



Patterns of Genital Sexual Arousal in Transgender Men

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Psychological Science

1–11

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DOI: 10.1177/0956797620971654

www.psychologicalscience.org/PS

Abstract

Most men show genital sexual arousal to one preferred gender. Most women show genital arousal to both genders, regardless of their sexual preferences. There is limited knowledge of whether this difference is driven by biological sex or gender identity. Transgender individuals, whose birth sex and gender identity are incongruent, provide a unique opportunity to address this question. We tested whether the genital responses of 25 (female-to-male) transgender men followed their female birth sex or male gender identity. Depending on their surgical status, arousal was assessed with penile gauges or vaginal plethysmographs. Transgender men's sexual arousal showed both male-typical and female-typical patterns. Across measures, they responded more strongly to their preferred gender than to the other gender, similar to (but not entirely like) 145 cisgender (nontransgender) men. However, they still responded to both genders, similar to 178 cisgender women. In birth-assigned women, both gender identity and biological sex may influence sexual-arousal patterns.

Keywords

sexual arousal, gender identity, transgender, sexual orientation

Received 5/14/20; Revision accepted 9/17/20

In cisgender individuals, a female birth sex matches a gender identity of woman, and a male birth sex matches a gender identity of man. There is a consistent difference between cisgender men and women in the specificity of their genital sexual arousal to sexual stimuli, measured with either a penile strain gauge or a vaginal plethysmograph. Most cisgender men show genital sexual arousal to one preferred gender but not to the other gender, whereas most cisgender women show arousal to both genders, regardless of self-reported sexual preferences (Bailey et al., 2016). There are exceptions to this general sex difference. For instance, in cisgender men, sexual responses to one preferred gender are more pronounced in heterosexual and homosexual men than bisexual men (Jabbour et al., 2020). Another exception to the general sex difference is among cisgender women. Even though homosexual women are, like heterosexual women, sexually aroused to both genders, they also respond, unlike heterosexual

women, somewhat more strongly to their preferred gender than to the other gender (Rieger et al., 2016). In general, however, specific sexual arousal to a preferred gender characterizes men more than women and can therefore be considered male typical, whereas nonspecific arousal to both genders can be considered female typical (Bailey, 2009; Chivers et al., 2007).

Because the majority of people are cisgender, their birth sex and gender identity are strongly correlated (Zucker, 2017). Thus, for most people, it is unknown whether sex differences in their sexual arousal are linked to their birth sex or gender identity. However, the very existence of transgender individuals suggests that birth sex and gender identity do not have to match, and in theory, one or the other could be more relevant

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for the organization of sexual arousal. The literature often focuses on birth sex (Bailey, 2009), but gender identity could also be influential. Gender identity is a component of social identity that affects the sense of self, treatment by other individuals, and the ascription of social roles (Eagly & Wood, 2017). Furthermore, because gender identity is so central to the self, it can cause individuals distress if their gender identity is not correctly expressed: Transgender people can experience gender dysphoria until their physical sex becomes aligned with their gender identity (de Vries et al., 2014; Murad et al., 2010). Given the relevance of gender identity to the self, it is informative to understand its potential contributions to sexual arousal, independent of birth sex.

Moreover, through a focus on transgender individuals, the study of sexual of arousal can aid in understanding the identity of those who are transgender. There are several stereotypical and stigmatizing beliefs about transgender individuals (Howansky et al., 2019). For instance, one public perception is that transgender men (i.e., female to male) are indistinguishable from homosexual cisgender women (Kiss, 2018) or that transgender men have to be attracted to women, which might make transgender men with attractions to men doubt their own gender identity (Bockting et al., 2009). A study of transgender men's physiological sexual arousal could help support the notion of their gender identities and their sexual attractions.

Transgender people have rarely been studied in this context. One reason for this is that the estimated population size is small, ranging from 0.3% to 1.3% (Zucker, 2017). One study focused on the patterns of genital sexual arousal in postoperative transgender women (i.e., male to female) with vaginal photoplethysmographs. Transgender women's arousal was specific toward their preferred gender, similar to the patterns in cisgender men and unlike the patterns in cisgender women (Chivers et al., 2004). Thus, in people with a male birth sex, sexual-arousal patterns might not be driven by their gender identity but by their birth sex.

Sexual responses of transgender men have not been studied, and because of the difference in specificity between cisgender men and women, it cannot be assumed that transgender men have sexual responses that are either equivalent to, or opposite from, those of transgender women. Thus, one of our aims in the present study was to examine whether the arousal patterns of transgender men reflect their gender identity (gender-specific sexual arousal like most men) or their birth sex (gender-nonspecific sexual arousal like most women).

Gender identity relates to appearance, behavior, and cognition; for example, transgender men are, in this respect, more male typical than most cisgender women,

Statement of Relevance

People who are transgender identify as one gender but were born with the body of the other gender. Relatively little is known about how transgender identification translates into behavior generally and into sexual responsiveness in particular. That is, do transgender people behave in line with their birth sex or in line with the gender they identify as? Because most men and women differ substantially in their sexual responses to erotic videos showing men or women, we used these sexual responses to tell us whether a person behaves in a male-typical or female-typical way. We found that even though transgender men (i.e., female-to-male transgender) had some female-typical responses, in line with their female birth sex, they also showed striking male-typical responses, in line with their male gender identity. Hence, for transgender men, their physiological sexual arousal is in part reflective of their male identity.

