#### **ORIGINAL PAPER**



# **How Autogynephilic Are Natal Females?**

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#### **Abstract**

Blanchard proposed that autogynephilia is a natal male's paraphilic sexual arousal in response to the thought or fantasy of being a woman. Furthermore, based on evidence collected from natal males with gender dysphoria, Blanchard argued that autogynephilia is the fundamental motivation among nonhomosexual males (i.e., those not exclusively attracted to men) who pursue sex reassignment surgery or live as transgender women. These ideas have been challenged by several writers who have asserted, or offered evidence, that autogynephilia is common among women. However, their evidence was weakened by problematic measures and limited comparison groups. We compared four samples of autogynephilic natal males (N = 1549), four samples of non-autogynephilic natal males (N = 1339), and two samples of natal females (N = 500), using Blanchard's original measure: the Core Autogynephilia Scale. The autogynephilic samples had much higher mean scores compared with non-autogynephilic natal males and natal females, who were similar. Our findings refute the contention that autogynephilia is common among natal females.

**Keywords** Autogynephilia · Females · Transgender · Paraphilias · Sex differences

## Introduction

Autogynephilia has been defined as the paraphilic propensity of a natal male to experience sexual arousal by the thought or fantasy of being a woman (Blanchard, 1989a, 1991). Blanchard proposed that autogynephilia is one of two distinct motivations for transgender identity among natal males. The second motivation for transgender identity is exemplified in highly feminine natal males attracted exclusively to men, whom Blanchard called "homosexual transsexuals." Autogynephilic transsexuals are fundamentally motivated by their erotic interest in being a woman, whereas homosexual transsexuals are motivated by their non-erotic affinity with women and femininity. Consequently, according to Blanchard, autogynephilia and extreme femininity that is associated with male homosexuality are two distinct reasons why natal males pursue sex reassignment surgery. Blanchard's model has received considerable empirical support, although

some aspects have received more support than others (for reviews of research on autogynephilia, see Blanchard, 2005; Lawrence, 2013, 2017). Lawrence (2010a) has estimated that autogynephilic transsexuals are currently the most common type of male-to-female transsexual in North America and Western Europe.

The proposition that autogynephilia is a paraphilia exclusively experienced by natal males comprises two related ideas: that autogynephilia is a paraphilia and that it occurs only in natal males. These ideas are related, because paraphilias have been observed almost exclusively in natal males (American Psychiatric Association, 2013; Konrad et al., 2015). Thus, if autogynephilia was common in natal females, this would be evidence against the idea that it is a paraphilia.

In his seminal work on autogynephilia, Blanchard (1989b) developed the "Core Autogynephilia Scale." This measure includes eight items asking respondents whether they have experienced sexual arousal in response to different thoughts or fantasies about being a woman or having a woman's body. For example, one item asks: "Have you ever become sexually aroused while picturing yourself having a nude female body or with certain features of the nude female form?" Blanchard studied gender dysphoric natal males, finding that those who were exclusively attracted to men (whom he called "homosexual transsexuals") had substantially lower scores

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on the Core Autogynephilia Scale compared with other gender dysphoric natal males ("nonhomosexual transsexuals"; Blanchard, 2005). Blanchard did not assess autogynephilia in natal females or in non-gender dysphoric natal males.

# **Studies of Autogynephilia in Natal Females**

In a study focusing mainly on male-to-female transsexuals, Veale et al. (2008) also assessed natal females using items adapted from Blanchard's (1989b) Core Autogynephilia Scale. Importantly, however, they changed the wording of six (out of eight) items from the original measure. Specifically, the words "attractive or more attractive" were added. For example, Blanchard's item "Have you ever been sexually aroused by the thought of being a woman?" was changed to "Have you ever been sexually aroused by the thought of being an attractive or more attractive woman?" The authors believed these changes would make the new items more applicable to natal females. However, the item modifications also altered their meaning. Blanchard's scale assessed sexual arousal related to the fantasy or idea of being a woman; Veale et al.'s revised scale to the fantasy or idea of being an attractive, or more attractive, woman. For those whose sexuality is expressed interpersonally, being attractive may connote interpersonal sexual interaction. In contrast, autogynephilia does not require an interpersonal context. Many autogynephilic natal males' sexual fantasies involve only themselves as women. Furthermore, their sexual behaviors are often solitary, such as erotic cross-dressing in private (Blanchard, 1989a, 1991; Hsu et al., 2015, 2017; Lawrence, 2013).

