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Male Sexual Orientation in Independent Samoa: Evidence for Fraternal Birth Order and Maternal Fecundity Effects

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Abstract In Western cultures, male androphiles tend to have greater numbers of older brothers than male gynephiles (i.e., the fraternal birth order effect). In the non-Western nation of Independent Samoa, androphilic males (known locally as *fa'afafine*) have been shown to have greater numbers of older brothers, older sisters, and younger brothers (Vasey & VanderLaan, 2007). It is unclear, however, whether the observed older brother effect, in the context of the additional sibling category effects, represented a genuine fraternal birth order effect or was simply associated with elevated maternal fecundity. To differentiate between these two possibilities, this study employed a larger, independent replication sample of *fa'afafine* and gynephilic males from Independent Samoa. *Fa'afafine* had greater numbers of older brothers and sisters. The replication sample and the sample from Vasey and VanderLaan were then combined, facilitating a comparison that showed the older brother effect was significantly greater in magnitude than the older sister effect. These results suggest that fraternal birth order and maternal fecundity effects both exist in Samoa. The existence of these effects cross-culturally is discussed in the context of biological theories for the development of male androphilia.

Keywords Birth order · Maternal immune hypothesis · Fecundity · Sexual orientation · Samoa · *Fa'afafine*

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Introduction

The fraternal birth order effect refers to the finding that number of older brothers is uniquely predictive of male sexual orientation (Blanchard, 2004). Specifically, androphilic males (i.e., males who exhibit sexual attraction/arousal toward adult males) tend to have greater numbers of older brothers than gynephilic males (i.e., males who exhibit sexual attraction/arousal toward adult females). Evidence in support of the fraternal birth order effect is overwhelming. It has been documented in participants examined in recent years and in participants examined decades ago: in psychiatric patients and non-patient volunteers; in participants examined during childhood and adulthood; in transsexual participants and those who experience no dysphoria with their sexed bodies; in representative, national samples; in non-Caucasian citizens of the United States (i.e., Black, Hispanic, East Indian, and Asian); and, in samples collected from different Western nations, including England, Italy, The Netherlands, Canada, and the United States (for review, see Blanchard, 2004), by independent researchers (e.g., Bogaert, 2003; Camperio Ciani, Corna, & Capiluppi, 2004; King et al., 2005; Rahman, Clarke, & Morera, 2009; Rice, Harris, Lang, & Chaplin, 2008; Schwartz, Kim, Kolundziji, Rieger, & Sanders, 2009). In addition, this effect is specific to the influence of biological, as opposed to non-biologically related, older brothers regardless of whether males are raised with these brothers (Bogaert, 2006).

The existence of the fraternal birth order effect has prompted speculation regarding what influence biological older brothers have on the development of sexual orientation in their younger male siblings. The most prominent hypothesis is that this effect reflects the progressive immunization of some mothers to the male-specific antigens that are produced in response to the gestation of each successive male fetus. The production of maternal antibodies in response to the presence of these male-specific antigens is thought to influence the sexual differentiation of each successive male fetus' brain and, by extension, those neural regions that regulate sexual orientation. This line of reasoning has been referred to as the maternal immune hypothesis (Blanchard, 2004; Blanchard & Bogaert, 1996; Blanchard & Klassen, 1997).

Despite the reliability with which the fraternal birth order effect has been observed, Blanchard (2004) cautioned that relying solely on data from Western populations presented limitations. Because male androphilia is expressed differently across cultures (Murray, 2000), extrapolating from patterns observed in Western populations to make statements regarding the development of male androphilia in non-Western populations may be imprudent. In contrast to Western cultures in which androphilic males tend to identify as "gay" or "homosexual" men, there are many non-Western cultures in which androphilic males tend to be transgendered and occupy "alternative" gender categories that are distinguished from "men" and "women." Some contemporary examples include the *xanith* of Oman, the *hijra* of India, the *kathoey* of Thailand, the *travesti* of Brazil, the *fakafefine* of Tonga, and the *fa'afafine* of Samoa (Murray, 2000). Cultural differences in the expression of male androphilia may reflect unique cultural influences toward development, in which case attempts to compare the development of male androphilia in different cultural settings may not be warranted (e.g., Davenport, 1987; Johnson, Jackson, & Herdt, 2000).