starting in childhood (Olson & Gülgöz, 2018; Olson et al., 2015; Singh et al., 2010; Zucker et al., 2012). Transgender men could therefore be more male typical than cisgender women in other ways, including their physiological sexual-arousal patterns. That is, if, like behavior, genital sexual arousal is associated with gender identity, transgender men might show male-typical arousal, consistent with their male identity. Therefore, they may show substantial sexual arousal to their preferred gender but not to the other gender, similar to cisgender men. However, because one study found that transgender women have male-typical arousal (Chivers et al., 2004), it could mean that for transgender people, in general, birth sex has a primary influence on their sexual-arousal patterns. Therefore, transgender men could have female-typical genital arousal and be sexually aroused to both genders, in line with their female birth sex. Furthermore, transgender men could show a combination of male-typical and female-typical patterns. That is, similar to homosexual cisgender women, who are female typical in their sexual arousal because of their responses to both genders but also male typical in the sense that they respond more to their preferred gender than the other gender (Rieger et al., 2016), transgender men may show such combination of male-typical and female-typical responses.

A further question in the present research was how genital sexual arousal can be measured in transgender men. Around 2% of transgender men undergo a surgery called metoidioplasty (James et al., 2016), which

releases the clitoris, enlarged by testosterone, from the suspensory ligament. The penis created by this procedure is 1 in. to 3 in. in length and enlarges during arousal (Cotten, 2012). It may therefore be viable to measure arousal in postoperative transgender men using a smaller penile strain gauge. Because this surgery is rare, in the present study, we were able to recruit only six transgender men who had metoidioplasty. We therefore measured the genital sexual arousal of transgender men with either a penile strain gauge or a vaginal plethysmograph, depending on surgical status. Using different measures within the same birth sex allowed for the investigation into potential differences in responses to genital sexual arousal due to differences in measurement technique.

In sum, we predicted that cisgender men's sexual-arousal patterns would be more gender specific than those of cisgender women. Furthermore, on the basis of the available literature, we predicted that one or both of the following patterns would be detected: (a) Transgender men would show male-typical sexual arousal with stronger sexual responses to the preferred gender than to the other gender, similar to cisgender men, and (b), transgender men would show female-typical sexual arousal, with sexual responses to both genders, similar to cisgender women. In addition, we explored the utility of a penile gauge instead of a vaginal probe in measuring genital sexual arousal of transgender men.

Method

This research was approved by the University of Essex's ethics committee and was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki. The experiments reported in this article were not preregistered. Requests for the data can be sent via e-mail to G. Rieger. For an explanation of additional measures that were not included in the present article, see Section S1 in the Supplemental Material available online.

Participants

Participants were recruited via United Kingdom Pride festivals, university mailing lists and fairs, and online forums for transgender men (e.g., Tumblr). Whether participants were transgender was assessed with separate questions about gender identity, birth sex, and whether the two differed. This was initially recorded through a survey and confirmed during the visit to the lab.

Participants consisted of 25 transgender men, six of whom used a small penile gauge and 19 of whom used the vaginal probe. Self-reported sexual attraction to men and women was assessed with a 7-point scale

(Kinsey et al., 1948). A score of 0 or 1 meant exclusive or almost exclusive attraction to women ($n = 5$); scores of 2, 3, or 4 stood for varied degrees of bisexual attraction ($n = 16$); and a score of 5 or 6 meant almost exclusive or exclusive attraction to men ($n = 4$). Three transgender participants took part twice because of their interest in another assessment. Because these participants are rare, we did not immediately exclude their second assessments but, rather, analyzed data in different ways: first, by including participant as a random effect to account for the repeated measures of these three participants and, second, by excluding the second assessment of these three participants (and not using participant as a random effect). The inclusion or exclusion of their repeated participation did not alter the findings (see the Results section).

Cisgender participants reported a gender identity that was congruent with their birth sex. A total of 178 cisgender women and 145 cisgender men participated during the same time frame as transgender participants. Their sexual attraction was assessed with scales that were identical to those for transgender participants (Kinsey et al., 1948). A score of 0 or 1 meant exclusive or almost exclusive attraction to women (60 cisgender women, 74 cisgender men), 2 to 4 stood for varied degrees of bisexual attraction (39 cisgender women, 28 cisgender men), and 5 or 6 meant almost exclusive or exclusive attraction to men (79 cisgender women, 43 cisgender men).

For cisgender men, the relationship (β) of their sexual attraction with their genital sexual arousal to male or female sexual stimuli falls between 0.80 and 0.90 (Rieger et al., 2015; Watts et al., 2018). Thus, significant power of 80% can be achieved with a minimum of nine cisgender men with different sexual attractions. The present study exceeded this minimum number. For cisgender women, the corresponding effect is low, at approximately 0.20 (Rieger et al., 2016). For this weak effect, the relationship of their sexual attraction with their genital response to male or female stimuli is often not significant, and a focus may be given on the expected magnitude of effect rather than on level of significance. In fact, achieving significant power of 80% for this effect requires a minimum of 193 cisgender women with varied sexual attractions. We aimed to achieve this minimum number but fell 15 participants below (results for cisgender women were still significant in predicted directions). Finally, prior data from our lab indicate that the sex difference in effect (i.e., the interaction of sexual attraction with sex, predicting genital response to men or women) has a magnitude (β) of 0.23. For this interaction, a minimum of 173 cisgender men and women with varied sexual attractions was needed to achieve significant power of 80%. The present sample exceeded this number.

