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Measurement of Sexual Arousal in Postoperative Male-to-Female Transsexuals Using Vaginal Photoplethysmography

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Men's sexual arousal patterns are category-specific: Men typically display significantly greater physiological responses to sexual stimuli depicting members of their preferred gender category. Category-specific patterns of sexual arousal have not been consistently reported in natal women. We used vaginal photoplethysmography to examine patterns of sexual arousal in 11 male-to-female (MtF) transsexuals following sex reassignment surgery (SRS) and in 72 natal women. Subjective arousal was measured with a continuous response lever. Video clips depicting sexual activity between two males, two females, or one male and one female were used as erotic stimuli. All transsexual participants displayed category-specific sexual arousal. Five homosexual transsexual participants (attracted exclusively to males before sex reassignment) showed greater genital and subjective responses to male than to female stimuli, while six nonhomosexual transsexual participants showed the opposite pattern. Vaginal pulse amplitude (VPA) was lower in transsexual participants than in natal women. The mean correlation between VPA and subjective responses was high in nonhomosexual transsexuals, but was significantly lower in homosexual transsexuals and in natal women. One transsexual participant who reported a change in sexual orientation following sex reassignment displayed VPA and subjective responses consistent with her pre-reassignment sexual orientation. We conclude that male-to-female transsexuals display male-typical category-specific sexual arousal following SRS, and that vaginal photoplethysmography is a promising methodology for studying patterns of sexual arousal in postoperative transsexuals.

KEY WORDS: transsexual; sex reassignment surgery; vaginal photoplethysmography; sexual arousal; sexual orientation.

INTRODUCTION

One of the goals of sex reassignment surgery (SRS) in male-to-female (MtF) transsexuals is to create genital structures that will permit patients to engage in sexual activity in a manner consistent with their gender identity. Surprisingly, however, there has been little formal study of the physiological responses of MtF transsexuals' surgically reconstructed genitals during sexual arousal. As part of an investigation of category-specific sexual arousal in natal women, Chivers, Rieger, Latty, and Bailey (2004) used vaginal photoplethysmography to measure the genital responses of 11 post-SRS MtF transsexuals during viewing of erotic video stimuli (EVS). The transsexual participants were not the focus of the Chivers et al. study, but were included primarily to determine whether vaginal photoplethysmography was capable of detecting category-specific sexual arousal (i.e., significantly different physiological responses to male vs.

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female stimuli). In this report, we describe the genital physiological responses of the transsexual participants in greater detail. We offer an expanded discussion of category-specific sexual arousal in the transsexual participants, and we address the following three additional topics: (1) amplitude of vaginal photoplethysmographic responses in transsexuals vs. natal women; (2) correlations between genital and subjective responses in transsexuals vs. natal women; and (3) genital and subjective responses in a transsexual participant who reported a change in sexual orientation following sex reassignment.

SRS and Postoperative Sexual Arousal in MtF Transsexuals

Sex reassignment surgery in MtF transsexuals involves removal of the testicles and the erectile tissue of the penis, and vaginoplasty, the creation of a vaginal cavity or *neovagina* between the rectum and the bladder (for a review, see Karim, Hage, & Mulder, 1996). The neovagina is lined with skin flaps or skin grafts, or less commonly with a segment of large bowel. The inverted skin of the penis is often used to line the neovagina; this technique is called *penile inversion* vaginoplasty. Penile inversion vaginoplasty is considered to be the method of choice for neovaginal construction in MtF SRS (Giraldo, Mora, Solano, Gonzáles, & Smith-Fernández, 2002; Karim et al., 1996), and the majority of surgeons who perform MtF SRS use the penile inversion technique (Giraldo et al., 2002). When penile skin is insufficient, scrotal skin flaps or grafts or split-thickness skin grafts from other donor sites can also be used to line the neovagina (Karim et al., 1996).

It is clear that many postoperative MtF transsexuals can develop significant pelvic vasocongestion and genital engorgement in response to sexual stimulation. Karim, Hage, Bouman, and Decker (1991) described 13 MtF patients who experienced narrowing of the neovaginal opening or swelling of the urethral meatus during sexual arousal, as a result of incomplete resection of genital erectile tissue during SRS. Lawrence (2004) found in a follow-up study of MtF SRS patients that 15 (6%) of 232 respondents reported narrowing of the neovaginal introitus during sexual arousal, suggesting significant genital vasocongestion.

Reports of vaginal lubrication with sexual stimulation provide additional evidence of arousal-induced genital vasocongestion after MtF SRS. Vaginal lubrication is caused by transudation of fluid into the vaginal lumen due to pelvic vascular engorgement (Levin, 1991). Vaginal lubrication with arousal has been observed following vaginoplasty for vaginal agenesis in natal women (Allesandrescu, Peltecu, Buhimschi, & Buhimschi, 1996; Masters & Johnson, 1961, 1966). Some postoperative MtF transsexuals also report significant vaginal lubrication with sexual arousal (Lawrence, 2004; Muirhead-Allwood, Royle, & Young, 1999a).

