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Abstract

Some research suggests that bisexual-identified men show bisexual genital arousal, whereas other research indicates monosexual arousal: they are aroused to one sex only. These seemingly contradictory findings may be due to the type of men identifying as bisexual and the performed analyses. We examined whether both bisexual and monosexual arousal patterns could co-occur within the same sample. 114 men of different sexual orientations viewed erotic videos of males or females while their penile circumference was measured. On average, bisexual-identified men were more aroused to males than females, and especially if WKHLGHQWLILHGDVELEWHXDO. However, also on average, bisexual men showed bisexual arousal, and especially if they were

ELVH[XDO OHDQh' . Furthermore, there was more variability in the arousal patterns of bisexual-identified men, compared with other men. Based on their physiological sexual arousal, bisexual men appear to be a more diverse group than men who identified as heterosexual or homosexual.

Keywords: sexual orientation, sexual arousal, bisexuality

Bisexual Men with Bisexual and Monosexual Genital Arousal Patterns

Physiological sexual arousal to erotic stimuli can be assessed in laboratory settings as an indicator of male sexual orientation. Heterosexual and homosexual men typically show specific sexual arousal patterns, with most heterosexual men being exclusively aroused to females and most homosexual men being exclusively aroused to males (Bailey, 2009; Freund, 1963; Freund, Watson, & Rienzo, 1989; Rieger et al., 2015). However, unlike for most heterosexual or homosexual men, the genital arousal patterns of bisexual-identified men do not necessarily match their sexual self-identities (Bailey, 2009). In most research, the majority of bisexual-identified men showed genital arousal patterns that resembled those of homosexual men (Bailey, Rieger, & Rosenthal, 2011; Freund, Langevin, & Barlow, 1974; Rieger, Chivers, & Bailey, 2005; Tollison, Adams, & Tollison, 1979). Moreover, a sub-group of bisexual-identified men showed heterosexual arousal; yet, on average, none showed bisexual arousal (Hsu, Rosenthal, Miller, & Bailey, 2016; Rieger et al., 2005). In sum, these particular findings suggest that many bisexual-identified men are sexually aroused to one sex only, thus, show monosexual arousal, similar to most heterosexual and homosexual men.

However, evidence for bisexual arousal patterns in men comes from other studies that worked with the same dataset (Rosenthal, Sylva, Safron, & Bailey, 2011; 2012; Rieger, Rosenthal, Cash, Linsenmeier, Bailey, & Savin-Williams, 2013). On average, these bisexual-identified men

showed substantial arousal to both male and female sexual stimuli. Similarly, a meta-analysis of existing genital arousal data at the time indicated that bisexual men show genital bisexual arousal, compared with heterosexual and homosexual men, even if this average effect was weak in magnitude, $p = .04$, $d = -.22 [-.40, -.01]$ (Rieger et al., 2015).

A different line of research suggests that bisexual men are sexually aroused if presented with bisexual stimuli; that is, sexual stimuli simultaneously depicting males and females (Cerny & Janssen, 2011; Rosenthal, Sylva, Safron, & Bailey, 2012). Because of the nature of these stimuli it is difficult to distinguish if these bisexual men were sexually aroused by both sexes, or only one of the presented sexes. In fact, when responses of the same men to stimuli depicting only men or only women were investigated, bisexual-identified men from one dataset showed bisexual arousal patterns (Rosenthal, Sylva, Safron, & Bailey, 2011), whereas in the other dataset they had arousal patterns similar to homosexual men (Bailey et al., 2011).

This review so far indicates that there might be different types of men who identify as bisexual, and depending on the sample, their arousal patterns may or may not confirm their sexual self-identities. However, these varied findings might not be purely a matter of sample. Depending on the types of analyses, bisexual or seemingly monosexual arousal can be observed in bisexual men. For example, if a contrast score of arousal to males versus females is used, bisexual men may show homosexual arousal in the sense that they are more aroused to men than women (Rieger et al., 2005; Rieger et al., 2013). Yet, such a contrast score cannot point to substantial arousal to both sexes. For instance, a bisexual man might be more aroused to men than women, but still show stronger arousal to women than most homosexual men. Similarly, another bisexual man might be more aroused to women than men, but still show stronger arousal to men than most heterosexual men. Thus, bisexual-identified men could show stronger responses to their physiologically less-

arousing sex compared to heterosexual or homosexual men, and therefore show bisexual arousal (Bailey, 2009). In fact, when their sexual responses to their physiologically less arousing sex are examined, bisexual men can, on average, show bisexual arousal patterns, even though they simultaneously show stronger arousal to men than women (Rieger et al., 2013). Thus, the type of bisexual or not.