Given these power analyses, if one assumes that transgender men show sexual-attraction effects like cisgender men, then a minimum of nine transgender men with varied sexual attractions is required. Our sample of 25 transgender men with different sexual attractions exceeded this minimum. However, if one assumes that transgender men show sexual-attraction effects like cisgender women, a minimum number of 193 is required. Our sample was below that minimum. Yet, as aforementioned, sexual-attraction effects in cisgender women are weak, and it may be more insightful to focus on the expected magnitude and direction of effect rather than level of significance. Furthermore, transgender men willing and able to come to a lab are drawn from a small population and therefore difficult to find. For this reason, it is scientifically informative to examine their physiological sexual-arousal patterns, even if their numbers are small.

There was no prespecified target number of transgender participants. However, we stopped recruiting when we realized that we had maxed out our opportunities to recruit transgender men (in addition to cisgender women of different sexual attractions, for whom we calculated a large number to achieve powerful effects). For consistency in methodology, all cisgender men who were recruited in the same time frame as transgender men and cisgender women were included in the analyses, even if their numbers exceeded the number set by the above power analyses.

Mean ages for transgender men, cisgender men, and cisgender women were 22.88 years ($SD = 3.70$), 24.67 years ($SD = 9.47$), and 24.37 years ($SD = 7.23$), respectively. Groups did not significantly differ in age, $F(2, 345) = 0.65$, $p = .52$, $R^2 = .004$, 95% confidence interval (CI) = $[-.009, .02]$. In transgender men, 88% were White, and 12% were of other ethnicities. In cisgender men, 83% were White, and in cisgender women, 77% were White. These percentages did not significantly differ between groups, $\chi^2(2, N = 348) = 2.82$, $p = .24$.

Materials and measures

Sexual attraction. Two 7-point Kinsey-type scales were used (Kinsey et al., 1948), which participants completed after arriving at the lab. One scale asked about sexual attraction, ranging from exclusive attraction to the opposite gender (0), to the midpoint of equal bisexual attraction (3), to exclusive attraction to the same gender (6). The other scale asked about sexual-orientation identities, ranging from exclusively heterosexual (0), to bisexual (3), to exclusively homosexual (6; for the exact phrasing, see Section S2 in the Supplemental Material). Measures were highly correlated. In cisgender men, attraction to the opposite gender (women) corresponded with a heterosexual orientation, and attraction to the same gender (men)

corresponded with a homosexual orientation, $r(144) = .98$, $p < .0001$, 95% CI = $[.98, .99]$. In cisgender women, attraction to the opposite gender (men) corresponded with a heterosexual orientation, and attraction to the same gender (women) corresponded with a homosexual orientation, $r(176) = .97$, $p < .0001$, 95% CI = $[.96, .98]$. In transgender men (who have a male identity), correlations were as in cisgender men, with an attraction to the opposite gender (women) corresponding with a heterosexual orientation and attraction to the same gender (men) corresponding with a homosexual orientation, $r(23) = .93$, $p < .0001$, 95% CI = $[.84, .97]$. Cisgender women's responses were reverse scored. Responses were then averaged for each participant. Thus, for each group, higher average scores meant stronger attraction and orientation toward men. This composite score is hereafter described as "sexual attraction to men or women."

Stimuli. Sexual videos were 3-min long, with three featuring a male model masturbating and three featuring a female model masturbating. These stimuli had been previously selected to be the most arousing videos from a large pool (Rieger et al., 2015). Baseline arousal was assessed using six 2-min clips without any sexual content taken from a nature documentary. These clips have been verified to facilitate a return to an unaroused level (Rieger et al., 2015). Videos were presented full screen with a resolution of 768×536 pixels.

Genital data. Genital responses were recorded every 5 ms using a BIOPAC MP100 data-acquisition unit and the program AcqKnowledge (Version 4.3; BIOPAC Systems, Goleta, CA). A vaginal photoplethysmograph measured change in vaginal-pulse amplitude in cisgender women and preoperative transgender men. The amplitude signal was sampled at 200 Hz and high-pass filtered at 0.5 Hz with 16-bit resolution. Amplitude was measured peak to trough for each vaginal pulse.

Penile responses of cisgender men and postoperative (metoidioplasty) transgender men were measured with a penile strain gauge, as the phallus created from the enlarged clitoris is homologous to a cisgender penis. The signal was sampled at 200 Hz, low-pass filtered to 10 Hz, and digitized with 16-bit resolution. Most gauges for cisgender men were 70 mm in circumference. Gauges for transgender men were 50 mm in circumference. Before sessions, gauges were calibrated with a cone to assess circumference increase in 5-mm steps. Signals were transformed into millimeters of circumference.

Procedure

Written consent was obtained from participants before seating them in a booth, where they faced a screen with a resolution of $1,024 \times 768$ pixels. Participants were

briefed on how to handle measurement devices and were then left in privacy for the remainder of the study. After the genital device was in place, they were instructed via an intercom to keep their eyes on the screen regardless of whether they liked the content or not. First, participants viewed a neutral stimulus, followed by sexual stimuli alternating with nature scenes, playing in a random order. The procedure took approximately 45 min.

Analyses of genital data were conducted in ways that have previously produced reliable results (Watts et al., 2018). Response to each stimulus was averaged within participants, and these averages were *z*-scored within participants. Next, standardized responses to the 10 s preceding a sexual stimulus (at the end of a neutral stimulus and when responses had returned to baseline) were subtracted from the standardized response to this stimulus. Then, for each participant, we computed an average response to all male stimuli and, separately, to all female stimuli. These average responses were then used to create a contrast score for each participant. Positive numbers indicated stronger genital responses to men, and negative numbers indicated stronger responses to women.