Balsma et al. (1995) used vaginal photoplethysmography to measure vaginal pulse amplitude (VPA) in 5 MtF transsexuals and 10 natal women before and during viewing of EVS. All 10 natal women and 3 of 5 transsexuals displayed increases in VPA during viewing of EVS, but the increases were smaller in the transsexual group. In 2 transsexual participants, VPA could not be analyzed due to artifacts. Schroder and Carroll (1999) successfully recorded VPA waveforms during baseline conditions (i.e., without sexual stimulation) in all 17 postoperative MtF transsexuals they studied. They reported that the transsexuals' VPA waveforms were similar to those of natal women, and they proposed that vaginal photoplethysmography might be a useful technique for studying sexual responses in postoperative transsexuals.

Measuring physiological genital arousal in response to EVS is an accepted technique for assessing erotic preferences in biologic males (Freund & Watson, 1991; Harris & Rice, 1996; Seto, 2001). Some MtF transsexuals claim that their sexual orientation changed after SRS, reporting that they were primarily attracted to females before SRS but primarily attracted to males following SRS (Bentler, 1976; Daskalos, 1998; Lawrence, 2005; Muirhead-Allwood, Royle, & Young, 1999b; Schroder & Carroll, 1999). It is not known, however, whether such reported changes in sexual orientation are accompanied by greater physiological genital arousal to male vs. female sexual stimuli (Freund, 1985; Lawrence, 1999).

METHOD

Participants

Participants were 11 MtF transsexuals and 72 natal women. Their method of recruitment has been described elsewhere (Chivers et al., 2004). All transsexual participants had undergone SRS a minimum of three months prior to the study.

Participants completed a questionnaire concerning their age, ethnicity, medication use, and sexual orientation. They reported their feelings of sexual attraction and their sexual experience during adolescence and adulthood, including the year prior to participation, using a 7-point Kinsey scale (Kinsey, Pomeroy, & Martin, 1948). Feelings of sexual attraction during adolescence were used to

categorize transsexual participants as either homosexual (Kinsey 5 or 6) or nonhomosexual (Kinsey 0–4) relative to birth sex. This categorization was based on the observation that heterosexual and bisexual MtF transsexuals tend to have similar patterns of erotic interests, which differ significantly from those of homosexual MtF transsexuals (Blanchard, 1989).

The mean age of the transsexual participants was 43 years (*SD*, 11 years; range, 29–59 years). Seven transsexual participants were White, two were Hispanic, and two did not specify their ethnicity. Five transsexual participants were categorized as homosexual relative to birth sex, and six were categorized as nonhomosexual. The mean age of the homosexual transsexual participants at time of SRS was 31 years, while the mean age of the nonhomosexual transsexual participants at time of SRS was 47 years. This difference was significant, $t(9) = 3.7$, $p = .003$. Nine transsexual participants reported using estrogen-containing hormone replacement medications and two did not.

The mean age of the natal female participants was 27 years (*SD*, 6 years; range, 18–40 years). They were significantly younger than the transsexual participants, $t(80) = 7.0$, $p < .0001$. Forty-eight natal female participants were White, 4 were Asian, 12 were Black, 6 were Hispanic, and 2 reported their ethnicity as Other. All natal female participants were premenopausal and none were taking hormonal medications.

Measures

We used vaginal photoplethysmography (Geer, Morokoff, & Greenwood, 1974) to measure genital response during viewing of EVS. Participants continuously reported their subjective sexual arousal during viewing of EVS by pushing a lever (Cerny Response Apparatus) through a 180° arc. The lever's full rearward position represented no sexual arousal, and its full forward position represented the level of arousal associated with orgasm.

Genital and subjective data were continuously recorded and digitized using MP100 Biopac Photoplethysmographic Assessment software. VPA was measured peak-to-trough in μV; the signal was band-pass filtered (0.5–10 Hz) and digitized at 40 Hz. The AC signal from the response lever was transformed into percent deflection, low-pass filtered at 0.5 Hz, and digitized at 40 Hz.

Procedure

The experimental procedure has been previously described by Chivers et al. (2004). Participants inserted the vaginal probe to a depth of 5 cm, with the light source and detector facing the anterior vaginal wall. They then watched an 11-minute adaptation video depicting religious ceremonies, ancient architecture, and landscapes. Next they watched seven stimulus videos, which were presented in random order; each consisted of a 2-minute video clip with sound. These depicted: (a) female-female oral sex, (b) female-female vaginal penetration with a strap-on dildo, (c) male-female cunnilingus, (d) male-female vaginal penetration, (e) male-male fellatio, (f) male-male anal penetration, and (g) a neutral stimulus consisting of landscapes and wildlife. We recorded VPA and subjective arousal during each video clip. Video clips were separated by return-to-baseline intervals, during which participants completed pencil-and-paper distraction tasks.

