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Prenatal Stress and Gender Role Behavior in Girls and Boys: A Longitudinal, Population Study

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Prenatal stress influences neural and behavioral sexual differentiation in rodents. Male offspring of stressed pregnancies show reduced masculine-typical characteristics and increased feminine-typical characteristics, whereas female offspring show the opposite pattern, reduced feminine-typical and increased masculine-typical characteristics. These outcomes resemble those seen following manipulations of gonadal hormones and are thought to occur because stress influences these hormones during critical periods of development. Research on prenatal stress and human sexual differentiation has produced inconsistent results, perhaps because studies have used small samples and assessed prenatal stress retrospectively. We related maternal self-reports of prenatal stress to childhood gender role behavior in a prospective, population study of 13,998 pregnancies resulting in 14,138 offspring. Neither stress reported during the first 18 weeks of pregnancy nor stress reported from week 19 of pregnancy to week 8 postnatal related to gender role behavior in male offspring at the age of 42 months. In female offspring, maternal reports of stress during both periods showed only small correlations with masculine-typical behavior. Although this relationship remained significant when other factors that related to stress were controlled, these other factors made larger contributions to girls' gender role behavior than did prenatal stress. In addition, in both boys and girls, older male or female siblings, parental adherence to traditional sex roles, maternal use of tobacco or alcohol during pregnancy, and maternal education all related significantly to gender role behavior. Our results suggest that prenatal stress does not influence the development of gender role behavior in boys and appears to have relatively little, if any, influence on gender role behavior in girls.

Key Words: **stress; prenatal; sexual differentiation; gender role behavior; child; behavior; androgen; socialization.**

The sexes differ on average in certain psychological characteristics, including toy and activity preferences, aggression, and sexual orientation (Collaer and Hines, 1995; Maccoby and Jacklin, 1974). In addition, these characteristics show individual variability within each sex. One explanation for this variability involves prenatal stress. According to this hypothesis, prenatal stress causes hormonal changes that influence gender development.

Stressing pregnant rats reduces masculine-typical sexual behavior and increases feminine-typical sexual behavior in male offspring (Ward, 1972, 1984). These effects have been seen with a variety of stressors, including physical restraint under hot, bright lights, social crowding, and conditioned emotional responses (Ward, 1984). Other behaviors that show sex differences, including juvenile play behavior, also are less masculine-typical in male rats exposed to prenatal stress (Ward, 1984; Ward and Stehm, 1991). In addition, prenatal stress influences neural development in male rats, reducing the size of the sexually dimorphic nucleus of the preoptic area (SDN-POA) and of the spinal nucleus of the bulbocavernosus (SNB), neural regions that normally are larger in males than in females (Anderson, Fleming, Rhees, and Kinghorn, 1986; Grisham, Kerchner, and Ward, 1991; Kerchner and Ward, 1992).

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These effects of prenatal stress are similar to those seen when testicular hormones are removed from male animals during perinatal development. For instance, if male rats are castrated on the day of birth, they show less masculine-typical behavior and more feminine-typical behavior as adults (Goy and McEwen, 1980). This is because testicular hormones direct sexual differentiation of the mammalian brain and behavior during critical periods of early development. Prenatal stress disrupts a surge of testosterone that normally occurs in the developing male rat, and this could be the mechanism underlying the influence of stress in males of this species (Ward and Weisz, 1980, 1984; Ward, 1984).

Prenatal stress also has some influences on developing female rats. The stress treatment paradigm that has been used most commonly to study male rats does not appear to alter sexual behavior in females (Ward, 1984). However, using other paradigms, stress has been found to influence other sexually differentiated characteristics. For instance, prenatal stress impairs fertility and fecundity in female rats (Herrenkohl, 1979). Prenatal stress also influences behavior in other rodents, impairing feminine-typical copulatory behavior in female mice (Allen and Haggett, 1977) and increasing masculine-typical patterns of juvenile play behavior and adult courtship behavior in female guinea pigs (Sachser and Kaiser, 1996).

