Abstract—Are sisters of twin brothers behaviorally or physiologically masculinized? Prenatal exposure to their brothers’ androgens and postnatal socialization experiences unique to girls growing up with twin brothers might influence their attitudes, pubertal development, and reproductive histories. To investigate, we studied age- and cohort-matched samples of Finnish sisters from same-sex and opposite-sex twin pairs. Using data from two ongoing longitudinal studies of consecutive birth cohorts of Finnish twins, we assessed pubertal development at ages 11 and 14 and endorsement of attitudes associated with femininity at age 16. We also studied fertility in Finnish women of same- and opposite-sex twin pairs born from 1958 through 1971, with femininity at age 16. We also studied fertility in Finnish women from same- and opposite-sex twin pairs born from 1958 through 1971, obtaining information on their child-bearing histories when they were ages 15 to 28. Results of each comparison were unambiguously negative: There was no evidence of differences between sisters from same- and opposite-sex twin pairs, and thus, no evidence of either androgenization or cross-sex socialization.

What are the consequences, biological and social, of having a [co-]twin of the opposite-sex? . . . sissiness in the boy and boyishness in the girl . . . ? (Koch, 1966, p. 2)

In the 35 years since Koch’s question, there has been much speculation, and some suggestive evidence, that sisters of twin brothers are “masculinized” relative to age-matched females with twin sisters. The nature and pattern of these differences in attitudes and social behaviors have been attributed both to prenatal androgenization and to the postbirth socialization experiences unique to co-twins from opposite-sex twin pairs. Koch’s own earlier research (Brim, 1958; Koch, 1956) and similar studies that followed (Rosenberg & Sutton-Smith, 1968; Sutton-Smith & Rosenberg, 1970) were cast within social learning models and focused on sibling influences on sex typing in two-child, nontwin families. The studies had limitations (Ruble & Martin, 1998) and yielded inconsistent results, but, perhaps as a consequence, interest in sex typing as a function of the sex composition of sibling dyads continues (e.g., McHale, Crouter, & Tucker, 1999; McHale, Updegraff, Helms-Erikson, & Crouter, 2001).

One focus of current research is on co-twins from brother-sister twin pairs. Recent investigations of female members of opposite-sex twin pairs (OSF twins) have considered a hormonal, rather than social, explanation of expected sex-typing effects (Miller, 1994, 1998). Reports that in utero exposure to adjacent males can androgenize female rodents (vom Saal, 1989), and evidence that early exposure to androgens in girls with congenital adrenal hyperplasia has a masculinizing effect on their sex-typed play in childhood (Berenbaum & Hines, 1992; Berenbaum & Snyder, 1995), led investigators to study sisters of twin brothers for masculinizing effects on attitudes and behaviors. Suggestive results, in which behaviors or attitudes of adult OSF twins tend toward the male mean, have been reported for several of the sensation-seeking scales (Resnick, Gottessman, & McGue, 1993), spatial ability (Cole-Harding, Morstad, & Wilson, 1988), and social attitudes (Miller, 1994; Miller & Martin, 1995). But other reports, including three studies of OSF twin children, have been negative; these include Koch’s study of teacher ratings of sissiness and tomboyishness in a small sample of children from same- and opposite-sex twin pairs (Koch, 1966), a comparison of parental reports of play activities and playmate preferences in a similar, but larger, twin sample (Elizabeth & Green, 1984), and an observational study of sex-typed play behavior among 3- to 8-year-old OSF and SSF (same-sex female) twin children (Henderson & Berenbaum, 1997). Negative results also characterized a comparison of reproductive behaviors (Loehlin & Martin, 1998) in female Australian twins; OSF and SSF twin women did not differ across an array of variables related to menstruation and reproduction.

Thus, evidence that OSF twins are masculinized is, at best, inconsistent and uncertain. In part, that may be a consequence of the small samples of opposite-sex twin pairs in some of the previous research—as few as 19 (Koch, 1966), 31 (Henderson & Berenbaum, 1997), or 51 pairs (Resnick et al., 1993)—unavoidable and unmeasured self-selection biases in some samples (Elizabeth & Green, 1984), and an inability to precisely match for age and cohort in comparisons of same-sex and opposite-sex twin pairs from heterogeneous samples of volunteer twins.

