Psychosexual Differentiation in the Human

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ABSTRACT

This review presents the major findings in studies on humans of chromosomal, gonadal, prenatal hormonal and environmental contributions to sex dimorphic behaviors. The hypotheses derived from these studies are evaluated. Findings relevant to possible biological antecedents in the formation of gender identity, gender role behaviors, sexual orientation and "parenting" behaviors are reviewed and critically discussed.

INTRODUCTION

This review summarizes the research to date that bears on the possible influence of prenatal hormonal environment on later behavior in humans. To do this, the following format will be utilized: first, the major tenets or hypotheses which express our understanding of the nature of various hormonal influences on later behavior will be stated; second, the major human studies will be reviewed; third, these hypotheses will be critically analyzed in light of the findings from human studies; and, finally, suggestions will be made both for studies needed to clarify the validity of our hypotheses and underlying assumptions as well as for additional concepts that may facilitate a unified view of the effects of prenatal exposure to hormones on later behavior in humans. The critical review of assumptions and hypotheses is not only important for those of us working in the field, but also for those working in related fields, particularly those who attempt to integrate human studies into theory concerning normal dimorphic development in males and females.

Hypotheses

There are 5 major hypotheses implicit in the understanding of studies in humans. These are, in ontogenetic order:

1) Differentiation of mammals will be along female lines in the absence of androgens during early "critical" periods of prenatal development. Physiologically, this includes the differentiation of the internal (Wolfian or Mullerian ducts) and external (genital tubercle) reproductive systems. Current animal research indicates that this principle applies to the brain as well as to the reproductive system (Gorski, 1971).

2) Gender identity is defined as the unified and persistent experience of oneself as male, female or ambivalent, particularly as experienced in self-awareness. Gender identity is not determined by chromosomes, gonadal or prenatal hormonal influences, but rather is determined by rearing. There is a further assumption that in sex assignment there is a critical period, after which reassignment will be difficult if not impossible (18 months to 2 years).

3) Gender role is defined as actions, activities and behavior indicating to others or to the self the degree to which one is male, female or ambivalent. Gender role behaviors are influenced by prenatal hormonal environment.

4) Sexual orientation (in adulthood) is generally subsumed under gender role, but in humans, sexual object choice is most fruitfully considered a separate category of dimorphic behavior. Sexual orientation is generally thought to be essentially environmentally determined.
Sex chromosomes certainly do not determine sexual orientation, nor do gonads. The role, if any, of prenatal hormones is not known.

5) **Parenting** is also generally subsumed under gender role. Parenting is defined as the desire and capacity for child caretaking and is of particular importance as it is necessary for species survival. Knowledge is very sparse concerning the relative biological or environmental influence on parenting even in regard to normal individuals. For example, can fathers be successful primary caretakers? We know “parenting” behavior as such seems to appear early in life. Further, there is some evidence that parenting may be influenced by prenatal hormones.

**Studies on Humans**

The current hypotheses are derived from a number of studies of humans with histories of abnormal prenatal hormonal environments. Many of these studies parallel laboratory studies in other mammalian species in some crucial aspects.

The research reviewed here includes studies of individuals from “clinical populations” as well as of individuals exposed to exogenous hormones during the mother’s pregnancy. These studies on humans are primarily retrospective. They use semistructured interviews and score for behavioral data.

This research has examined gender dimorphic patterns of behavior in childhood and adolescence. The behavioral areas evaluated include gender role, gender identity, sexual orientation and cognition. In the review of human research below, findings relating to the first 3 areas will be outlined in relation to the hypotheses. While there are considerable data of interest regarding cognition in these subjects, thus far there are no data to support any hypotheses of clear-cut *dimorphic* influences on cognition from any of the “affected” or “treated” samples. Thus studies of cognition will be excluded.

**Clinical Conditions**

There are 5 major experimental groups that have been available for study. Three groups are represented by clinical syndromes. Whereas normal individuals are concordant for chromosomes, gonads, prenatal hormonal environment, reproductive system morphology and rearing, in these 3 groups, discordance of one kind or another constitutes the variable of interest. The other 2 experimental groups are represented by exogenous exposure during prenatal life to “defeminizing” or to “virilizing” hormones.