Compared with male-to-female transsexuals, natal females scored significantly lower on Veale et al.'s (2008) revised scale. Despite this difference, Veale et al. noted that "a number of biological females endorsed items on the Core Autogynephilia [Scale]" (p. 595). However, they expressed skepticism about the existence of autogynephilia in natal females for two reasons: first, because the scientific and clinical literature was bereft of reports of its existence, and second, because they doubted that their measures were adequate for demonstrating it. Indeed, they concluded that "it is unlikely that these biological females actually experience sexual attraction to oneself as a woman in the way that Blanchard conceptualized it" (p. 595).

Blanchard's (1989a, 1991) original research on autogynephilia focused on clinical populations of natal males with gender dysphoria. He was primarily concerned with clarifying which, if any, were distinct populations of male-to-female transsexuals. Thus, neither non-dysphoric natal males nor natal females were assessed in this research. Moser (2009) suggested that Blanchard's neglect of the latter populations led him astray. Specifically, Moser argued that both men and women commonly experience sexual arousal to their own

bodies. Consequently, Moser recruited 51 "female professional employees of an urban hospital," to answer a 9-item scale that allegedly accurately assessed autogynephilia; 29 natal women provided responses. However, only one of these items was closely related to an item on the Core Autogynephilia Scale. Moser concluded that 93% of the respondents would be considered autogynephilic, if autogynephilia is understood as "ever having erotic arousal to the thought or image of oneself as a woman" (p. 539).

Lawrence (2010b) criticized Moser's (2009) study, arguing that the items were not good measures of autogynephilia, especially for natal women. Lawrence argued that some of Moser's items were inappropriate, because they tended to conflate sexual arousal to the idea of having a female body (or engaging in stereotypically feminine behavior) with arousal to interpersonal sexual fantasies. For example, one of Moser's items, "I have been erotically aroused by preparing (shaving my legs, applying make-up, etc.) for a romantic evening or when hoping to meet a sex partner" was an adaptation of Blanchard's item "Have you ever felt sexually aroused when putting on women's perfume or makeup, or when shaving your legs?" (Note that this item was not on the Core Autogynephilia Scale [Blanchard, 1989b] but from the Cross-Gender Fetishism Scale [Blanchard, 1985].) Only Moser's item has an interpersonal component. Furthermore, sexual arousal evoked by "preparing...for a romantic evening" seems quite different than sexual arousal evoked by putting on women's perfume or makeup or shaving one's legs in a solitary occasion. Lawrence concluded that Moser's items ostensibly measuring autogynephilia were instead measuring "something superficially resembling autogynephilia in women" (p. 1).

Beyond the questionable item content, Moser's (2009) study lacked two important comparison groups: natal males with, and without, autogynephilia. If natal females are autogynephilic in a similar manner as autogynephilic natal males, then both should show autogynephilia to a similar degree. Furthermore, both should evidence appreciably more autogynephilia compared with non-autogynephilic natal males—unless of course Moser would argue that all groups are equally autogynephilic.

Moser (2009) is not the only one to argue that autogynephilia is more common than Blanchard (1989a, 1991) proposed. Serano (2020) asserted that autogynephilia reflects female embodiment fantasies, described as "sexual arousal in response to one's real or imagined body and/or expressions of gender" (p. 768). Serano also asserted that such fantasies are relatively common, based on findings from Veale et al. (2008), Moser (2009), and Lehmiller (2018). Lehmiller surveyed 4175 American adults, one-third of whom reported that they had fantasized about being the opposite sex. Serano's analysis did not rely on empirical data beyond these three studies.