Despite this cultural variability, cross-cultural universals in the psychosexual development of male androphiles appear to exist. For example, in Western cultures, male androphiles exhibit elevated gender-atypical behavior during childhood (Bailey & Zucker, 1995). Retrospective studies conducted in Independent Samoa, Brazil, Guatemala, Turkey, Thailand, and the Philippines have shown the same pattern of childhood gender-atypicality among male androphiles raised in these non-Western cultures (Bartlett & Vasey, 2006; Cardoso, 2005, 2009; Whitham & Zent, 1984). Such cross-cultural similarities in childhood behavior add weight to arguments that similar biological influences, which transcend cultural differences, play a role in the development of male androphilia. Further weight would be added to such arguments if it could be demonstrated that causal biological factors, such as those postulated by the maternal immune hypothesis, are likely to influence the development of male androphilia in non-Western cultures. Hence, establishing the existence of the fraternal birth order effect—a hypothesized outcome of maternal immune responses—in a non-Western culture would further substantiate arguments that similar biological influences underlie the development of male androphilia cross-culturally.

To date, no studies have demonstrated a fraternal birth order effect in a non-Western culture, but some have indicated that male androphiles in non-Western cultures tend to be later born among their siblings (Poasa, Blanchard, & Zucker, 2004; Tsoi, Kok, & Long, 1977; Vasey & VanderLaan, 2007; Zucker & Blanchard, 2003; Zucker, Blanchard, Kim, Pae, & Lee, 2007). Vasey and VanderLaan (2007) provided a systematic investigation of birth order and male sexual orientation in Samoan androphilic and gynephilic males. In Samoa, most androphilic males are referred to as members of an alternative gender category known as *fa'afafine*. Translated literally, *fa'afafine* means "in the manner of a woman." These individuals self-identify as *fa'afafine* and *not* as men or women. Although the term *fa'afafine* implies that the members of this category are uniformly very feminine, they are, in fact, a heterogeneous group in terms of their gender role presentation (Schmidt, 2003; Vasey & Bartlett, 2007). In appearance and mannerisms, although most would be considered effeminate, they range from strikingly feminine to unremarkably masculine, although instances of the latter are rare.

Utilizing a sample of 83 *fa'afafine* as well as a control group of 114 Samoan gynephilic males, Vasey and VanderLaan (2007) found that *fa'afafine* tended to have greater numbers of older brothers, older sisters, and younger brothers. The finding that *fa'afafine* have more older brothers than their gynephilic counterparts is consistent with patterns observed in Western populations. However, none of the observed sibling category effects took precedence over another (i.e., the three sibling category effects documented did not significantly differ in magnitude), indicating no clearly unique contribution of older brothers and, thus, no genuine fraternal birth order effect.

Sibling category effects, apart from older brother effects, have been reported on occasion in studies of Western populations (Blanchard, 1997; Blanchard & Lippa, 2007; Bogaert, 1998; King et al., 2005). However, given that older brother effects are reported consistently whereas other sibling category effects seem to be a relatively rare occurrence in studies conducted in Western populations, one possible explanation is that these less often observed effects represent cases of Type I error. Alternatively, these additional sibling category effects may have indicated an association between male sexual orientation and the fecundity of kin. Elevated fecundity has been documented among the kin of androphilic males (Blanchard & Lippa, 2007; Camperio Ciani et al., 2004; Iemmola & Camperio Ciani, 2009; King et al., 2005; Rahman et al., 2008; Schwartz et al., 2009). Hence, the sibling category effects that are occasionally observed alongside older brother effects may be a consequence of elevated fecundity in the mothers of androphilic males.

This study replicated Vasey and VanderLaan (2007) using a larger, independent sample to determine whether the sibling category effects they observed were genuine or were likely to represent cases of Type I error. In addition, the replication sample was combined with the sample of *fa'afafine* and gynephilic males from Vasey and VanderLaan to create the largest data set concerning birth order and male androphilia ever acquired for a non-Western population. The primary advantage of doing so was that the size of the combined sample provided greater statistical power to test for possible differences in the magnitudes of different sibling category effects, thereby allowing an assessment of whether a genuine fraternal birth order effect existed in addition to a fecundity effect.