A) **Children with elevated androgens.** The only known medical condition occurring in humans with relative frequency (1:20,000 live births) that results in clearly elevated androgens during prenatal life in genetic females is congenital adrenal hyperplasia (CAH). The condition, which occurs in both males and females, results from a genetically based error affecting the functioning of the adrenal cortex such that it cannot produce cortisol. Thus the adrenal glands produce elevated levels of adrenal androgens beginning early in prenatal life until treatment is instituted postnatally. Genetic females with this condition generally are born with masculinized external genitalia due to the high levels of prenatal androgens. Optimal medical management involves early postnatal diagnosis and treatment. Treatment consists of corticosteroid replacement and, in females, early corrective surgery to restore the external genitalia to a normal appearance.

Ehrhardt, Epstein and Money (1968) assessed the long term (current and retrospective) behavior patterns in 15 early-treated and early-corrected females, with a matched control group. The control group consisted of normal females of the same age (5 to 16 years), race, IQ and socioeconomic background. Semi-structured interviews were conducted with children and mothers and then scored according to preformulated ratings. Two raters were used, one blind to the diagnosis of the subject. Reliability was assessed by comparison of the ratings arrived at by each rater. This procedure of data collection and analysis has been generally used with minor changes in the subsequent studies. The findings in this study were as follows: 1) Gender identity was female in all subjects. 2) Gender role in affected girls differed from controls in several areas.

a) Energy expenditure or activity level in play and sports: affected children showed significantly higher levels compared with controls.

b) Preference for playmates: affected children preferred boys to girls more often.

c) Tomboyism: affected children were labeled as long term tomboys by themselves and others more than were control children.

d) Role ambivalence: affected children expressed more feelings of ambivalence (such as
that it might be more fun to be a boy, without expressing any desire to change gender if they could.

e) Career vs marriage: affected children expressed greater interest in a career as being more or equally as important as marriage in the future, while control children tended to feel marriage was more important.

f) Appearance: affected children were less interested in appearance, "dressing up," hairdo and makeup than controls.

g) Doll-play: affected children were less interested in doll play than were controls during childhood. Many had a strong preference for play with "boys' toys" and little or no interest in dolls.

h) Pregnancy: affected children expressed less interest in play rehearsal for being pregnant.

i) Infant care: affected children also expressed little interest in taking care of babies or playing with small babies, whereas control children expressed considerable interest in this activity.

j) Wedding play: affected children expressed low interest in fantasies about or play rehearsal for later weddings and marriage compared with controls.

From these findings, there would appear to be 2 major clusters of behavioral (gender role related) differences between affected girls and normal girls. The affected (prenatally virilized) girls tended to have a higher activity level, leading to greater interest in outdoor play, sports and play with boys. The "tomboy" label and many of the other differences could stem from the preference for more active play. The second cluster of behavior may also be related to activity level, but are more probably separate from it; that is, the affected children's decreased interest in being mothers and taking care of babies. Sexual orientation was not assessed in this study as the children were all too young (age range 5 to 16 years).

A subsequent study (Ehrhardt and Baker, 1974) using a different population of CAH children from a different city (Buffalo Children's Hospital) confirmed the above findings. Ehrhardt and Baker used unaffected female siblings of patients as controls. The family study design was a next step in choosing a control group to confirm or disprove the previous findings. The Buffalo study sample differed from the previously studied subjects in that the population tended to be of a lower socioeconomic status, representative of the overall population of Buffalo, which has a large blue-collar population.

In spite of the differences in socioeconomic status and control group compared with the first study, the Buffalo study confirmed that: gender identity was female; energy was enhanced; and rehearsal for infant care was decreased in the experimental group. All of the 10 areas of more specific gender role behavioral differences showed exactly the same pattern of differences between the experimental and control groups. The age range of affected subjects was 6–19 years (n = 17); of controls it was 6–24 years (n = 11). In this study as in the previous one, sexual orientation was not assessed.

Genetic males with CAH were also evaluated with unaffected male siblings as controls. The only significant difference found was in an elevated energy expenditure in play and athletics in affected males.

In summary, the study of a possible influence of prenatal exposure to excess androgens in females seems to indicate that gender identity is not affected, at least up to the age of early adolescence. This lack of effect is an important finding in itself. In contrast, gender role behaviors are affected in a manner consistent with generally accepted sex differences in cultural gender role stereotypes for normal males and females. A higher energy expenditure including a high interest in sports and outdoor play and a lower interest in and rehearsal for caretaking of infants during childhood are generally accepted sex differences between normal males and females.