The blogger Scott Alexander (2020) surveyed a large sample of "cis men," "cis women," "trans men," and "trans women," using the following item: "Picture a very beautiful woman. How sexually arousing would you find it to imagine being her?" Although trans women tended to endorse more sexual arousal to this item compared with other groups, Alexander concluded that these feelings were common among cisgender (i.e., non-transgender) people as well. That is, Alexander was more impressed with the similarity than with the differences among the groups. However, Alexander also failed to use Blanchard's (1989b) Core Autogynephilia Scale. Indeed, Alexander's results depended on a single item that was not very similar to any from Blanchard's scale. Because single-item measures often have low reliability and validity, and because the item used was not from an existing measure of autogynephilia, interpreting Alexander's findings is difficult.

Surprisingly, no researcher to date has simply used Blanchard's (1989b) Core Autogynephilia Scale to study autogynephilia in women. All eight items can be answered by either natal males or females. For example, one item is: "Have you ever become sexually aroused while picturing yourself having a nude female body or with certain features of the nude female form?" This item straightforwardly assesses sexual arousal to the thought or fantasy (factual for natal women) of having a female body. To be sure, most natal females may find the idea of endorsing this item to be odd, but so may most natal males. Importantly, none of Blanchard's original items conflates autogynephilia with interpersonal romantic or sexual fantasies, or with the idea of being, especially attractive.

## The Current Study

We compared natal females (two samples), natal males not selected for autogynephilia (four samples), and natal males selected for autogynephilia (four samples) using Blanchard's (1989b) Core Autogynephilia Scale. To the extent that natal females tend to be autogynephilic, their scores should be elevated and more similar to those of autogynephilic natal males than to those of non-autogynephilic natal males.

#### Method

## **Participants**

## **Autogynephilic Samples**

Sample 1: Internet-Recruited Autogynephilic Natal Males. Participants were 148 adult males (M age = 34.4 0 years, SD = 11.20) recruited from Internet forums dedicated to erotic fiction and media depicting autogynephilic fantasies, including cross-dressing and male-to-female

transformation. Recruitment materials specified that eligible participants were "men, aged 18 years and older, who have sexual interest in cross-dressing or being a woman." Data from these participants were previously reported in a study by Hsu et al. (2015).

Sample 2: Autogynephilic Natal Male Crossdressers. Participants were 27 male cross-dressers (M age = 45.93 years, SD = 10.29) recruited using advertisements placed in stores, nightclubs, and Internet forums that catered to male cross-dressers in the Chicago area. Recruitment materials specified that eligible participants were "men, aged 18 years and older, who have sexual interest in crossdressing." Data from these participants were previously reported in a study by Hsu et al. (2017).

Sample 3: Social Media-Recruited Autogynephilic Natal Males. Participants were 96 natal males (M age = 44.67 years, SD = 14.01) recruited through social media sites Twitter and Reddit. Recruitment materials provided a link to a survey with the explanation that we were seeking "anyone who has 15 min to complete the survey, concerning atypical sexual interests. It is not important that you have atypical sexual interests to complete it. (We need the whole range.) Natal males and females welcome." For the sample reported here, we included only natal males who indicated on a dichotomous ("yes" or "no") item that they have ever wondered whether they might be transgender. Furthermore, all participants in this sample reported scores of 5 or lower on the Kinsey scale, which measures relative sexual attraction to the opposite sex versus the same sex during adulthood (Kinsey et al., 1948). Exclusive sexual attraction to the same sex is indicated by a Kinsey score of 6. Thus, all other scores on the Kinsey scale indicate that a respondent is not exclusively homosexual (i.e., nonhomosexual). According to Blanchard's (1989a) argument, nonhomosexual natal males who have gender dysphoria or transgender identity are autogynephilic. The single-item assessments of past transgender consideration and of sexual orientation used to identify members of Sample 3 were far less stringent than the diagnostic assessments used by Blanchard. Furthermore, Sample 3 is the only one of the four autogynephilic samples recruited in a manner that did not focus on likely autogynephilic individuals. Thus, it is possible that Sample 3 contains individuals who are not autogynephilic.