We sought more definitive tests for differences in relevant outcome measures at three developmental stages in population-based twin cohorts in Finland. Our samples were large, representative, and standardized for age and cohort, so comparisons of OSF and SSF twins were not confounded by age and cohort variation, and our SSF twin samples contained about equal numbers of monozygotic and dizygotic twins, as expected from population-based sampling. We studied a diversity of measures, selected for presumed sensitivity to sex-typed differences, whether caused by hormonal effects before birth or subsequent sibling socialization.

PUBERTAL DEVELOPMENT IN EARLY ADOLESCENCE

Pubertal development was assessed at ages 11 and 14 using the five-item Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988), which assesses growth spurt, skin changes, growth of body hair, and, for girls, breast development and age at...
menarche. The sample of twin sisters, drawn from an ongoing study (FinnTwin12; Rose, Dick, Viken, Pulkkinnen, & Kaprio, 2001), consisted of five consecutive and complete birth cohorts of Finnish twin girls born in 1983 through 1987 and initially tested with a baseline questionnaire that included the PDS in the late autumn of the year in which the girls reached age 11. Response rates to an invitation to participate in the FinnTwin12 study approached 90% across all five cohorts (the twins’ parents made the decision whether to participate), and approximately 96% of all individual twins in these participating families returned their individual questionnaires at the age-11 baseline. We compared pubertal development in OSF and SSF twins at baseline and at follow-up at age 14. At age 11, pubertal development was modest, whereas at the follow-up, administered within 3 months of the twins’ 14th birthdays, pubertal development was fairly complete for most girls in the sample. Thus, the two test administrations of the PDS straddled a period of rapid pubertal change. We randomly chose 1 sister from each of the same-sex pairs and compared pubertal development of these SSF twins with the pubertal development of all OSF twins. The proportion reporting menarche and total PDS scores were compared at both ages (see Table 1).

At age 11, the sample included 1,545 female twins (762 SSF twins and 783 OSF twins); 5.6% of those girls reported that they had experienced menarche. The proportion from the same-sex pairs was 4.5%, and that from the opposite-sex pairs 6.6%. The direction was opposite expectation, but did not reach significance on a two-tailed Fisher’s exact test. Total PDS scores for SSF and OSF twins at age 11 were virtually identical, and the difference did not approach statistical significance. At age 14, 80.9% of the girls were postmenarchal, and again there was no difference between SSF and OSF twins: 82.2% of twin sisters randomized from the same-sex pairs and 79.6% of all girls from the opposite-sex twin pairs were premenarchal. At the age-14 follow-up, pubertal development scores were markedly greater than at baseline, but again virtually identical in the two samples. Variance for PDS scores were equivalent also for the SSF and OSF twins at both ages.

We also asked whether effects on pubertal development were evident among brothers from opposite-sex twin pairs (OSM), compared with brothers from same-sex twin pairs (SSM). The PDS for boys substitutes development of facial hair and voice change for the items on breast development and menarche in the girls’ scale. PDS scores for SSM and OSM twins at ages 11 and 14 were effectively equivalent in both means and variances, and no differences approached statistical significance.

### STEREOTYPIC FEMININE INTERESTS AT AGE 16

Our study of feminine interests at age 16 was based on a total of 5,679 individual twins from FinnTwin16, a study of five consecutive cohorts of Finnish twins born in 1975 through 1979 and assessed initially within 2 months of reaching their 16th birthdays, during 1991 through 1996 (Rose, Kaprio, Winter, Koskenvuo, & Viken, 1999). Baseline response rates from individual twins in this study approximated 90%. The sample included 3,776 individual twins from same-sex pairs and 1,903 individual twins from opposite-sex twin pairs. The staggered administration of questionnaires across 60 months of baseline assessment, and the prompt return and high compliance of the adolescent twins, yielded data with rigorous age standardization.

The Feminine Interest (FEM) scale is a 30-item content scale derived by Wiggins (1966) from psychometric and intuitive analyses of the total Minnesota Multiphasic Personality Inventory item pool to obtain content scales that are internally consistent. The scale measures endorsement of stereotypic feminine interests (e.g., enjoying reading love stories and poetry) and traditional career aspirations (e.g., to be a florist or a nurse) together with nonendorsement of traditional masculine occupations and leisure interests (e.g., reading mechanics magazines, working as a building contractor, fishing, hunting lions in Africa). As Wiggins noted, FEM scale scores may be susceptible to test-taking biases, but respondents with a genuine preference for activities culturally and traditionally defined as “feminine” will achieve high scores on the scale. The content of the FEM scale taps important gender-diagnostic individual differences (Lippa, 1991), and the scale meets the major criterion for a study of potential prenatal androgenization or cross-socialization effects, because the bimodal distributions of FEM scale scores in samples of adolescent males and females are largely nonoverlapping, with widely displaced means.