Parenthetically, one additional study must be mentioned, as it addresses the possibility that any of the following could lead to the above findings in some as yet unknown way: lifelong medical management; the psychological impact of a genital anomaly; lack of optimal management leading to some degree of continued elevated postnatal levels of androgens. Ehrhardt and Money (1967) studied 10 girls exposed prenatally to exogenously administered synthetic progestins. Some girls evidenced masculinization at birth, some having an enlarged clitoris, but generally were less virilized than the CAH girls. Those requiring it were surgically corrected with one procedure performed early in infancy. No further medical followup or management was required by any
of the girls. The age range of subjects and matched controls was 4 to 14 years. The gender role findings were similar to the findings from the study of CAH girls, but with less significant differences between exposed girls and controls. This study makes it extremely unlikely that postnatal virilization, chronic hospital care and/or psychological impact of ambiguous genitalia is in some way responsible for the findings in the CAH girls.

B) Adolescents with elevated androgens. As previously mentioned, the CAH subjects and controls in the previous studies were too young for an evaluation of adolescent and/or adult sexual orientation, eroticism, and sexual behavior. Three subsequent adolescent studies reported findings in these areas.

Ehrhardt and Baker (1976) did a followup study of 13 genetic females aged between 12 to 24 years (mean age 16 years). All subjects had been participants in our earlier study of CAH children.

Physical development at puberty appeared to follow the model of androgenized nonhuman primates (somewhat delayed onset of menstruation) rather than the model of androgenized lower mammals, where prenatal androgens completely impair the pituitary-ovarian cyclicity in genetic females. In our human sample, breast development occurred in 12 of the 13 girls at age 13 or younger. Six of the sample had started to menstruate before age 13 and 3 girls had started late, between the ages of 14 to 17. Two of these 3 had been on less than optimal cortisone replacement with poor compliance with medical management, including phases of no treatment at all. Four patients had not yet started menstruation at the time of the study. They were, however, the 4 youngest subjects, all below 13½ years. Of the 9 menstruating, 5 were moderately irregular or had episodes of secondary amenorrhea.

In evaluating the adolescent behavior data, it is important to note that many of the more severely prenatally virilized girls required a second surgery or use of dilators at adolescence to correct the vagina to allow normal sexual intercourse. At the time of followup, about half the sample needed some correction of their vagina. This situation limits possible experiences and may also have a secondarily important influence through psychological factors on the behaviors of interest. The behavioral areas relevant to this review are as follows:

a) Interest in boys and dating: Eight of the 13 subjects expressed moderate to strong interest in dating boys. Among the 5 girls who were little interested or disinterested, 4 were the youngest girls below 14 years of age, and the 5th was a 20-year-old girl who was quite withdrawn, having little interest in any socializing with women or men.

b) Dating experience: Twenty-three percent of the sample had frequent to several dating experiences. Seventy-seven percent had occasional dates or none at all.

c) Necking experiences: Somewhat surprisingly, in view of dating experiences, approximately 70% of the sample had frequent or occasional necking experiences with boys. Twenty-seven percent of these also reported petting experiences with boys.

d) Fantasies about heterosexual intercourse: Approximately half of the sample expressed fantasies and thoughts about intercourse.

e) Actual heterosexual experience: Three women had started an active sex life with men. In all cases, the first coital experience occurred at 17 years or older. One of these women married at the age of 19 years.

f) Homosexual fantasies: Two women reported homosexual fantasies. In one, this took the form of a "crush" in her early teens. She later was highly interested in boys and was exclusively heterosexual.

g) Homosexual experience: The other woman, who had homosexual fantasies, also had both homosexual and heterosexual experiences. She appeared to be truly bisexual in orientation. None of the other women reported homosexual fantasies or experiences.

Of additional interest was the fact that some of the childhood behaviors mentioned above changed during adolescence. For instance, low interest in appearance, grooming and dressing attractively all changed during this period. Such changes had occurred in about half of the girls by the time of followup. However, many girls, while more interested in their dress, retained a tendency toward preferring functional clothing.

The low interest in becoming a parent and low childcare interest during childhood persisted throughout adolescence. No one in the sample expressed a strong interest in becoming a parent. About one-third of the sample was moderately inclined towards having a family one day, while two-thirds had little interest or rejected the idea.

Another followup study of 17 CAH adolescent and young women from Johns Hopkins
who received early treatment (Money and Schwartz, 1977) had quite similar findings overall, but a higher incidence of homosexual relationships was found. However, the incidence remained quite low and it cannot be stated that this increased incidence is significantly greater than that for a control sample of equal size.