Sample 4: Internet-Recruited Autogynephilic Natal Males. Participants were 1278 natal males (M age = 29.94 years, S D = 10.64) recruited from Internet forums and other online websites focused on autogynephilic fantasies or interests, such as cross-dressing or being a woman. Recruitment materials specified that eligible participants were "cross-dressers, transfeminine people, and others broadly interested in the idea of presenting as or being women" and that they must be 18 years or older.



## **Presumptively Non-Autogynephilic Natal Male Samples**

Sample 5: Qualtrics Online Panel of Non-Autogynephilic Males. Participants were 441 adult males (M age = 46.04 ye ars, SD = 14.52) recruited using the Qualtrics Online Panel. The only requirements were that participants be at least 18 years old, male, and willing to answer questions pertaining to sexuality. No one was excluded from this sample for showing evidence of autogynephilia.

Sample 6: Social Media-Recruited Sample of Non-Autogynephilic Males. Participants were 205 adult males (M ag e = 51.45 years, SD = 14.63) recruited through social media sites Twitter and Reddit for the same survey as Sample 3 (see above). These males indicated on a dichotomous ("yes" or "no") item that they have never wondered if they might be transgender. No other exclusions were made.

Sample 7: Mechanical Turk Sample of Non-Autogynephilic Males. Participants were 392 adult males (M age = 37.11 years, SD = 12.79) recruited using the Mechanical Turk platform for paid research participants. The only requirements were that participants be at least 18 years old, male, and willing to answer questions pertaining to sexuality. No one was excluded from this sample for showing evidence of autogynephilia.

Sample 8: Prolific Sample of Non-Autogynephilic Males. Participants were 301 adult males (M age = 37.66, SD = 12.25) recruited using the Prolific platform for paid research participants. The only requirements were that participants be at least 18 years old, male, and willing to answer questions pertaining to sexuality. No one was excluded from this sample for showing evidence of autogynephilia.

#### **Natal Female Samples**

Sample 9: Social Media-Recruited Sample of Natal Females. Participants were 203 adult natal females (M age = 43.76 ye ars, SD = 12.01) recruited through social media sites Twitter

and Reddit for the same survey as Samples 3 and 6 (see above). No exclusions were made.

Sample 10: Prolific Sample of Natal Females. Participants were 297 adult natal females (M age = 34.30, SD = 11.65) recruited using the Prolific platform for paid research participants. The only requirements were that participants be at least 18 years old, female, and willing to answer questions pertaining to sexuality. No exclusions were made.

#### Measures

## Core Autogynephilia Scale

The Core Autogynephilia Scale (Blanchard, 1989b) consists of eight items in which respondents indicate dichotomous agreement or disagreement with questions about whether they have ever experienced sexual arousal by the thought of being a woman or having a woman's body (or specific parts of a woman's body). For example, one item asks: "Have you ever become sexually aroused while picturing yourself having a nude female body or with certain features of the female form?" Scores range from 0 (no endorsement of any item) to 8 (endorsement of all 8 items). Calculated separately for each sample, Cronbach's alpha ranged from 0.83 (Sample 1) to 0.93 (Samples 3, 5, and 6).

