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BIOLOGICAL AND PSYCHOSOCIAL CORRELATES OF ADULT GENDER-VARIANT IDENTITIES: NEW FINDINGS

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ABSTRACT

This study examined biological and psychosocial variables that are relevant to the etiology of gender-variance. Data were collected over the internet from 2277 participants of either gender who identified as transsexual, other gender-variant, and not gender-variant. We found number of gender-variant relatives, handedness, emotional abuse, finger length ratios (2D:4D), and systematizing significantly predicted Adult Gender-Variance among participants of both genders. Adult Gender-Variance was also predicted by number of older brothers among birth-assigned males. No significant differences were found in extreme right-handedness or mental rotation. No significant interaction effects were found with sexual orientation. While these findings are generally consistent with past research, there were limitations of the internet-based methodology, including a non-representative sample.

KEY WORDS: transsexualism; gender-variance; etiology; gender identity; 2D:4D; abuse; systematizing; handedness.

INTRODUCTION

A number of studies have reported biological and psychosocial correlates relevant to the etiology of gender-variance. However, none of these studies assessed more than a few of

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these in one study. Also, often these studies have not been replicated in the academic literature and sometimes they do not include comparison groups of non gender-variant (NGV) participants.

Veale, Clarke, and Lomax (2010b) reviewed previous studies of these correlates. They reported evidence for a genetic component of gender-variance based on studies of twins and other within-family concordance and of studies that have looked specifically at genes. They also reported evidence that prenatal androgen levels correlate with gender-variance, from studies of finger length ratios (2D:4D) of transsexuals, and of individuals with polycystic ovary syndrome and intersex and related conditions being more likely to have a gender-variant identity. Also, there is evidence that that transsexuals have some parts of their brain structure that is sex atypical, a greater likelihood of non-right-handedness, a greater tendency to report childhood abuse, and male-to-female (MF) transsexuals to have a greater number of older brothers (Veale et al., 2010b).

The etiological relevance of some of these variables is briefly explained here. The ratio between the length of the second and fourth fingers (2D:4D) and ability to mentally rotate three-dimensional objects are believed to be an indicator of prenatal sex hormone levels (see Veale et al., 2010b for a review). The causes of non-right handedness are not completely understood. There is evidence that non-right handedness is associated with increased prenatal androgen levels and developmental instability. Developmental instability refers to a persons' susceptibility to developmental disturbances which result in reduced reproductive fitness and increased likelihood of impaired neurodevelopment (Veale et al., 2010b). The elevated number of older brothers found in MF transsexuals (e.g. Blanchard, Zucker, Cohen-Kettenis, Gooren, & Bailey, 1996) has also been found in NGV homosexual males. It has been proposed each male fetus results in progressive immunisation of Y chromosome linked antigens for the following male fetus which results in less brain masculinisation (Blanchard & Bogaert, 1996).

The aim of the present study is to replicate the findings of previous research on number of siblings, within family concordance of gender-variance, handedness, abuse, 2D:4D, and mental rotation and explore the correlation with systematizing and parental age and cohabitation amongst a large convenience sample of gender-variant participants and NGV comparisons. This is the first study to look at a comprehensive range of these correlates and to gain some idea of the relative strength of each of them using regression analysis. We hypothesize that, consistent with previous research, there will be differences between gender-variant participants and comparison groups in the biological and psychosocial variables.

METHOD

Participants

Participants were recruited for an internet-based survey investigating the development of gender and sexuality through lesbian, gay, bisexual, and transgender (LGBT) related online forums and mailing lists and Google online advertising. A press release was also put out by Massey University which attracted some non-LGBT participants. We received 2708 responses to the questionnaire; however, the data from 431 responses could not be included because they were duplicates or were not complete enough to be included in this study. This left a convenience sample of 2277.

Participants were mostly European, well-educated and living in Western countries. Further data on ethnicity, country, level of education, and age are given by Veale, Clarke, and Lomax (2009). Male assignment at birth was reported by 66% of participants. 41% of birth-assigned males and 19% of birth-assigned females identified as transsexual; 43% of birth-assigned males and 33% of birth-assigned females identified as an other gender-variant identity (OGV; transvestite, gender queer, drag artist, cross-dresser, androgygne, or bi-, third-, omni-, or non-gendered); and 17% of birth-assigned males and 48% of birth-assigned females did not identify as a gender-variant identity (NGV).

Measures

Two versions of this questionnaire were completed. The first version collected the first 681 responses. The questionnaire was upgraded to a second version which included additional questions (outlined below) for the remaining 1596 responses.