Moreover, the review thus far indicates that some bisexual-identified men show bisexual arousal, whereas others show arousal to men only, and still a subset may show arousal to women only. This could mean that within a group of bisexual-identified men, there is greater variability in their sexual arousal to males and females as compared to both heterosexual men (who are primarily aroused to women) and homosexual men (who are primarily aroused to men). In fact, such increased variability in the arousal patterns of bisexual-identified men has been reported, independent of whether bisexual men showed bisexual arousal patterns or not on a group level (Rieger et al., 2005; Rieger et al., 2013).

Even though the present research focused on genital arousal patterns, it is noteworthy that across other objective measures of sexual response, results for bisexual men also appear mixed. For instance, with regards to pupil dilation to sexual stimuli, one study indicated that bisexual men had bisexual responses (Rieger & Savin-Williams, 2012), but another study did not confirm this pattern (Rieger et al., 2015). A third study indicated that bisexual men showed more pupil dilation to both males and females, on average, than heterosexual and homosexual men (Attard-Johnson, Bindemann, & Ó Ciardha, 2016). With regards to neural responses, one study suggested that bisexual men had less distinct reactions to male and female stimuli than heterosexual or homosexual men (Safron et al., 2017).

A topic related to bisexuality concerns men whose identities indicate a strong preference for one sex, but not H[FOXVLYHO\VR VXFK DV PRVWO\KHWHURVH[XDORU PRVWO\KRPRVH[X (Vrangalova & Savin-Williams, 2012). In one study, mostly heterosexual men showed more genital arousal and pupil dilation to female than male sexual stimuli, but still responded more strongly to both sexes than exclusively heterosexual men (Savin-Williams, Rieger, & Rosenthal, 2013). Correspondingly, mostly homosexual men appear more bisexual in their genital arousal, if not pupil dilation patterns, than homosexual men (Savin-Williams, Cash, McCormack, & Rieger, 2017; Semon, Hsu, Rosenthal, & Bailey, 2017). However, it has not been systematically investigated how the arousal patterns of mostly heterosexual and mostly homosexual men compare to those of men who report bisexual attractions with equal preferences. We therefore examined the arousal patterns of men who reported sexual orientations to both males and females but varied in whether they were leaning more towards men or women.

In sum, the literature suggests that at least three patterns of genital arousal can be detected in a group of bisexual-identified men. We therefore made the following predictions:

1) On average, bisexual-identified men will show arousal patterns more similar to homosexual men than to heterosexual men.

2) However, also on average, bisexual men will show substantial bisexual arousal, compared with homosexual men and heterosexual men.

3) There will EH JUHDWHU YDULDELOLW\LQ ELVH[XDO PHQ\ JHQLWDO DURXVDO WRZ women when compared with homosexual men and heterosexual men.

In addition to these predictions, our analyses allowed examining men who reported attraction to both men and women, but with a stronger preference for one sex over the other. Because the literature on this topic is sparse, we made no predictions about how the arousal

patterns of bisexual-attracted men with stronger preferences for one sex compared to those who reported equal preferences to men and women.

Method

~~RESULTS~~

Recruitment and Participants

Participants were recruited from university events and Pride events, Facebook groups, and WKHFVXDOHQFRXQWHUVVHFWLRQRIKEDULHOLVWURU. Participants would not have any significant influence on results. Our advertisements asked to SDUWLFLSDWHLQDVWXGRQVH[XDODURXVDOLQRU to understand the exprHVVLRQRIVH[XDORULH[DWDWLRQ. Participants were not informed on hypotheses.

We estimated sample size based on previous studies, one of which reported that bisexual men showed significant bisexual arousal (Rosenthal et al., 2011), the other reported significant homosexual arousal and more variability in arousal (Rieger et al., 2005). Both of these studies used data from 80-90 men across different sexual orientations for analyses; we therefore aimed for 90 men with varied sexual orientations as a minimum.