Like the effects of prenatal stress on sexual differentiation in males, the effects of prenatal stress on sexual differentiation in females resemble those seen following perinatal manipulations of gonadal hormones. Female rats, mice, and guinea pigs exposed to testosterone during early development show increased male-typical play as juveniles and increased male-typical copulatory behavior as adults (Goy and McEwen, 1980). One of the primary effects of stress is to stimulate hormone production by the adrenal gland, and stress has been reported to produce "extraordinarily high levels of testosterone" in pregnant rats (Beckhardt and Ward, 1983, p. 112) and elevated androgen in both male and female mice fetuses (vom Saal, Quadagno, Even, Keisler, Keisler, and Kahn, 1990). Therefore, prenatal stress could influence sexual differentiation in female rodents by increasing adrenal androgen production in either the mother or the fetus.

Stress during pregnancy also has been suggested to influence human sexual differentiation. Dorner and co-workers, working in what was then the German Democratic Republic (East Germany), interviewed 100 heterosexual, 40 bisexual, and 60 homosexual men about stressful events that had occurred during their mother's pregnancy with them (Dorner, Schenk, Schmiedel, and Ahrens, 1983). About 68% of the homosexual men and 40% of the bisexual men reported moderately to severely stressful events, many associated with life during wartime. In contrast, only 6% of the heterosexual men reported similarly stressful events. However, subsequent studies in the Federal Republic of Germany (West Germany) did not produce similar results. In one study, no increase in homosexuality was found in men conceived during the war (Schmidt and Clement, 1990). In a second study, recollections of psychosocial or physical stress during pregnancy did not predict sexual orientation in a sample of 50 men (Wille, Borchers, and Schultz, 1987).

Studies of men in the United States also have provided weak or no support for an association between sexual orientation and prenatal stress. One study reported a marginally significant difference between 39 homosexual and 68 heterosexual men in retrospective reports of maternal stress during the second trimester of pregnancy, but numerous other comparisons (e.g., of stress during other phases of pregnancy) were not significant (Ellis, Ames, Peckham, and Burke, 1988). A second study of 143 men and 72 women showed no relation between recalled prenatal stress and sexual orientation in males, but, for women in this study, recalled prenatal stress was associated with reduced heterosexual orientation (Bailey, Willerman, and Parks, 1991).

Interpretation of the findings from previous human research on prenatal stress and sexual differentiation is difficult. Relatively small samples have been studied and in all cases prenatal stress has been assessed retrospectively, from pregnancies that occurred decades earlier. The present study assessed the relationship between maternal reports of prenatal stress and human gender development prospectively, in a large, population sample of male and female offspring. It tested two hypotheses suggested by research on rodents: (1) stress impairs masculine-typical development, or enhances female-typical development, in male offspring; and (2) stress enhances masculine-typical development or impairs feminine-typical development in female offspring. The research project that provided the data for this study is longitudinal and the children involved are still developing. In this report we focus on their gender role behavior at the age of 42 months.

METHOD

Data for this study were collected as part of the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC, now called the Avon Longitudinal Study of Parents and Children). The study measures biological, environmental, and social factors associated with pregnancy outcomes and child health. Full details of the study are given elsewhere (Golding, Pembrey, Jones, and the ALSPAC Study Team, 2001).

Participants

The ALSPAC cohort consists of all pregnant women resident within a geographically defined area of Avon, England, and with expected delivery dates between April 1, 1991 and December 31, 1992. A total of 13,998 pregnant women enrolled in ALSPAC resulting in 14,138 children. This represents approximately 90% of all pregnancies occurring in the geographical area during the defined time period.

Procedures

Mothers enrolled in ALSPAC completed questionnaires at weeks 18 and 32 of pregnancy. Questionnaires also were completed postnatally at 4 weeks, 8 weeks, 6 months, 8 months, 15 months, 18 months, 21 months, 24 months, 30 months, 33 months, 38 months, and 42 months. Possible effects of stress on gender role development were not the only focus of the study. Participants understood that the study was measuring biological, social, and environmental factors that could influence the health, well-being, and development of children. Thus, they were unaware of the specific hypotheses under investigation for this report.