One further study of 18 CAH females receiving late treatment living in the USSR (Lev-Ran, 1974) found that in spite of late diagnosis and treatment, no one in the sample reported homosexual fantasies or experiences, while many of the patients were married or had had heterosexual fantasies. It is possible that sexual taboos inhibited either the reporting of homosexual fantasies or experiences or caused inhibition of such overt experiences in subjects in this study.

None of the above studies used matched control groups. This lack makes it difficult to evaluate how different CAH girls are from their peers. Further, lesbian women usually initiate sexual contacts later than homosexual men. Therefore, it is possible that it is still somewhat early to be certain of the adult outcome in CAH females. However, none of the data from studies thus far reported supports hypotheses for a determining role of prenatal androgens on later sexual orientation. Such a role is extremely unlikely in this group of subjects given the number of fetally virilized girls who have been reported to be married and/or involved in normal heterosexual fantasies and sexual behavior.

C) Genetic males with complete androgen insensitivity. Individuals with this rare sex-linked genetic condition are chromosomal males born with the phenotype of a normal female. The fetal testes make normal amounts of androgens, but the cells in the affected children's bodies are unable to respond to the testosterone. The condition is often not identified until the children do not menstruate in adolescence. Neither the Mullerian nor the Wolffian internal reproductive systems has differentiated normally. Mullerian inhibiting substance is also produced normally by the testes and the Mullerian system becomes vestigial. The estrogen normally produced by the testes feminizes these children at puberty.

Masica et al. (1971) studied a sample of 10 testicular-feminized (TF) girls followed at Johns Hopkins. The investigators found gender identity to be unequivocally female in all cases, concordant with rearing (and discordant with sex chromosomes and gonads).

Gender role was also female, that is, not characterized by any of the "defeminized" behavior patterns found in CAH girls. Sexual orientation in testicularly feminized girls was heterosexual (by sex of rearing and gender identity) in all cases. The investigators found that most girls in their sample expressed an interest in having children and many went on to marry and adopt babies.

D) Genetic males with partial androgen insensitivity. Money and Ogunro (1974) interviewed 10 subjects with incomplete androgen insensitivity (Reifenstein's syndrome), of whom 8 were raised as males and 2 as females. The gender identity of 9 of the 10 subjects was unambivalently concordant with sex of rearing, in spite of severe functional genital impairment with a "clitoral-sized phallus" in 4 of the males. One subject raised as a female expressed ambivalence about the assigned gender. This subject had 3 affected siblings (not included in this study), 2 of whom had gender identity problems which the authors speculated contributed to the subject's ambivalence.

Gender role behaviors such as the use of cosmetics and clothing and preferences as to hair style were gender appropriate (that is, concordant with sex of rearing) in all cases. There appeared to be no particular predisposition to a high level of outdoor activity (only 2 subjects reported energetic outdoor activity, which diminished after puberty). Most interesting was parental play. Only the 2 subjects reared as females recalled childhood play with dolls and other early parental play rehearsals. On the other hand, this play pattern did not predict interest in becoming a parent in later life as 7 of the 8 males either were parents by adoption or anticipated adopting children. One raised as a female had decided not to adopt children. The other subject raised as a female and the youngest male had "rationalized against child-bearing." The authors interpreted these findings to support the hypothesis that caretaking of the young "is not a sexually dimorphic trait, though its intensity and threshold of expression may be sexually dimorphic."

In sexual orientation, 8 of the 9 subjects with any sexual experience had exclusively heterosexual experience. The one subject who indicated possible gay identity experienced no difficulty about being accepted coitally as a woman and had
only one lesbian experience of brief duration early in the teen years with no interest in having another lesbian experience or relationship.

While complete androgen insensitivity in males may represent a close converse to CAH in females using the McEwen (1976) model for the feminized male and masculinized female, Reifenstein's syndrome of partial androgen insensitivity adds an important new dimension. As a group, CAH affected individuals raised as male or female express overall defeminized gender role behaviors in childhood. Androgen insensitive genetic and gonadal males are all reared as females and exhibit demasculinized gender role behaviors. Partially androgen insensitive individuals appear to exhibit childhood gender role behaviors concordant with rearing as either male or female. Although the sample studied was small and lacked a control group, if this finding is replicated it would appear to indicate that these individuals are in some way more vulnerable to postnatal environmental influences upon gender role behaviors.

