studies employing psychophysiological and subjective techniques often find no synchrony between these indices of sexual arousal in sexually healthy young women (Geer, Morokoff, & Greenwood, 1974; Heiman, 1977; Laan, Everaerd, Van Bellen, & Hanewald, 1994; Laan & Everaerd, 1995; Meston & Gorzalka, 1995, 1996a; Palace & Gorzalka, 1990), women with arousal and orgasmic difficulty (Meston & Gorzalka, 1996b), and women with dyspareunia (Wouda et al., 1998). This issue of synchrony has been examined in only two studies of postmenopausal women. Whereas Myers and Morokoff (1986) found significant correlations between genital and subjective measures, Morell et al. (1984) did not. Given that people tend to develop more negative attitudes towards erotica as they age (Merritt, Gerstel, & LoSciuto, 1975), desynchrony between genital and subjective sexual arousal could be especially pronounced in older women. This study aims to examine the relationship between genital and subjective arousal patterns in pre- and postmenopausal women to determine if the degree of synchrony varies with age and menopausal status.

METHODS

Participants

A total of 71 women participated in this study. Twenty-five women were premenopausal and between the ages of 20 and 35; 21 women were pre-

menopausal and between the ages of 44 and 53; and 25 women were postmenopausal and between the ages of 46 and 64. At the time of testing, postmenopausal women were not receiving hormone replacement therapy. All women were sexually functional, which we determined on the basis of screening during a telephone interview and later confirmed by scores on the Derogatis Sexual Functioning Inventory (DSFI; Derogatis, 1978). We assessed exclusion criteria during an initial telephone screen and included: nonheterosexuality, current use of medications known to affect vascular or sexual functioning (for example, antihypertensives or antidepressants), diabetes, hypertension, and lack of sexual experience. Subjects were told during the telephone screen that the purpose of the study was to examine the effects of aging and menopause on sexual arousal.

Procedure

Each woman participated in two sessions; a repeated-measures design allowed each subject to serve as her own control. During session one, a female researcher oriented the subject to the laboratory equipment, obtained written consent, and provided a battery of questionnaires to be completed in a private room. Questionnaires included the DSFI (a standardized self-report multidimensional test designed to measure the current level of sexual functioning), the Beck Anxiety Inventory (Beck, 1993; to assess general levels of anxiety), the Golombok Rust Inventory of Sexual Satisfaction (Rust & Golombok, 1985; to assess relationship and sexual satisfaction), and the Sexual Inventory, unpublished (to assess the subject's perception of sexual arousal levels that would be attainable during the viewing of an erotic visual stimulus). Following completion of the questionnaires, each woman was seated comfortably in a reclining chair and asked to insert the vaginal probe with the aid of diagrammed instructions after the female researcher had left the room. The instrument was sterilized in a solution of Cydex-activated glutaraldehyde between uses. A TV monitor was placed on a high table so that subjects could comfortably recline on a couch with full view of the screen. They were provided with a light blanket and instructed to lie quietly for a 5-min adaptation period before the start of the video. Each film sequence included a 1-min display of the word "relax," followed by a 3-min neutral stimulus depicting a documentary of a geographical location (either glaciers or Stonehenge). Immediately following, a 3-min erotic stimulus, which had been shown in another study to elicit positive sexual feelings, was presented. It consisted of a nude heterosexual couple engaging in foreplay, mutual manual-genital and oral-genital stimulation, and intercourse.

Psychophysiological testing was identical in session two, apart from varied neutral and erotic film stimuli presentation, which we counterbalanced across groups. Subjects were also randomized to take part in LIH prior to watching the video segments in either the first or the second session. The procedure of LIH has been described elsewhere (Clark and Hemsley, 1982)

and consists of having subjects breathe along with a prerecorded tape of paced respiration at a rate of 30 breaths/min for 2 min. Subjects were instructed to breathe in as deeply as possible, through the mouth as well as the nose, and breathe out, completely exhaling, according to the recorded breathing. They were told to close their eyes during the LIH procedure in order to minimize feelings of light-headedness and confusion. Because prior reports suggested increased sensitivity to hyperventilation at the menstrual and premenstrual phases of the cycle (Damas-Mora, Davies, Taylor, & Jenner, 1980), all premenopausal women were assessed during the ovulation phase, which was determined by asking subjects their cycle length and usual ovulatory onset.

