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INVITED COMMENTARY

Commentary on Kishida and Rahman (2015), Including a Meta-analysis of Relevant Studies on Fraternal Birth Order and Sexual Orientation in Men

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Introduction

The term *fraternal birth order effect* refers to the finding that homosexual men, on average, have greater numbers of older brothers than do demographically comparable heterosexual men. This finding has been demonstrated in studies conducted in the U.K., the U.S.A., Canada, Finland, Independent Samoa, Italy, the Netherlands, Spain, and Turkey. Several articles have reviewed the history of this research area and summarized the evidence available at their time of publication (Blanchard, 1997, 2004, 2008; Bogaert & Skorska, 2011).

Kishida and Rahman (2015) recently published an empirical study of male sexual orientation in relation to subjects' numbers of older brothers, hand-preference, and self-reported childhood effeminacy. They concluded, in regard to their comparisons of homosexual and heterosexual subjects on older brothers, that "The results did not replicate the fraternal birth order effect." The purpose of this Commentary is to argue that Kishida and Rahman's categorical conclusion, as flatly worded in their Abstract, is overstated and potentially misleading. We will take the position that Kishida and Rahman's study did produce evidence of a fraternal birth order effect, and that their results are in line with the great bulk of previous studies on this topic.

The simplest of Kishida and Rahman's birth order analyses was a set of four univariate *t* tests, with group (homosexual or heterosexual) as the independent variable, and numbers of older brothers, older sisters, younger brothers, and younger sisters as the dependent variables. In these and in their other statistical tests, they reported and based their conclusions on two-tailed probabilities.

The homosexual group had a greater mean number of older brothers than did the heterosexual group, but the difference was not statistically significant ($p = .09$); similarly, the homosexual group had a greater mean number of older sisters but that result was also not significant ($p = .14$). The homosexual group had significantly smaller mean numbers of younger brothers ($p = .03$) and younger sisters ($p = .03$).

That pattern of results is precisely the pattern predicted by Blanchard (2014) for the case when a fraternal birth order effect is present but is obscured by a significantly lower sibship size in the homosexual group. Blanchard recommended that comparability of sibship sizes be assessed using the variable *other siblings,* defined as the sum of older sisters, younger brothers, and younger sisters. Kishida and Rahman found that the homosexual group did, in fact, have a significantly smaller family size, as measured by the other-siblings variable.[1] Kishida and Rahman went on to carry out a type of family-size correction recommended by Blanchard as one potential fix for mismatched family sizes, but the adjusted statistics for older brothers produced a virtually identical result ($p = .10$).

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[1] Tangentially, this result is consistent with at least one large-scale study finding that homosexual men have smaller average family sizes than do heterosexual men (Blanchard, 2012). It is inconsistent with the balancing selection hypothesis that genes predisposing men to homosexuality escape elimination from the population because the decreased fertility of men with the heritable form of homosexuality is offset by an increased fertility among biological relatives who carry the same genetic variants.

Applicability of a One-Tailed Test for Older Brothers

It is clear from the *t* test results already presented that a one-tailed test of the prediction that homosexual men should have more older brothers than heterosexual men would be significant at $p < .05$. Kishida and Rahman do not explicitly make that point, although they do refer to the *t* test for older brothers as indicating a "trend."

The difference between Kishida and Rahman's interpretation of their finding for older brothers as negative and our interpretation of the same finding as positive comes down to the justification for accepting a one-tailed test. In their view, prior research on fraternal birth order and sexual orientation has resulted in a "poor consensus," which would argue against a one-tailed test based on strong directional expectations. In our view, prior research has produced the most consistent findings one could possibly hope for in the real-life investigation of a non-obvious association, and therefore the interpretation of a one-tailed test is amply justified. We will support our position in two ways: first, by critically examining the studies that Kishida and Rahman cite as providing important negative results on older brothers and homosexuality and, second, by conducting a new meta-analysis of relevant studies as free as possible from any bias on our part.