Stress

Stress was assessed by questionnaire at 18 weeks gestation, regarding the period from the onset of pregnancy, and at 8 weeks postnatal, regarding the period since the middle of the pregnancy until 8 weeks following the child's birth. We refer to the first time period as prenatal and the second as perinatal, although both primarily reflect prenatal stress. The questionnaire used at both time points included 41 items from inventories devised specifically to assess stress in obstetric groups (Barnett, Hanna, and Parker, 1983; Brown and Harris, 1978). Items were similar to those used in prior studies of prenatal stress and human sexual differentiation and included topics such as economic and relationship difficulties, problems with the pregnancy, job change or loss, and serious illness or death of family members or close friends. The internal reliability of the inventory, as indicated by the α coefficient, is 0.68.

The inventory assessed both the number of stressful life events and their perceived impact. Each item was rated in one of five categories: "Yes, affected me a lot," "Yes, affected me moderately," "Yes, affected me mildly," "Yes, but did not affect me," and "No, did not happen" and was rated from 0 to 4, with higher scores indicating greater stress. Two scores were calculated for each time period. These were as follows: (1) the number of stressful life events and (2) the perceived impact of the events.

Gender Role Behavior

Gender role behavior was assessed at 42 months of age using the Pre-School Activities Inventory (PSAI), a standardized instrument, with established reliability and validity (Golombok and Rust, 1993a,b). The PSAI was designed specifically to assess individual differences in gender role behavior within each sex as well as differences between the sexes. It is completed by the mother or child's primary caretaker and includes 24 items assessing the child's frequency of involvement with sex-typical toys, games, and activities. Each item has a score of 1 to 5, representing the response categories: "never," "hardly ever," "sometimes," "often," and "very often." A higher score indicates more masculine-typical behavior.

Control Variables

The ALSPAC data set includes approximately 10,000 variables for each pregnancy. To control for possible confounding influences, prior to data analyses, we identified background variables that could also relate to gender development or hormonal differences. These included demographic factors (birth weight, maternal age, maternal education), the presence in the home of older male or female siblings, the presence of a male partner in the home, the mother's employment status, parental adherence to traditional sex roles, and the mother's use of tobacco, alcohol, and cannabis. Measures of the maternal social network and of depression, anxiety, and other personality characteristics were also examined, because they have been suggested to modify the effects of stress (Lobel, 1994).

Background factors. Three demographic factors were assessed: (1) maternal age; (2) the mother's highest educational qualification (categorized into five levels, with 1 being the lowest and 5 the highest); and (3) the child's birth weight.

The presence of older brothers or sisters in the home, the presence of a male partner in the home, and the mother's employment status formed four dichotomous variables: (1) older brother(s) present in the home or not; (2) older sister(s) present in the home or not; (3) male partner living in the home or not; and (4) mother returned to, or began, work since the birth of the child or not.

Parental adherence to traditional sex roles was assessed for mothers who were living with male partners. They indicated who carried out each of seven sex-typed domestic activities. For each item there were seven response categories: "me always," "me mostly," "sometimes me, sometimes my partner," "my partner mostly," "my partner always," "always both of us," and "someone else." A high score on the scale indicates reduced adherence to traditional sex roles.

Tobacco, alcohol, and cannabis use was assessed for several periods and scores for the same variable at different times correlated highly. To provide the most rigorous control possible for our analyses, we selected the individual assessments that correlated most closely with PSAI scores. For tobacco use, this was the number of cigarettes smoked at 32 weeks of gestation. For alcohol use, it was consumption during the first 3 months of gestation, assessed with the categories: "less than one glass per week," "one or more glasses per week," "one to two glasses per day," and "three or more glasses per day." For cannabis use, it was the mother's indication of whether or not she had smoked cannabis in the 6 months prior to the pregnancy.

Social network and personality. The mother completed a questionnaire regarding her social network at 21 months postnatal. The measure included 10 items relating to the frequency of contact with family and friends and the number of people to whom she could turn to discuss personal problems and important decisions or to borrow money. A higher score indicates a larger supportive network.