Immediately prior to and following the film, subjects completed a self-report questionnaire assessing autonomic arousal, perceptions of genital sexual arousal, subjective sexual arousal, anxiety, positive affect, and negative affect rated on a Likert scale (Heiman & Rowland, 1983). At the completion of session two, all subjects were debriefed and provided \$20 for their participation. All procedures were approved by the University of British Columbia Behavioural Research Ethics Board.

Psychophysiological Recording

VPA was monitored throughout the subjects' exposure to each film segment and recorded on a HP Vectra Celeron personal computer using the software program AcqKnowledge III, Version 3.5 (BIOPAC Systems, Santa Barbara, CA) and a model MP100WSW data acquisition unit (BIOPAC Systems) for analog/digital conversion. A sampling rate of 200 samples/s was used for VPA throughout the 180 s of neutral film exposure and 180 s of erotic film exposure. The signal was band-pass filtered (0.5–30 Hz.) Data were analyzed in 30-s segments, then averaged over the neutral and erotic segments separately, resulting in one data point for neutral and one data point for erotic segments per subject per session. Artifact detection following visual inspection of the data permitted the omission of the 30-s portion containing the artifact and was replaced by the average of the 30-s intervals immediately preceding and following.

Data Analyses

Analyses of variance (ANOVA) were used to investigate the effects of menopause, age, and heightened SNS activity—via LIH—on VPA and subjective ratings. Pearson product moment correlations were used to investigate the degree of association between genital and subjective ratings of arousal for each of the hyperventilation and no hyperventilation conditions, both across all women and between groups of women. Given that there is no absolute metric for VPA, change scores for VPA were calculated by dividing the average value during the erotic by the average value during the neutral stimulus,

then multiplying by 100 (Heiman, 1980). Difference scores for subjective measures were computed by subtracting neutral values from erotic values for each subjective measure. Multiple regression analyses were used to determine which, if any, demographic predictors were related to sexual arousal. In all conditions a p level of .05 was deemed significant.

RESULTS

Demographic Information

Average ages were 24.5 in the young premenopausal group, 47.8 in the older premenopausal group, and 56.0 in the postmenopausal group. Most women were Caucasian and had an average of 15.5 years of education. Postmenopausal women were an average of 9 years postmenopausal and ranged between 1 and 27 years. There were significantly more health problems in older premenopausal women compared to younger women, $F(2,8) = 4.922$, $p < .01$, and younger women were less likely to be currently employed than all older women, $F(2,69) = 10.517$, $p < .0001$. About 60% of younger premenopausal (15/25), 71% of older premenopausal (15/21), and 64% of postmenopausal (16/25) women were currently involved in a heterosexual relationship. Beck Anxiety Inventory scores were low in all groups and did not differ between the groups, $p > .05$. Mean psychopathology scores derived from the DSFI Brief Symptom Inventory subscale were low and did not differ between groups ($p > .05$). Although sexual frequency was significantly lower in older women compared to younger women, $F(2,68) = 5.364$, $p < .01$, and reports of vaginismus symptoms were higher in postmenopausal women compared to premenopausal women, $F(2,65) = 2.493$, $p < .05$, overall relationship and sexual satisfaction did not differ between the groups, $p > .05$. Notably, there was a significant difference in the highest level of sexual arousal that subjects believed that they could ever experience, given adequate stimulation, $F(2,69) = 4.243$, $p < .01$. Closer inspection of the data revealed that young premenopausal women reported that they believed they could attain higher levels of sexual arousal than all other women; however, reported levels of actual achieved sexual arousal did not differ between the groups, $F(2,69) = 1.13$, $p > .05$.

Effects of Erotic Film on Genital Sexual Arousal

There was a significant main effect of film on VPA, $F(1,65) = 66.21$, $p < .0001$, suggesting that the erotic film significantly facilitated genital arousal in all women. The main effect of group, $F(2,65) = 0.43$, $p > .05$, and interaction between film and group, $F(2,65) = 0.0001$, $p > .05$, were not significant. These findings were paralleled in the hyperventilation condition with a main effect of film, $F(1,64) = 55.38$, $p < .0001$. However, no significant main effect

of group, $F(2,64) = 0.33$, $p > .05$, or interaction between film and group, $F(2,64) = 1.88$, $p > .05$ was observed. So that we could determine if there were baseline differences in VPA, we conducted a one-factor ANOVA using group as the fixed factor. There were no significant group differences at neutral baseline in either the control, $F(2,65) = 0.70$, $p > .05$, or hyperventilation, $F(2,64) = 0.18$, $p > .05$, conditions. Whether or not subjects were currently involved in a heterosexual relationship did not affect these findings, $p > .05$.