Data Reduction and Analysis

We separately averaged each participant's genital and subjective arousal measures over the 2-minute time period for each stimulus category, yielding a mean raw VPA value and a mean subjective arousal value for each of the six sexual stimuli and for the neutral stimulus. We then calculated a *maximum sexual-neutral VPA contrast* value for each participant, which was her largest mean raw VPA value for any of the six sexual stimuli minus her mean raw VPA value for the neutral stimulus. To facilitate comparisons between participants, we also computed standardized VPA scores and standardized subjective scores within-participants by z-score transformation of mean raw VPA values and mean subjective arousal values, a technique that has previously been used to aid the interpretation of male sexual arousal data (Blanchard, Racansky, & Steiner, 1986; Harris, Rice, Quinsey, Chaplin, & Earls, 1992).

We calculated a *male-female VPA contrast* score for each participant, the sum of her standardized VPA scores for the two male-male stimuli minus the sum of her standardized VPA scores for the two female-female stimuli. Similarly, we calculated a *male-female subjective contrast* score for each participant, the sum of her standardized subjective scores for the two male-male stimuli minus the sum of her standardized subjective scores for the two female-female stimuli. Positive male-female contrast scores indicated greater arousal to male stimuli, while negative male-female contrast scores indicated greater arousal to female stimuli. Finally, we calculated a *VPA-subjective correlation* for each participant, the Pearson product-moment correlation of her standardized VPA scores and standardized subjective scores for the six sexual stimuli and for the neutral stimulus. Probability values $\leq .05$ were considered statistically significant.

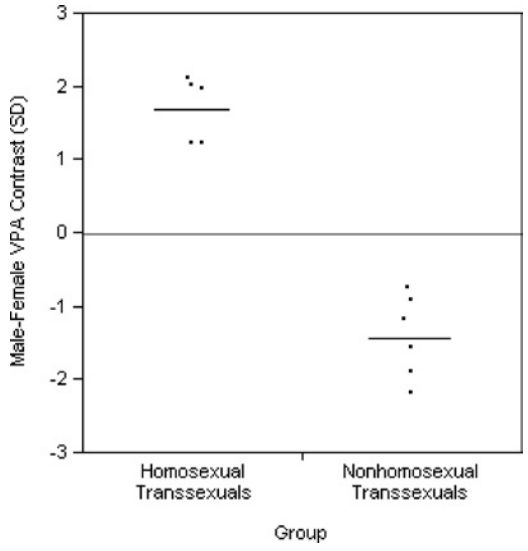

Fig. 1. Transsexual participants' male-female VPA contrast scores, by transsexual type. The long horizontal line indicates the grand mean; short horizontal lines indicate group means.

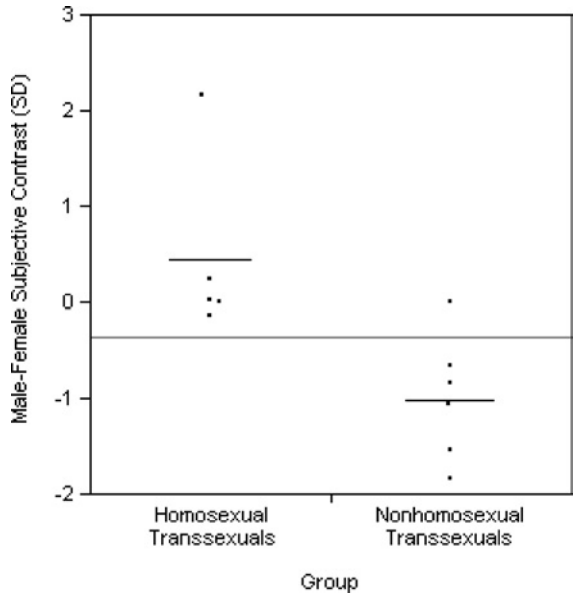

Fig. 2. Transsexual participants' male-female subjective contrast scores, by transsexual type. The long horizontal line indicates the grand mean; short horizontal lines indicate group means.

RESULTS

Genital and Subjective Responses in Transsexual Participants

Comparison of the male-female VPA contrast scores of the homosexual and nonhomosexual transsexual participants revealed significant differences in genital arousal patterns. These data are displayed in Fig. 1. Homosexual transsexual participants had a mean male-female VPA contrast score of 1.7 *SD* (95% CI, 1.2 to 2.2 *SD*), indicating greater genital arousal to male stimuli. Nonhomosexual transsexual participants had a mean male-female VPA contrast score of −1.4 *SD* (95% CI, −1.9 to −1.0 *SD*), indicating greater genital arousal to female stimuli. The male-female VPA contrast scores of the two transsexual groups were significantly different, $t(9) = 10.0$, $p = .0001$.