Proportion of gay/gender-variant relatives

Participants were asked about the numbers of siblings, aunts, and uncles they had, and whether these relatives (as well as parents and grandparents) are/were homosexual/bisexual, transsexual, or OGV. This number was converted into a proportion of relatives with parents and siblings receiving twice the weighting as grandparents, aunts, and uncles because they have twice the genetic concordance. Participants who completed the second version of the questionnaire were also asked their parents' age at the time of their birth.

Abuse

Emotional abuse was measured using the five-item emotional abuse subscale of the Childhood Trauma Questionnaire – Short Form (Bernstein et al., 2003). In the present study, this scale had an internal consistency coefficient of $\alpha = .84$. Each item begins with the phrase

"When I was growing up," and participants select from a 7-point Likert response scale from "Not true at all" to "Very true". Bernstein et al. reported an internal consistency coefficient of $\alpha = .87$ among a normative sample of 579 American adults. They also reported evidence for criterion-related validity with a correlation of .48 between the scale and therapist observations of emotional abuse among a sample of adolescent inpatients. Confirmatory factor analyses have supported the construct validity of the emotional abuse subscale among adolescent psychiatric inpatients, adult substance abusers, and female health maintenance organization members (Bernstein, Ahluvalia, Pogge, & Handelsman, 1997; Bernstein et al., 1994; Bernstein et al., 2003).

Physical abuse was measured using one item of the Child Abuse and Trauma Scale that has been shown to be a accurate screener for physical abuse (Thombs, Bernstein, Ziegelstein, Bennett, & Walker, 2007).

Sexual abuse was measured using a single question designed by the third author (Veale, Clarke, & Lomax, 2010a). This question assessed both the participants' certainty and severity of the abuse.

Handedness and 2D:4D

Handedness was assessed using the Edinburgh Handedness Inventory (Oldfield, 1971) using the response scales suggested by Bogaert (2007): : 5-point responses from "Always right" to "Always left". Categorization of participants' handedness also followed Bogaert, with scores of 100 categorized as extreme-right-handed, scores from 50 to 95 moderate-right-handed and scores from -100 to 45 non-right handed.

Lengths of participants' second and fourth fingers on the right hand were also collected. The specific instructions given to participants were taken from the BBC Internet Study (Reimers, 2007). Participants were also given the option of using an "online ruler" which is simply the image of a ruler in a pop-up browser window (see Veale, 2008, details from the author, for an assessment of the online ruler).

Sexual orientation

This was measured using participants' self-rating on six-item Kinsey scales for sexual fantasies and experience used by Bailey (1989). Participants were categorized as homosexual (relative to birth-assigned sex) if they reported Kinsey scores of 5 or 6 for both fantasies and experience. 77 (31%) of male NGV participants who responded to this question were classified as homosexual. Corresponding numbers for birth-assigned male OGV participants

were 50 (8%), MF transsexuals 48 (8%), female NGV 31 (8%), birth-assigned female OGV 30 (12%), and FM transsexuals 18 (12%).

Mental rotation and systematizing

Spatial ability was measured using the Mental Rotation Test (adapted from Vandenberg & Kuse, 1978). In this 30-item test, participants were required to view two three-dimensional cuboids, and decide whether they are the same (only rotated) or different objects. Participants were given two minutes to give as many correct answers as possible and were penalized for incorrect responses. This test has consistently outperformed other measures in differentiating sex and sexual orientation, and is thought to measure underlying neurocognitive structural differences (see Rahman & Wilson, 2003 for a review).

Systematizing was measured only in the second version of the questionnaire using 8 items taken from the Systematizing Quotient – Short Form (Wakabayashi et al., 2005). This scale measures desire to construct and analyze systems. Participants respond to statements (e.g., "I find it easy to grasp exactly how odds work in betting.") on a 7-point Likert scale from "Strongly agree" to "Strongly disagree". Wakabayashi et al. reported an internal consistency coefficient of .88, factorial validity, and discriminant validity between males versus females, science students versus humanities students among a 23-item version of the Systematizing Quotient. In the present study, this scale had an internal consistency coefficient of $\alpha = .74$.

Social desirability

The Balanced Inventory of Desirable Responding (BIDR) – short form (Stober, Dette, & Musch, 2002) was included to measure social desirability. This 16-item scale used 7-point Likert scales from "Not true at all" to "Very true". Stober et al. reported internal consistencies of .66 for Self Deception and .67 for Impression Management. In the present study, the corresponding internal consistencies were .70 and .60. A number of studies have reported evidence for concurrent validity with the BIDR correlating highly with other measures of social desirability (Lanyon & Carle, 2007; Paulhus, 1988; Stober et al., 2002).