A further arousal score was computed to measure level of bisexual arousal by examining average arousal to female stimuli and to male stimuli and by selecting for each participant the lower of the two responses, compared with baseline. This created a new variable representing participants' responses to their less-arousing gender. Stronger responses to the less-arousing gender indicate more bisexual arousal in a participant. Cisgender women usually respond more strongly to their less-arousing gender than cisgender men, consistent with the observation that cisgender women are more bisexual in their response, on average (Rieger et al., 2015). Response to the less-arousing gender therefore appeared useful to examine the degree of male-typical or female-typical arousal patterns of transgender men.

Results

Variables for differences among transgender men, cisgender men, and cisgender women, and correlations within each group, are available in Section S3 in the Supplemental Material.

Differences between transgender men and cisgender men and women

We predicted that among cisgender participants, men would show more male-typical (gender-specific) sexual arousal than women, whereas women would show more female-typical (gender-nonspecific) sexual arousal. We

further examined whether transgender men could show male-typical patterns of genital sexual arousal, similar to cisgender men; female-typical arousal patterns, similar to cisgender women; or a combination of male-typical and female-typical patterns.

At first, we computed three multiple regression analyses, one for each group: transgender men, cisgender men, and cisgender women. The dependent variable was the contrast score (genital response to men or women). Negative numbers meant stronger sexual responses to women, and positive numbers meant stronger responses to men, across all groups. The independent variable was self-reported sexual attraction, with lower numbers meaning more attraction to women and higher numbers meaning more attraction to men, also across all groups. In the case of transgender men, we computed a mixed-effects regression analysis to account for repeated measures of three participants. Results indicated a main effect of transgender men's sexual attraction on their sexual responses to men or women, $b = 0.34$, 95% CI = [0.12, 0.57], $p = .005$, $\beta = 0.61$, 95% CI = [0.29, 0.93]. This finding means that transgender men who reported stronger attraction to women had greater genital responses to women, whereas those who reported stronger attraction to men responded more strongly to men. The corresponding effect was stronger in cisgender men, $b = 0.50$, 95% CI = [0.44, 0.55], $p < .0001$, $\beta = 0.83$, 95% CI = [0.74, 0.92], and weaker in cisgender women, $b = 0.07$, 95% CI = [0.01, 0.12], $p = .02$, $\beta = 0.18$, 95% CI = [0.03, 0.32] (Fig. 1). Thus, in each group, sexual attraction to men or women related positively to genital response to men or women, and for this effect, results for transgender men were between those for cisgender men and cisgender women.

We then conducted an additional regression analysis to test for a potential difference in effect between transgender men, cisgender men, and cisgender women, again predicting genital sexual arousal to men or women by sexual attraction. Further predictors were participant group (transgender men, cisgender men, cisgender women) and the interaction of sexual attraction with group. This interaction was significant, $b = -0.22$, 95% CI = [-0.25, -0.18], $p < .0001$, $\beta = -0.42$, 95% CI = [-0.50, -0.35], suggesting that the relationship of sexual attraction with genital sexual arousal to men or women differed by group. Specifically, for cisgender men, the effect of their sexual attraction on their arousal to men or women was significantly stronger than the average effect (taken across all groups), $b = 0.19$, 95% CI = [0.11, 0.27], $p < .0001$, $\beta = 0.37$, 95% CI = [0.21, 0.53]. In contrast, for transgender men, the effect was not significantly different from the average effect, $b = 0.05$, 95% CI = [-0.09, 0.20], $p = .46$, $\beta = 0.08$, 95%