Method

Participants

All participants were recruited through a network sampling procedure on the two larger and more populated islands of Upolu and Savai'i. A network sampling procedure involves contacting initial participants who display qualities of interest (i.e., status as *fa'afafine* or gynephilic man), then obtaining referrals from them to additional participants who, in turn, provide further referrals, and so on. The rate of participation for all groups was greater than 90%.

To replicate the study by Vasey and VanderLaan (2007), new data were collected from 133 self-identified *fa'afafine* and 208 self-identified straight men that had not been interviewed previously. These data were collected during three field trips (March–June 2007; December 2007; July–September 2008). In order to obtain sufficiently large sample sizes to compare the magnitudes of different sibling category effects, we combined the data from the 133 *fa'afafine* and 208 gynephilic males in the replication sample with data from the sample of 83 *fa'afafine* and 114 gynephilic males interviewed in Vasey and VanderLaan. Thus, the combined sample consisted of 216 *fa'afafine* and 322 gynephilic males.

Procedure and Measures

All participants were interviewed using a standardized questionnaire that was available in English and Samoan, after being translated and back-translated by two fluent Samoan-English speakers. A Samoan-speaking research assistant was present to answer Samoan-speaking participants' questions.

The questionnaire contained questions concerning basic biographic information regarding sexual orientation and age. Sexual orientation was assessed using Kinsey ratings (Kinsey, Pomeroy, & Martin, 1948). Specifically, participants were asked the following question: "Which statement best describes your sexual feelings during the last year?" Participants then selected one of the following seven possible responses: "sexual feelings only toward females" (Kinsey rating = 0), "most sexual feelings toward females, but an occasional fantasy about males" (Kinsey rating = 1), "most sexual feelings toward females, but some definite fantasy about males" (Kinsey rating = 2), "sexual feelings about equally divided between males and females with no strong preference for one or the other" (Kinsey rating = 3), "most sexual feelings toward males, but some definite fantasy about females" (Kinsey rating = 4), "most sexual feelings toward males, but an occasional fantasy about females" (Kinsey rating = 5), or "sexual feelings only toward males" (Kinsey rating = 6). Samoans, both inside and outside the *fa'afafine* community, recognize that *fa'afafine* are biological males that are socially distinct from men and women. Nevertheless, for the sake of consistency, participants were told, prior to answering questions pertaining to the Kinsey ratings, that the category "males" included straight men and/or *fa'afafine* whereas the category "females" included women.

With respect to participants in the replication sample, 129 (97%) *fa'afafine* described their sexual feelings as exclusively androphilic (Kinsey rating = 6), and the remaining 4 (3%) reported most sexual feelings toward males, but occasional fantasies about females (Kinsey rating = 5). For gynephilic males, 200 (96%) described their sexual feelings as exclusively gynephilic (Kinsey rating = 0), and the remaining 8 (4%) reported most sexual feelings toward females, but occasional fantasies about males (Kinsey rating = 1). Of the additional 83 *fa'afafine* interviewed in Vasey and VanderLaan (2007), all described their sexual feelings as exclusively androphilic (Kinsey rating = 6). Of the 114 gynephilic males, 104 (91.2%) described their sexual feelings as exclusively gynephilic (Kinsey rating = 0). Ten (8.8%) reported most sexual feelings toward females, but occasional fantasies about males (Kinsey rating = 1).

The age ranges of *fa'afafine* and gynephilic males in the replication sample were 18–53 and 18–67, respectively. We compared these *fa'afafine* and gynephilic males for age differences. *Fa'afafine* were significantly younger, on average, than the gynephilic males (*fa'afafine*, $M \pm SD = 27.83$ years $\pm$ 7.98; gynephilic males, 29.78 ± 8.73), $t(337) = 2.07$, $p = .04$. (Note: age data were missing for two *fa'afafine* participants.) The age ranges of *fa'afafine* and gynephilic males in the combined sample were 18–60 and 18–67, respectively. For the combined sample, there was no statistically significant difference between these groups with respect to age (*fa'afafine*, $M \pm SD = 28.81$ years ± 8.20; gynephilic males, 28.42 ± 8.23), $t(527) < 1$. (Note: age data were missing for eight *fa'afafine* participants and one gynephilic male participant.)