We randomly selected 1 twin from each same-sex pair and then compared FEM scale scores, in separate distributions for twin boys and twin girls from same- and opposite-sex twin pairs. Distributions of the scores for the four twin types are shown in Figure 1. The distributions for SSF and OSF twins, shown in the upper part of the figure, are virtually identical: The means and standard deviations are 18.95 and 3.28 for SSF twins and 19.00 and 3.29 for OSF twins. Contrary to demonstrating any socialization or androgenization effects, OSF twins had slightly higher, not lower, FEM scale scores than did SSF twins.

Presumably, postnatal socialization effects can occur with equal likelihood from sister to brother as from brother to sister, as Koch (1966) suggested. So, it is of interest to note that the distributions of FEM scale scores for SSM and OSM twins, shown in the lower part of the figure, suggest that growing up with a same-sex twin brother versus an opposite-sex twin sister had no influence on boys’ development of stereotypic feminine (or masculine) interests. The mean FEM scale score for male twins from same-sex pairs is 8.30, with a standard deviation of 3.06; the mean for males from opposite-sex pairs is 8.12, with a standard deviation of 3.08. And the difference between means of

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### Table 1. Pubertal development at ages 11 and 14 in dizygotic twin sisters from same-sex and opposite-sex twin pairs

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Age 11</th>
<th>Age 14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSF</td>
<td>OSF</td>
</tr>
<tr>
<td>Menarche</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>762</td>
<td>783</td>
</tr>
<tr>
<td>Percentage postmenarche</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance of difference</td>
<td>.075</td>
<td>.324</td>
</tr>
<tr>
<td>Pubertal Development Scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>749</td>
<td>772</td>
</tr>
<tr>
<td>Mean score</td>
<td>1.66</td>
<td>1.68</td>
</tr>
<tr>
<td>Significance of difference</td>
<td>.394</td>
<td>.600</td>
</tr>
</tbody>
</table>

Note. SSF = females in same-sex twin pairs; OSF = females in opposite-sex twin pairs. 
Fisher’s exact test of proportions, two-tailed. 
$^a$ t test of means, two-tailed.
OSF and OSM twins (10.88) is slightly greater than that (10.65) between means of SSF and SSM twins.

**FERTILITY IN EARLY ADULTHOOD**

We examined child-bearing histories into early adulthood in a sample of 7,528 women from same-sex twin pairs and 4,767 sisters from opposite-sex twin pairs. Born in 1958 through 1971, these twins were linked to Central Population Records to obtain information for an event history analysis of their reproductive histories to January 1, 1987, when they ranged in age from 15 to 28. The analysis was done on exact dates of births of children and deaths of twins. None of the twins born in 1971 delivered a child born before the end of follow-up. In all other birth cohorts of the analysis, at least one child was born, and about 50% of twin sisters from the oldest cohort (born in 1958) had delivered a child at the end of follow-up. We used standard methodology for analyzing the occurrence of events with known occurrence times. The estimates of mean and median age at first birth were calculated using the stratified Kaplan-Meier-product limit method. Strata were formed by twin type (like-sex pair/opposite-sex pair). When estimating fertility rates by life-table techniques, we accounted for twins who were deceased by placing them into the “lost” category.

Breslow’s (1970) test was used to evaluate the differences between the fertility curves. The test weights first births that occur in younger age groups more heavily than those that occur in older age groups. Estimates for fertility odds ratios were calculated using Cox’s proportional hazards regression model. Confidence limits were based on normal approximation.