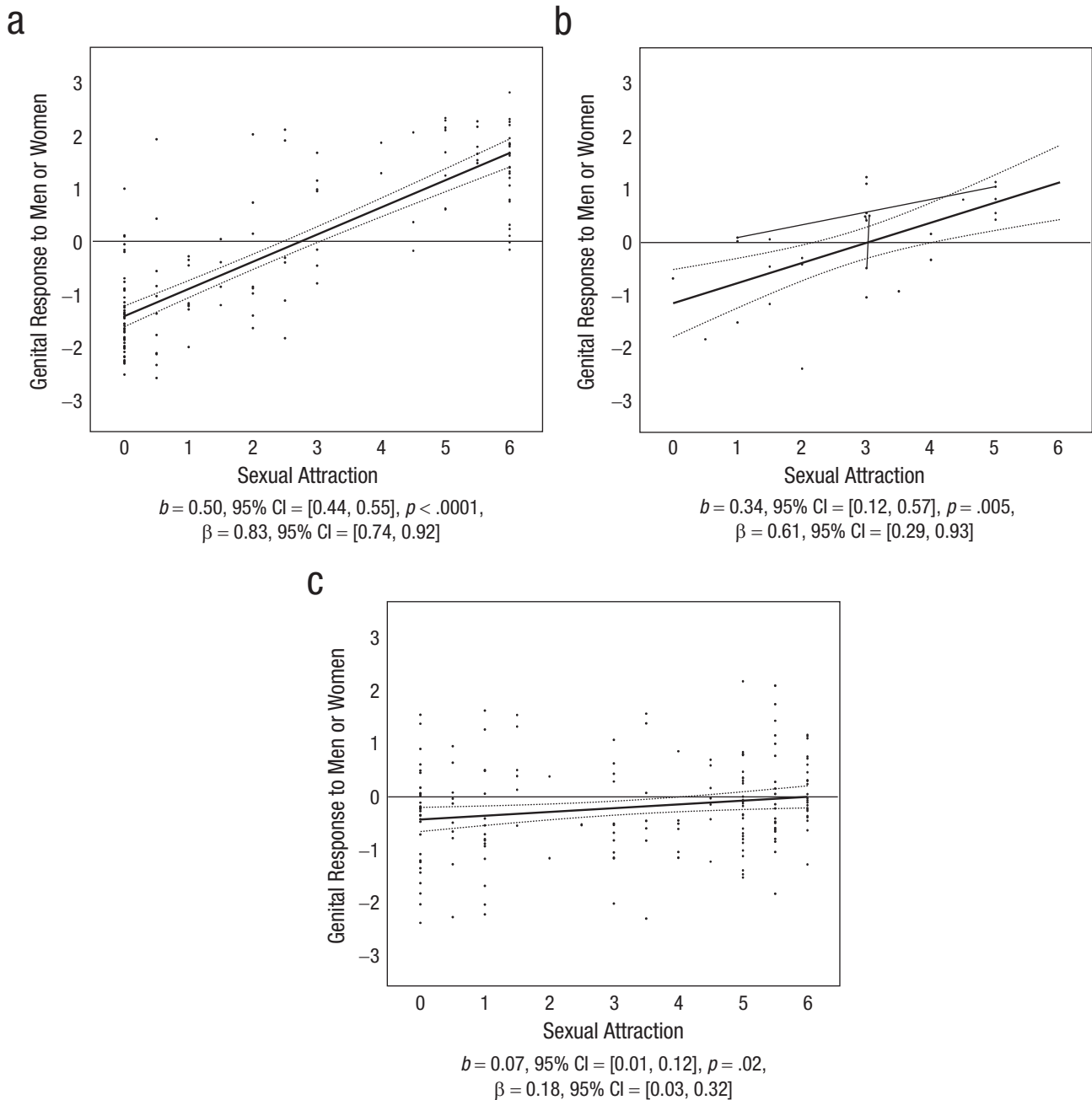


Fig. 1. Genital responses to men or women in relation to self-reported sexual attraction in (a) cisgender men ($n = 145$), (b) transgender men ($n = 25$), and (c) cisgender women ($n = 178$). On the x-axis, lower scores indicate more self-reported attraction toward women, 3 indicates an equal bisexual attraction, and higher scores indicate more attraction toward men. On the y-axis, negative scores indicate more genital sexual arousal toward women (standardized within participants), 0 indicates equal arousal, and positive scores indicate more arousal toward men. Each dot represents a participant. The thin solid lines in (b) connect data of repeatedly measured participants. In all graphs, the thick solid lines represent regression estimates, and the dashed lines above and below them represent 95% confidence intervals (CIs). The statistics represent main effects of sexual attraction on genital sexual arousal to men or women.

CI = [-0.13, 0.29]. For cisgender women, this effect was smaller than the average effect, $b = -0.24$, 95% CI = [-0.32, -0.16], $p < .0001$, $\beta = -0.45$, 95% CI = [-0.60, -0.30]. These results confirm the findings illustrated in Figure 1: Transgender men's arousal was shifted in a male-typical direction because they were more aroused

to their preferred gender than to the other gender. This effect was not as strong as in cisgender men but was stronger than in cisgender women.

We note that in Figure 1b, one of the repeatedly measured transgender men had a change in self-reported sexual attraction (from Kinsey 1 to 5), and this was

reflected in a change in arousal. Excluding the second sessions of these repeated participants, the overall effect of transgender men's sexual attraction on their arousal patterns remained similar to the one reported above, $b = 0.35$, 95% CI = [0.14, 0.56], $p = .002$, $\beta = 0.59$, 95% CI = [0.24, 0.94].

To further test the degree to which transgender men's arousal was shifted in a male-typical or female-typical direction, we examined group differences in their responses to the less-arousing gender, which was our index of bisexual arousal. On average, cisgender men had the weakest responses to their less-arousing gender, $M = 0.24$, 95% CI = [0.17, 0.31], although a one-sample t test indicated that their responses still exceeded baseline (0), $t(144) = 6.70$, $p < .0001$, $d_z = 0.56$, 95% CI = [0.45, 0.68]. Transgender men had stronger responses to their less-arousing gender, compared with baseline, $M = 1.02$, 95% CI = [0.66, 1.39], $t(24) = 5.83$, $p < .0001$, $d_z = 1.16$, 95% CI = [0.91, 1.46]. Cisgender women had the strongest responses, $M = 1.29$, 95% CI = [1.20, 1.38], $t(177) = 27.95$, $p < .0001$, $d_z = 2.08$, 95% CI = [1.98, 2.19] (Fig. 2).

Prior work suggests that bisexual individuals may respond more strongly to their less-arousing sex than those with exclusive attraction to men or women (Rieger et al., 2015). Bisexuality was not the main focus of the present research, but it was important to statistically control for such a pattern. This can be tested with the quadratic effect of sexual attraction on the response to the less-arousing sex: Participants whose scores are in the midrange (bisexual range) of the Kinsey scale could have greater responses to their less-arousing sex, and thus greater bisexual responses, than those whose scores are on either end of the Kinsey scale (exclusively attracted to women or men).