Critiques of King et al. (2005), Frisch and Hviid (2006), Zietsch et al. (2012), and Bogaert (2010)

Kishida and Rahman used a handful of studies to support their position that the empirical evidence for a fraternal birth order effect is inconclusive. These studies are presumably important, in Kishida and Rahman's view, because of their relatively large sample sizes. In our view, they have over-interpreted the results of one study (King et al., 2005) and minimized the questionable or limited methodology of three others (Bogaert, 2010; Frisch & Hviid, 2006; Zietsch et al. (2012).

King et al. (2005)

King et al. (2005) found that homosexual men have significantly more older brothers and older sisters than do heterosexual men, with the between-groups difference in older brothers being larger. King et al. discuss only one possible interpretation or implication of their result for older sisters: "The birth order effect for gay males has been interpreted as a possible maternal immune reaction against Y-linked histocompatibility antigens…that results in homosexuality…. However, it is difficult to see how this might be so if our finding about older sisters is upheld" (p. 121). Kishida and Rahman (2015) repeatedly cited King et al.'s finding for older sisters as important evidence against the reliability of the fraternal birth order effect.

Neither King et al. (2005) or Kishida and Rahman (2015) mention that the first author had already explained in several publications that a secondary elevation of older sisters is to be expected (e.g., Blanchard, 1997, 2004; Blanchard & Bogaert, 1996; Jones & Blanchard, 1998). Blanchard (1997) wrote that "A proband's number of older brothers and number of older sisters tend to be positively correlated. Therefore, if Proband A has more older brothers than Proband B, Proband A is also likely to have more older sisters than Proband B" (p. 38). Blanchard (2004, p. 175) and Blanchard and Bogaert (1996, p. 27) made the same point in similar language. Jones and Blanchard (1998) took this phenomenon for granted ("Of course, boys with older brothers tend also to have older sisters," p. 777) and went on to develop separate formulas for homosexual and heterosexual men intended to predict their birth order among their sisters from their birth order among their brothers.

Thus, the finding that between-groups differences in older sisters are occasionally statistically significant is not strong evidence against the fraternal birth order effect. The positive correlation between older brothers and older sisters (except, perhaps, in populations with very small average family sizes) makes it probable that the expected excess of older brothers will be accompanied by a (usually lesser) excess of older sisters, and that virtually guarantees that between-groups differences in older sisters will sometimes be statistically significant. One reason this may occur is because any between-groups difference, however small, in any variable will test out as statistically significant if the sample size is large enough. A second possibility is that when samples are drawn from populations with relatively high fertility rates, the positive correlation between older brothers and older sisters makes the observation of both sibling category effects in relation to male sexual orientation more readily observable. Regarding this latter possibility, samples from the high fertility Samoan population have repeatedly shown simultaneous older brother and older sister effects (VanderLaan & Vasey, 2011; Vasey & VanderLaan, 2007). Importantly, however, direct comparison of the magnitudes of these effects showed that the older brother effect takes precedence (VanderLaan & Vasey, 2011).

Frisch and Hviid (2006)

Frisch and Hviid (2006) studied the family-demographic correlates of homosexual (i.e., same-sex) and heterosexual (i.e., opposite-sex) marriage. There is no reason to suppose that the factors that cause a homosexual man to choose to enter a same-sex marriage are the same as the factors that caused him to develop a homosexual orientation in the first place. Frisch and Hviid acknowledged that distinction, although they worded it differently: "Because we do not know how representative men and women in same-sex marriages are of homosexuals in

general, our findings should not be used incautiously to define childhood determinants of sexual orientation" (p. 546).

Frisch and Hviid's (2006) study was not designed specifically to study the fraternal birth order effect, and there are a few things beyond the problematic usefulness of marriage as a proxy for orientation that further make their study suboptimal as a study of that effect. First, Frisch and Hviid studied same-sex marriages occurring after 1989, the year in which same-sex marriage was legalized in Denmark, but they studied opposite-sex marriages occurring after 1970. This might have introduced artifactual differences between the homosexual and heterosexual groups that could affect detection of a fraternal birth order effect. Second, Frisch and Hviid truncated the sibship variables at three siblings. Thus, for example, the number of older brothers recorded for a subject was limited to four values: 0, 1, 2, and 3 or more. Third, there were apparent problems in the methods used in identifying and counting sibs from official records (Blanchard, 2007), which Frisch and Hviid acknowledged and corrected in a partial reanalysis of their data (Frisch & Hviid, 2007).