Effects of Erotic Film on Subjective Sexual Arousal

Prior to erotic film exposure, there were no differences in subjective autonomic arousal, physical genital arousal, subjective sexual arousal, anxiety, or positive or negative affect between the groups, $p > .05$ throughout. The erotic film significantly increased subjective autonomic arousal ($F(1,63) = 108.29$, $p < .0001$), perceptions of physical genital arousal ($F(1,68) = 138.87$, $p < .0001$), subjective sexual arousal ($F(1,68) = 64.51$, $p < .0001$), and positive affect ($F(1,67) = 69.62$, $p < .0001$) in all women (Table 1). There were no significant main effects of group or interactions between film and group for any subjective measure, $p > .05$ throughout. There was a statistically significant interaction between group and film on anxiety, $F(2,69) = 3.213$, $p < .05$, where anxiety scores decreased slightly in premenopausal women and increased in postmenopausal women with the erotic film. A similar pattern of results to the no hyperventilation condition occurred during the hyperventilation condition: subjective autonomic arousal, $F(1,65) = 73.42$, $p < .0001$; perceptions of physical genital arousal, $F(1,65) = 71.55$, $p < .0001$; subjective sexual arousal, $F(1,65) = 81.31$, $p < .0001$; and positive affect, $F(1,65) = 78.76$, $p < .0001$. There was no effect of the erotic film on anxiety, $F(1,66) = 0.51$, $p > .05$; however, there was a marginal increase in negative affect in all women, $F(1,63) = 4.09$, $p < .05$, in the hyperventilation condition (Table 2).

TABLE 1. Difference Scores Between Neutral and Erotic Subjective Measures During the No-Hyperventilation Condition

	Young premenopausal	Older premenopausal	Older postmenopausal
Subjective sexual arousal**	2.7 (0.5)	2.4 (0.5)	2.1 (0.5)
Subjective genital arousal**	10.0 (1.2)	8.9 (1.2)	8.8 (1.5)
Autonomic arousal**	6.2 (0.9)	8.9 (1.4)	6.9 (1.4)
Positive affect**	6.4 (1.2)	5.8 (1.3)	6.3 (1.3)
Negative affect	0.9 (0.9)	1.0 (1.2)	1.2 (1.1)
Anxiety*	-0.2 (0.2)	-0.5 (0.2)	0.2 (0.2)

Note. Positive values indicate an increase in that subjective experience from neutral to erotic conditions. Data represent means \pm (S.E.M.)

* $p < .05$, interaction between group and film

** $p < .0001$, main effect of erotic film

TABLE 2. Difference Scores Between Neutral and Erotic Subjective Measures During the Hyperventilation Condition.

	Young premenopausal	Older premenopausal	Older postmenopausal
Subjective sexual arousal**	2.9 (0.5)	2.2 (0.5)	2.0 (0.4)
Subjective genital arousal**	9.4 (2.1)	8.7 (2.0)	10.0 (1.5)
Autonomic arousal**	7.7 (1.0)	7.6 (1.7)	6.0 (1.5)
Positive affect**	8.3 (1.2)	8.0 (1.8)	6.3 (1.4)
Negative affect	-0.2 (0.6)	1.1 (0.7)	1.3 (0.6)
Anxiety*	-0.2 (0.3)	-0.2 (0.2)	0.1 (0.2)

Note. Positive values indicate an increase in that subjective experience from neutral to erotic conditions. Data represent means \pm (S.E.M.)

* $p < .05$, main effect of erotic film

** $p < .0001$, main effect of erotic film

Effects of Hyperventilation on Genital Sexual Arousal

Inspection of the data suggested that hyperventilation may have had specific effects only on the group of younger premenopausal women (Figure 1). However, a repeated measures ANOVA, including all groups, did not demonstrate an overall difference in VPA, $F(1,60) = 1.30$, $p > .05$, a group difference in VPA, $F(2,60) = 0.27$, $p > .05$, or an interaction, $F(2,60) = 1.00$, $p > .05$. Therefore, planned dependent t -tests were run on each group and they