Regression analyses suggested that the groups differed in the quadratic relationship of sexual attraction with bisexual arousal, which is visualized in Figure 2. In cisgender men, those with bisexual attraction had greater bisexual responses than those attracted to women only or men only; this quadratic effect of sexual attraction was significant, $b = -0.04$, 95% CI = [-0.06, -0.01], $p = .001$, $\beta = -0.36$, 95% CI = [-0.58, -0.14]. No such quadratic effect of sexual attraction on bisexual response was found in cisgender women, $b = 0.03$, 95% CI = [-0.003, 0.06], $p = .07$, $\beta = 0.15$, 95% CI = [-0.01, 0.31], and transgender men, $b = -0.04$, 95% CI = [-0.21, 0.12], $p = .60$, $\beta = -0.10$, 95% CI = [-0.50, 0.31]. A further regression analysis indicated that when we controlled for these differences in the quadratic effect of sexual attraction, average group differences in bisexual response remained significant. Cisgender men showed lower-than-average bisexual responses (averaged across all groups), $b = -0.46$, 95% CI = [-0.63, -0.28], $p < .0001$, $\beta = -0.56$, 95% CI = [-0.78, -0.33]; transgender men had

greater bisexual responses compared with the average response, $b = 0.23$, 95% CI = [0.01, 0.44], $p = .04$, $\beta = 0.19$, 95% CI = [0.01, 0.37]; and cisgender women also had greater bisexual responses, $b = 0.22$, 95% CI = [0.05, 0.38], $p = .009$, $\beta = 0.29$, 95% CI = [0.07, 0.51].

Overall, results indicated that transgender men were relatively more male typical than cisgender women in their genital sexual arousal because they showed stronger responses to their preferred gender, but they were still more female typical than cisgender men because of their levels of bisexual arousal. Cisgender men and cisgender women differed in the predicted way.

Penile-gauge and vaginal-probe measures in transgender men

A further component of the present research was investigating the use of a penile gauge or a vaginal probe in transgender men. For transgender participants only, we conducted a mixed-effects regression analysis, with genital sexual arousal to men or women as the dependent variable and sexual attraction and measurement device (vaginal probe or penile gauge) as the independent variables. We also tested for an interaction between sexual attraction and device. Participants were a random effect to account for repeated measures of three participants.

Results showed a significant effect of sexual attraction, $b = 0.36$, 95% CI = [0.14, 0.58], $p < .003$, $\beta = 0.63$, 95% CI = [0.30, 0.97]; no significant effect of device, $b = -0.23$, 95% CI = [-0.99, 0.52], $p = .52$, $\beta = -0.12$, 95% CI = [-0.45, 0.22]; and no significant interaction of sexual attraction with device, $b = -0.17$, 95% CI = [-0.70, 0.37], $p = .52$, $\beta = -0.10$, 95% CI = [-0.44, 0.24]. Thus, across measures, transgender men had male-shifted arousal patterns; their arousal to men or women was linked to their self-reported attraction. When we excluded the second session for the three participants who took part twice, both the main effect for sexual orientation, $b = 0.36$, 95% CI = [0.14, 0.58], $p = .003$, $\beta = 0.60$, 95% CI = [0.24, 0.97], and device, $b = -0.17$, 95% CI = [-0.95, 0.60], $p = .64$, $\beta = -0.08$, 95% CI = [-0.45, 0.28], remained similar, as did the interaction, $b = -0.16$, 95% CI = [-0.71, 0.39], $p = .56$, $\beta = -0.10$, 95% CI = [-0.47, 0.26].

To further examine the effects of each measurement device, we computed additional mixed-effects regression analyses, separately for each device, predicting sexual-arousal patterns by sexual attraction. For the 19 participants who used the vaginal probe, their self-reported attraction correlated with their genital sexual arousal to men or women, $b = 0.33$, 95% CI = [0.04, 0.63], $p = .03$, $\beta = 0.59$, 95% CI = [0.20, 0.98]. This effect was not significant in the six participants who used the penile gauge, $b = 0.48$, 95% CI = [-0.16, 1.13], $p = .10$,