Personality traits were assessed at 18 weeks of gestation using the Interpersonal Sensitivity Measure (IPSM) (Boyce and Parker, 1989) and the anxiety and depression subscales of the Crown-Crisp Experiential Index (CCEI). The IPSM includes 36 items that assess five subscales (interpersonal awareness, need for approval, separation anxiety, timidity, and fragile innerself). Each item is scored from 1 to 4 indicating: "very like," "moderately like," "moderately unlike," and "very unlike," myself. Higher scores indicate greater interpersonal sensitivity. The CCEI is designed to assess neurotic symptoms (Crown and Crisp, 1979). For each of 24 items involving symptoms, one of four responses is indicated: "never," "not very often," "often," or "very often." Higher scores reflect more anxiety or more depression.

RESULTS

Summary data for raw PSAI scores, stress variables, and quantitative background variables are provided in Table 1. As expected, mean PSAI scores were higher for boys than girls ($t = 136.5$, df (9309.5), $P < .001$), as was birth weight ($t = 11.30$, df (15260.4), $P < 0.001$). Unpredicted differences between male and female offspring were seen in maternal age ($t = 2.67$, df (12,866), $P = 0.008$) and maternal social network ($t = -2.38$, df (10, 278), $P = 0.017$). Mothers of boys were older and had less extensive social networks than mothers of girls. None of the four stress scores and none of the other quantitative or qualitative background variables differed significantly for male versus female offspring.

Prior to further data analyses, variables were evaluated for normality and for extreme scores using SPSS 7.5. The distributions of scores for stress, tobacco use, and social network were slightly skewed and included some extreme Z scores. To meet the assumptions of statistical models, the data were normalized using a logarithmic transformation (stress and tobacco use) or a square root transformation (social network).

Correlations between the four stress measures and PSAI scores are shown in Table 2. For boys, none of the correlations was significant. For girls, each of the four stress measures correlated with PSAI scores. In all cases, higher numbers of stressful events and greater perceived stress related positively to more masculine-typical scores on the PSAI.

Subsequent analyses were conducted to determine whether control factors could account for the relationship between stress and gender role behavior in girls and to explore control factors related to gender role behavior in both boys and girls. To limit the number of analyses in those procedures involving stress, we focused on a single measure (perceived prenatal stress). This measure was chosen because the perceived impact of stressful events is more influential than their numbers and because the animal models on which predictions were based involve prenatal stress (Sachser and Kaiser, 1996; Ward, 1972).

To determine whether control factors could account for the small relationship observed between stress and gender role behavior in girls, correlations between

TABLE 1
Descriptive Statistics by Sex for Gender Role Behavior, Stress, and Quantitative Control Variables

	Boys			Girls		
	M	*SEM*	*n*	*M*	*SEM*	*n*
PSAI Score***	62.43	0.125	4863	36.92	0.138	4531
Number of stressful events T1	8.41	0.098	6106	8.57	0.103	5715
Perceived impact T1	3.62	0.033	6106	3.66	0.035	5715
Number of stressful events T2	7.39	0.099	5279	7.47	0.104	4931
Perceived impact T2	3.08	0.033	5269	3.11	0.034	4920
Maternal age**	27.87	0.061	6650	27.64	0.061	6218
Parental adherence to traditional sex roles	16.50	0.039	4473	16.46	0.040	4182
Social network score*	23.07	0.058	5326	23.27	0.060	4954
Child's birth weight (kg)***	3.43	0.007	7885	3.33	0.006	7485
CCEI Anxiety	4.87	0.046	5988	4.96	0.048	5609
CCEI Depression	4.42	0.040	5945	4.44	0.041	5577
IPSM						
Interpersonal awareness	18.23	0.058	6572	18.21	0.061	6186
Need for approval	25.77	0.046	6550	25.73	0.046	6184
Separation anxiety	16.48	0.059	6571	16.48	0.060	6189
Timidity	20.55	0.057	6566	20.44	0.059	6181
Fragile inner-self	8.82	0.037	6526	8.75	0.038	6155
Tobacco use during pregnancy	2.34	0.071	5736	2.23	0.072	5453

Note. Means for boys and girls differ $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$ T1, prenatal timepoint. T2, Perinatal timepoint.