Adult Gender-Variance

Adult Gender-Variance was measured using the four items on the Cross-Gender Identity, Cross-Gender Feminization, and Cross-Gender Social/Sexual Role subscales of Docter and Fleming's (1992) Cross Gender Questionnaire that were appropriate for NGV participants and for birth-assigned females if the genders in the questions were reversed (e.g. "Since the age of 17, have you wished you had been born a boy instead of a girl?" was

reversed to “Since the age of 17, have you wished you had been born a girl instead of a boy?”). Participants responded on 7-point Likert scales from “Strongly agree” to “Strongly disagree”. From a sample of 682 birth-assigned male transvestites and transsexuals, Docter and Fleming reported internal consistency coefficients of .86-.92 on the four subscales of the Cross Gender Questionnaire, and the scale showed discriminant validity between transvestite and transsexual groups. This scale included an additional four items asking participants how masculine/feminine they think they are and how masculine/feminine they exhibit themselves to others. In the present study, the Adult Gender-Variance scale had an internal consistency coefficient of $\alpha = .85$. This scale was able to significantly distinguish between the three levels of gender-variant identity with large effect sizes (partial η^2 of .44 in birth-assigned males and .48 in birth-assigned females), suggesting construct validity.

Procedure

This survey was hosted online, and participants were recruited through Internet advertising and from the first author contacting various international gay, lesbian, bisexual, or transgender-related groups. Data analysis was conducted using SPSS version 15. Approval for this research was granted by Massey University Human Ethics committee.

Results

Between-group differences

Biological and psychosocial variables were subjected to two-way analysis of variance having three levels of gender-variant identity (transsexual, OGV, NGV) and two levels of birth-assigned gender (male, female). Results of these ANOVAs are presented in Table 1.

Significant differences between gender identity groups in Table 1 are outlined here. Female-assigned OGVs reported a significantly greater proportion of gay relatives than all of the other groups except FM transsexuals; transsexuals and OGVs reported a significantly greater number of gender-variant relatives, a greater amount of emotional, physical, and sexual abuse, and scored significantly lower on the Edinburgh Handedness Inventory (suggesting a tendency towards non-right-handedness) than NGVs; OGVs scored significantly lower than NGVs on Mental Rotation; MF transsexuals and female NGVs scored significantly lower than FM transsexuals and male NGVs on the Systematizing Quotient; FM transsexuals had a significantly older mother's age at birth than MF transsexuals; and transsexuals had significantly fewer years living with both parents and with

Table 1 Two-way ANOVAs of biological and psychosocial variables with level of gender-variant identity and birth-assigned gender as independent variables.

			Transsexual	OGV	NGV	F_{gender}	$F_{identity}$	$F_{interaction}$
Proport-	M	*n*	573	598	234	41.31,	3.86,	4.32,
ion of gay		$\overline{X}$	.025	.027	.027	$p < .01$;	$p = .02$;	$p = .01$;
relatives†		CI	.019-.031	.021-.032	.019-.036	53.88,	2.25,	3.22,
	F	*n*	140	243	352	$p < .01$	$p > .05$	$p = .04$
		$\overline{X}$	.050	.058	.036			
		CI	.039-.061	.050-.067	.029-.043			
Propor-	M	*n*	583	608	236	3.46,	14.56,	0.23,
tion of		$\overline{X}$	.011	.011	.000	$p > .05$;	$p < .01$;	$p > .05$;
gender-		CI	.008-.014	.008-.014	-.004-.005	4.04,	20.27,	0.32,
variant	F	*n*	140	242	353	$p = .05$	$p < .01$	$p > .05$
relatives†		$\overline{X}$	.015	.013	.004			
		CI	.009-.020	.008-.017	.001-.008			
Edin-	M	*n*	410	431	160	0.41,	12.57,	0.63,
burgh		$\overline{X}$	47.93	56.42	64.75	$p > .05$	$p < .01$	$p > .05$
Handed-		CI	42.92-52.93	51.53-61.30	56.73-72.77			
ness	F	*n*	87	154	264			
Inventory		$\overline{X}$	47.85	53.43	69.70			
		CI	36.97-58.72	45.26-61.60	63.46-75.94			
Emotion-	M	*n*	516	528	187	12.26,	22.71,	2.03,
al abuse		$\overline{X}$	15.64	13.14	10.30	$p < .01$	$p < .01$	$p > .05$
		CI	14.87-16.42	12.37-13.91	9.02-11.58			
	F	*n*	119	215	301			
		$\overline{X}$	16.32	14.46	13.33			
		CI	14.70-17.93	13.26-15.66	12.31-14.34			
Physical	M	*n*	501	503	188	0.14,	13.75,	2.19,
abuse		$\overline{X}$	2.24	1.80	1.29	$p > .05$	$p < .01$	$p > .05$
		CI	2.04-2.45	1.60-2.00	0.96-1.63			