## Results

Table 1 and Fig. 1 show the mean of the Core Autogynephilia Scale for each sample (Blanchard, 1989b). Sample means were much higher for the autogynephilic samples (range 4.27–7.00) than for the non-autogynephilic samples (range 0.85–1.75). Figure 2 provides the frequency distribution of scores for each sample. Consistent with the mean differences, the figure reveals striking differences between the autogynephilic and non-autogynephilic groups. For example, every

**Table 1** Sample means for the Core Autogynephilia Scale

Sample	Group	Recruitment	Core Autogynephilia Scale			
			N	M	SD	SE
1	Autogynephilic natal males	Internet forums	148	7.00	1.73	0.14
2	Autogynephilic natal males	Chicago local venues	27	6.44	2.47	0.48
3	Autogynephilic natal males	Social media	96	4.27	3.18	0.32
4	Autogynephilic natal males	Internet forums	1278	6.86	1.91	0.05
5	Non-autogynephilic natal males	Qualtrics	441	1.48	2.56	0.12
6	Non-autogynephilic natal males	Social media	205	1.11	2.26	0.16
7	Non-autogynephilic natal males	Mechanical Turk	392	1.17	2.35	0.19
8	Non-autogynephilic natal males	Prolific	301	0.85	1.98	0.11
9	Natal females	Social media	203	1.26	2.08	0.15
10	Natal females	Prolific	297	1.75	2.11	0.12

Core Autogynephilia Scale scores range from  $0\ to\ 8$ 



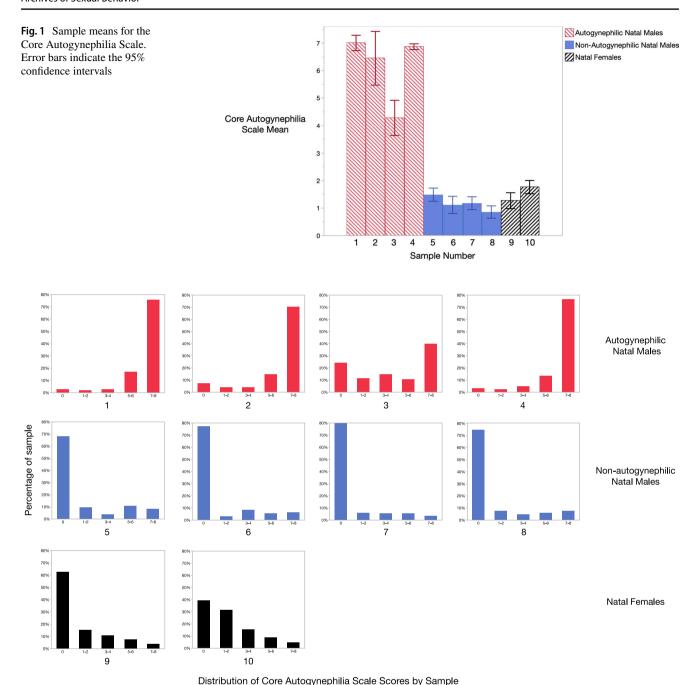


Fig. 2 Distributions of Core Autogynephilia Scale scores for the ten samples. Scores were binned as follows: 0, 1–2, 3–4, 5–6, and 7–8

non-autogynephilic sample had a much higher percentage of scores of 0 (indicating no endorsement of any autogynephilia) than of scores of 7 or 8 (indicating endorsement of all or nearly all items). In contrast, all autogynephilic samples had higher percentages of subjects endorsing 7 or 8 than endorsing 0.

Table 2 shows the results of significance tests of three planned contrasts among the various samples. (Examining a limited number of planned contrasts is preferable, with

respect to both Type 1 error control and clarity, compared with contrasting every pair of samples. All tests were conducted using the pooled error variance.) Contrasts I and II are orthogonal and thus statistically independent (Judd et al., 2017). Contrast III, comparing natal females and autogynephilic natal males, is not orthogonal to the others, but was estimated because of its importance to this study. Exact probabilities are provided so that those who want to make corrections for multiple testing can do so.