PSAI scores and control variables were first examined (Table 3). Several of the control variables related to gender role behavior in the predicted direction. These included maternal age and education, the presence of older sisters or brothers in the home, parental adherence to traditional sex roles, birth weight, and maternal use of tobacco, alcohol, and cannabis. Girls showed more feminine-typical behavior if they had older sisters, if their parents adhered to traditional sex roles, or if they had lower birthweight. They showed more masculine-typical behavior if they had older brothers, if their mothers were older or more educated, or if their mothers used tobacco, alcohol, or cannabis. Whether or not the mother returned to work after the child's birth and whether or not the mother had a male partner living in the home did not relate to girls' PSAI scores. Two of eight variables were included because they might modify the effects of stress correlated with PSAI scores. These were the mother's social network and maternal timidity. Daughters of more timid mothers and daughters of mothers with a smaller social network showed more feminine-typical gender role behavior.

Because of the significant correlations between some of the control variables and gender role behavior in girls, we next conducted a step-wise multiple regression analysis that included these variables as well as prenatal stress as predictors of PSAI scores. It indicated that the relationship between prenatal stress and gender role behavior in girls remained significant after the effects of the control variables were removed (see

TABLE 2
Correlations between Stress and Gender Role Behavior in Boys and Girls

	r	r^2	n
Girls			
Prenatal stress (prior to week 18 of gestation)			
Number of stressful events	0.066**	0.0044	3832
Perceived impact of stressful events	0.080**	0.0064	3832
Perinatal stress (from week 18 of gestation to week 8 postnatal)			
Number of stressful events	0.041**	0.0017	4092
Perceived impact of stressful events	0.036**	0.0013	4092
Boys			
Prenatal stress (prior to week 18 of gestation)			
Number of stressful events	−0.012	0.0001	4238
Perceived impact of stressful events	−0.015	0.0002	4238
Perinatal stress (from week 18 of gestation to week 8 postnatal)			
Number of stressful events	−0.008	0000	4418
Perceived impact of stressful events	−0.007	0000	4418

$^*P < 0.05$.
$^{**}P < 0.01$.

TABLE 3

Correlations between Gender Role Behavior and Control Variables for Girls and Boys

	PSAI Scores					
	Girls			Boys		
	N	*r*	r^2	*N*	*r*	r^2
Maternal age	4401	0.087***	0.0076	4725	−0.024	0.0006
Maternal education	4716	0.062***	0.0038	4474	−0.088***	0.0077
Older sister(s) in the home	4189	0.137***	0.0187	4568	0.153***	0.0234
Older brother(s) in the home	4189	−0.119***	0.0142	4568	−0.151***	0.0228
Parental adherence to traditional sex roles	3543	0.112***	0.0125	3783	−0.061***	0.0037
Birth weight	4559	−0.034*	0.0012	4911	0.013	0.0002
Mother returned to work	4095	0.015	0.0002	4383	0.003	0.0000
Mother has a live-in partner	4407	−0.019	0.0004	4702	−0.021	0.0004
Tobacco use	4065	0.057***	0.0032	4286	0.078***	0.0061
Alcohol use	4427	0.066***	0.0043	4731	0.049***	0.0024
Cannabis use	4262	−0.050***	0.0025	4569	0.013	0.0002
Maternal social network	4183	0.066***	0.0044	4456	−0.007	0.0000
CCEI Depression	4017	0.030	0.0009	4341	−0.023	0.0005
CCEI Anxiety	4037	0.006	0.0000	4367	−0.015	0.0002
IPSM						
Interpersonal awareness	4399	−0.014	0.0002	4723	−0.063***	0.0040
Need for approval	4398	−0.022	0.0005	4713	−0.010	0.0001
Separation anxiety	4399	−0.009	0.0001	4723	−0.031*	0.0096
Timidity	4398	−0.033*	0.0011	4722	−0.039**	0.0015
Fragile inner-self	4384	−0.020	0.0004	4699	−0.054***	0.0029

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 4). However, several control variables also were significant, and all of these made larger contributions to girls' gender role behavior than did prenatal stress.

