EARLY ANDROGENS ARE RELATED TO CHILDHOOD SEX-TYPED TOY PREFERENCES

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Abstract—Girls with congenital adrenal hyperplasia (CAH) who were exposed to high levels of androgen in the prenatal and early postnatal periods showed increased play with boys' toys and reduced play with girls' toys compared with their unexposed female relatives at ages 3 to 8. Boys with CAH did not differ from their male relatives in play with boys' or girls' toys. These results suggest that early hormone exposure in females has a masculinizing effect on sex-typed toy preferences.

Sex differences in children's toy preferences have been demonstrated repeatedly. Boys prefer construction and transportation toys, whereas girls prefer dolls, doll furnishings, and kitchen supplies (Connor & Serbin, 1977; Liss, 1981). These preferences appear to be partially learned, through modeling and reinforcement. For example, children at various stages of development emulate the behavior of same-sex models in preference to opposite-sex ones (Bussey & Bandura, 1984; Huston, 1983). We present evidence that these sex-typed toy preferences are also related to prenatal or neonatal hormones (androgens).

 Gonadal hormones play a major role in the development of sex differences in behavior and the brain in a variety of species, including rodents, songbirds, and primates (Arnold & Gorski, 1984; Beatty, 1979; Goy & McEwen, 1980; MacLusky & Naftolin, 1981). A unique opportunity to study hormonal influences on human sex-typed behavior is provided by the genetic disorder congenital adrenal hyperplasia (CAH). Because of an enzymatic defect, individuals with CAH produce high levels of adrenal androgens beginning in utero. Postnatal treatment with corticosteroids (and mineralocorticoids for the 75% who are also salt-losers) normalizes hormone levels (White, New, & Dupont, 1987).

If early hormone exposure affects the development of sex-typed behavior in human beings as it does in other species, then CAH girls should show behavior similar to that of normal boys. Previous studies have suggested that CAH females show intense physical energy expenditure, "tomboyism," rough outdoor play, preference for traditionally masculine toys and activities (Ehrhardt & Baker, 1974; Ehrhardt, Epstein, & Money, 1968), and greater spatial ability than their female relatives (Resnick, Berenbaum, Gottesman, & Bouchard, 1986). These findings parallel those reported in other samples with prenatal exposure to masculinizing hormones due to maternal ingestion during pregnancy (Ehrhardt & Meyer-Bahlburg, 1979; Hines, 1982), and are especially interesting in light of recent reports of sex differences in human brain structure (Allen, Hines, Shryne, & Gorski, 1989; Hines & Green, 1991; Swaab & Fliers, 1985).

Although prior studies of CAH girls suggest that hormones can influence childhood behavior, methodological limitations encouraged us to pursue this issue. Specifically, in prior studies, (a) behavior was assessed from interviews rather than direct observation; (b) data were collected with knowledge of the patient or control status of the subject; (c) behaviors were usually rated as present or absent, rather than as continuous traits; and (d) masculine and feminine behaviors were often not assessed separately, but instead treated as opposite ends of a single continuum. Therefore, the present study of individuals with CAH focused on objective, quantifiable measures of sex-typed toy preferences, with assessments made by raters blind to the patient or control status of subjects. We hypothesized that CAH girls would show greater preference for boys' toys than their unaffected female relatives, and reduced preference for girls' toys. We did not predict effects for CAH boys because androgen treatment has inconsistent effects in male experimental animals (Baum & Schretlen, 1975; Diamond, Llacuna, & Wong, 1973).

METHOD

Subjects

We recruited 3- to 8-year-old children with CAH from pediatric endocrine clinics at eight hospitals in the Midwest and California and tested 26 girls and 11 boys. Because of the restricted age range studied and family constellations, only 16 patients (43%) had a same-sex control. Therefore, we combined relatives of male and female patients to obtain our control groups. The control groups consisted of 15 unaffected female relatives (10 sisters and 5 first cousins) and 18 unaffected male relatives (14 brothers and 4 first cousins). Patients and controls did not differ significantly in birth order or age. Mean ages in months were as follows: female patients, 66.54 (range: 36-99); female controls, 61.80 (range: 36-93); male patients, 64.18 (range: 41-101); and male controls, 69.78 (range: 33-99).

Illness Characteristics

Although behavioral changes in CAH girls may be caused by androgen influences on the developing brain, it has been suggested that changes might instead result from social or illness factors (Quadagno, Briscoe, & Quadagno, 1977; Slipjer, 1984). For example, because androgen levels are high in utero, females have masculinized genitalia. Surgical reconstruction is often neces-
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sary, although postnatal treatment prevents further virilization. Parents may treat their CAH daughters in a masculine fashion as a response to this masculine appearance at birth. Therefore, we asked parents to complete a questionnaire which included the item “I encourage my child to act as a girl should.” The questionnaire was available for 24 CAH and 11 control girls.