The questionnaire also included a section pertaining to birth order. Specifically, participants were asked to list all of the children their mothers gave birth to from first- to last-born. In addition to indicating their own birth order, participants indicated whether each sibling was male or female. We recorded four data points for each participant: number of older brothers, number of older sisters, number of younger brothers, and number of younger sisters. Participants' birth orders were quantified using Slater's Index (number of older siblings/total number of siblings), a metric that expresses birth order as a value between 0 (first-born) and 1 (last-born), and controls for family size (Slater, 1958). For each participant, we also computed two additional birth order indices, which were introduced by Jones and Blanchard (1998): (1) Fraternal Index (number of older brothers/total number of brothers), and (2) Sororal Index (number of older sisters/total number of sisters).

Results

Replication Sample

Table 1 presents descriptive statistics regarding the total number of siblings as well as the numbers of older brothers, older sisters, younger brothers, and younger sisters for *fa'afafine* and gynephilic males for the replication sample. *Fa'afafine* had a greater number of siblings, on average, than did gynephilic males, $t(339) = 4.63$, $p < .001$.

Table 2 presents descriptive and inferential statistics pertaining to the Slater's, Fraternal, and Sororal indices for *fa'afafine* and gynephilic males in the replication sample. Slater's, Fraternal, and Sororal index values could not be computed for participants who did not have siblings, brothers, or sisters, respectively. Inferential statistics were performed to test for biases in the birth orders of *fa'afafine* and gynephilic males. For each index, the mean index value for each group was compared against a value of .5, the expected mean index value for samples drawn from a hypothetical stable population. *Fa'afafine* were significantly more likely to be later born according to all three indices. Gynephilic males were significantly more likely to have been early born according to Slater's index, but did not differ significantly from the expected .5 value for the Fraternal and Sororal indices. Between-group comparisons of *fa'afafine* and gynephilic males revealed that *fa'afafine* were significantly more likely to be later born for all three indices.

A logistic regression analysis was conducted with sexual orientation (i.e., gynephilic versus androphilic) as the dichotomous criterion variable and number of older brothers, number of older sisters, number of younger brothers, and number of younger sisters as the predictor variables. The model accounted for 13.9% of the variance in sexual orientation. Table 3 presents the results of the logistic regression analysis. The results indicated that number of older brothers and number of older sisters were both statistically significant predictors of sexual orientation. The odds ratios derived from the logistic regression analysis for the effects of number of older brothers and number of older sisters were 1.36 and 1.14, respectively.

Expected sex ratios were obtained from the Samoan Statistical Service Division of the Ministry of Finance (2006) and indicated that a ratio of 109 male live births for every 100 female live births was appropriate for the cohort range of our sample. Table 4 presents the total and expected numbers of all male siblings, older male siblings, and younger male siblings for *fa'afafine* and gynephilic males. We assessed whether the total number of males in each category differed from the expected values based on the Samoan population parameters using the z approximation to the binomial test. The total number of male siblings, number of older brothers, and number of younger brothers did not differ significantly from the expected values for *fa'afafine*. The total number of male siblings was significantly different from the expected value for gynephilic males. Analyses revealed that, for gynephilic males, the number of older brothers, but not younger brothers, was significantly lower than the expected value.

It is necessary to note that given the age disparity between our *fa'afafine* and gynephilic male samples, we also performed analyses in which we controlled for age. These analyses revealed that age had no impact on the statistical significance of the results reported here. Therefore, the analyses are presented here without controlling for age.

Table 1 Descriptive statistics for the total number of siblings as well as the numbers of older brothers, older sisters, younger brothers, and younger sisters of *fa'afafine* and gynephilic males

Sibling category	*Fa'afafine* *M* (*SD*)	Gynephilic males *M* (*SD*)
Replication sample		
All siblings	5.62 (2.63)	4.34 (2.41)
Older brothers	1.92 (1.68)	0.86 (1.15)
Older sisters	1.70 (1.59)	1.02 (1.15)
Younger brothers	0.96 (1.14)	1.19 (1.36)
Younger sisters	1.04 (1.40)	1.27 (1.27)
Combined sample		
All siblings	5.93 (2.81)	4.35 (2.33)
Older brothers	2.06 (1.74)	0.99 (1.24)
Older sisters	1.85 (1.64)	1.10 (1.18)
Younger brothers	1.01 (1.25)	1.06 (1.22)
Younger sisters	1.01 (1.33)	1.20 (1.24)

Combined Sample

Table 1 presents descriptive statistics regarding the total number of siblings as well as the numbers of older brothers, older sisters, younger brothers, and younger sisters for *fa'afafine* and gynephilic males for the combined sample. *Fa'afafine* had a greater number of siblings, on average, than did gynephilic males, two-tailed independent t-test with between-group equality of variances not assumed; Levene's test for equality of variances, $F = 10.11$, $p = .002$; $t(402.03) = 6.85$, $p < .001$.