	F	*n*	115	206	302			
		$\overline{X}$	1.85	2.05	1.29			
		CI	1.43-2.28	1.74-2.37	1.03-1.55			
Sexual	M	*n*	519	518	193	54.11,	5.91,	1.10,
abuse		$\overline{X}$	0.90	0.69	0.47	$p < .01$	$p < .01$	$p > .05$
		CI	0.77-1.03	0.56-0.82	0.25-0.69			
	F	*n*	122	213	298			
		$\overline{X}$	1.34	1.42	1.10			
		CI	1.06-1.61	1.22-1.63	0.93-1.28			
2D:4D	M	*n*	491	488	169	0.02,	2.73,	2.98,
		$\overline{X}$	0.993	0.982	0.984	$p > .05$	$p > .05$	$p = .05$
		CI	0.988-0.998	0.977-0.987	0.976-.993			
	F	*n*	113	203	281			
		$\overline{X}$	0.983	0.981	0.994			
		CI	0.972-0.993	0.973-0.989	0.987-1.001			
Mental	M	*n*	372	323	149	0.46,	4.94,	2.07,
rotation		$\overline{X}$	8.79	8.49	10.20	$p > .05$	$p = .01$	$p > .05$
		CI	8.12-9.46	7.77-9.20	9.15-11.26			
	F	*n*	87	150	245			
		$\overline{X}$	9.70	7.91	9.05			
		CI	8.32-11.08	6.86-8.96	8.22-9.87			
System-	M	*n*	327	333	111	1.23,	0.84,	33.33,
atizing		$\overline{X}$	26.53	31.09	34.37	$p > .05$	$p > .05$	$p < .01$
quotient		CI	25.52-27.54	30.08-32.09	32.64-36.11			
	F	*n*	67	113	185			
		$\overline{X}$	34.26	31.48	28.40			
		CI	32.03-36.50	29.76-33.20	27.07-29.76			
Mother's	M	*n*	297	297	104	9.21,	0.35,	4.10,
age at		$\overline{X}$	26.74	26.85	27.84	$p < .01$	$p > .05$	$p = .02$
partici-		CI	26.03-27.47	26.13-27.57	26.62-29.06			
pant's	F	*n*	60	101	174			
birth		$\overline{X}$	29.48	28.79	27.40			
		CI	27.88-31.09	27.55-30.03	26.46-28.35			

Father's	M	*n*	275	284	96	4.17,	0.84,	2.26,
age at		$\overline{X}$	30.11	29.66	31.14	$p = .04$	$p > .05$	$p > .05$
partici-		CI	29.29-30.93	28.85-30.47	29.74-32.53			
pant's	F	*n*	56	98	169			
birth		$\overline{X}$	32.32	31.14	30.66			
		CI	30.50-34.14	29.77-32.52	29.62-31.71			
Years	M	*n*	284	290	102	5.90,	5.94,	2.72,
until age		$\overline{X}$	14.11	13.76	15.28	$p = .02$;	$p < .01$;	$p > .05$;
18 living		CI	13.40-14.83	13.05-14.46	14.08-16.47	7.49,	3.66,	1.38,
with both	F	*n*	45	92	173	$p = .01$	$p = .03$	$p > .05$
parents†		$\overline{X}$	11.33	13.85	14.44			
		CI	9.53-13.14	12.59-15.11	13.52-15.36			
Years	M	*n*	281	288	102	1.73,	1.27,	0.61,
until age		$\overline{X}$	16.72	16.76	17.00	$p > .05$;	$p > .05$;	$p > .05$;
18 living		CI	16.31-17.12	16.35-17.16	16.32-17.68	3.57,	0.84,	0.49,
with	F	*n*	45	91	171	$p > .05$	$p > .05$	$p > .05$
mother†		$\overline{X}$	15.91	16.73	16.75			
		CI	14.89-16.94	16.00-17.45	16.22-17.27			
Years	M	*n*	281	289	102	7.29,	5.44,	2.52,
until age		$\overline{X}$	14.90	14.41	15.78	$p = .01$;	$p < .01$;	$p > .05$;
18 living		CI	14.23-15.58	13.74-15.08	14.65-16.90	8.62,	3.19,	1.35,
with	F	*n*	44	92	172	$p < .01$	$p = .04$	$p > .05$
father†		$\overline{X}$	12.14	14.22	15.03			
		CI	10.43-13.85	13.03-15.40	14.17-15.90			