A total of 134 men were recruited. However, 6 men (2 heterosexual, 1 bisexual, 3 homosexual) were excluded from analyses due to problems with apparatus. Another 14 men (5 heterosexual, 3 bisexual, 6 homosexual) were excluded due to a lack of sufficient arousal, using criteria similar to past work (Rieger et al., 2005). That is, participants were excluded if they failed to exhibit a minimum of 0.5 SD genital arousal to a sexual stimulus as compared to baseline, or a minimum of 2mm increase in penile circumference compared to baseline. Fourteen men without substantial arousal out of 130 recruited men (excluding those with faulty apparatus) makes about 11% of the sample. This proportion is substantially smaller than the approximate 30% reported by Rieger et al. (2005) and closer to the 15% reported by Rosenthal et al. (2011).

Using a 7-point scale (Kinsey, Pomeroy, & Martin, 1948) the remaining 114 men identified themselves as heterosexual ($n = 36$), bisexual ($n = 11$), or homosexual ($n = 12$). The remaining 65 men were identified as heterosexual ($n = 9$), bisexual ($n = 5$), or homosexual ($n = 29$).

The average age (SD) was 23.07 (6.03). The majority (83%) was White, followed by Black (6%), Chinese (2%) and other ethnicities.

Materials and Measures

Sexual Orientation. In addition to their sexual orientation identities participants indicated their sexual attractions toward men and women on 7-point scales (Kinsey et al., 1948). Measures of sexual orientation and sexual attraction were averaged for their strong correlation ($p < .0001$, $r = .95$). For this composite, a score of 0 indicated exclusive heterosexuality, 3 bisexuality with equal preferences, and 6 exclusive homosexuality. This composite score of sexual orientation was used in all analyses.

Genital arousal. Penile circumference was measured with indium/gallium strain gauges placed around the middle of the penis. Before each session, gauges were calibrated on a cone for two circumferences (80 and 110mm). Data were recorded by a BIOPAC MP150 acquisition unit and the AcqKnowledge software package. The signal was sampled at 200 Hz, low-pass filtered to 10 Hz and digitized with 16 bits resolution.

Stimuli. We used 6 sexual videos and 7 neutral videos, lasting for 3 minutes and 2 minutes, respectively. Three of the sexual videos portrayed women and three portrayed men, masturbating in a bedroom. The sexual videos were selected in previous research to be the most attractive male and female models from a large pool of videos (Rieger et al., 2015). Neutral stimuli consisted of nature videos, 7KHFRQWH

were engaging but not sexual to help participants return to an unaroused baseline. All videos were 768 by 536 pixels resolution, presented in full screen at their regular aspect ratio.

Procedure

Upon arrival in the laboratory, participants provided written informed consent and completed a survey on their age, ethnicity, and sexual orientation. Participants were then seated in a booth facing a screen and instructed on how to place the penile gauge. This was done in privacy. Each session started with one neutral video to assure that participants were not aroused before viewing sexual stimuli. Sexual videos were presented in random order, and a sexual video was always followed by a randomly selected neutral video. After each nature video, and before the next sexual video, there was a break in which we checked whether a participant had fully returned to baseline arousal. If not, we asked him to perform an arithmetical task to distract him. Once baseline arousal was reached, the experiment continued. Each session took approximately two hours.

For each participant, genital data were averaged across the entire 3 minutes of each stimulus. We then computed z-scores of these averages within participants. Moreover, responses across the entire 10 seconds preceding a sexual stimulus (at the end of a neutral stimulus and at which time participants had returned to baseline) were averaged and z-scored. Next, the standardized response to baseline was subtracted from the standardized response to the subsequent sexual stimulus to achieve, for each stimulus, a comparison to baseline arousal. We next computed, for each participant, average values across stimuli of the same sex, reflecting his overall genital response to males and females, each compared to baseline. Finally, for each participant, we computed contrast scores representing responses to males versus females.

Results

Prediction 1

We predicted that self-identified bisexual men show, on average, arousal patterns closer to homosexual men than heterosexual men. A multiple regression analysis was conducted, predicting the genital arousal contrast to males versus females by sexual orientation. The focus was on the possibility of a quadratic effect of sexual orientation, in addition to a linear effect. We expected heterosexual men (Kinsey Score 0) to show stronger arousal to females than males, and homosexual men (Kinsey Score 6), to show stronger arousal to males than females. Men with degrees of bisexual orientations (Kinsey Scores 1-5) could fall in-between; yet, if bisexual men showed, on average, stronger arousal to males than females, their arousal pattern would be closer to those of homosexual men than heterosexual men, resulting in a negative, quadratic effect of sexual orientation on arousal.