E) Turner's syndrome. Turner's syndrome (gonadal dysgenesis) occurs in about 1:2000 live births. The syndrome is characterized genetically by a missing sex chromosome (46 XO) or a mosaic pattern of sex chromosomes in some or all cell lines tested. The children generally look morphologically like normal females at birth, but often have some dysmorphic features such as webbed neck, low hairline, or wide-spaced nipples and sometimes have heart and kidney anomalies as well. The syndrome is often not identified at birth. The children present in late childhood for short stature, another feature of the syndrome, or for amenorrhea and lack of secondary sex characteristics in adolescence. The Mullerian internal reproductive system is generally normal, but gonads are generally quite undifferentiated (gonadal streaks) and these children are infertile. Estrogen replacement is instituted in adolescence. The development of secondary sex characteristics and the onset of menstruation then follow.

Ehrhardt et al. (1970), using semistructured interviews, evaluated developmental behavior patterns of 15 Turner's syndrome girls (aged 8 to 16 years) and controls matched on the basis of age, sex, race, IQ and parents' socioeconomic level. All subjects were reared unambiguously as female and all had a female gender identity. In terms of gender role, subjects differed significantly from controls in expressing an increased interest in appearance, a lower interest in active outdoor play and decreased fighting. Two of the 15 stated that they never fought, even when attacked.

In general, the study found nonsignificant trends in gender role behavior in the following directions: a lower frequency of being labeled a tomboy; preferring or being content to be a girl in all cases (2 controls thought it would be more fun to be a boy); a higher interest in frilly dresses; an exclusive preference for girls as playmates; playing with dolls and avoiding boys' toys; and a strong interest in infant care. The authors noted that the interest in infants, while present to a moderate to strong degree in everyone in both samples, was demonstrated more actively in the subject group by a somewhat higher frequency of actual child caretaking, babysitting, and taking care of younger siblings.

Although the subjects in the sample were young, there were no reports among adolescents of homosexual fantasies in either group. Adolescent experience also was exclusively heterosexual.

Since in mammals it is the presence of sufficient amounts of testosterone during fetal differentiation that is responsible for morphologic differentiation along male lines, it could be assumed that subjects with Turner's syndrome would lack or have even lower amounts of fetal testosterone than are present in normal females. Therefore, one would expect, if prenatal hormonal environment plays a role in later expression of dimorphic gender role behaviors, that individuals with Turner's syndrome would be minimally defeminized by their prenatal environment and that their developmental behavior would also be minimally defeminized. From this one study, this appears to be the case.

F) Children with estrogen/progesterone exposure. A number of studies have looked at the influence of prenatal exposure to estrogen or progesterone on later behavior. Before summarizing these studies, there are 2 major issues requiring brief consideration. Unlike animal studies, where it has been shown that progesterone can antagonize androgen action under certain conditions in certain species in both males and females (Resko, 1975), such extensive, precisely designed and controlled studies on humans are obviously not possible. Fetuses exposed to exogenous doses of excess estrogens and/or progesterone (there is no
known clinical syndrome for elevated endogenous prenatal values of these substances) are generally exposed for some clinical reason related to the mother's pregnancy. Accordingly, the doses are usually quite small compared with those used in animal studies and are administered at different times during pregnancy. Further, a wide variety of synthetic substances is used, making it most difficult to evaluate possible long term hormonal influences on the later behaviors that are generally studied in humans. All of the above factors make it extremely difficult to provide adequate control groups. Lastly, a hormonal effect is inferred by behavioral evaluation alone. That is, there are no physiologically measurable effects on genital differentiation that support the assumption that there was a hormonal environment that unquestionably influenced dimorphic development in the body. These are accepted limitations in working with human subjects. These factors also highlight the difficulties of generalization from animal to human studies.

Yalom et al. (1973), in a double-blind study of the offspring of diabetic mothers treated with diethy stilbestrol plus progesterone during pregnancy, reported findings that appear to support the hypothesis of an antiandrogenizing effect of progesterone upon some aspects of human gender role behaviors. A sample of 20 treated males was compared to a matched control group (age 16 to 17 years). The treated males were found to be somewhat less aggressive, had decreased athletic coordination and had decreased overall masculine interests and less heterosexual experience compared with controls. The control group was not matched according to the disease of the mothers, and children of normal mothers as well as diabetic mothers were used as controls.

A second study of offspring of women with toxemia during pregnancy who had been treated with progesterone were subsequently followed up in a double-blind study by Zussman et al. (1975). The authors looked at both males and females with a matched control group. The control group included some children of untreated toxemic pregnancies and some children from normal pregnancies. Thirty subjects and 29 controls aged 16 to 19 years were used in the study. The authors reported that males showed a significantly decreased interest in dating and marriage, and females revealed a decreased interest in tomboyism and an increased interest in appearance. In males, there also were some trends toward decreased physical activity and decreased heterosexual activity compared with controls.