Note: M = birth-assigned male; F = birth-assigned female; OGV = other gender-variant identity; NGV = no gender-variant identity; CI = 95% confidence interval; † dependent variable not normally distributed – second *F* scores for rank-order tests.

their father until age 18 than the other two groups. The ANOVA for mental rotation scores did not change significantly when age and level of education were added as covariates.

A nominal regression was calculated to see if the proportion of extreme- and non-right handed participants differed among birth-assigned gender, and gender-variant identity. NGV participants were less likely to be non-right-handed, Wald $\chi^2(1, n = 1491) = 26.18$, $p <$

.01, odds ratio = .40, and more likely to be extreme-right-handed than transsexuals, Wald $\chi^2(1, n = 1491) = 6.16$, $p = .01$, odds ratio = 1.56. OGV participants were less likely to be non-right-handed than transsexuals, Wald $\chi^2(1, n = 1491) = 8.66$, $p < .01$, odds ratio = .66.

Sexuality as a moderating variable

When homosexuality relative to birth-assigned sex (two levels – homosexual, non-homosexual) was added as a predictor variable to make three-way ANOVAs, there were no significant main effects for homosexuality on any of the variables in Table 1.

Handedness as a moderating variable

On separate tests, handedness (two levels – right-handed, non-right-handed) was added as a predictor variable to make three-way ANOVAs. For proportion of gender-variant relatives, $F(1, 2066) = 9.17$, $p < .01$, emotional abuse, $F(1, 1833) = 9.60$, $p < .01$, and mental rotation, $F(1, 1294) = 6.48$, $p = .01$, there were a significant main effects for handedness. Non-right-handed participants reported significantly more gender-variant relatives and emotional abuse and scored lower on mental rotation than right-handed participants.

Linear Regression

Linear regression models for predictors of Adult Gender-Variance among birth-assigned males and females are outlined in Tables 2 and 3 respectively. In these analyses 2D:4D and proportion of gender-variant relatives were centered – the mean subtracted from each score – to eliminate collinearity with the intercept. Predictor variables were only included if doing so resulted in an improvement of adjusted r^2. Two comparative models for are outlined in Tables 2 and 3 – the second model includes the Systematizing Quotient. This was given its own model because it is questionable whether it is measuring a biological marker (a "male brain") which could cause a gender-variant identity. Among the predictors of these models there was no evidence of multicollinearity - the greatest variance inflation factor score was 1.11, the lowest tolerance score was .90, and the highest condition index score was 13.85.

Significant predictors amongst both birth-assigned genders were gender-variant relatives, handedness, emotional abuse, 2D:4D, and systematizing. Number of older brothers predicted Adult Gender-Variance in only birth-assigned males.

Social desirability

No significant correlation was found between BIDR and reported 2D:4D among gender-variant (transsexual and OGV) participants' of both birth-assigned sexes. There was also no significant correlation between gender-variant birth-assigned females' BIDR and the

Systematizing Quotient (r = .12). While the corresponding correlation among birth-assigned males was marginally significant (r = .08, p = .05), this was not in the direction of appearing more atypical of birth-assigned gender.

Table 2 Linear regression for biological and psychosocial variables predicting Adult Gender-Variance among birth-assigned males.

Predictor	Model 1			Model 2		
	β	*t*	*p*	β	*t*	*p*
Number of older brothers (ranked)	.10	2.68	.01			
Proportion of gender-variant relatives (ranked)	.10	2.68	.01	.08	2.43	.02
Edinburgh Handedness Scale[1]	-.08	-2.18	.03	-.07	-2.08	.04
Emotional abuse	.26	6.92	<.01	.21	5.89	<.01
2D:4D	.11	2.88	<.01	.07	2.11	.04
Systematizing Quotient				-.27	-10.70	<.01
Intercept (unstandardized beta)	17.03	12.30	<.01	29.50	18.88	<.01
r^2	.12			.25		
Adjusted r^2	.12			.24		

Note: n = 667, β = standardized regression weights, [1] higher scores for right-handedness

Table 3 Linear regression for biological and psychosocial variables predicting Adult Gender-Variance among birth-assigned females.