Setting the above problems aside, however, there is one more thing that makes it difficult to compare Frisch and Hviid's (2006) study with other studies on fraternal birth order: Their statistical procedures were unlike those used in any other study on this topic. We therefore reanalyzed Frisch and Hviid's data in order to produce results comparable in form to the other findings reviewed in this Commentary. It is possible to approximate the mean numbers of older brothers, older sisters, younger brothers, and younger sisters for the homosexual and heterosexual groups in Frisch and Hviid's study. (We used the original 2006 rather than the adjusted 2007 data because the 2007 article did not report data on younger brothers and younger sisters, and also because Frisch and Hviid (2007) indicated that any incomplete counting of siblings would more likely affect older sisters than older brothers—the latter being our primary concern.)

The data needed to compute these means come from Table 4 in Frisch and Hviid (2006). We will illustrate these computations with the 429,181 heterosexually married men. These comprised 309,126 with 0 older brothers, 96,447 with 1 older brother, 19,567 with 2 older brothers, and 4041 with 3 or more older brothers. Because relatively few subjects had more than 3 siblings of any given type, we treated subjects with 3 or more older brothers as if they had exactly 3 older brothers, and we computed the approximate mean number of older brothers as follows: $(0 \times 309,126 + 1 \times 96,447 + 2 \times 19,567 + 3 \times 4041)/429,181 = 0.34$. Repeating this calculation for all relevant data yielded the following means (with SDs in parentheses): Older brothers, homosexual = 0.37 (0.62), heterosexual, 0.34 (0.61); older sisters, homosexual = 0.30 (0.59), heterosexual, 0.27 (0.55); younger brothers, homosexual = 0.39 (0.64), heterosexual = 0.47 (0.69); and younger sisters, homosexual = 0.35 (0.60), heterosexual, 0.43 (0.65).

A series of *t* tests showed that the between-groups difference in older brothers was not statistically significant, $t(431069) = 1.82$, $p = .07$. The homosexually married men had more older sisters than the heterosexually married men, $t(431069) = 2.38$, $p = .02$, but fewer younger brothers, $t(431069) = -4.55$, $p = .000005$, or younger sisters, $t(431069) = -5.38$, $p = .00000008$.

As a way of decreasing the impact of the most extreme and least precise data-points—namely, 3+ older brothers, 3+ older sisters, and so on—we carried out a logarithmic transformation of all the sibship variables, for example: log older brothers = $\log_{10}$ (older brothers + 1). All between-groups differences in the transformed data were statistically significant. The homosexually married men had more older brothers, $t(431069) = 2.09$, $p = .04$, and more older sisters, $t(431069) = 2.07$, $p = .04$. They also had fewer younger brothers, $t(431069) = -4.59$, $p = .000004$, and younger sisters, $t(431069) = -5.48$, $p = .00000004$.

In summary, Frisch and Hviid's (2006) homosexually married men do appear to be born later in their sibships than their heterosexually married men, although it is not possible to attribute this finding to older brothers more than to older sisters. Despite the large size of the sample, the focus of the study (marriage not orientation) and the various methodological limitations mentioned above preclude it from providing clear evidence about the existence of the fraternal birth order effect in homosexually oriented men, one way or the other.

Bogaert (2010)

Although Bogaert's (2010) analysis of birth order in relation to male sexual orientation in a British probability sample did not yield a statistically significant fraternal birth order effect, his method had two limitations. To begin with, this study compared birth order in heterosexual versus gay + bisexual men combined. The proportion of men in the gay + bisexual group who reported bisexual patterns of attraction was 19 % (26 of 134), and the proportion with sexual experience who reported bisexual patterns of behavior was 11 % (13 of 115). Thus, the final sample of 132 gay + bisexual men used for the birth order analysis included a substantial number of bisexual men. Given that only a subset of bisexual men exhibit arousal patterns characteristic of homosexual men (Rieger et al., 2013), combining bisexual and homosexual men may have obscured the fraternal birth order effect.