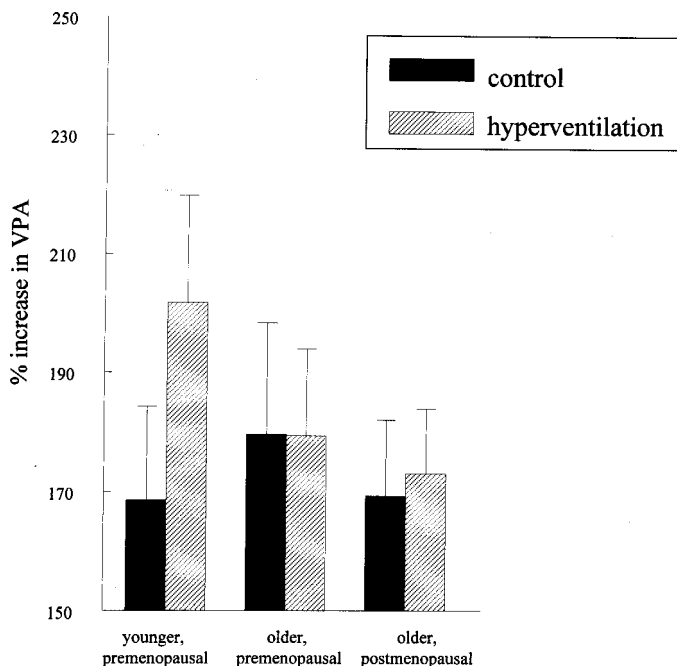


FIGURE 1. Effects of laboratory-induced hyperventilation on vaginal pulse amplitude (VPA) percent increase scores (neutral to erotic) in young premenopausal, older premenopausal, and older postmenopausal women. Data represent means \pm S.E.M.

demonstrated that indeed LIH significantly facilitated VPA response in younger premenopausal women, $t(18) = -2.977$, $p < .01$, but not in older premenopausal women, $t(18) = 0.012$, $p > .05$, or postmenopausal women, $t(20) = -0.166$, $p > .05$.

Effects of Hyperventilation on Subjective Sexual Arousal

There were no significant effects of hyperventilation on any difference score measure of subjective arousal: autonomic arousal, $F(1,59) = .270$; physical sexual arousal, $F(1,64) = 0.002$; anxiety, $F(1,66) = 0.243$; negative affect, $F(1,61) = 0.497$; feelings of femininity, $F(1,59) = 0.042$; positive affect, $F(1,63) = 1.901$; or subjective sexual arousal, $F(1,64) = 0.011$, $p > .05$ throughout. Hyperventilation had no effect on any group differences in subjective sexual arousal, nor the interaction between group and condition, $p > .05$ throughout. Hyperventilation alone had no significant effects on any measure of subjective responses before exposure to the erotic film: autonomic arousal, $F(1,62) = 0.03$; physical sexual arousal, $F(1,65) = 1.55$; anxiety, $F(1,66) = 0.50$; negative affect, $F(1,63) = 1.43$; feelings of femininity, $F(1,62) = 2.48$; and subjective sexual arousal, $F(1,66) = 0.085$, $p > .05$ throughout. There was a significant interaction of hyperventilation and group on positive affect, $F(2,66) = 3.21$, $p < .05$, where positive affect significantly decreased in both age groups of premenopausal women but remained unchanged in postmenopausal women.

Genital-Subjective Correlations

In the no-hyperventilation condition, Pearson product moment correlation analyses revealed a significant correlation between VPA and perceptions of genital sexual arousal ($r = .308$, $p < .0001$) but no significant correlation between VPA and subjective sexual arousal ($r = .135$, $p > .05$). When correlations were run by group, there were no significant correlations between VPA and perceptions of genital sexual arousal ($p > .05$) or VPA and subjective sexual arousal ($p > .05$) in young premenopausal women. However, correlations were significant between VPA and perceptions of genital sexual arousal in older premenopausal women ($r = .482$, $p < .01$) and in postmenopausal women ($r = .303$, $p < .05$). Correlations between VPA and subjective sexual arousal also were significant in older premenopausal women ($r = .422$, $p < .01$), and marginally significant in postmenopausal women ($r = .264$, $p = .076$; Table 2).