Predictor	Model 1			Model 2		
	β	*t*	*p*	β	*t*	*p*
Proportion of gender-variant relatives (ranked)	.12	2.17	.03	.12	2.16	.03
Edinburgh Handedness Scale	-.19	-3.38	<.01	-.14	-2.50	.01
Emotional abuse	.19	3.34	<.01	.16	2.86	.01
2D:4D	-.13	-2.37	.02	-.11	-2.05	.04
Mother's age at participant's birth	.09	1.69	.09	.10	1.77	.08
Systematizing Quotient				.19	3.42	<.01
Intercept (unstandardized beta)	13.50	6.28	<.01	7.44	2.70	.01
r^2	.13			.16		
Adjusted r^2	.12			.15		

Note: n = 298, β = standardized regression weights

Sexual orientation correlations

Table 4 shows there was no relationship between sexual orientation and most of the biological and psychosocial correlates that predicted adult gender-variance on the regression models. Also, birth-assigned males did not have differing correlation coefficients to birth-assigned females. Confidence intervals were calculated using Fisher *r*-to-*z* transformations.

Table 4 Correlation between sexual orientation Kinsey score and variables predicting adult gender-variance.

		Sexual fantasy		Sexual experience	
		BA Male	BA Female	BA Male	BA Female
Older brothers (ranked)	*r*	.10**	.04	.05	.05
	95% CI	.04 to .15	.00 to .11	-.05 to .09	-.03 to .13
Proportion of gender-	*r*	-.04	.01	-.07*	.00
variant relatives (ranked)	95% CI	-.09 to .01	-.08 to .07	-.13 to -.02	-.08 to .08
Edinburgh handedness	*r*	.00	.03	.01	.10*
	95% CI	-.06 to .07	-.06 to .12	-.06 to .07	.01 to .20
Emotional abuse	*r*	.00	.00	.01	-.04
2D:4D	*r*	.04	.02	.01	-.01
Mother's age	*r*	-.02	-.03	.01	-.06
Systematizing	*r*	-.16**	-.03	-.11**	-.06
	95% CI	-.23 to -.09	-.14 to .08	-.18 to -.03	-.18 to .06

Note: * $p < .05$ ** $p < .01$; BA = birth-assigned; CI = 95% confidence interval

Within-family concordance of transsexualism

Because a very small proportion of participants reported transsexual relatives this variable was not included in the statistical analyses. However, there were six MF transsexuals who reported a transsexual relative – two brothers, a father, a maternal uncle, a paternal aunt, and a maternal grandparent. Two FM transsexuals reported a transsexual relative – a brother and a maternal aunt. Assuming that participants were aware of the gender identity of all their reported relatives, this equates to a prevalence ratio of transsexualism of 1:1479 among relatives of MF transsexuals and 1:969 among relatives of FM transsexuals.

Discussion

A number of biological and psychosocial variables were found to be associated with Adult Gender-Variance. In the variables that showed between-group differences, OGV participants tended to score intermediate between transsexuals and NGVs. This is consistent with a "dosage" effect. Those with the more extreme "dose" of the biological or psychosocial variable are more likely to develop a more extreme gender-variant identity. This is also supportive of the hypothesis that OGV identities are less extreme manifestations transsexualism, rather than distinct occurrences (cf. Veale, Lomax, & Clarke, in press).

Each of the variables assessed in this research are discussed in turn.

Number of siblings

Although there were no significant between group differences in number of siblings, number of older brothers was a significant predictor in the regression model among birth-assigned males. This finding is consistent with past research (reviewed by Veale et al., 2010b). However, in contrast to previous findings, this effect did not appear to be related to sexual orientation typology. In line with past research, there were no significant between-group differences for number of older sisters and number of younger brothers or sisters and none of these variables were significant predictors in the regression model.

Within-family concordance of sexuality- and gender-variant relatives

Birth-assigned female participants in this research were significantly more likely to report homosexual/bisexual relatives and among these, gender-variant birth-assigned females were especially likely to report such relatives. There was no tendency for birth-assigned females to be more likely than birth-assigned males to be homosexual/bisexual (relative to birth-assigned sex) in this study, meaning this effect could not be explained by the increased reporting within-family concordance of homosexuality among relatives of homosexual birth-assigned females (Bailey & Benishay, 1993; Bailey et al., 1999).