Similar results were observed for subjective sexual arousal, which are shown in Fig. 2. The mean male-female subjective contrast score for homosexual transsexual participants was 0.4 *SD* (95% CI, −0.4 to 1.3 *SD*), indicating greater subjective arousal to male stimuli. The mean male-female subjective contrast score for nonhomosexual transsexual participants was −1.0 *SD* (95% CI, −1.74 to 0.25 *SD*), indicating greater subjective arousal to female stimuli. The male−female VPA subjective contrast scores of the two transsexual groups were significantly different, $t(9) = 3.0$, $p = .02$.

Vaginal Pulse Amplitude in Transsexual vs. Natal Female Participants

The transsexual participants had lower mean raw VPA values during neutral stimuli than the natal female participants, and also had lower maximum sexual-neutral VPA contrast values than the natal women. Fig. 3 shows mean raw VPA values with neutral stimuli for the transsexual and natal female participants. The overall mean of these VPA values for the transsexual participants was 31 μV (*SD*, 13 μV) vs. 82 μV (*SD*, 89 μV) for the natal female participants, a difference that approached statistical significance, $t(81) = 1.9$, $p = .06$. Fig. 4 shows maximum sexual-neutral VPA contrast values for the transsexual and natal female participants. The mean maximum sexual-neutral contrast value for the transsexual participants was 12 μV (*SD*, 5 μV) vs. 40 μV (*SD*, 32 μV) for the natal female participants. This difference was significant, $t(81) = 2.9$, $p = .005$.

Because the transsexual participants were significantly older than the natal female participants, we examined whether mean raw VPA values with neutral stimuli and maximum sexual-neutral VPA contrast values were significantly correlated with age. There was no significant correlation between age and mean raw VPA value with neutral stimuli for either the natal female participants, $r(72) = -.14$, $p = .25$, or for the transsexual participants, $r(10) = .54$, $p = .11$. There was also

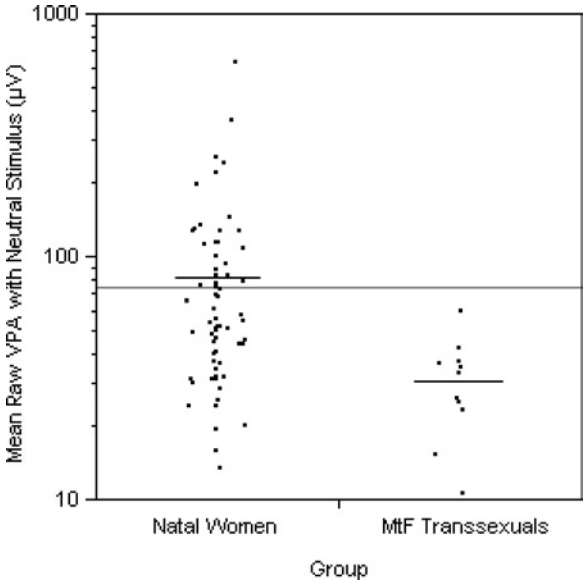

Fig. 3. Participants' mean raw VPA with neutral stimulus, by group. The long horizontal line indicates the grand mean; short horizontal lines indicate group means.

no significant correlation between age and maximum sexual-neutral VPA contrast value for the natal female participants, $r(72) = -.19$, $p = .11$, or for the transsexual participants, $r(10) = .02$, $p = .96$.

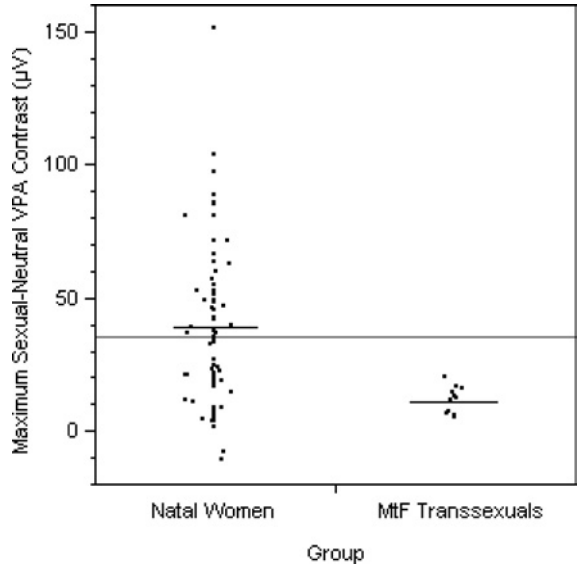

Fig. 4. Participants' maximum sexual-neutral VPA contrast, by group. The long horizontal line indicates the grand mean; short horizontal lines indicate group means.