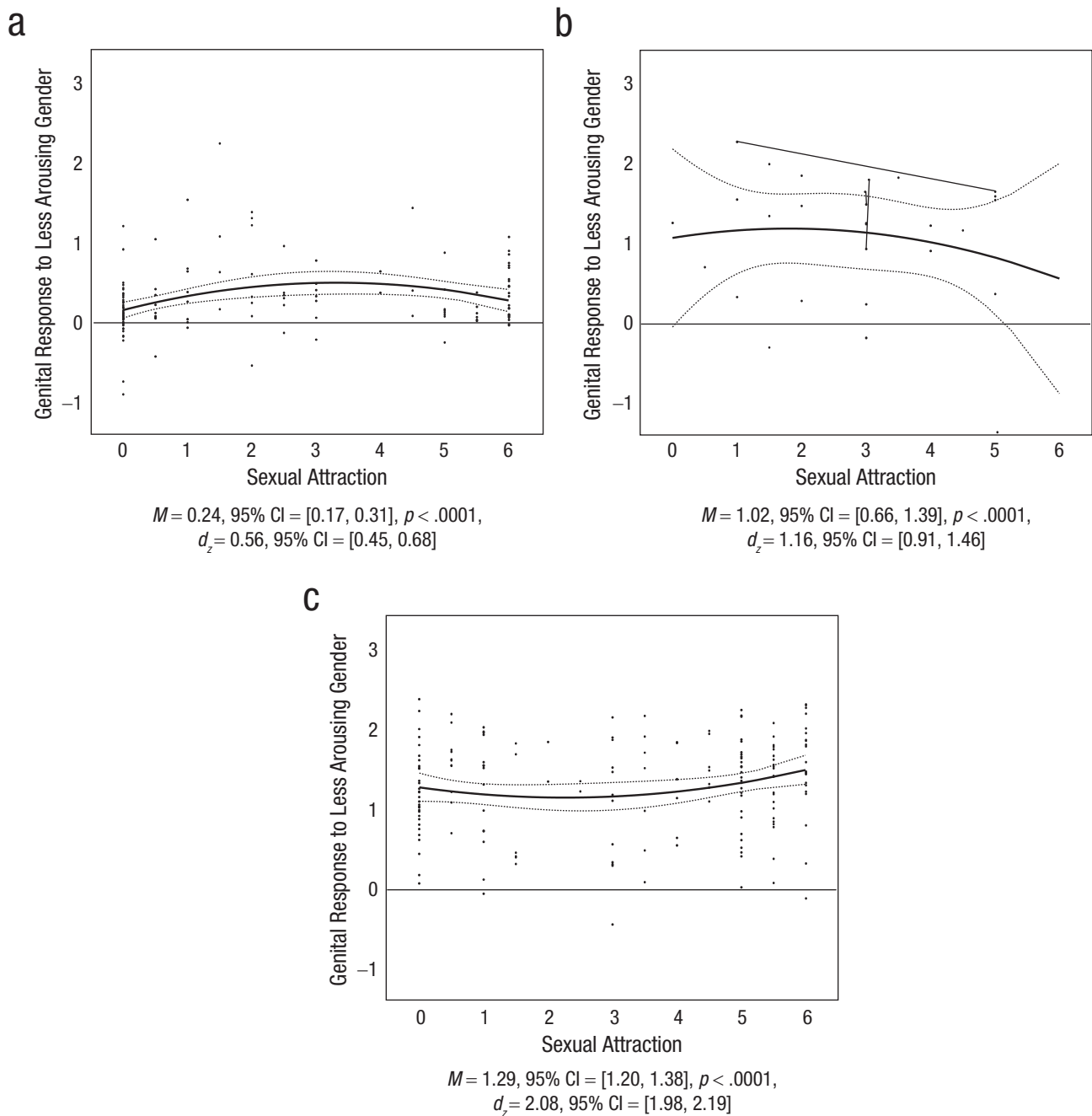


Fig. 2. Genital responses to the less-arousing gender in relation to self-reported sexual attraction in (a) cisgender men ($n = 145$), (b) transgender men ($n = 25$), and (c) cisgender women ($n = 178$). On the x -axis, lower scores indicate more self-reported attraction toward women, 3 indicates an equal bisexual attraction, and higher scores indicate more attraction toward men. On the y -axis, higher scores indicate stronger genital responses toward the less-arousing gender (standardized within participants). Each dot represents a participant. The thin solid lines in (b) connect data of repeatedly measured participants. In all graphs, the thick solid lines represent regression estimates, and the dashed lines above and below them represent 95% confidence intervals (CIs). The statistics show mean responses to the less-arousing gender and associated effect sizes, both determined by comparing these responses with baseline (0).

$\beta = 0.73$, 95% CI = [-0.06, 1.52], even though their effect was larger in magnitude than for those who used the vaginal probe. Overall, with both measures, there were correspondences of transgender men's self-reported

sexual attraction with their sexual-arousal patterns (Fig. 3). When we excluded the second session for the three participants who took part twice, both the effect for the vaginal probe, $b = 0.33$, 95% CI = [0.08, 0.58], $p = .01$,

