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ABSTRACT

Hormone levels and changes in hormone levels were evaluated three times across a 1-year period as concurrent and predictive correlates of the socio-emotional functioning of 56 boys 10- to 14-years-old and 52 girls 9- to 14-years-old who represented the five stages of Tanner's criteria of pubertal development. The hormone measures were serum levels of gonadotropins, sex steroids, adrenal androgens, and corticosteroid. An additional measure was testosterone-estradiol binding globulin. The measures of adolescent social-emotional functioning were based on adolescent questionnaire and interview self-reports on psychological functioning (impulse control, emotional tone, body- and self-image, and self-esteem); social functioning (social relationships, morals, family relationships, and social competence); and anxiety, depression, and affective/neurotic symptoms. Concurrent hormone-behavior relations were more likely to replicate for boys than for girls. Concurrent relations were stronger than predictive relations for boys, but of similar strength for girls. The best predictor of social-emotional functioning at Time 3, for boys, was timing of maturation based on pubertal stage at Time 1 and, for girls, the rate of change in hormone levels from Time 1 to Time 3. (RH)

Concurrent and Predictive Relations between Hormone Levels and Social-Emotional Functioning in Early Adolescence

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My paper, and Gale Incff-Germain's presentation, are based on a short-term longitudinal study carried out collaboratively at NIMH by Elizabeth Susman, Gale Inoff-Germain, Lorah Dorn, and me with endocrinologists at NICHD, George Chrousos, Gordon Cutler, and Lynn Loriaux. We began data collection in 1982 and logged in the last hormone values early last year.

What we set out to do in this study was to examine relations between psychological functioning and pubertal status -- pubertal status based on hormone levels as well as on physical stage of pubertal development -- in a sample of normal pubertal-age boys and girls.

At the outset, we knew that hormones influence physical maturation. We also knew, based on prior evidence, that physical maturity status is likely to influence social-emotional adjustment in early adolescence. The major interest, therefore, was to explore at a descriptive level, what was more or less unknown: whether there are relations between hormones and adjustment across the pubertal years.

Our first cross-sectional analyses revealed that there indeed are significant hormone-behavior relations in normal pubertal-age adolescents; and that these relations tend to be stronger and more consistent for boys than for girls. In further cross-sectional analyses, and also in longitudinal analyses, we are finding support for these first results. I will present findings in summary form and offer some interpretations.

To begin with, a brief description of the study. Our sample comprises 56 boys and 52 girls, enrolled by age and pubertal stage. At the time of entry into the study, the age range was 10 to 14 years for boys and 9 to 14 years for girls. The adolescents represented all five stages of pubertal development (Tanner criteria). They were seen three times across a one-year period, at 6-month intervals, for assessments of physical maturity and endocrine status, 6-month intervals, for assessments of physical maturity and endocrine status, as well as psychological assessments.

In addition to pubertal stage based on genital stage for boys and breast stage for girls -- the measures relevant to this presentation -- our physical maturity measures included pubic hair stage (Tanner criteria) and height and weight for both boys and girls; and, additionally for boys, testicular volume.

Our hormone measures included serum hormone level determinations for hormones of the hypothalamic-pituitary-gonadal axis (gonadal axis) and the hypothalamic-pituitary-adrenal axis (the adrenal axis).

For the gonadal axis, we assessed gonadotropins, luteinizing and follicle stimulating hormone (LH and FSH), and two sex steroids, testosterone (T) and estradiol (E_2). For the adrenal axis, we assessed three adrenal androgens: dehydroepiandrosterone (DHEA), its sulfate (DHEAS), and androstenedione (4A). Also assessed, but not relevant here, were cortisol (F), another adrenal axis hormone, and two binding globulins, one for testosterone and estradiol (TeBG) and one for cortisol (CBG).

Why these particular hormones for a study of pubertal hormone-behavior relations? This figure shows schematically hormone levels of the two axes by chronological age, the adrenal axis at the top and the gonadal axis at the bottom. The adrenal axis hormones begin to rise at adrenarche, typically between the ages of 6 and 8, but, as you can see, they continue to rise gradually throughout puberty and reach asymptote in late adolescence. The gonadal axis hormones begin to rise later, with the onset of puberty, typically between the ages of 9 and 13; first, the gonadotropins; followed by the sex steroids. The sex steroids rise steeply and tend to reach asymptote around mid-adolescence. It is this rise of gonadal axis hormones that is thought to play a role in adjustment and behavior problems in early adolescence.