Table 2 presents descriptive and inferential statistics pertaining to the Slater's, Fraternal, and Sororal indices for *fa'afafine* and gynephilic males in the combined sample.

Table 2 Descriptive and inferential statistics for *fa'afafine* and gynephilic males on the Slater's, Fraternal, and Sororal indices

Index	*Fa'afafine*					Gynephilic males					Group comparison: two-tailed independent *t*-test		
	n	*M* (*SD*)	Two-tailed one-sample *t*-test			*n*	*M* (*SD*)	Two-tailed one-sample *t*-test					
			t	*df*	*p*			*t*	*df*	*p*	*t*	*df*	*p*
Replication sample													
Slater	130	.63 (.32)	4.64	129	<.001	207	.44 (.37)	−2.42	206	.016	5.06[a]	301.34	<.001
Fraternal	125	.65 (.36)	4.58	124	<.001	183	.46 (.44)	−1.26	182	.208	4.13[b]	295.22	<.001
Sororal	119	.62 (.39)	3.44	118	.001	190	.44 (.41)	−1.87	189	.063	3.82	307.00	<.001
Combined sample													
Slater	213	.64 (.32)	6.48	212	<.001	316	.48 (.36)	−1.09	315	.277	5.52[c]	484.81	<.001
Fraternal	203	.66 (.36)	6.22	202	<.001	282	.49 (.43)	−0.57	281	.567	4.77[d]	473.07	<.001
Sororal	197	.65 (.39)	5.34	196	<.001	293	.47 (.40)	−1.13	292	.260	4.75	488.00	<.001

[a] Levene's test for equality of variances, $F = 6.1$, $p = .014$

[b] Levene's test for equality of variances, $F = 18.87$, $p < .001$

[c] Levene's test for equality of variances, $F = 5.56$, $p = .019$

[d] Levene's test for equality of variances, $F = 23.63$, $p < .001$

Table 3 Logistic regression of sexual orientation on numbers of siblings

Predictor	ΔR^2	Change in −2 log likelihood[a]	Significance of the change[b]
Replication sample			
Older brothers	−0.078	30.25	<0.0001
Older sisters	−0.014	5.45	0.0195
Younger brothers	<−0.001	0.02	0.8794
Younger sisters	−0.001	0.24	0.6242
Combined sample			
Older brothers	−0.070	42.84	<0.0001
Older sisters	−0.019	11.45	0.0007
Younger brothers	−0.003	2.13	0.1444
Younger sisters	<−0.001	0.27	0.6033

Note: Model if term (predictor) removed. The results show the effect of removing one predictor at a time from the regression equation, while leaving the remaining three predictors in the model. The removal of older brothers as well as the removal of older sisters produced a statistically significant decrease in correct prediction of the groups' sexual orientations

[a] Distributed as χ^2 with 1 df

[b] Two-tailed *p*

These analyses were performed in the same fashion as for the replication sample. *Fa'afafine* were significantly more likely to be later born according to all three indices. Gynephilic males did not differ significantly from the expected .5 value for all three indices. Between-group comparisons of *fa'afafine* and gynephilic males revealed that *fa'afafine* were significantly more likely to be later born for all three indices.

A logistic regression analysis was conducted with sexual orientation (i.e., gynephilic versus androphilic) as the dichotomous criterion variable and number of older brothers, number of older sisters, number of younger brothers, and number of younger sisters as the predictor variables. The model accounted for 13.5% of the variance in sexual orientation. Table 3 presents the results of the logistic regression analysis. The results indicated that number of older brothers and number of older sisters were both statistically significant predictors of sexual orientation. The odds ratios derived from the logistic regression analysis for the effects of number of older brothers and number of older sisters were 1.34 and 1.17, respectively.