A potentially more critical limitation, however, was the truncated nature of the birth order information used in the study by Bogaert (2010). Probands reported their total numbers of brothers and sisters, respectively, as well as whether they were firstborn, lastborn, or in between. Through a series of decision rules (see Bogaert, 2005), this information was then used to provide reasonable, although imprecise, estimates of numbers of older and younger brothers and sisters. Thus, the truncated nature of the birth order information available for this sample also may have obscured the fraternal birth order effect, and Bogaert (2010) remarked that "these data were less than optimal to examine sibling characteristics" (p. 112).

There are two additional points raised by Bogaert (2010) worth noting with regard to these national probability sample findings. First, although a significant fraternal birth order effect was not detected, the findings were in the expected direction (i.e., the group of gay/bisexual men had more older brothers on average than the group of heterosexual men). Second, in two earlier studies of national probability samples, Bogaert (2003, 2005) did find evidence consistent with fraternal birth order.

Zietsch et al. (2012)

Zietsch et al. (2012) did not find evidence consistent with the fraternal birth order effect in an Australian community-based twin sample; however, this study contained at least three limitations that might have contributed to the null findings. First, unlike other birth order studies, this sample consisted solely of probands who were twins. As Zietsch et al. noted, "there may be something about twin births or twin families that nullifies the relationship" (p. 529). Second, like Bogaert (2010), Zietsch et al. combined gay and bisexual men into the same, non-heterosexual group; however, unlike Bogaert, Zietsch et al. did not provide details on the proportion of bisexual men in their non-heterosexual sample. Consequently, it is difficult to discern the extent to which the inclusion of bisexual men might have obscured the fraternal birth order effect in this study. Third, Zietsch et al. only reported data on numbers of older brothers and not numbers of siblings in other sibling categories. Thus, it is unclear whether the sexual orientation comparison for numbers of older brothers was confounded by other factors such as family size. If such were the case, it is possible that using corrective procedures such as those described by Blanchard (2014) would have made it possible to detect the fraternal birth order effect in this sample. Furthermore, it is not possible to evaluate whether other metrics such as the ratio of older brothers to older sisters would have yielded the expected elevated older sibling sex ratio among the non-heterosexual group of probands.

A Meta-analysis of Independent Studies

Blanchard (2004) carried out a meta-analysis based entirely on his own research; this consisted of 12 studies comprising 14 samples. In total, 10,143 subjects (3181 homosexuals and 6962 heterosexuals) were included. The results reinforced the conclusion from individual studies that male homosexuality is positively associated with a subject's number of older brothers but not with his numbers of older sisters, younger brothers, or younger sisters.

The conclusion of Blanchard (2004) has been generally reinforced in numerous individual studies by the present authors and their colleagues. These studies used a variety of metrics commonly employed in birth order research (e.g., numbers of older and younger brothers and sisters, Slater's Index, Berglin's Index, sibling sex ratio). Apart from the 2010 study described above, Bogaert elsewhere reported data consistent with the fraternal birth order effect in several studies, including national probability samples (Bogaert, 2000, 2003; Bogaert & Cairney, 2004) as well as in a sample of non-White men from the Kinsey Interview data archive (Bogaert, 1998). In a seminal study, Bogaert (2006) showed that, consistent with the maternal immune hypothesis, only biological older brothers—and not non-biologically related older brothers (e.g., adopted, step-brothers)—increased the odds of homosexuality in men. In two samples from Samoa, transgender males who reported sexual attraction to the same biological sex (i.e., men) reported significantly more biological older brothers and older sisters than heterosexual Samoan men (VanderLaan & Vasey, 2011; Vasey & VanderLaan, 2007), and subsequent analysis showed that older brothers took precedence in predicting male sexual orientation in Samoa (VanderLaan & Vasey, 2011). Similarly, evidence of the fraternal birth order effect was obtained in clinic-referred samples of children and adolescents who experienced gender dysphoria (i.e., incongruence between one's experienced gender and the gender assigned at birth) (Schagen, Delemarre-van de Waal, Blanchard, & Cohen-Kettenis, 2012; VanderLaan, Blanchard, Wood, & Zucker, 2014).[2] In addition to reinforcing the conclusion of Blanchard (2004), the diverse samples in which the present authors and their colleagues have repeatedly replicated the fraternal birth order effect demonstrate the ubiquity of the fraternal birth order effect.