We also examined characteristics of the child’s disease: age at diagnosis, degree of genital virilization at diagnosis, and salt-losing status. This information was obtained from medical records, available on 25 girls and 10 boys. Medical ratings were made by two research assistants who had no knowledge of the child’s behavioral scores. Age at diagnosis and salt-losing status were recorded with perfect reliability. Most patients were diagnosed in the early neonatal period: Median age at diagnosis was 11 days for girls (range: 0 days to 64 months) and 30 days for boys (range: 14 days to 54 months). Degree of virilization was rated on a scale ranging from 0 (normal female) to 6 (normal male), with intermediate values reflecting varying degrees of clitoral enlargement and fusion of the labia (Prader, 1954). Interrater reliability was .82; mean ratings were used. All girls had some degree of genital virilization: The mean Prader score was 3.0 (range: 1–5). One girl had been raised as a boy for the 1st month.

Toy Preference Materials and Procedure

Toy preference was measured by the amount of time the child played with toys shown by others to be preferred by girls, by boys, or equally by the sexes (neutral). The boys’ toys included transportation toys (a helicopter, two cars, and a fire engine) and construction toys (blocks and Lincoln Logs). The girls’ toys included three dolls, kitchen supplies, a toy telephone, and crayons and paper. Neutral toys, used as a control, included books, two board games, and a jigsaw puzzle. The toys were arranged in a standard order on the floor of the pediatric clinic or the child’s home, in an area approximately 8 ft by 10 ft surrounded by screens.

The child was brought into the play area individually and told to play with the toys however he or she wanted. The 12-min session was videotaped for later scoring. The first 10 min of each session were usually scored; the additional 2 min were scored only if sections of the initial 10 min were unscorable (e.g., if the child attempted interaction with the videotaper). Order of testing the patient and control was random.

We scored the amount of time the child played with each toy and then summed the time spent in play with the toys in each of the three categories, to produce total scores for play with boys’ toys, girls’ toys, and neutral toys. All tapes were rated by the same two raters, who had not tested the children and who were blind to their patient or control status. Interrater reliability was very high: The median correlation was .99 for individual toys and .99 for total scores. Data reported here represent the mean scores of the two raters.1

RESULTS

Statistical tests are one-tailed when hypotheses are directional (sex differences and female CAH–control comparisons for time spent in play with boys’ and girls’ toys) and two-tailed when no difference is hypothesized (all comparisons for play with neutral toys) or when the direction of the difference is not specified (male CAH–control comparisons).

Sex Differences

As expected, control boys and girls differed in the amount of time they played with boys’ toys and girls’ toys, but not neutral toys (see Fig. 1). The magnitudes of the differences (in standard deviation units, or d; Cohen, 1977) are consistent with those reported by other investigators. Further, control boys preferred boys’ toys to girls’ toys, t(17) = 4.58, p < .001. Control girls had the opposite preference, but the difference was not significant, t(14) = −1.17.2

CAH Patient–Control Comparisons

Females

As hypothesized, CAH girls spent significantly more time playing with boys’ toys than did control girls (d = .89), t(37) = 2.66, p < .01, and about as much time as the control boys (see Fig. 1). Further, like control boys, CAH girls played significantly more with boys’ toys than with girls’ toys, t(23) = 2.93, p < .01. This effect is also seen in the subsample of patients with a same-sex relative control (N = 11 pairs): The mean time in play with boys’ toys was 327.23 s for CAH girls and 166.35 s for matched girls, t(10) = 2.20, p < .05.

CAH girls also played less with girls’ toys than did the control girls, t(37) = −2.02, p < .05, but this effect is smaller than that for boys’ toys (d = .65). Perhaps because of low statistical power, the difference is not significant in matched-pairs analysis of the 11 patient–control pairs, t(10) = −1.09. Because total play time was limited, play with one set of toys tended to reduce play with another set, so reduced play with girls’ toys may have partly resulted from increased play with boys’ toys. In fact, the correlations among play with boys’, girls’, and neutral toys are all moderately negative, ranging from −.30 to −.69 (all ps < .01, one-tailed). In this context, however, it is important to note that there were no differences between CAH and control girls in play with neutral toys (both matched and unmatched t-values < 1.0).

There were no significant differences between CAH and control girls in parents’ responses to the question “I encourage my child to act as a girl should,” with 59.1% and 63.6% responding “yes,” respectively. Amount of time spent playing with sex-typed toys was not significantly related to any disease

1. Two children (both CAH girls) who played with no toys during their sessions were excluded from all analyses. These girls are similar to the other subjects in disease characteristics. Analyses including these subjects do not change the interpretation of the results.