TABLE 4

Stepwise Multiple Regression of Girls' Gender Role Behavior

	β	*t*
Older brother(s) in the home	0.122	5.802**
Parental adherence to traditional sex roles	0.094	4.702**
Alcohol use	0.065	3.226**
Maternal social network	0.081	4.026**
Maternal education	0.067	3.173**
Older sister(s) in the home	−0.074	3.538**
Tobacco use	0.058	2.851**
Maternal age	0.062	2.975**
Maternal timidity	−0.057	2.836**
Prenatal stress	0.047	2.316*
Excluded variables		
Cannabis use	−0.036	1.760
Birthweight	0.004	0.208

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

These were the presence of older sisters or brothers in the home, parental adherence to traditional sex roles, maternal use of alcohol or tobacco, maternal age, maternal education, the maternal social network, and maternal timidity. Two variables, cannabis use and birthweight, were excluded from the model.

Finally, although correlations between stress measures and PSAI scores were not significant in boys, we also correlated boys' PSAI scores with control variables (Table 3). In boys, like girls, older brothers were associated with more masculine-typical behavior and older sisters with more feminine-typical behavior. Also, having a more educated mother or parents who did not adhere as strongly to traditional sex roles was associated with reduced sex-typed behavior. In addition, maternal tobacco use and alcohol use were associated with more masculine-typical behavior and greater maternal timidity was associated with less masculine-typical behavior. However, unlike for girls, maternal education, birthweight, the maternal social network, and cannabis use did not relate to gender role behavior in boys. Also unlike girls, maternal interpersonal awareness, separation anxiety, and fragile

TABLE 5
Stepwise Multiple Regression of Boys' Gender Role Behavior

	β	t
Older brother(s) in the home	0.122	6.144**
Parental adherence to traditional sex roles	−0.079	4.220**
Alcohol use	0.045	2.386*
Maternal education	−0.074	−3.8**
Older sister(s) in the home	0.131	6.623**
Tobacco use	0.05	2.591*
Maternal fragile inner-self	−0.058	−3.067*
Excluded variables		
Prenatal stress	0.349	−0.018
Interpersonal awareness	0.433	−0.015
Separation anxiety	0.938	0.002
Maternal timidity	0.86	0.003

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

inner-self related to gender role behavior in boys. The remaining control variables did not relate to gender role behavior in either sex. These were as follows: whether or not the mother returned to work, whether or not the mother had a live-in partner, and maternal scores on measures of depression, anxiety, and need for approval. When all significant correlates of PSAI scores in boys were included along with prenatal stress in a stepwise multiple regression analysis, older brothers or sisters, parental adherence to traditional sex roles, maternal education, maternal use of tobacco and alcohol, and maternal fragile inner-self remained significant. Prenatal stress, interpersonal awareness, separation anxiety, and maternal timidity were excluded from the model (Table 5).

DISCUSSION

We found that maternal self-reports of stress during pregnancy showed only a small relationship to gender role behavior in female offspring and no relationship at all in male offspring. In addition, in both girls and boys, several other factors related to gender role behavior. These included maternal education, the presence of older brothers or sisters in the home, parental adherence to traditional sex roles, and maternal use of tobacco or alcohol.

Prenatal Stress and Gender Role Behavior in Girls

We observed the predicted relationship between maternal reports of prenatal stress and gender role behavior in girls, and this relationship remained when control variables that also related to gender role behavior were considered. However, stress accounted for only a small proportion of the overall variance in girls' behavior, and several other background accounted for more of the variance than did stress. This suggests that individual differences in girls' gender role behavior result from many factors, with prenatal stress playing a minor role, if any.

To our knowledge, only one prior study of prenatal stress and human development has reported data for female offspring. That study found an association between prenatal stress and a lesbian sexual orientation (Bailey *et al.*, 1991). Our results are similar, in that prenatal stress was associated with increased masculine-typical gender role behavior. Our findings are also consistent in direction with previous work on female rodents (Allen and Haggett, 1977; Herrenkohl, 1979; Ward, 1984), including one study finding that prenatal stress increased masculine-typical play behavior in female guinea pigs (Sachser and Kaiser, 1996). However, the effect of stress in humans appears to be much smaller than in female rodents.

