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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. © 2002 Elsevier Science (USA)

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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 Child-

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