Genital-subjective correlations were slightly different during the hyperventilation condition (Table 3), with a significant VPA-subjective genital sexual arousal correlation ($r = .187$, $p < .05$); and marginally significant VPA-subjective sexual arousal correlations ($r = .170$, $p = .051$) in all groups combined. Analyses by group revealed that the correlation between VPA and perceptions of genital sexual arousal remained nonsignificant in young premeno-

TABLE 3. Correlations Between (1) VPA and Perceptions of Genital Sexual Arousal, and (2) VPA and Subjective Sexual Arousal During the Control and Hyperventilation Conditions.

	All groups	Young, premenopausal	Older, premenopausal	Older, postmenopausal
NO HYPERVENTILATION				
VPA-perception of genital arousal	$r = 0.308^{**}$	$r = 0.194$	$r = 0.482^{**}$	$r = 0.303^*$
VPA-subjective sexual arousal	$r = 0.135$	$r = 0.141$	$r = .422^{**}$	$r = 0.264-$
HYPERVENTILATION				
VPA-perception of genital arousal	$r = 0.187^*$	$r = 0.111$	$r = 0.294-$	$r = 0.144$
VPA-subjective sexual arousal	$r = 0.170^*$	$r = 0.371^{**}$	$r = 0.172$	$r = -0.032$

Note. Values represent pearson product moment correlation coefficients.

$-p < .08$

* $p < .05$

** $p < .01$

pausal women ($p > .05$); however, the VPA-subjective sexual arousal correlation in this group was statistically significant ($r = .371$, $p < .01$). In contrast, all VPA-subjective correlations in older pre- and postmenopausal women were no longer significant ($p > .05$ throughout).

Multiple Regression Analyses

When several predictor variables were entered into a multiple regression analysis predicting percent change scores for VPA, it was found that only two variables significantly accounted for the variance in VPA percent change scores. Self-reports of the highest level of sexual arousal ever achieved, $\beta = 0.376$, $p < .05$, and the Golombok Rust Inventory total score, $\beta = -0.984$, $p = .05$, significantly accounted for variance in VPA change scores, whereas prior sexual experience, symptoms of sexual difficulty, and overall sexual satisfaction failed to account for any of the variance. These same predictors did not account for any of the variance in subjective sexual arousal.

DISCUSSION

Results from this study indicate that the erotic film significantly facilitated genital responding in all women, regardless of age or menopausal status. These data corroborate the findings of Laan and van Lunsen (1997) and Myers and Morokoff (1986). However, they are inconsistent with the findings of Morrell and colleagues (1984), who found significantly lower VPA in postmenopausal women. It is possible that the differences in VPA in Morrell et al. (1984) may be due to the type of erotic stimulus used. It has been demonstrated that the type of erotica employed, in particular whether the films

were obtained from a commercially available or an educational source, can significantly influence the pattern of genital responding (Palace & Gorzalka, 1992). The current study employed commercially available contemporary erotica containing explicit sexual material and may produce higher levels of genital arousal in all women compared to other forms of less-intense erotic material.

Subjective sexual arousal and perceptions of genital arousal increased in response to the erotic film and did not differ among the groups. Although findings from the current study are consistent with those of Morrell and colleagues (1984), who found no differences in subjective sexual arousal to the erotic stimulus between pre- and postmenopausal women, the overall magnitude of subjective sexual arousal was higher in the current study (54% increase versus 79% increase in the present study). Laan and van Lunsen (1997) also found that subjective sexual arousal did not differ between pre- and postmenopausal women. However, Myers and Morokoff (1986) reported lower levels of erotica-induced subjective sexual arousal in postmenopausal women. Our current findings that positive affect increased in all women lends support to the notion that sexually explicit female-oriented material evokes high levels of genital and subjective sexual arousal in all women, regardless of age or menopausal status. This is supported by the current findings that negative affect was not induced by the erotic film in any groups. The current affective changes in response to the erotic film are inconsistent with the observation of Merritt and colleagues (1975) that women's attitudes toward erotica become increasingly intolerant with age. However, the use of female-oriented erotic material has been common practice for only the past decade and may explain why studies published in the 1970s and 1980s, which employed male-oriented erotica, reported negative affective responses in older women (Merritt et al., 1975).

The LIH technique employed in the current study has been shown to reliably lead to a state of SNS predominance for at least 7 min (Achenbach-Ng et al., 1994). Given that onset of the erotic stimulus in the current study occurred 4 min after the cessation of hyperventilation (1 min "relax" and 3 min neutral film), it is reasonable to assume that physiological recording during the erotic film segment took place during a period of heightened SNS activity. This assumes that methodological precautions taken (paced audio recording, a researcher remaining with each subject during LIH) served to minimize individual differences in reactions to the LIH procedure. The current findings suggest differential genital arousal in younger and older women to LIH-induced SNS activation. Specifically, it appears that younger women benefited from the LIH technique, whereas older women, regardless of menopausal status, did not.