Prenatal Stress and Gender Role Behavior in Boys

Our findings for boys contrast with predictions based on research in rats, where prenatal stress causes incomplete masculinization of brain and behavior (Anderson *et al.*, 1986; Grisham *et al.*, 1991; Kerchner and Ward, 1992; Ward, 1972, 1984), including a reduction in male-typical play (Ward and Stehm, 1991). This is thought to occur because stress disrupts the surge of testosterone that normally occurs in male rat fetuses on days 18 and 19 of gestation (Ward, 1984). The difference between humans and rats may occur because the adrenal hormone response to stress is less dramatic in humans (Sachar, 1980). Alternatively, the prenatal period of sexual differentiation is longer in the human (from about week 8 to 24 of gestation (Smail, Reyes, Winter and Faiman, 1981)) than in the rat (from about day 18 to 19 of gestation (Ward, 1984)), and this may allow more scope for the human to compensate for perturbations in hormones, for instance, via feedback mechanisms that reduce testicular androgen production (Brown-Grant, Fink, Greig, and Murray, 1975; Pang, Levine, Chow, Faiman, and New, 1979).

Our findings for boys also contrast with Dorner's reports associating prenatal stress with male homosexuality (Dorner *et al.*, 1983). In this respect our results are consistent with the majority of other studies of humans that also have provided limited or no support for a link between prenatal stress and sexual orientation (Bailey *et al.*, 1991; Ellis *et al.*, 1988; Schmidt and Clement, 1990; Wille *et al.*, 1987). One of these studies, like Dorner's, involved offspring of pregnancies conceived during the extreme stress of wartime (Schmidt and Clement, 1990). However, methodological limitations, such as small, selected samples and retrospective measures of stress during pregnancies decades past, limited the implications that could be drawn from these failures to replicate. Our results are based on a longitudinal, general population study of thousands of pregnancies and so are not subject to these methodological limitations.

Nevertheless, we measured childhood gender role behavior, not adult sexual orientation, and so cannot rule out the possibility that prenatal stress influences sexual orientation, as suggested by Dorner, but not boys' gender role behavior, as investigated by us. However, two types of findings argue against this possibility. First, in rodents, prenatal stress influences both juvenile play behavior and adult sexual behavior in male offspring (Ward, 1984; Ward and Stehm, 1991). Second, in human males, childhood gender role behavior is a strong predictor of adult sexual orientation (Green, 1987). At the least, our results suggest that the stresses typically experienced by pregnant women in Avon, England, and probably in similar cultural settings, do not influence gender role development in boys by the age of $3\frac{1}{2}$ years. In addition, if these types of stressors are influential in girls, their effects are very small. Nevertheless, it will be necessary to follow these children as they develop through adolescence and into adulthood to determine whether our findings for early childhood gender role behavior predict behavior in later life, including adult sexual orientation.

Factors Other Than Stress That Influence Gender Role Behavior

We found six control factors to relate to gender role behavior in both boys and girls and to remain significant in the stepwise multiple regression analyses. These were the presence of older brothers or sisters in the home, parental adherence to traditional sex roles, maternal use of alcohol or tobacco, and maternal education. The best studied of these variables is the sex of siblings. Like us, prior studies generally also have found that children with older brothers show more masculine-typical behavior and that those with older sisters show more feminine-typical behavior (e.g., Rust, Golombok, Hines, Johnston, Golding, and the ALSPAC Study Team, 2000). The association we saw between parental adherence to traditional gender roles and gender role behavior in offspring extends prior work finding that children in nonconventional families are less sex-typed than children in two-parent, married couple, families (Weissner, Garnier, and Loucky, 1994). However, Weissner *et al.* found no relationship between childhood gender role behavior and parental adherence to traditional sex roles in terms of domestic duties. We might have been able to detect this relationship, because we had a larger sample. We included maternal use of alcohol and tobacco as control factors, because these substances may influence testosterone levels, which in turn could influence sex-typical behavior (e.g., Cutler, Wilderson, Gingras, and Levin, 1996; McGivern, Handa, and Redei, 1993; McGivern, McGeary, Robeck, Cohen, and Handa, 1995), and because mothers who drink alcohol or smoke may be less sex-typed than other women. Similarly, more educated mothers may be less sex-typed than other women and may have less sex-typed children, either because of shared genetic predispositions or through socialization. Our data provide some support for relationships between several of the control factors and gender role behavior. Additional investigations are needed, however, to substantiate these relationships and, if substantiated, to determine the mechanisms (social, genetic, hormonal, or some combination) responsible for them.

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