The results were that 1,689 of the SSF twins had given birth, as had 1,144 of the OSF twins. Forty-eight SSF twins and 26 OSF twins were deceased at the end of follow-up, and equivalent proportions of women in the two twin samples had not given birth: .776 of SSF twins and .760 of OSF twins. The mean age at delivery of the firstborn child was 26.05 years for SSF twins and 25.97 years for OSF twins. Neither these means nor the median ages at first birth differed (see Table 2). The fertility curves of OSF and SSF twins did not statistically differ ($p = .264$, Breslow’s test), and there was no difference in event history analyses that examined differences at younger or older ages separately. The fertility odds ratio of women from opposite-sex twin pairs was not significantly elevated compared with that for women from same-sex pairs (see Table 2). Clearly, the negligible trends evident in these results are opposite expectation, and the analysis provides no ev-
Femininity and Fertility in Opposite-Sex Female Twins

Table 2. Fertility-fecundity in twin sisters from same-sex and opposite-sex twin pairs

<table>
<thead>
<tr>
<th>Measure</th>
<th>Same-sex pairs</th>
<th>Opposite-sex pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of women</td>
<td>7,528</td>
<td>4,767</td>
</tr>
<tr>
<td>Number of births</td>
<td>1,689</td>
<td>1,144</td>
</tr>
<tr>
<td>Mean age at first birth\a</td>
<td>26.05</td>
<td>25.97</td>
</tr>
<tr>
<td>(95% confidence interval)</td>
<td>(25.94–26.16)</td>
<td>(25.83–26.11)</td>
</tr>
<tr>
<td>Median age at first birth\a</td>
<td>27.43</td>
<td>27.42</td>
</tr>
<tr>
<td>(95% confidence interval)</td>
<td>(27.02–28.02)</td>
<td>(27.00–28.05)</td>
</tr>
<tr>
<td>Fertility odds ratio\a</td>
<td>1.00</td>
<td>1.029</td>
</tr>
<tr>
<td>(95% confidence interval)</td>
<td>(0.95–1.11)</td>
<td></td>
</tr>
</tbody>
</table>

\aKaplan-Meier estimate.
\bCox model estimate.

Evidence of a difference between same-sex and opposite-sex twin sisters for this parameter of reproductive behavior.

DISCUSSION

Boys will be boys—
And even that . . . wouldn’t matter if we could only prevent girls from being girls. (Hope, 1894, p. 137)

Our results, from representative, population-based, and age-standardized twin samples, suggest that experiences unique to sisters of twin brothers do not prevent them “from being girls” in their stereotypic attitudes associated with femininity in midadolescence. Nor do those experiences alter their pubertal timing in early adolescence or their reproductive behavior to age 28. And if boys will be boys, they will, apparently, be no less so should they grow up with a twin sister.

Our analyses provide no evidence of sex-typed effects either from androgenization in utero or from socialization effects during early development. The measures we used are relevant to such effects, were they present. Of course, the results do not deny that socialization effects from older siblings occur, as reported in recent research with nontwin families (McHale et al., 2001). We failed to find effects on stereotypic masculine-feminine interests in age- and cohort-matched opposite-sex twin pairs in adolescence. But we cannot dismiss them: Effects have been reported for age-displaced nontwin siblings in young adulthood (Rosenberg & Sutton-Smith, 1968; Sutton-Smith & Rosenberg, 1970) using questionnaires with very similar content. Such effects may be complex; may vary with family constellation, age displacement of siblings, and their birth order; and may be evident only at age-specific periods of development. And the effects may be asymmetric (Rust, Golombok, Hines, & Johnston, 2000); Older brothers may both masculinize and feminize their younger siblings, whereas older sisters may neither reduce masculinity of their younger brothers nor increase femininity of their younger sisters. Were asymmetric effects of this sort present in brother-sister co-twins, they would not be revealed in the unidimensional FEM scale measure we employed.

Nor do our negative results deny that effects attributable to in utero androgenization might be found in nonbehavioral domains: Positive results for frequency of otoacoustic emissions have been reported in a small sample of OSF twins (McFadden, 1993). But quite clearly, the notion that studies of OSF twins might reveal robust effects of hormonal transfer in utero, advanced by Miller (1994, 1998), is made improbable by our results. Prenatal androgen administration masculinizes juvenile behavior of female monkeys, and the importance of hormonally mediated dispositions in their sex-typed behavior is easily evident; but in monkeys, and surely in humans, consistent behavioral sex typing is strongly shaped by specific social experience (Wallen, 1996). Gender development in children undeniably occurs within sibling dyads and larger peer groups, and understanding the development of gender and sex-typed behavior in children requires a psychobiological perspective (Maccoby, 2000). Our results, finding no differences in sex-typed behaviors among brothers and sisters from same- and opposite-sex twin pairs, underscore the importance of that perspective in gender development.

REFERENCES


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