The current findings suggest that SNS activation prior to an erotic visual stimulus may be a useful technique for discriminating subgroups of women. This is similar to the findings of Meston and Gorzalka (1996b), who found that only in cases of heightened SNS activity could orgasmic and anorgasmic

women be discriminated on genital measures. It is possible that the LIH procedure did not produce an equivalent increase in SNS activity in older women. Because SNS activity increases with age (Dinneno, Jones, Seals, & Tanaka, 2000), it is possible that LIH effectively enhanced genital arousal in younger women with lower basal SNS activity but that administration of further SNS activity to older women did not produce any additional effects. It would seem worthwhile to repeat the present study using other methods of increasing SNS activity. SNS activity was not directly measured in this study, and future studies should aim to directly measure SNS activity during erotic film exposure in order to reconcile the current finding.

Across all women, VPA was found to correlate significantly with perceptions of genital arousal but not with subjective sexual arousal during the control (no hyperventilation) condition, suggesting that although women may be aware of genital arousal, their subjective feelings of sexual arousal may not necessarily increase. This finding is of potential importance for researchers examining the construct of subjective sexual arousal in women. Although researchers instruct their subjects to rate subjective arousal as "any mental sexual pleasure," others use the construct of "perceptions of genital sensations" to denote subjective arousal. Clearly, from the current findings, use of the latter in measuring subjective sexual arousal is problematic because it is inconsistent with subjective sexual arousal. Of the three psychophysiological studies conducted on postmenopausal women, one did not attempt to correlate genital and subjective measures of arousal (Myers & Morokoff, 1986), one found no relationship (Morrell et al, 1984), and one found a significant negative correlation between VPA and self-reported arousal problems (Laan & van Lunsen, 1997). In both studies that compared genital to subjective arousal, pre- and postmenopausal women were examined as a group, not allowing for an examination of desynchrony that might be age and/or menopause dependent. The current study aimed to address this issue by conducting correlations on each subgroup separately. Analyses revealed that without prior SNS activation, the correlations between VPA and perceptions of genital arousal and between VPA and subjective sexual arousal were not significant in younger premenopausal women. It is interesting to note that, in older pre- and postmenopausal women, both correlations were statistically significant. Based on these findings, desynchrony between genital and subjective arousal appears to be characteristic only of younger women. This again is a novel finding and suggests that the clinical assessment of genital sexual arousal in older women may be aided by the use of the vaginal photoplethysmograph. It is possible that older and postmenopausal women are more sensitive to the genital changes that accompany erotic stimulus exposure and are perhaps more likely to perceive this genital arousal as a subjective sexual experience; however, this is speculation. The use of female-oriented erotica facilitated this synchrony and allowed positive sexual feelings to follow from increased physiological arousal. The finding that

subjective sexual arousal and positive affect increased in older women supports this idea.

The slightly different pattern of findings during the hyperventilation condition may help to explain these effects. Following SNS induction, the VPA-subjective sexual arousal correlation in younger premenopausal women achieved statistical significance. This suggests that the enhanced genital sensations following LIH also were subjectively interpreted as being sexually arousing. In older women, LIH did not enhance VPA, which may have prevented a significant genital-subjective correlation. Given that sexual and relationship satisfaction and current involvement in a sexual relationship did not differ between the groups, it is unlikely that differences in current sexual activity account for the findings.

Overall, the data demonstrates no differences in genital or subjective sexual arousal in response to an erotic visual stimulus between pre- and postmenopausal women or between younger and older women. Hyperventilation differentiates genital arousal between younger and older women, even though subjective arousal does not. These data provide support for the use of the LIH procedure as a feasible alternative to prior modes of eliciting SNS activity for the examination of genital arousal in women, and it remains to be tested in women with female sexual arousal disorder who display impaired genital responding. It is reasonable to assume that in this subgroup of women, genital arousal may be enhanced with the use of LIH prior to an erotic stimulus. The current data also suggests that prior reports of desynchrony between genital and subjective measures may be exclusive to younger premenopausal women. Regardless of menopausal status, genital and subjective measures were in synchrony in older women.

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