We conducted further analyses to assess whether the older brother and older sister effects differed in magnitude. In doing so, we used Fisher's *r* to *z* transformations to compare the partial correlations between sexual orientation and each of these statistically significant predictor variables, while controlling for all of the other sibling categories. The partial correlation between sexual orientation and number of older

Table 4 Comparisons of the total and expected[a] numbers of all male siblings, older male siblings, and younger male siblings for *fa'afafine* and gynephilic males

Sibling category	*Fa'afafine*					Gynephilic males				
	Total	Expected	*SD*	*z*	p^b	Total	Expected	*SD*	*z*	p^b
Replication sample										
All	384	389	13.66	−0.37	.7114	427	470	15.01	−2.86	.0042
Older	256	251	10.97	0.46	.6456	179	203	9.88	−2.43	.0150
Younger	128	138	8.15	−1.23	.2186	248	266	11.30	−1.59	.1118
Combined sample										
All	663	666	17.88	−0.17	.8650	660	729	18.70	−3.69	.0002
Older	444	438	14.51	0.41	.6818	319	350	12.97	−2.39	.0168
Younger	219	228	10.46	−0.86	.3898	341	378	13.47	−2.75	.0060

[a] Calculated as the total number of siblings for each category multiplied by 0.52, which is the number of live male births divided by the total number of live births reported by the Samoan Statistical Services Division of the Ministry of Finance (2006) appropriate for the cohort range of the samples examined here

[b] Two-tailed *p*

brothers was .275, and the partial correlation between sexual orientation and number of older sisters was .145. A two-tailed comparison of these partial correlations revealed that the older brother effect was significantly greater in magnitude, $z = 3.16$, $p = .002$.

Table 4 presents the total and expected numbers of all male siblings, older male siblings, and younger male siblings for *fa'afafine* and gynephilic males. We assessed whether the total number of males in each category differed from the expected values based on the Samoan population parameters using the *z* approximation to the binomial test. The total number of male siblings, number of older brothers, and number of younger brothers did not differ significantly from the expected values for *fa'afafine*. The total number of male siblings was significantly different from the expected value for gynephilic males. Subsequent analyses revealed that the observed numbers of older and younger brothers were both significantly lower than the expected values.

Discussion

The findings of this study were consistent with those of previous studies examining the relationships between male sexual orientation, birth order, and the fecundity of kin. To begin with, in both Western and non-Western cultures, androphilic males tend to be later born (Blanchard, 2004; Poasa et al., 2004; Tsoi et al., 1977; Vasey & VanderLaan, 2007; Zucker & Blanchard, 2003; Zucker et al., 2007). When we quantified birth order using Slater's, Fraternal, and Sororal indices, *fa'afafine* were later born relative to gynephilic males as well as theoretical expectations based on the null model of a hypothetical stable population.

Studies conducted in Western cultures also point to an association between male androphilia and increased fecundity among kin (Blanchard & Lippa, 2007; Camperio Ciani et al., 2004; Iemmola & Camperio Ciani, 2009; King et al., 2005; Rahman et al., 2008; Schwartz et al., 2009). Vasey and VanderLaan (2007) reported that greater numbers of siblings on the part of *fa'afafine* were due to the existence of older brother, older sister, and younger brother effects. In the replication sample considered here, we observed independent older brother and older sister effects, suggesting that these two effects are genuine, and not the result of Type I error. However, there was no younger brother effect observed for the replication sample. In addition, the younger brother effect was not present in the combined sample even though this sample included the participants from Vasey and VanderLaan. As such, the absence of a younger brother effect in the present study raises the possibility that this effect represented a case of Type I error and was, therefore, not genuine.

It appears that there are various factors responsible for producing the older brother and older sister effects observed here. In Western samples, the older brother effect is due to a greater than expected number of older brothers among androphilic males, based on known population parameters for sex ratios, as well as a tendency for androphilic males to be later born (Blanchard, 2004). In contrast, the sex ratios of older siblings for *fa'afafine* did not differ from expected population values whereas gynephilic males had significantly fewer older brothers than expected in both the replication and combined samples. It seems likely, then, that the basis for the older brother effect reported here is threefold. First, gynephilic males have fewer older brothers than expected. Second, *fa'afafine* tend to be later born among their brothers compared to gynephilic males. Third, the mothers of *fa'afafine* tend to produce more children than the mothers of gynephilic males.