Table 2 Contrast specifications and results for statistical tests of differences in the Core Autogynephilia Scale among groups

Sample number	Group	Contrast			
		I	II	III	
1	Autogynephilic natal males	+	0	+	
2	Autogynephilic natal males	+	0	+	
3	Autogynephilic natal males	+	0	+	
4	Autogynephilic natal males	+	0	+	
5	Non-autogynephilic natal males	_	_	0	
6	Non-autogynephilic natal males	_	_	0	
7	Non-autogynephilic natal males	_	_	0	
8	Non-autogynephilic natal males	_	_	0	
9	Natal females	_	+	_	
10	Natal females	_	+	_	
	Mean	4.88	0.36	4.64	
Contrast results	SE (pooled)	0.137	0.116	0.160	
	t	35.7	3.1	29.0	
	p	$6*10^{-237}$	0.003	$2*10^{-165}$	

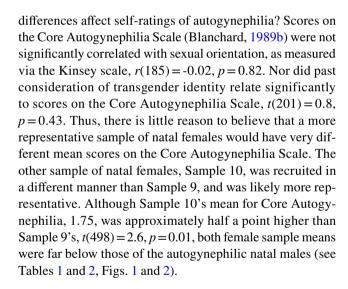
Contrast I compares autogynephilic natal males with non-autogynephilic natal males and natal females. Contrast II compares natal females with non-autogynephilic natal males. Contrast III compares autogynephilic natal males with natal females. In the upper portion of the table, columns I–III show which samples are being compared for each contrast (+indicating a positive coefficient, -indicating a negative coefficient, and 0 indicating the sample is not included in the contrast). Means for contrasts in the lower portion of the table represent the unweighted differences between sample means. Significance tests used the pooled variance estimates. Denominator degrees of freedom were 3378

Contrast I compared the average sample mean of the autogynephilic samples (Samples 1–4) with the average sample mean of the non-autogynephilic samples (Samples 5–10). This difference, 4.88 points in favor of the autogynephilic samples, was highly significant.

Contrast II compared the average sample mean of the natal females (Samples 9 and 10) with the average sample mean of the non-autogynephilic males (Samples 5–8). If female sexuality is autogynephilic to some degree, this contrast should reveal it. The difference between females and non-autogynephilic males, 0.36 points, was statistically significant (p=0.003), but much smaller than the difference between autogynephilic and non-autogynephilic participants. It was also much smaller than the highly significant difference between autogynephilic participants and natal females, 4.64 points (Contrast III).

#### **Variation in Natal Females?**

Probably owing to the Twitter followers of the first author, who recruited Samples 3, 6, and 9, one sample of natal females (Sample 9) was strikingly variable in at least two respects: sexual orientation and past consideration of being transgender. Of the 203 natal females, only 22% (N=45) reported Kinsey scores of 0 indicating exclusive heterosexuality, and 30% (N=61) had considered they might be transgender at some point in their lives. Clearly, the female sample was unrepresentative on these variables. But did these



# **Discussion**

Contrary to findings by Moser (2009) as well as speculation and analysis by Serano (2020), we found very large differences in autogynephilia between natal females and autogynephilic natal males. Our results are consistent with those of Veale et al. (2008) and Alexander (2020), who found that natal males likely to be autogynephilic scored higher than natal females on their measures of autogynephilia.



A primary advantage of the present study compared with the past research reviewed herein was our use of the Core Autogynephilia Scale (Blanchard, 1989b), which Blanchard designed for scientific research on autogynephilia. All prior research comparing natal females to autogynephilic natal males used modified or alternative measures that had questionable validity for that purpose. Furthermore, Alexander's (2000) study used a single-item instrument, likely to have low reliability.

A second advantage of the present study was its inclusion of several samples other than autogynephilic natal males. Besides natal females, the four samples of non-autogynephilic natal males and four samples of autogynephilic natal males, all recruited somewhat differently, allow some insight into the consistency of results as well as their interpretation. For example, the natal female samples (Samples 9 and 10) and the non-autogynephilic natal male samples (Samples 5–8) all had similar low mean scores on the Core Autogynephilia Scale, compared with the autogynephilic natal male samples (Samples 1–4). Thus, our results suggest that women are no more autogynephilic than typical men are.