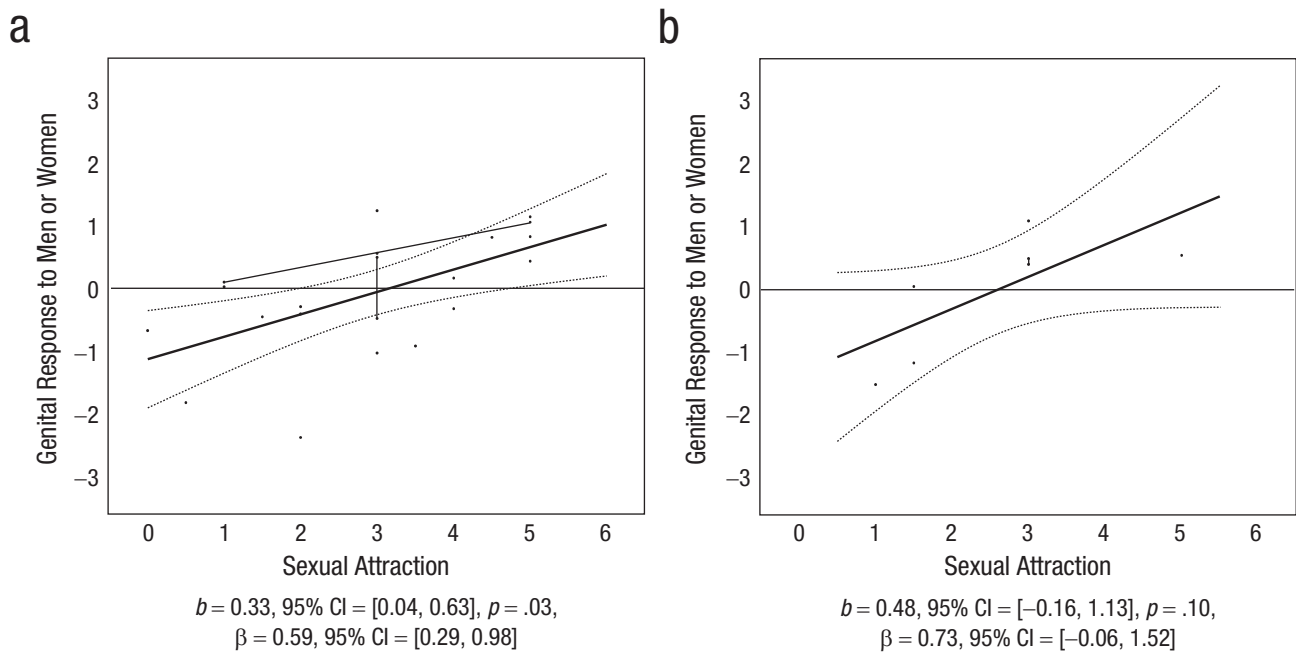


Fig. 3. Genital responses to men or women in relation to self-reported sexual attraction in transgender men who used (a) the vaginal probe ($n = 19$) and (b) the penile gauge ($n = 6$). On the x -axis, lower scores indicate more self-reported attraction toward women, 3 indicates an equal bisexual attraction, and higher scores indicate more attraction toward men. On the y -axis, negative scores indicate more genital sexual arousal toward women (standardized within participants), 0 indicates equal arousal, and positive scores indicate more arousal toward men. Each dot represents a participant. The thin solid lines in (b) connect data of repeatedly measured participants. In both graphs, the thick solid lines represent regression estimates, and the dashed lines above and below them represent 95% confidence intervals (CIs). The statistics represent main effects of sexual attraction on genital sexual arousal to men or women.

$\beta = 0.55$, 95% CI = [0.13, 0.98], and the penile gauge, $b = 0.48$, 95% CI = [-0.16, 1.22], $p = .10$, $\beta = 0.72$, 95% CI = [-0.24, 1.68], remained similar to those reported above.

Discussion

The present findings suggest the existence of both male-typical and female-typical sexual-arousal patterns in transgender men because they showed some gender-specific sexual arousal, similar to cisgender men, but also showed bisexual arousal, similar to cisgender women.

Because of the small population of transgender men (Zucker, 2017), our sample of transgender men was small and was reduced further by the intrusive nature of the experiment. Thus, we consider it notable that we were able to recruit 25 transgender men. However, this small sample is a limitation of this work, and our following interpretations are tentative.

The present findings differed from the results of a previous study that focused on genital sexual arousal in transgender women and who showed patterns typical for their male birth sex and atypical for their female gender identity (Chivers et al., 2004). In our sample of transgender men, arousal patterns were at least partially

in line with their male gender identity. This included the finding that transgender men who reported attraction to women were indeed sexually aroused by women, and those attracted to men were indeed aroused by men. This makes these two groups of transgender men distinct from each other, in addition to each group being distinct from cisgender women of different sexual attractions. Hence, transgender men should not be dismissed as being “lesbians in denial” (Kiss, 2018), nor should those who report attraction to men be dismissed as not having a male gender.

Another component of the present study was the use of different arousal measures for transgender men. Penile gauges appeared to capture arousal in postoperative transgender men and did not lead to different patterns of sexual responses compared with transgender men who used the vaginal probe. We stress that the number of transgender men who used a penile gauge was small, and no firm conclusions can be made. Still, some speculation is useful. If one assumes that these findings were valid, it would suggest that the arousal functions of a penis created through metoidioplasty are similar to those of cisgender penises. This interpretation, too, would verify the male typicality of transgender men. Furthermore, because transgender men who used the vaginal probe and those who used

the penile gauge had similar arousal patterns, it suggests that different measurement devices do not inherently result in different responses. Different measurement devices are often used for cisgender men and women, and they repeatedly show different arousal patterns (Chivers, 2017). The present findings indicate that the vaginal probe can pick up gender-specific arousal patterns in birth-sex women, which suggests that it is not a matter of the device that leads to gender-nonspecific arousal patterns in cisgender women. This conclusion is in line with emerging work using alternative measures of sexual arousal that confirm that sexes differ in the gender specificity of their sexual responses, such as genital thermography (Huberman & Chivers, 2015) or clitoral responses (Suschinsky et al., 2020).

Future research should test a larger sample of transgender men with a more equal distribution of sexual attraction, measurement type, and transition stage. In the present sample, 20 participants used testosterone supplements, whereas five did not. We could not detect reliable differences in effect depending on the use of testosterone (results not discussed above), but because the latter group was so small, this null finding may not be reliable. In future work, researchers should also consider other factors that could affect transgender men's sexual-arousal patterns, including the types of sexual stimuli used or their history of male and female romantic and sexual partners.

In conclusion, transgender men appear to show a combination of male-typical and female-typical patterns of genital sexual arousal. These results indicate that for birth-assigned women, differences in sexual arousal may not be solely based on their natal sex but may also be influenced by their gender identity. In other words, for transgender men, their physiological sexual arousal is at least in part reflective of their gender identity.

Transparency

Action Editor: Kate Ratliff

Editor: Patricia J. Bauer

Author Contributions

J. Raines, L. Holmes, and G. Rieger designed the study with assistance from S. Orbell. J. Raines, L. Holmes, T. M. Watts-Overall, E. Slettevold, and D. C. Gruia conducted the experiment. J. Raines, L. Holmes, and G. Rieger analyzed the data and wrote the manuscript. S. Orbell revised the manuscript. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

Funding


This research was supported by the American Institute of Bisexuality (RSC2519) and the University of Essex (DG00832).

Open Practices

Data and materials for this study have not been made publicly available, and the design and analysis plans were not preregistered.

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Supplemental Material

Additional supporting information can be found at <http://journals.sagepub.com/doi/suppl/10.1177/0956797620971654>

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