The study by Blanchard (2004) might be criticized on the grounds that a meta-analysis of studies by a single investigator or network of affiliated researchers will simply reproduce the experimenter bias present in the original studies. This potential problem could be exacerbated if the meta-analysis was conducted by the same people who carried out the original studies. We therefore conducted, for the purpose of this Commentary, a simple meta-analysis that would be as free from our own potential unconscious biases as possible. We searched the English-language literature for all fraternal birth order studies that would meet the following criteria:

1. Neither of the present authors nor any of their customary collaborators carried out the collection or analysis of the original data.
2. The study sample consisted entirely of singleton births, or else the number of multiple births was simply the (small) number expected by chance.
3. Homosexual orientation was classified according to the subject's self-report and not from proxy variables like same-sex marriage.
4. The original authors reported statistical comparisons for all four types of siblings (older brothers, older sisters, younger brothers, and younger sisters), either within a univariate or multivariate design.

[2] In these studies, same-biological-sex sexual orientation was determined via questionnaires for adolescents in the study by VanderLaan et al. (2014) and otherwise inferred based on childhood-onset of gender dysphoria.

Table 1 Comparisons of homosexual and heterosexual groups on mean numbers of siblings

Authors	Older brothers	Older sisters	Younger brothers	Younger sisters
Robinson and Manning (2000, p. 341)	++	+	0	0
Green (2000, p. 792, Table 4)[a]	++	+	+	+
Rahman, Wilson, and Abrahams (2004, pp. 874–875)	+	+	−	−
Rahman (2005, pp. 386–387)	++	+	+	−
King et al. (2005, pp. 119–121)	++	++	−	−
Francis (2008, p. 374, Table 2)[b]	+	−−	−	−
Rahman et al. (2008, p. 967, Table 5), whites	+	−	−	−
Rahman et al. (2008, p. 967, Table 6), non-whites	−	−	−−	−−
Iemmola and Camperio Ciani (2009, p. 396)	++	0	0	0
Rahman, Clarke, and Morera (2009, pp. 254–255)	++	+	−	−
Schwartz et al. (2010, pp. 101–103)	++	++	+	++
Gómez-Gil et al. (2011, p. 507)[a]	++	+	−	−
Kangassalo, Pölkki, and Rantala (2011, p. 503)	++	++	−−	−
Bozkurt, Bozkurt, and Sonmez (2014, Table 1)[c]	++	+	+	−
Positive results/usable study	13/14	10/13	4/12	2/12
Two-tailed sign test for column, *p* value	.002	.092	.388	.039

Cell entries are interpreted as follows: A "+" sign indicates that the homosexual group had more siblings of the type indicated by the column heading than did the heterosexual group, and a "++" sign indicates that this difference was statistically significant at $p < .05$, two-tailed, in the original study. Similarly, a "−" sign indicates that the homosexual group had fewer siblings of the type indicated by the column heading than did the heterosexual group, and a "−−" sign indicates that this difference was statistically significant at $p < .05$, two-tailed, in the original study. A "0" indicates that the original authors reported that the comparison was not statistically significant, but they included no additional information, not even which of the observed means was higher. The sign tests (last two rows of the table) were based on all available comparisons, whether statistically significant or not; in other words, the statistical significance levels from the original studies were ignored

[a] Subjects were male-to-female transsexuals, whose sexual orientations were dichotomously classified, according to their natal sex, as homosexual or non-homosexual (heterosexual, bisexual, and asexual). The rationale for this classification of male-to-female transsexuals is given in Blanchard (1989) and Lawrence (2010)

[b] Results in this table are for one measure of sexual orientation, *sexual identity*, dichotomized as homosexual or bisexual versus heterosexual. In Francis's tables, this measure is called "Not 100 % Heterosexual." This was the measure of sexual orientation emphasized in the original article

[c] The study group was homosexual transsexuals and the comparison group was heterosexual cissexuals

Using these criteria, we identified 13 studies, which included 14 samples. We used the simplest meta-analytic technique, namely, the sign test (Rosenthal, 1978). This is a version of the binomial test that assumes that, under the null hypothesis, the probability of a positive or negative result is .50. In the present context, a positive result is a finding that a study's homosexual group had more siblings of a given type than did its heterosexual group, and a negative result is a finding that a study's homosexual group had fewer siblings of a given type than did its heterosexual group. The results are shown in Table 1.