# Scales, Traits, Sex, and Stigma

Someone intent on rescuing the hypothesis that autogynephilia is common in natal females could proceed as follows: "Look at Fig. 2. There are plenty of natal females with nonzero scores on the Core Autogynephilia Scale. See, autogynephilia is common in women!" Indeed, for example, 37% of natal females in Sample 9 and 61% of natal females in Sample 10 had scores of at least 1 on the scale.

We believe this argument is mistaken, because it equates small positive scores on the Core Autogynephilia Scale with meaningful elevation on trait autogynephilia. This equivalence is especially likely to be incorrect when comparing two groups that fundamentally differ in relevant ways, as do natal males and females. An accumulating body of research shows that men and women respond very differently to erotic stimuli (Bailey, 2009; Safron et al., 2020). Men have a more category-specific pattern of sexual arousal; that is, they tend to respond to erotic stimuli featuring the gender (or age) they find most attractive. In contrast, most women have a relatively undifferentiated pattern of sexual arousal in the laboratory. Postoperative trans women show the male pattern, consistent with their natal sex (Lawrence et al., 2005). Although research has yet to clarify the ways that these differences influence or reflect sexual interests, we suspect they limit generalizability of self-report responses from natal males to natal females. This concern is compounded by the very different distributions of scores between the natal female and the autogynephilic samples. It is also magnified by the large sex difference in paraphilic phenomena (for a discussion of this issue, see Bailey &

Hsu, 2017). If there were natal women who spent a great deal of time and erotic energy focusing on their feminine bodies and behavior, and if this sexual interest was sufficiently strong that it interfered with their interpersonal sexual relations, we would be much more credulous about the idea of autogynephilia in natal females. However, we do not know of women like this. A detailed study of natal females with high scores on the Core Autogynephilia Scale would be illuminating.

Our results suggest that in contrast to natal females, autogynephilic natal males tend to score much higher on the Core Autogynephilia Scale (Blanchard, 1989b). The percentages of autogynephilic participants with scores of 7 or 8 (the two highest scores) were 76% (Sample 1), 70% (Sample 2), 40% (Sample 3), and 76% (Sample 4). The percentages with scores of 0 (the lowest score) were 3%, 7%, 24%, and 3%, respectively. A detailed study of natal males from putatively autogynephilic samples with Core Autogynephilia Scale scores of 0 would also be illuminating.

Scientific research on autogynephilia has been heavily criticized by some activists (for a review and analysis of examples, see Dreger, 2008) and scholars (e.g., Serano, 2010, 2020), for both alleged scientific deficiencies and the belief that it is stigmatizing to transgender persons. To be sure, an increasing number of transwomen agree with the theory of autogynephilia and support its scientific investigation (e.g., Brown, 2020; Hayton, 2021; Lawrence, 2013, 2017; Yardley, 2017). But autogynephilia currently remains stigmatized among an appreciable subset of transgender persons. This provides one explanation why some autogynephilic persons, especially autogynephilic transwomen, might like to believe that autogynephilia is common. If many people experience it, then autogynephilia is both normal and unlikely to account for transgender identity, which is rare. Furthermore, autogynephilic natal males enjoy the fantasy that they are like women. If natal women were autogynephilic, then autogynephilic natal males would be like women in that respect.

We do not believe that autogynephilia should be stigmatized or associated with moral disapproval. Nevertheless, our data suggest that it is uncommon among both natal males and natal females. Indeed, it remains unknown whether any natal females experience autogynephilia, as originally conceptualized by Blanchard.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s10508-022-02359-8.

Funding Conru Foundation (Sample 4).

**Availability of Data and Materials** The item-level and total scores for the Core Autogynephilia Scale are provided as a supplementary file, in Excel format.

Code Availability Not applicable.



#### **Declarations**

**Conflict of interest** The authors have no conflicts of interests or competing interests to declare.

**Ethical Approval** The authors certify that the research complies with ethical standards and was approved by the Institutional Review Boards of Northwestern University (Samples 1–3, 5–10) and Pennsylvania State University (Sample 4).

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