Further to testing these predictions, an examination of the distribution of arousal scores indicated that most sexual arousal patterns could be explained by a cubic effect of sexual orientation, in addition to a quadratic effect. We therefore tested for cubic effects, simultaneously with linear and quadratic effects, in all of our analyses. We explain the meaning of these cubic effects in the following.

The linear effect of sexual orientation on the male-female genital contrast score was significant, $p < .0001$, $\beta = 1.26$, 95% CI [.90, 1.63]. This meant that, on average, heterosexual men were most aroused to females, homosexual men most aroused to males, and bisexual men fell in the middle. This linear effect was qualified by a negative quadratic effect, $p = .02$, $\beta = -.12$, [-.22, -.02]. This indicated that bisexual men were, on average, more similar to homosexual men than heterosexual men in their genital arousal patterns. Although bordering significance and not predicted, a cubic effect of sexual orientation on the arousal contrast was also found, $p = .05$, $\beta = -.37$ [-.75, .01]. This finding appeared informative. It suggested that it was ³bisexual leaning

homosexual men (Kinsey Scores 4-5), in particular, who showed arousal patterns similar to homosexual men (Figure 1A).

Prediction 2

The prediction was that bisexual men, as a group, showed more bisexual arousal than homosexual and heterosexual men. To test this prediction, we examined men's average arousal to female stimuli and their average arousal to male stimuli and then selected the lower of these two responses (whichever sex it was). This resulted in one variable representing their responses to their less arousing sex. Bisexual arousal does not need to mean equal arousal to both sexes. Rather, a response to the less arousing sex (as compared to homosexual or heterosexual men) would confirm their bisexual arousal.

We conducted a multiple regression analysis, with a focus on a curvilinear effect of sexual orientation on sexual responses to the less arousing sex. If bisexual men (who are in the midrange of the Kinsey scale) show stronger response to the less arousing sex than heterosexual men or homosexual men (who are at the end points of the Kinsey Scale), then the relationship of sexual orientation with their sexual responses should be inversely U-shaped. In fact, a negative quadratic effect indicated that bisexual men, on average, were more aroused to the less arousing sex than homosexual and heterosexual men, $p < .0001$, $\beta = -.45 [-.65, -.26]$. Although not predicted, this pattern was qualified by a cubic effect, $p = .02$, $\beta = .85 [.13, 1.56]$, because bisexual arousal was strongest for heterosexual men (Kinsey Scores 1-2), (Figure 1B).

Prediction 3

We predicted greater variability in the arousal patterns of bisexual-identified men compared with heterosexual and homosexual men. Analyses thus far indicated that, on average,

bisexual men had bisexual arousal, but with a stronger preference for males (Figures 1A & 1B). Regardless of these general findings, bisexual men also appeared to have more variability in their arousal contrast scores than heterosexual and homosexual men: some bisexual men appeared particularly aroused to males over females, and other bisexual men were particularly aroused to females over males (Figure 1A). To investigate this variability, we computed the absolute residuals from the cubic effect depicted in Figure 1A. If bisexual men had more variability in their arousal patterns than heterosexual and homosexual men, then their absolute residual values should be larger than for other men.

A multiple regression analysis was conducted, with a focus on the quadratic effect of sexual orientation on the absolute residuals of the genital arousal contrast. A negative quadratic relation showed that these absolute residuals were, on average, larger for bisexual men than homosexual and heterosexual men, $p < .0001$, $\beta = -.42 [-.62, -.22]$. This finding was marginally qualified by a cubic effect, because these residuals were largest in men who identified as heterosexual, $p = .06$, $\beta = -.69 [-.04, 1.42]$ (Figure 1C).

Discussion

Present findings suggest that, on average, bisexual men were more aroused to males than females. However, also on average, they were most likely to show bisexual arousal, compared with heterosexual and homosexual men. Furthermore, there was considerably more variability in their genital arousal to males or females, compared with other men.