Correlations between VPA and Subjective Arousal in Transsexual and Natal Female Participants

We compared VPA-subjective correlations for the natal female and transsexual participants. For the natal women, mean $r = .38$ (*SD*, .44; range, −.62 to .97); r was statistically significant (>.75) in 15 (21%) of the 72 natal women. For the transsexual participants, mean $r = .57$ (*SD*, .37; range, −.18 to .95); r was statistically significant (>.75) in 3 (27%) of the 11 transsexual participants. Mean correlations were not significantly different between the natal female and transsexual groups, $t(81) = 1.4$, $p = .18$. We observed a significant difference in VPA-subjective correlations between the two transsexual groups, however. For the five homosexual transsexual participants, mean $r = .33$ (*SD*, .43; range, −.18 to .73); r was statistically significant in 0 participants. For the six nonhomosexual transsexual participants, mean $r = .78$ (*SD*, .13; range, .62 to .95); r was statistically significant in three participants. The mean r of the nonhomosexual transsexual participants was significantly higher than the mean r of the homosexual transsexual participants, $t(9) = 2.4$, $p = .04$, and was also significantly higher than the mean r of the natal women, $t(76) = 2.2$, $p = .03$. The mean rs of the homosexual transsexual participants and the natal women did not differ significantly from each other, $t(75) < 1$. Fig. 5 shows the distribution of VPA-subjective correlations for all three participant groups.

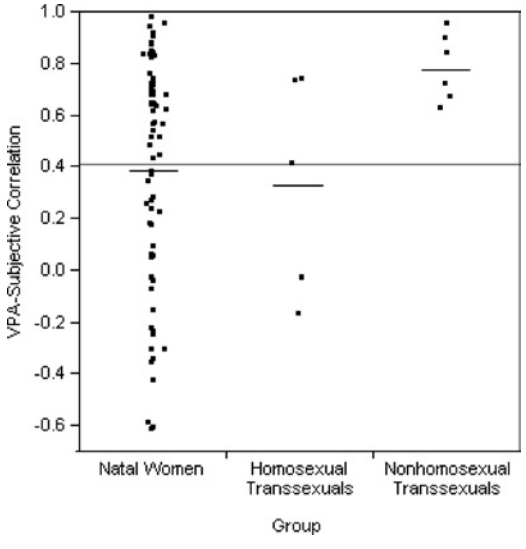

Fig. 5. Participants' VPA-subjective correlations, by group. The long horizontal line indicates the grand mean; short horizontal lines indicate group means.

Genital and Subjective Arousal in a Transsexual Participant Reporting a Change in Sexual Orientation

Ten of the 11 transsexual participants reported relatively consistent patterns of sexual orientation before and after SRS. One participant reported exclusive sexual attraction to and experience with females during adolescence and also while living as a man during adulthood. She reported that after SRS, however, her sexual attraction during the previous year had been mostly to men and her sexual experience during the previous year had been exclusively with men. She rated the idea of sex with a man as "very exciting" and the idea of sex with a woman as "neutral." Despite these self-reports, her male-female VPA contrast score was −1.2 *SD*, and her male-female subjective contrast score was −1.5 *SD*, indicating that she displayed greater physiological and subjective responses to female stimuli than to male stimuli. Her responses were comparable in direction and magnitude to those of transsexual participants who reported consistent sexual orientation toward females before and after SRS.

DISCUSSION

Our purposes in this investigation were to: (1) describe the VPA responses of MtF transsexuals to EVS, including the presence or absence of category-specific arousal; (2) compare VPA responses to EVS in MtF transsexuals and natal women; (3) compare the correlations between VPA and subjective responses to EVS in MtF transsexuals vs. natal women; and (4) examine whether reported changes in sexual orientation following MtF sex reassignment were consistent with observed patterns of physiological and subjective arousal.

VPA Responses and Category-Specific Arousal in Transsexuals

Our results demonstrate that vaginal photoplethysmography is capable of detecting physiological sexual arousal responses to EVS in MtF transsexuals. In the transsexual participants, arousal measured by vaginal photoplethysmography correlated with subjective arousal as well or better than in a comparison group of natal women. This was true even though VPA responses to neutral stimuli and changes in VPA responses to EVS were substantially smaller in the transsexual participants than in the natal female participants.

Our results also demonstrate that postoperative MtF transsexuals display a category-specific pattern of sexual arousal, which is typical of nontranssexual males and which appears to be atypical of natal women (Chivers et al., 2004). Investigators have previously documented category-specific sexual arousal in male applicants for sex reassignment using penile plethysmography (Barr, 1973; Barr & Blaszczynski, 1976; Barr, Raphael, & Hennessey, 1974), but our results provide the first demonstration of category-specific sexual arousal in MtF transsexuals following SRS.