Transsexuals and OGVs of both genders were significantly more likely to report gender-variant relatives than NGVs. This is consistent with previous research that has found elevated levels of within-family concordance of gender-variance (reviewed by Veale et al., 2010b). Given the methodology of this research, it is not possible to distinguish whether this is the result of a genetic or social learning effect. However, it has been reported elsewhere that usually these individuals are not aware that their relative is gender-variant until they reach adulthood (Green, 2000), suggesting a genetic explanation is more likely. The genes

that play a role in this development may be those that are responsible for prenatal androgen levels.

However, the operational definition of gender-variant relatives was somewhat open to interpretation. Participants were asked the number of relatives they "know or suspect are gender-variant (e.g. transsexuals, transgender, transvestites, cross-dressers, drag artistes, gender-queer)". It is possible that gender-variant participants had a lower threshold for describing their relatives as gender-variant than NGV participants did. On the other hand, it might be expected that NGV participants would report a greater number of gender-variant relatives as one of the reasons that they had become interested in our research in the first place could have been because of having a gender-variant relative. For this reason we did not actively recruit participants from online groups for "significant others" of gender-variant persons.

The operational definition for transsexual relatives was stricter – a participant needed to "know" this relative was transsexual. Consistent with the findings of gender-variant relatives, the prevalence of transsexualism amongst the relatives of transsexuals was higher than the most liberal estimates amongst the general population (Tsoi, 1988; Veale, 2008).

Handedness

This study found non-right-handedness was significantly related to Adult Gender-Variance in both the between-group and regression analyses among participants assigned to either gender. This result is in line with previous findings (reviewed by Veale et al., 2010b) and consistent with the hypothesis that developmental instability has a role to play in the development of gender-variance. However, in contrast to the findings of Herman-Jeglinska, Dulko, and Grabowska (1997), this study did not find an elevated level of extreme-right-handedness among gender-variant participants, which is unsupportive of the developmental instability hypothesis.

Abuse

This study found increased levels of emotional, physical, and sexual abuse among transsexuals and OGVs. This is in line with trends of previous research (reviewed by Veale et al., 2010b) and this is one of the few studies to use a comparison group. Emotional abuse was the only significant abuse predictor of Adult Gender-Variance in the regression models. This is likely to be because emotional abuse was the strongest predictor and any additional prediction from physical and sexual abuse was not significant. Using structural equation

modeling, (Veale et al., 2010a) found evidence that abuse was a cause of gender-variance among birth-assigned males and an effect of gender-variance among birth-assigned females.

The sexual abuse findings should also be interpreted in light of the fact that it was measured using a question in which psychometric properties are not available for. This question was also double-barreled – assessing both severity and certainty – which is a sub-optimal way to construct items.

2D:4D

No between-group differences were found in 2D:4D. However, 2D:4D was a significant predictor in the regression models for both birth-assigned genders in the expected directions – masculinized 2D:4D predicted gender-variance in birth-assigned females and feminized 2D:4D predicted gender-variance in birth-assigned females. Generally this is consistent with previous research (reviewed by Veale et al., 2010b) and supportive of the prenatal hormone hypothesis.

This research did not find the usual sex difference between NGV males and female. This is likely to be because (1) a significant proportion NGV participants in this research were not heterosexual and non-heterosexuality has been related to sex-atypical 2D:4D (e.g. Manning, Churchill, & Peters, 2007) and (2) 2D:4D was self-measured which has been shown to result in increased measurement error (Manning et al., 2007).

Mental rotation

No significant relation between mental rotation score and gender-variance was found on any of the statistical tests so no further evidence for the neurobiological explanation of gender-variance can be taken from these data. However, the mental rotation test we used differed from the original by Vandenberg and Kuse (1978) in that we only had one comparison stimulus instead of three[1]; it is likely that this made the test less difficult. Also, this test did not show the usual sex difference among NGV participants. Again, this could have been because a significant proportion NGV participants were not heterosexual, and non-heterosexuality has been related to sex-atypical mental rotation scores (Peters, Manning, & Reimers, 2007).

[1] This alteration was made because we were not able to publish the original test online for copyright reasons.