These patterns have been described before, but not necessarily within the same sample, and the overall interpretation of past work was that bisexual-identified men are more likely to show homosexual arousal than bisexual arousal (Rieger et al., 2005; Rieger et al., 2013; Rosenthal et al., 2011; Rosenthal et al., 2012).

clearly evident. Work that found bisexual arousal in bisexual-identified men after exclusively sampling men who reported substantial sexual and romantic relationships with both men and women (Rosenthal et al., 2011). Thus, it appears unlikely that we, for whatever reason, oversampled those with bisexual genital arousal patterns.

Perhaps the reasons for our findings (and their difference to some past findings, in which bisexual men showed monosexual arousal) lie in the fact that most work on this topic has been conducted over the last 40 years, and it is especially the earlier work that did not confirm bisexual arousal in bisexual-identified men (Rieger et al., 2005; Tollison et al., 1979). Some men first identify as bisexual before later identifying as homosexual (Semon et al., 2017). In increasingly progressive times, larger numbers of homosexual men might skip this transitional stage, coming out as homosexual without identifying as bisexual first. It is therefore possible that those men who remain to identify as bisexual are likely to be men whose sexual arousal pattern matches their identity, and that the present study was more likely than prior research to recruit them.

Moreover, the present findings suggest a potentially informative modification to past findings. Whether or not bisexual men were, on average, likely to show bisexual arousal or homosexual arousal depended on how exactly they described themselves. Those who identified as 'bisexual' were most likely to show bisexual arousal, compared with all other men (Figure 1B). If this pattern is valid, it is worth speculating about its reasons. Perhaps, social pressures explain why men who exhibit the clearest pattern of bisexual genital arousal identify as 'bisexual leaning heterosexual.' These men might experience strong attractions towards both sexes; however, because they can be aroused to females, they lean in their identity in the heterosexual direction, acting more in line with social expectations.

In contrast to the arousal patterns of bisexual men who indicated stronger attractions to women, those who identified as bisexual leaning heterosexual were particularly likely to show strong genital arousal to males over females, and less likely to exhibit bisexual arousal (Figures 1A & 1B). This finding is consistent with the aforementioned notion that some homosexual men go through a phase of defining themselves as bisexual before adopting a homosexual identity (Semon et al., 2017).

Notably, also, variation in arousal to men or women was particularly evident in men who identified as bisexual leaning heterosexual (and showed bisexual arousal, on average) compared with those who identified as bisexual leaning homosexual (and showed arousal to men, on average; Figure 1C). This suggests that a bisexual arousal pattern is - even among the sub-group of bisexual-identified men who were most likely to show it - less consistent than a homosexual arousal pattern.

One limitation of the present work is that it offers no causal explanation as to why some men identify as bisexual and show bisexual arousal, whereas others do not. Reasons other than the speculations provide thus far might be true. For instance, bisexual men are more likely to change their sexual orientation identities over time than heterosexual or homosexual men (Savin-Williams, Joyner, & Rieger, 2012). In theory it is possible that their changing identities, or their changing sexual experiences with men and women, lead to changes in their sexual arousal patterns to males and females over time (and potentially explain varied results for their arousal patterns across different samples). Future work on bisexual arousal patterns could address this question.

Another limitation with work like ours is that the stimuli used did not have the potential to elicit bisexual genital arousal in each bisexual man. For example, in some bisexual-identified men

their bisexual arousal may only be elicited with sexual stimuli depicting both males and females (Cerny & Janssen, 2011; Rosenthal et al., 2012). Further work in this direction will likely add to the conclusion that a bisexual identity encompasses a range of men who identify as such for a variety of reasons. For some, but not for others, their reason may be based on their sexual arousal patterns.

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Figure 1. ~~REMOVED FROM PAPER~~

females, B) their genital response to their less arousing sex, and C) the absolute residuals of the effect shown in A. On the Y-axis, genital responses are z-scored within participants. On the X-axis, 0 represents an exclusive heterosexual orientation, 3 a bisexual orientation with equal preferences, and 6 an exclusive homosexual orientation. Lines represent regression coefficients with 95% confidence intervals. ~~DRWV UHSUHVHQW SDUWLFLSDQWV \$PHUJLPHV~~ linear, quadratic, and cubic effects of sexual orientation on genital arousal.