Clearly, the older brother effect is patterned differently in Samoa relative to the West. These differing patterns may arise due to population differences in fertility rates or attitudes that influence reproductive output, such as rules about the optimal number or sex of offspring (e.g., Blanchard & Lippa, 2007; Zucker et al., 2007). Regardless, in the context of the maternal immune hypothesis (Blanchard, 2004; Blanchard & Bogaert, 1996; Blanchard & Klassen, 1997), the consequence of producing greater numbers of children is that later-born sons will have a higher probability of being androphilic. Thus, although the sex ratios of older siblings appear to be patterned differently in Western populations relative to Samoa, the underlying mechanism that results in the developmental endpoint of male androphilia may be the same.

The tendency of *fa'afafine* to be later born and their mothers' tendency to exhibit elevated fecundity are also necessary considerations to account for the observed older sister effect. The mothers of gynephilic males produced more daughters than expected whereas the mothers of *fa'afafine* produced more children and the sex ratio of these offspring did not deviate from the expected population value. As such, the only avenue by which an older sister effect could have emerged is through the elevated fecundity of *fa'afafine's* mothers and the fact that *fa'afafine* are later born among their sisters. Interestingly, it has been proposed that Samoan parents decide a male child will be raised as a *fa'afafine* when there are insufficient numbers of girls in the family to carry out traditional female chores (Danielsson, Danielsson, & Pierson, 1978; Mageo, 1992). It is important to note, as Vasey and VanderLaan (2007) originally pointed out, that empirical evidence demonstrating that *fa'afafine* actually have more older sisters refutes this particular hypothesis regarding the etiology of *fa'afafine*.

Regardless of how the older brother and older sister effects arose, the present study found multiple, independent sibling category effects. In such an instance, it is difficult to discern whether the observed older brother effect represents a genuine fraternal birth order effect or is merely a consequence of a maternal fecundity effect. Certainly, the older brother and older sister effects, coupled with the overall sexual orientation difference in number of siblings, support the existence of a maternal fecundity effect. However, the fact that the older brother effect was greater in magnitude suggests that biological older brothers do, in fact, contribute to the development of male androphilia above and beyond any developmental influences that may be associated with biological older sisters. It appears, then, that number of older brothers is a unique predictor of male sexual orientation in Independent Samoa and, therefore, that a genuine fraternal birth order effect exists for *fa'afafine*. As such, the finding that the older brother effect was significantly greater than the older sister effect is the most valuable contribution the present study makes toward the literature concerning birth order and male sexual orientation in non-Western populations.

In addition to supporting the existence of both fraternal birth order and maternal fecundity effects, there was yet another consistency between the findings of the present study and those conducted in Western populations. The odds ratio of 1.33 associated with the older brother effect in Western populations indicates that each additional older brother increases the chances of developing male androphilia by approximately 33% (Cantor, Blanchard, Paterson, & Bogaert, 2002). In our combined sample, the odds ratio associated with the older brother effect was 1.34, indicating that each additional older brother increases the chances of developing male androphilia by approximately 34% in Samoa. These remarkably similar values suggest that the manner in which older brothers influence the development of male androphilia is constant across diverse populations.

Another aspect of our findings that deserves mention is in regards to the sibling sex ratios observed. As mentioned, in Western samples, androphilic males typically have an excess of brothers in relation to the expected sex ratio whereas gynephilic males do not (Blanchard, 2004). In contrast, our data from Samoa did not conform to this pattern. The sibling sex ratio for *fa'afafine* did not differ from the expected pattern. The lack of a higher than expected sibling sex ratio among the siblings of *fa'afafine*, coupled with their larger sibships, is consistent with mathematical models presented by Suarez and Przybeck (1980), which predict decreases in the sibling sex ratios of androphilic males as mean sibship sizes increase. The sibling sex ratio of gynephilic males did, however, significantly deviate from the expected population-based values, with gynephilic males having fewer brothers than expected. Interestingly, these Samoan data are consistent with patterns of relatively more strongly male-biased sibships in Western samples of highly feminine androphilic males such as homosexual transsexuals (Blanchard, 1997).

Vasey and VanderLaan (2007) also found that the sibling sex ratios of *fa'afafine* did not deviate from expected population-based values whereas gynephilic males had fewer brothers than expected. They highlighted that, given the Samoan population sex ratio is 109:100, it is difficult to reconcile why the families of gynephilic males, who presumably constitute the majority of the population, do not exhibit the expected sibling sex ratio whereas those of *fa'afafine* conform to the expected pattern. One possibility, they reasoned, was that their sample was somehow biased.