The elevated levels of fetal progesterone in these subjects might theoretically be expected to antagonize the normally low levels of adrenal and gonadal androgens. Thus, the subjects exposed to greater than normal amounts of progesterone might be expected to be more feminine or less "defeminized" than normal controls. The findings in females in this study can be interpreted as consistent with this hypothesis. Again, an interpretative problem, exists in the fact that although the control group was matched for age, sex and overall socioeconomic status, they were mixed for the condition of the mothers' disease. Two other studies will be briefly mentioned. In these the controls were as well matched as possible, but the degree of hormonal exposure in utero varied and in many cases was relatively low. Therefore, if behavioral consequences ensued, they could be expected to be quite mild.

Meyer-Bahlburg et al. (1977) and Ehnhart et al. (1977) reported findings on 13 males and 15 females exposed prenatally to medroxyprogesterone acetate (MPA) in a double-blind study with matched controls. Subjects were 8 to 14 years of age. As in previous studies, gender identity was not affected, but there were some treatment effects associated with gender role behaviors. Girls exposed to hormones showed a lower incidence of being labeled a tomboy and a greater preference for feminine clothing styles than did controls. Boys exposed to MPA did not differ from controls.

Sexual orientation was not reported as the subjects were too young. There were no significant differences in parenting rehearsal between subjects and controls, as expressed by interest in infants, doll play and fantasies of having children.

These findings are also consistent with the hypotheses that, in humans, progesterone-like drugs may be able to antagonize normal low levels of adrenal and ovarian androgens in females. The lack of a difference in males may well have been due to the low amounts of hormone administered compared with the quite high amounts of testosterone present prenatally in males.

Reinisch and Karow (1977), using the Catell Personality Inventory, studied 26 boys and 45 girls aged 5 to 17 who had been exposed
been well established that sex chromosomes themselves in no way determine gender identity, whereas they do determine differentiation of the primordial gonad via H-Y antigen (Wachtel, 1980). Genetic females, unambiguously reared as males, see themselves unambiguously as males (Money and Dalery, 1977). Genetic males, unambiguously reared as females, see themselves unambiguously as females (Money and Ogruno, 1974). Thus the assumption that gender identity is environmentally determined has come from a wealth of clinical data carefully collected and analyzed over a period of more than 2 decades. The "sensitive" period, requiring a sustained environmental influence to establish unambiguous gender identity, has been considered to be 3 to 4 years of age. When a sex "re-assignment" is considered, the "sensitive" period is shorter (18 months to 2 years). Whether this is the case because gender identity is irrevocably fixed by this time (consolidating from 2 to 3 or 4 years of age), or this period is definitive because parents are unable to make the change after a certain time of living with and raising their child as male or female, or both, has never been established (i.e., is it the child's or the parents' critical period?). In any event, it has been established that attempting to change gender identity in this culture after that age poses grave risks. Further, children whose parents are left uncertain regarding the gender of their child and who subsequently communicate their uncertainty, raise a child with difficulties in gender identity formation. The state of knowledge about gender identity rested at this point until 1978.

Imperato-McGinley et al. (1979) reported their observations of a group of male pseudohermaphrodites raised in the Dominican Republic apparently as normal females until adolescence, at which time they virilized heavily and generally by the age of 16 had decided to be males. These subjects reportedly changed both gender identity and gender role behaviors to those of sexually active normal males attracted to females. If gender identity is irreversibly fixed by the environment alone by the age of 2 years (hypothesis 2), the findings of Imperato-McGinley and her colleagues are clearly not possible. However, in support of their findings, Gajdusek (1977) has reported on another form of male pseudohermaphroditism occurring in several cultures in New Guinea. In one culture, the genital defect was recognized at birth or in early life

Morphologic Development in Humans

Studies of humans with abnormal prenatal environments thus far do not appear to require re-evaluation of the assumptions included in the first hypothesis outlined above: namely, those clinical syndromes of endogenous abnormality or other conditions of exogenous hormonal exposure during fetal life appear to act upon the differentiating fetus according to early critical-period-vulnerability rules that regulate the development of sexually dimorphic structures such as the external and internal reproductive systems in other mammals. Females exposed during a critical period to sufficient amounts of androgens are born with virilized external genitalia. Genetic males who are unable to respond to their own endogenous androgens are born with normal appearing female external genitalia and undifferentiated internal reproductive Wolffian and Mullerian systems. For obvious reasons, dimorphic brain differentiation has not yet been evaluated in humans as it has in animals. There is, however, ample evidence in humans that there are differences between normal males and females in the brain, at least functionally.