Systematizing Quotient

The concept of systematizing was has been used as an explanation of the development of autism (Baron-Cohen, 2002). Systematizing refers to a person's propensity to understand and be able to construct systems. Examples of systems include computers, musical instruments, weather, mathematics, political systems, and library organizing systems (Baron-Cohen, 2002). The Systematizing Quotient was developed to measure this construct. Other studies (as well as this one) have shown that NGV males score significantly higher on this measure than NGV females (Wakabayashi et al., 2007). Baron-Cohen proposed a theory called the "extreme male brain theory of autism" postulating that persons with autism have a markedly greater systematizing ability (a male-enhanced trait) than their empathizing ability (a female-enhanced trait) and as the name of the theory suggests, those scoring higher on systematizing have more of a "male brain". Whilst social environment may play a role in systematizing development, there is evidence that autism develops prenatally, probably due to the effects of prenatal hormone levels (reviewed in Baron-Cohen, Knickmeyer, & Belmonte, 2005). A recent study of children also found that systematizing was significantly predicted by fetal testosterone levels measured in amniotic fluid – in fact it was a stronger predictor of this than sex itself (Auyeung et al., 2006). Therefore, there is reason to believe that prenatal androgen levels are a significant contributor to the development of systematizing.

The Systematizing Quotient was included as an exploratory variable as this is the first time we are aware that this variable has been used as a proxy measure of prenatal androgen exposure. As expected, we found that systematizing was a significant predictor of Adult Gender-Variance in both the between-group and regression analyses among participants assigned to both genders at birth. Systematizing was an especially strong predictor among birth-assigned males, where its inclusion doubled the variance that was accounted for in the regression model. This finding is also supportive of the neurobiological basis as an explanation of gender-variance.

The finding of no significant correlation between BIDR and systematizing in the expected direction suggests that gender-variant participants were not distorting their systematizing responses to appear more atypical of birth-assigned gender. It should, however, be noted that the factors responsible for development of systematizing are still not well understood. It would be expected that gender-variant children would pursue play and

educational activities that would impact on the development of their systematizing *and empathizing* amongst gender-variant populations.

Parental age

While it is unclear whether this would play a role as a biological or psychosocial factor, there is evidence that male homosexuality is related to higher maternal age (Frisch & Hviid, 2006; Hare & Moran, 1979), so this variable was explored in this study. While there was no evidence that parental age was associated with Adult Gender-Variance among birth-assigned males, among birth-assigned females, maternal age was a marginally significant predictor of Adult Gender-Variance. Given the marginal nature of the finding, replication is needed before speculating on the role this plays in gender-variance development.

Sexual orientation as a moderating variable

When sexual orientation typology was added to the between-group analysis it did not produce any main or interaction effects with degree of gender-variant identity. This is despite the fact that previous researchers have proposed distinct etiologies for MF transsexuals dependent on sexual orientation type (Bailey & Triea, 2007; Freund & Blanchard, 1993; Freund, Steiner, & Chan, 1982). Closer inspection of the correlation between sexual orientation and the variables that predicted Adult Gender-Variance in the linear regression models found that most were not significantly related to sexual orientation. Also, none of the correlation coefficients differed significantly between birth-assigned males and females as might be expected if the etiology of gender-variance among birth-assigned males but not birth-assigned females could be differentiated by sexual orientation.

Lawrence and Bailey (2009) concluded that MF transsexual participants in our previous research that used similar internet methodology (Veale, Clarke, & Lomax, 2008) were overwhelmingly of the non-androphilic subtype. Although a small but significant proportion of our birth-assigned male gender-variant participants reported they were exclusively androphilic on both sexual fantasy and experience, our findings should be replicated on a non-Internet sample for verification.

Handedness as a moderating variable

Non-right-handed participants reported significantly more gender-variant relatives and emotional abuse and scored lower on mental rotation than right-handed participants. The meaning of these findings is unclear and replication is needed before any

Limitations and conclusions

The aim of the study is not to assess biological *versus* psychosocial influences. We could not come to any realistic conclusions about this because we have only been able to predict such a small amount of the variance in the regression models. There is a lot of influence on Adult Gender-Variance that is not accounted for in this model due to 1) measurement error and 2) influences that we have not been able to measure. (For an assessment of the relative strength of biological versus psychosocial influences, see Veale, Clarke, & Lomax, 2010c.)

A significant limitation of this research was the response rate – 25% of participants who began the questionnaire did not complete all the questions. Also, because some of the variables were included in the questionnaire later in the research collection process the data were not missing at random, so listwise deletion was required for the regression analyses. This resulted in only 42% of the participants that that started the questionnaire being able to be included in these analyses.

Secondly, it should be noted that this study did not find the usual sex differences between NGV participants in 2D:4D or Mental Rotation. It is therefore difficult to draw strong conclusions about the association of these variables with gender-variance in our study.

Finally, because all of the recruitment and data collection was carried out online, this research only represented those from the wider population who engaged with the Internet. However, with some exceptions, the findings seem to be in line with those of previous research using clinical samples. Future research is required to replicate these findings among a non-Internet-based sample.

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