2. Because the distributions of play scores are skewed, we conducted all analyses on data transformed in various ways (e.g., arcine, square root) and with nonparametric procedures. All analytic procedures produced similar results.
characteristic. For play with boys' toys, \( r_s = -0.10 \) for virilization, -0.29 for age at diagnosis, and 0.25 for salt-losing status (1 = salt-loser, 0 = simple virilizer). For play with girls' toys, corresponding \( r_s \) are -0.09, -0.14, and -0.06. Note, however, that the small sample size and restricted range (e.g., only 2 girls were simple virilizers) reduce the power of these analyses.

**Males**

In contrast to the differences observed between CAH and control girls, there were no significant differences between CAH boys and control boys on sex-typed play \((p > 0.20\) for play with boys' and girls' toys). Examination of medical characteristics in relation to sex-typed play in boys is not meaningful because of the lack of patient-control differences and limited variability in the sample.

**DISCUSSION**

Large differences between CAH girls and unaffected female relatives indicate masculinization of toy preferences in girls exposed to high levels of androgen during early development. These results are consistent with data from animal models and with prior studies of CAH and other females exposed to masculinizing hormones in *utero*. Our findings strengthen the conclusions of previous play studies in CAH girls because we used objective, quantifiable measures and behavioral ratings made without knowledge of patient or control status. The data also suggest a relative defeminization of toy preferences, although this result was less robust. Other studies of hormone-exposed samples have also been more likely to observe “masculinizing” than “defeminizing” effects of prenatal hormones, perhaps in part because the studies have concentrated on the former (Berenbaum, 1990; Ehrhardt & Meyer-Bahlburg, 1979; Hines, 1982). Although other hormones, such as 17-hydroxyprogesterone and corticosteroids, are also abnormal prenatally in CAH, it is unlikely that they account for the masculinized behavior in CAH girls, because these hormones have smaller and less consistent behavioral effects than androgen and may actually prevent masculinization (Erpino, 1975; Hull, Franz, Snyder, & Nishita, 1980).

It appears unlikely that the behavioral changes are due to social or illness factors. Our failure to find relationships between sex-typed play and physical virilization is consistent with other data in CAH patients indicating no relationship between degree of virilization and gender-role behavior (Slipjer, 1984). Although it is possible that any virilization results in different parental treatment, this argument is weakened by parents' retrospective reports that they did not treat CAH girls in a “masculine” fashion, here and in other studies (Ehrhardt & Baker, 1974; Resnick, 1982), and by data from rhesus macaques indicating that masculinization of juvenile play is unrelated to genital virilization or maternal behavior (Goy, Bercovitch, & McBrair, 1988). Nevertheless, given the disproportionate rate of return of questionnaires for our CAH and control girls and other problems inherent in questionnaire measures, direct observation of parental behavior would be valuable.

Our data indicate no changes in sex-typed toy preferences in CAH males, consistent with previous reports in nonhuman animals and people. CAH males have generally been reported not to differ from controls in sex-typed activities or abilities (Ehrhardt & Baker, 1974; Resnick et al., 1986).

Although the data are consistent with an androgen influence on sex-typed toy choices, it is not necessary that hormones have a direct influence on these choices. Hormones may affect toy choices indirectly, perhaps through an influence on activity level, motor skills, abilities, or temperament. For example, CAH girls may be more active than control girls, and boys' toys may facilitate active play (O'Brien & Huston, 1985).

Results from this study may also be relevant to understanding the development of sex-typed toy preferences in normal children. Normal males have higher testosterone levels than normal females from approximately week 8 to week 24 of gestation and from approximately the 1st to the 5th month of life (Smail, Reyes, Winter, & Faiman, 1981). These sex differences in hormones may

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**Fig. 1.** Time spent in play with sex-typed toys by female and male CAH patients and controls during 10 min of play. Scores are the sum of play with individual toys and therefore may exceed 600 s. Bars represent group means; lines represent standard errors; points represent individual subjects; \( d = \) difference between group means/average standard deviation. Group differences were evaluated by \( t \) test; \( *p < 0.05, **p < 0.01, ***p < 0.001, \) one-tailed.
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contribute to subsequent sex differences in behavior, such as those in toy preferences. Further, natural variations in levels or availability of testosterone among normal males and females might contribute to individual differences in sex-typed behavior.

Our data may also be relevant to evidence that early sex-typed toy preferences predict later behavior, including sexual orientation (Green, 1987) and spatial ability (Newcombe, Bandura, & Taylor, 1983; Sherman, 1967), and to evidence that spatial ability (Resnick et al., 1986) and sexual orientation (Money, Schwartz, & Lewis, 1984) are masculinized in CAH females (for discussion, see Berenbaum, 1990). Specifically, it is possible that hormonal influences on adult behaviors are mediated by childhood sex-typed toy preferences, although it is also possible that various sex-typed behaviors are influenced separately by hormones (Arnold & Gorski, 1984; Goy & Schreits, 1975). Neuroendoctrine effects of perinatal androgenization in the male ferret. Progress in Brain Research, 42, 343-355.


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