Gender Identity Formation

The second hypothesis, concerning the critical factor(s) that determine gender identity, has recently become highly controversial. It
and the affected children were reared and accepted as males in the society. The tribe has a name for the condition and has created a cultural myth to explain the phenomenon. However, in another tribe, the male pseudohermaphrodite members were identified at birth as females. When they virilized during adolescence, the tribe decided to reintegrate these individuals as males.

These important reports highlight the degree to which, in the study of human behavior, there are likely to be few, if any, simple cause-effect explanations that hold true for all individuals in all cultures. More specifically, these reports of male pseudohermaphrodites in other cultures do not tell us how male pseudohermaphrodites will behave or adjust in our culture; thus far, these reports are preliminary in that the studies rely on reports of subjects who were faced with the virilization of their bodies in adolescence, a time when reintegration and reevaluation of self and identity is occurring anyway. There are other issues regarding the report of male pseudohermaphrodites with 5a-reductase deficiency reared in the Dominican Republic. For example, individuals in our culture who are exposed to elevated androgens prenatally and then reared as females have consistently been reported to have an elevated activity level, to be highly interested in sports and outdoor play and to prefer boys' toys and boys as playmates. We do not as yet know the adult consequences of this long term behavior pattern in fatally virilized individuals in our culture, but do have an indication (Money and Schwartz, 1977) that it results in greater difficulty in adolescent adjustment in general. The 5a-reductase children develop their gender identity in the context of these temperamentally predispositions, a more sex-stereotyped culture and virilization, rather than feminization of the body in adolescence.

The CAH girls recognize that they are “different” than most of their female peers, but the permissiveness of our culture allows most such girls to understand their tomboyish behavior as an acceptable variant of normal female behavior. Therefore, gender identity does not appear to be affected as long as these girls are reared unambiguously as females. We do not know how the 5a-reductase male pseudohermaphrodites in the Dominican Republic or their families view and understand the affected children’s behavior. The two children with 5a-reductase deficiency followed at New York Hospital by Dr. Maria New both have a history of active outdoor play and tomboyish behavior that is very similar to the behavior of the CAH girls. There is no reason to believe that male pseudohermaphrodites in the Dominican Republic are not similar in this respect. Nonetheless, the studies by Imperato-McGinley et al. (1979) do leave us with important new data that imply that plasticity of the human organism with regard to gender identity may, under certain circumstances, extend far beyond the critical period we had previously considered.

In summary, while gender identity appears to be environmentally determined, the factors are extremely complex and new data (Imperato-McGinley et al., 1979) have raised a question about our prior hypothesis concerning a critical period for gender identity formation ending at the age of 2 years.

**Gender Role Behavior**

Human research thus far unequivocally supports the hypothesis that prenatal hormonal environment influences gender role behaviors and probably other aspects of human temperament that are not commonly viewed as sex dimorphic.

**Sexual Orientation**

Hormonal influence on sexual orientation is as yet very unclear. Money and Schwartz (1977) found a greater than expected number of CAH, fatally virilized girls who had had a recent homosexual experience, but Ehrhardt and Baker (1974) and Lev-Ran (1974) did not. There are remediable problems in all of the CAH adolescent-adult studies, which could clarify the picture in this group at least. These include the selection of appropriate controls, probably of 2 groups, one composed of normal girls and the other of normal "tomboyish" girls and follow-up into adulthood with careful discrimination to exclude those who have not had adequate genital repair to assure the possibility of normal heterosexual intercourse. This issue will be discussed further below.

**Parenting**

Hormonal influences upon interest in and ability for child care are also still very unclear. Girls with Turner’s syndrome and girls with TF are at least normally interested, and the latter group has been shown to marry and adopt babies. However, while the majority of CAH
girls studied appears to go through adolescence with partial reversals in some preadolescent behavior patterns, such as becoming interested in being attractive, in dating and in heterosexual relationships, thus far they do not appear to change with regard to their disinterest in having babies and becoming mothers.

While it would appear that there may be a prenatal hormonal influence on parenting (in CAH children at least), this has by no means been established. The low interest in CAH girls may be a secondary effect due to an elevated activity level leading to interest in early play that lowers opportunities for rehearsal. Further, there is no good evidence in humans that child caretaking is other than a culturally conditioned dimorphic behavior.