The present results were similar to Blanchard's (2004) meta-analysis of his own studies (see, especially, Blanchard, 2004, Fig. 1 and Table 2). In both meta-analyses, the homosexual subjects had a significant excess of older brothers and a secondary, non-significant excess of older sisters. Furthermore, in both meta-analyses, the homosexual subjects had fewer younger brothers and fewer younger sisters than did the heterosexual subjects. In Blanchard (2004), the difference approached statistical significance for younger brothers ($p = .055$), and in the present meta-analysis, the difference achieved statistical significance for younger sisters.

There is another way of looking at the data in Table 1 that leads to an additional conclusion. Suppose one interprets a "+" sign in the older brothers column as a confirmed prediction that the greater of the two means in this comparison should belong to the homosexual group. Then, the comparisons on older brothers predicted group sexual orientation correctly for all but one of the 14 studies. Now consider only the 13 studies that have usable data for both older brothers and older sisters.[3] The comparison of older brothers predicted group sexual orientation correctly for all but one of these 13 studies. The comparison of older sisters predicted incorrectly for the same study that older brothers had predicted incorrectly; however, it also predicted incorrectly for two more studies. Thus, older sisters did not improve predictive accuracy in this data set over that provided by older brothers alone. This result probably reflects, at a meta-analytic level, what is sometimes seen in individual studies: The number of older sisters may be significantly related to probands' sexual orientation

[3] One group of original authors reported that the comparison of older sisters was not statistically significant, but they included no additional information, not even which of the observed means was higher.

when the number of older sisters is considered in isolation, but its information value diminishes or disappears when number of older brothers is taken into account (e.g., Schwartz, Kim, Kolundzija, Rieger, & Sanders, 2010, pp. 102–03).

In summary, two non-overlapping meta-analyses as well as several individual studies by the present authors and their colleagues—studies not included in either meta-analysis—point to the same conclusion: Homosexual men, on average, have more older brothers than do heterosexual men. The bottom line would remain unchanged (or reinforced) even if we admitted the evidence from studies that we consider problematic or irrelevant (e.g., Frisch & Hviid, 2006; Zietsch et al., 2012).

Conclusion

In this Commentary, we have argued against two assertions made by Kishida and Rahman (2015) regarding the fraternal birth order effect. First, we disagree with their conclusion that their results did not replicate the fraternal birth order effect. There is a considerable literature demonstrating the fraternal birth order effect in a variety of samples. On these grounds, we assert that it is appropriate to use a one-tailed test for the directional hypothesis that homosexual men have more older brothers than do heterosexual men, and thus that the observed excess of older brothers in Kishida and Rahman's homosexual group should be considered consistent with prior empirical findings of a fraternal birth order effect. Also justifying a directional test is the fact that the possible causal pathway between older brothers and homosexuality has been laid out in a detailed theory (Blanchard, 2004) and not relegated to a black box of unaddressed proximate mechanisms.

Second, we respectfully disagree with Kishida and Rahman's (2015) claim that prior research on fraternal birth order and sexual orientation has resulted in a "poor consensus." To begin with, Kishida and Rahman's claim is not strongly supported by the studies they cited as indicating poor consensus. Our reanalysis of Frisch and Hviid's (2006) data did, in fact, show that homosexually married men had significantly more older brothers and older sisters, with significantly fewer younger brothers and younger sisters as well. King et al. (2005) similarly showed statistically significant older brother and older sister effects. As we explained above, older sister effects need not detract from the theoretical significance of older brother effects because occasional older sister effects are expected as by-products of the fraternal birth order effect. Of the remaining studies cited (i.e., Bogaert, 2010; Zietsch et al., 2012), both contained methodological limitations, many of which the studies' original authors noted as potentially contributing to the null findings. Moreover, the meta-analysis presented here, the meta-analysis published by Blanchard (2004), and the individual studies by the present authors and their colleagues (reviewed above) that were not included in either meta-analysis all overwhelmingly support the conclusion that older brothers increase the odds of homosexuality in men.

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