Although MtF transsexuals are sometimes described in popular accounts as "women trapped in men's bodies" (i.e., male-bodied persons who are psychosexually female; e.g., Gorman, 1995), they display a combination of female-typical, intermediate, and male-typical psychosexual characteristics. For self-rated femininity and masculinity on the Bem Sex-Role Inventory (Fleming, Jenkins, & Bugarin, 1980; Herman-Jegliñska, Grabowska, & Dulko, 2002) and for female-typical motor behavior (Barlow, Mills, Agras, & Steinman, 1980), MtF transsexuals appear to be similar to natal women (or more feminine than natal women) and dissimilar to nontranssexual males. For other gender-typical characteristics, such as occupational and hobby preferences (Lippa, 2001), use of gender-specific vocabulary (Kenna & Hoenig, 1984), verbal memory (Cohen-Kettenis, van Goozen, Doorn, & Gooren, 1998), and a composite measure of visuospatial ability (van Goozen, Slabbekoorn, Gooren, Sanders, & Cohen-Kettenis, 2002), MtF transsexuals' scores are intermediate between those of natal women and nontranssexual males. MtF transsexuals appear to be similar to nontranssexual males and dissimilar to natal females for Performance-Verbal IQ differential (Hunt, Carr, & Hampson, 1981), visuospatial ability involving two-dimensional figure rotation (Cohen-Kettenis et al., 1998; van Goozen et al., 2002), measures of self-esteem and dynamic body image (Wolfradt & Neumann, 2001), and number of sexual partners (Lawrence, 2005).[5] The male-typical, category-specific sexual arousal pattern observed in the present study provides additional evidence that MtF transsexuals display male-typical as well as female-typical psychosexual characteristics.

[5]Homosexual MtF transsexuals appear to differ from nonhomosexual MtF transsexuals in the degree to which they display sex-atypical psychosexual characteristics (e.g., Herman-Jeglińska et al., 2002). In the studies cited, Cohen-Kettenis et al. (1998) and van Goozen et al. (2002) studied only homosexual transsexuals; Herman-Jeglińska et al. (2002), Kenna and Hoenig (1984), and Lawrence (2005) studied homosexual and nonhomosexual transsexuals; and in the remaining studies (Barlow et al., 1980; Fleming et al., 1980; Hunt et al., 1981; Lippa, 2001; Wolfradt & Neumann, 2001), the sexual orientation of the transsexual participants was not reported.

Possible Causes of Lower VPA in Transsexuals

VPA provides a measure of vaginal blood flow, and changes in VPA in response to EVS reflect arousal-induced pelvic vascular engorgement (Laan, Everaerd, & Evers, 1995). Our results demonstrate that MtF transsexuals have lower baseline levels of vaginal blood flow than do natal women, and also show significantly smaller increases in vaginal blood flow during EVS viewing. We speculate that these differences in blood flow may reflect differences in the structure of the natal vaginal vs. neovaginal wall, differences in the innervation of natal vaginal vs. neovaginal vasculature, or differences in testosterone levels between the two groups.

The vaginal wall in natal women is typically highly vascularized, and contains cavernous erectile tissue in which vascular engorgement can occur. D'Amati et al. (2002) demonstrated cavernous or pseudo-cavernous tissue within the vaginal wall in 12 of 14 human natal female cadaver specimens examined. In contrast, the neovaginas of MtF transsexuals are usually lined with penile skin, often supplemented by full-thickness skin grafts from the scrotum or abdomen, or by partial-thickness skin grafts from the thighs or buttocks. Skin from these donor sites has not been reported to contain cavernous erectile tissue. The neovaginal cavity in transsexuals is created by blunt dissection along the rectovesicle septum (Denonvillier's fascia), which separates the rectum from the bladder and urethra (Hage, 1999). The operating surgeon deliberately dissects along this relatively avascular plane in order to avoid excessive bleeding. The only area in which contact between neovaginal donor skin and erectile tissue might be expected to occur would be at the neovaginal introitus, adjacent to the shortened urethra. The operating surgeon typically performs subtotal resection of erectile tissue in this area (Karim et al., 1991), but any remaining erectile tissue would lie in proximity to neovaginal skin near the introitus. Consequently, the walls of the neovagina in transsexuals are likely to be less highly vascularized than the walls of the vagina in natal women. They are also likely to be less capable of developing vasocongestion than the walls of natal vaginas, because they do not contain cavernous erectile tissue, and because they make only limited contact with residual erectile tissue, and only near the vaginal introitus.

Differences in the innervation of the vaginal vs. neovaginal vasculature might also have contributed to the observed differences in VPA response to EVS between the natal female and transsexual participants. In natal women, vaginal vasocongestion is activated through parasympathetic nerve fibers that originate in the sacral parasympathetic nucleus and travel via the pelvic nerves to the vagina (Giuliano, Rampin, & Allard, 2002). Vaginal vasocongestion in natal women appears to be mediated in part by vasoactive intestinal polypeptide (VIP) and by nitric oxide (NO). Nerves containing VIP and NO synthetase innervate capillaries and deep and superficial arteries and veins in the natal human vagina (Hoyle, Stones, Robson, Whitley, & Burnstock, 1996). It is not known whether the blood vessels surrounding the neovagina in MtF transsexuals might be similarly innervated. Even if this were the case, the ability of grafted skin to undergo vasodilation in response to neurogenic stimulation appears to be limited (Freund, Brengelmann, Rowell, Engrave, & Heimbach, 1981).