Lastly, the discontinuity in parenting rehearsal in childhood compared with interest in adulthood reported by Money and Ogunro (1974) suggests that the potential for “parenting” per se may not be a behavior easily determined by our commonly used retrospective semistructured interview techniques and that while this adult behavior appears to have clear-cut developmental antecedents, the actual relationship between the rehearsal behavior in play and the actual behaviors in adulthood is unknown. Parenting behavior then, like sexual orientation, is a behavior that appears in adolescence or adulthood with an unknown relationship to specific early environmental or biological factors. The CAH girls studied appear to be a partial exception in that their disinterest in having children appears to continue at least throughout adolescence and, in the few cases reported, into adulthood. However, we have not as yet determined the degree to which nonhormonal factors may relate to interest in becoming parents in these children. These factors include a lifetime of medical intervention and treatment, family factors and the effects of the personal experience of being in some way “damaged.” All of these questions require further study before we can focus on hormonal causes and/or critical periods of either hormonal or environmental exposure in this area of behavior.

In conclusion, research on humans is at a point where it is necessary to spell out and question the underlying assumptions regarding all of our hypotheses related to the study of human dimorphic behavior. As an example, this paper opened with several definitions, including that of gender identity, or the private experiences of oneself as male, female or ambivalent. In fact, we have no operational definition beyond asking someone whether they see themselves as male, female or ambivalent. Further, we tend to think of gender identity as a single entity that springs into being early and remains uniform throughout the life span. Is gender identity in adolescence the same experience of self as male or female that it was during childhood? Entirely new aspects of self and gender come into being consciously for the first time in adolescence. These aspects include self as a sexual object and the management of the morphologic body changes and arousal feelings of adolescence that make this reorientation paramount and inescapable. Adolescence also raises the specter of career, marriage and all the life choices of adulthood which one must now prepare for in earnest. We know that CAH girls have a difficult and prolonged period of resolution of all of these gender identity issues of adolescence. We do not know if their difficulties relate in part or at all to prenatal hormones.

Our not so secret agenda in human research, as in much animal research, is to shed light on such questions as what makes one person a transsexual, another homosexual or bisexual and another heterosexual. While the bulk of research thus far indicates that gender identity and sexual orientation are influenced, if not determined, by environment, there may be hormonal influences also. If so, it seems likely that for gender identity, the hormonal influences are not direct, but rather are mediated by how one understands and interprets one’s experience of self, in the context of personal behavior, against the background of relevant cultural factors.

We have assumed behavioral “critical periods” in humans following animal models and the observable critical periods in morphological development, particularly the development of dimorphic structures that differentiate unalterably prenatally. It may not be warranted to assume that the human brain, with a known potential for a significant degree of plasticity and recovery of function (as in brain-damaged victims) long past birth, and in many cases past adolescence, is then functionally or structurally fixed early in life with regard to dimorphic development regardless of developmental circumstances, be they environmental, physiological or belonging to other as yet unknown realms.
Sexual orientation represents a special case in human behavior, in that it appears to arise full-blown in adolescence with the onset of sexual attraction and fantasies, with as yet unknown antecedents. Extremely tomboyish girls may have a higher than average probability for a homosexual orientation, as represented by one adolescent study of CAH girls. We do not know if this is the case in other extremely tomboyish girls with no known history of hormonal abnormality. Conversely, there is evidence that there may be a higher than average probability for homosexuality in males who were effeminate during childhood (Whitman, 1977). These are correlational studies, however, and do not support cause-effect or antecedent-consequence interpretations. They do, however, allow the hypothesis of some kind of environmental-behavioral antecedents as influential in or related to the formation of sexual orientation.

We need more developmental-longitudinal studies with appropriate controls and probably more sensitive methodologies to arrive at a clearer understanding as to how all of the complex factors of chromosomes, gonads, prenatal hormonal environment, cultural and social environment and rearing factors interact to influence individuals to behave and experience themselves in various sex-dimorphic ways. Human behavior, like behavior in other species, is vulnerable, plastic and resilient. We must identify the periods of vulnerability, the limits of plasticity, and the extent of resiliency along with factors that may cause variations or predispositions that eventually limit or constrain the range of human dimorphic development.

REFERENCES


Yalom, I., Green, R. and Fisk, N. (1973). Prenatal exposures to female hormones: Effect on psycho-

Post-pubertal administration of progesterone. Presented at the Meeting of the Society for Research in Child Development, Denver, CO.