The possibility that sample bias is responsible seems questionable, however, given the consistency in the sibling sex ratio patterns observed in the present study and the study by Vasey and VanderLaan (2007). Also, because a network sampling procedure was employed to recruit participants, *fa'afafine* and gynephilic males were enlisted for the study in an identical manner and from the same social circles. Thus, if sample bias was somehow responsible for these sibling sex ratio patterns, then any hypotheses addressing the nature of the bias must take these two considerations into account. As an example of such a hypothesis, differences between Samoan *fa'afafine* and gynephilic males in emigration might create the necessary bias to produce the observed sibling sex ratio patterns. Specifically, if Samoan gynephilic males belonging to families with male-biased sibships were more likely to emigrate, then such gynephilic males would be relatively unavailable to include as participants. Thus, gynephilic males belonging to predominantly female-biased sibships would be relatively more available to sample, which could result in the sibling sex ratio patterns observed. Examining the sibships of Samoan-born *fa'afafine* and gynephilic males who have emigrated would aid in assessing the efficacy of this emigration hypothesis.

Vasey and VanderLaan (2007) provided an alternative explanation for the observed sibling sex ratio patterns. It is theoretically possible that a certain proportion of Samoan families are similar in composition to those of *fa'afafine* (i.e., greater number of children, expected offspring sex ratio). If so, this reproductive pattern would compensate for the effect of families that are similar in composition to those of gynephilic males (i.e., smaller number of children, lower offspring sex ratio), thereby creating the population-wide sex ratio observed in Samoa (i.e., 109:100).[1]

Speculating further, such differences in number and sex ratio of offspring may be associated with whether individuals are related to *fa'afafine*. In support of this speculation, the existing empirical literature indicates that the kin of androphilic males exhibit unique reproductive patterns with respect to elevated fecundity (Blanchard & Lippa, 2007; Camperio Ciani et al., 2004; Iemmola & Camperio Ciani, 2009; King et al., 2005; Rahman et al., 2008; Schwartz et al., 2009; Vasey & VanderLaan, 2007). Also consistent with this explanation, women are capable of varying in their tendency to produce male or female offspring (James, 2000), and elevated fecundity in women is associated with elevated (i.e., more strongly male-biased) offspring sex ratios (James, 1987). It is also worth noting that *fa'afafine* may facilitate increased reproductive success among their relatives via the elevated avuncular tendencies they exhibit (Vasey, Pocock, & VanderLaan, 2007; Vasey & VanderLaan, 2008, 2009, in press). Whether maternal factors that increase the odds of androphilia in later-born males represent a maternal adaptation for producing avuncular sons or a by-product of elevated maternal reproduction cannot be discerned from the current literature and requires investigation.

Studies in Western cultures have demonstrated fraternal birth order as well as fecundity effects in relation to male sexual orientation. This study provided empirical support for the existence of both effects in a non-Western culture. The cross-cultural consistency with which these effects have been documented is consistent with the conclusion that culturally invariant processes underlie the development of androphilia in males. In addition, the existence of a genuine fraternal birth order effect in Samoa suggests the maternal immune hypothesis is applicable in non-Western cultures.

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[1] Within the context of the alternative explanation provided by Vasey and VanderLaan (2007), the Samoan population sex ratio corresponds to the equation: $1.09 = r_f s_f x + s_g(1 - x)$, where 1.09 is the Samoan population sex ratio; r_f is the reproductive rate of women who reproduce like the mothers of *fa'afafine* (i.e., greater number of children) relative to women who reproduce like the mothers of gynephilic males; s_f is the offspring sex ratio of women who reproduce like the mothers of *fa'afafine* (i.e., expected offspring sex ratio); s_g is the offspring sex ratio of women who reproduce like the mothers of gynephilic males (i.e., lower than expected offspring sex ratio); x is the proportion of reproductive women in the Samoan population who reproduce like the mothers of *fa'afafine*. As an illustration, estimating the equation's parameters from descriptive statistics derived from the combined sample in the current study yields $r_f = 1.3$, $s_f = 1.09$, and $s_g = 0.89$. Solving the equation to find the value of x shows that $x = 0.38$, which corresponds to an estimate of 38% of Samoan reproductive women who reproduce like the mothers of *fa'afafine*.

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