It is also possible that the observed differences between the natal female and transsexual participants in VPA responses to EVS might have been related to differences in testosterone (T) levels between the two groups. Although we did not measure T levels in either group, it is reasonable to assume that the natal female participants, whose mean age was 27 years and who were premenopausal, had normal female T levels; Trienekens, Schmidt, and Thijssen (1986) found that in a group of 77 premenstrual women aged 18–48, mean T level was 32 ng/dL, and only 10% of participants had T levels of 17 ng/dL or below. In the transsexual participants, all of whom had undergone orchiectomy, T levels were probably substantially lower. Oefelein, Feng, Scolieri, Ricchiutti, and Resnick (2000) found a median T level of 15 ng/dL in 35 men who had undergone orchiectomy, with less than 10% of patients having T levels above 20 ng/dL. Røhl and Beuke (1992) reported a mean T level of 16 ng/dL in a similar group of 14 patients one year following orchiectomy; the highest T level in this group was 22 ng/dL.

There is conflicting evidence concerning the effect of T levels on genital blood flow changes in response to EVS in men and women. Bancroft and Wu (1983) and Kwan, Greenleaf, Mann, Crapo, and Davidson (1983) examined phallometric responses to EVS in hypogonadal men with and without testosterone supplementation and in normal male controls; neither study found any relationship between testosterone levels and phallometric responses. Pretreatment T levels in the hypogonadal men, however, averaged 128 ng/dL in the former study and 71 ng/dL in the latter, both well above the levels typical of orchiectomized males. Carani, Granata, Bancroft, and Marrama (1995) subsequently found that T treatment in hypogonadal men increased the duration and rigidity of erections in response to EVS, leading to the conclusion that some genital responses to EVS in males may be androgen sensitive.

Some studies have not found significant relationships between T levels and VPA responses to EVS in natal women. Tuiten et al. (1996) reported that women with hypothalamic amenorrhea and a mean T level of 24 ng/dL and normally menstruating women with a mean T level of 40 ng/dL did not differ in their VPA responses to EVS depicting heterosexual intercourse. Myers, Dixen, Morrissette, Carmichael, and Davidson (1990) found that in a group of postmenopausal women with pretreatment T levels in the range of 13–22 ng/dL, participants who received estrogen and 5 mg of methyltestosterone daily over an 8-week period showed VPA responses to EVS that were no different than in participants who received estrogen alone, estrogen and medroxyprogesterone, or placebo. T levels, however, actually decreased in the methyltestosterone group, and methyltestosterone levels were not reported. Laan, van Lunsen, and Everaerd (2001) studied VPA responses to EVS in a group of postmenopausal women receiving either tibolone (a synthetic steroid with weak estrogenic, progestogenic, and androgenic properties) or placebo; tibolone treatment was associated with significantly lower T levels and significantly higher free androgen levels, but the two groups did not differ significantly in VPA responses to EVS.

Other investigations, however, have found that higher T levels are associated with increases in VPA response to EVS in natal women. Tuiten et al. (1996) found that women with hypothalamic amenorrhea and a mean T level of 24 ng/dL showed significant increases in VPA response to EVS depicting heterosexual intercourse following 8 weeks of treatment with oral T undecanoate; the women's mean T level following treatment was 95 ng/dL, slightly above the female normal range. Tuiten et al. (2000) also demonstrated that a single dose of sublingual T increased VPA response to EVS in normally menstruating women, although the peak T levels that participants achieved were supraphysiological. Tuiten, van Honk, Verbaten, Laan, and Everaerd (2002) subsequently replicated these findings, using a slightly different protocol.

We believe it is unlikely that the observed differences in baseline VPA and in VPA during viewing of EVS between natal female and transsexual participants were due to differences in estrogen levels between the two groups. Higher estrogen levels are not associated with increased VPA responses to EVS in natal women (Laan & van Lunsen, 1997; Myers et al., 1990; Myers & Morokoff, 1986), and there is no reason suspect such an association would be present in MtF transsexuals. Lower estrogen levels are, however, associated with lower baseline (unstimulated) VPAs in natal women (Laan & van Lunsen, 1997); and treatment of postmenopausal women with tibolone, a steroid with estrogenic properties, increases baseline VPA (Laan et al., 2001). Two of the transsexual participants were not receiving estrogen replacement, and this could theoretically account for the observed trend toward lower VPAs with neutral stimulus in the transsexual group. An examination of baseline VPAs in these two participants suggests otherwise: While one had the lowest VPA with neutral stimulus of any transsexual participant, the other had the second highest VPA with neutral stimulus in the transsexual group.

Correlations Between Genital and Subjective Arousal

Correlations between genital arousal and subjective arousal are generally high in men but are typically lower in women. The reasons for these sex differences remain unclear (for a review, see Rosen & Beck, 1988). Using EVS and a continuous response lever to quantitate subjective arousal, a technique similar to that used in the present study, Wincze, Venditti, Barlow, and Mavissakalian (1980) found a mean VPA-subjective correlation of .38, with a range of .09 to .77, in 8 natal female participants; significant correlations were observed in 2 participants (25%). Steinman, Wincze, Sakheim, Barlow, and Mavissakalian (1981) reported VPA-subjective correlations ranging from .38 to .76 in another group of 8 natal female participants, using similar methodology; significant correlations were observed in 5 participants (63%). Using projected slides rather than EVS, Korff and Geer (1983) documented mean VPA-subjective correlations as high as .87 when natal female participants were instructed to attend to somatic sensations, but only .48 when participants did not receive such instructions; the percentages of participants with significant correlations ranged from 60% to 100%. Laan, Everaerd, van der Velde, and Geer (1995) found a mean VPA-subjective correlation of .59 in a group of 7 natal female participants exposed to multiple EVS in random order and instructed to report genital sensations; 5 participants (71%) had significant correlations. The VPA-subjective correlations we observed in the natal female participants, who were not given instructions to attend to somatic sensations, were generally consistent with these earlier reports.

We were surprised to find that the mean VPA-subjective correlation in the nonhomosexual transsexual group was significantly higher than in the homosexual transsexual group, and that the latter group did not differ from the natal female group. We expected that MtF transsexuals might show patterns of sexual arousal similar

to nontranssexual males, so we were more surprised by the relatively low correlations in the homosexual transsexual group than by the high correlations in the nonhomosexual group. Because the comparison between the two transsexual groups was unplanned, and because our sample size was small, the difference we observed may reflect a Type I error, and requires confirmation.

Examination of the transsexual participants' responses to specific EVS suggests a possible explanation for the lower mean VPA-subjective correlation observed in the homosexual transsexual group. The majority of the transsexual participants in both groups displayed relatively high VPA responses to all EVS that featured at least one member of their preferred sexual category, but most participants gave high subjective ratings only to those EVS that featured at least one member of their preferred sexual category *and* at least one female. The majority of the homosexual transsexual participants showed the highest VPA responses to the male-male oral sex video, but also displayed relatively high VPA responses to the other male-male video and to the two male-female videos. In contrast, 3 of the 5 homosexual transsexual participants gave very high subjective ratings *only* to one or both of the male-female videos, and very low subjective ratings to all the other EVS. Similarly, the majority of the nonhomosexual transsexual participants displayed high and relatively similar VPA responses to both female-female videos *and* to both male-female videos. Four of the 6 nonhomosexual transsexual participants gave relatively high subjective ratings to the two male-female videos *and* to either one or both of the female-female videos, and lower subjective ratings to the other EVS. Thus, the majority of the homosexual transsexual participants displayed strong VPA responses but weak subjective responses to both male-male stimuli, which contributed to a lower mean VPA-subjective correlation, whereas the majority of nonhomosexual transsexuals showed relatively strong VPA responses and strong subjective responses to one or both of the female-female stimuli, which contributed to a higher mean VPA-subjective correlation.

One possible interpretation of these observations is that, for a majority of the participants in the study, identification with at least one of the actors in an erotic video stimulus may have been a prerequisite for reporting a strong subjective response to that stimulus. This might explain why, in Fig. 2, male-female subjective contrast scores were close to zero for 4 of the 5 homosexual transsexual participants. Perhaps these 4 participants found the female-female videos generally unexciting subjectively because they did not include a male actor, and they found the male-male videos similarly unexciting subjectively because they did not include a female actor with whom they could identify. In future studies, questioning participants in greater detail about the reasons for their subjective responses to particular categories of EVS might help to explain observed correlations between VPA and subjective responses.

Arousal Patterns Following a Reported Change in Sexual Orientation

Although sexual orientation in biologic males is thought to be established early in life and to be virtually unchangeable in adulthood (Pillard & Bailey, 1995), some MtF transsexuals report that their sexual orientation changed following gender transition and SRS, invariably toward a greater preference for male partners. Freund (1985) hypothesized that such reports might reflect the desire of certain transsexuals to portray themselves as "typically feminine" or, alternatively, might reflect their erotic interest in the validation provided by male partners, rather than representing a genuine change in somatotypic preference. The potential mutability of sexual orientation in MtF transsexuals is of particular interest because sexual orientation underlies most typologies of MtF transsexuality. Measurement of VPA and subjective responses to EVS is a promising technique for assessing self-reported changes in sexual orientation following SRS.

We have demonstrated one instance in which such a self-reported change in sexual orientation was inconsistent with the participant's observed VPA and subjective responses. Conducting VPA and subjective response measurements in additional MtF transsexuals who report that their sexual orientation changed after SRS would help to clarify whether such self-reports are consistent with observed physiological arousal. A still more rigorous approach to this question might involve the prospective study of the stability of patterns of sexual arousal in MtF transsexuals before and after gender transition, hormone therapy, and SRS, using penile plethysmography before SRS and vaginal photoplethysmography after SRS.

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