Now, for a quick look at the Time 1 hormone levels by pubertal stage: gonadotropins, LH and FSH: our data suggest that generally gonadotropin levels rise 2- to 3-fold; sex steroids, testosterone and estradiol: on average, our data suggest that testosterone levels of boys rise about 10- to 18-fold, and that estradiol levels of girls rise about 6- to 8-fold; adrenal androgens DHEA, DHEAS, and androstenedione: our data suggest that generally adrenal androgen levels rise 2- to 3-fold.

Developmentally, pubertal changes at the physical and hormonal levels are interrelated. Specifically, at each assessment, (a) the various indices of physical maturity generally were highly correlated; (b) hormone level intercorrelations generally were moderate; and (c) hormone levels were moderately correlated with the physical maturity measures, and with chronological age.

Our behavioral measures include adolescent self-report, parent report, and observational data. The set of findings on which I am reporting involve adolescent social-emotional functioning in terms of self- and parent-reports, using scales from the Offer Self-Image Questionnaire for Adolescents, the Perceived Competence Scale for Children, and the Child Behavior Checklist.

In general, we found self-image to improve, competence and self-esteem to increase, and behavior problems to decrease across the year of the study. For the sake of brevity, I will use the term "adjustment" to refer collectively to these measures.

We examined hormone-adjustment relations by multiple regression analysis. In general, our findings suggest that rising hormone levels and advances in physical pubertal development have positive implications for the adjustment of boys and negative implications for the adjustment of girls. This conclusion is based not only on relations involving absolute hormone levels. Because our sample of boys and girls spans 4 to 5 years in age and all stages of pubertal development, we also explored the effect of two important aspects of puberty on hormone-adjustment relations: timing of puberty and rate of maturation.

On the timing issue: We know from the external physical changes that the age at onset of normal puberty is idiosyncratic; and that, physiologically, a wide range in the timing of puberty is defined as normal. We do not know whether earlier or later activation of the gonadal axis, the timing of the rise in pubertal hormones, has effects on behavior that are independent from the effects of physical changes. We do know that the rise in gonadotropin levels, which signals the onset of puberty, precedes external physical changes and that the rise in sex steroids also follows the initial rise in gonadotropins. Our study was not designed for intensive examination of the effects of the onset of puberty. However, we explored the timing issue by examining hormone-behavior relations with statistical control for the variance that hormone levels share with chronological age. This was done by entering age at the first step into the regression equation.

On the rate issue: The rate at which adolescents progress through the various stages of pubertal development, as defined by external physical changes, also is idiosyncratic. Some children mature very rapidly, moving through all pubertal stages within one to two years; others may take three, four, or even five years to reach the last stage of pubertal development. In our sample, we found the rate of physical maturation to be greater for boys than for girls. Of the boys, only 20% had not advanced in genital stage across the year that they were studied, about 40% had advanced one stage, and another 40% had advanced two or more stages. Of the girls, 30% were still at the same breast stage one year later, about 60% had advanced one stage, and only 10% had advanced more than one stage.

As we have no developmental "norms" for hormone levels we examined rate of hormone level change by pubertal stage. We stratified each Time 1 pubertal stage 1, 2, and 3 cohort into subgroups by rate of physical pubertal change across the year of the study; that is, by no change, change of one stage, change of two stages, etc. We then looked at change in hormone levels in these subgroups. For many of the hormones, we found that adolescents in a cohort who subsequently advanced in physical pubertal stage not only had a greater increase in hormone levels. They also had higher hormone levels to begin with than adolescents of the same cohort with no pubertal stage change across the year. This bar graph, which shows testosterone levels for the Pubertal Stage 3 cohort of boys, illustrates the rate issue for hormones. It shows testosterone levels for Time 1, Time 2, and Time 3 for the whole cohort, followed by three subgroups identified by rate of physical change, none, one stage, and two stages. Boys who advanced more pubertal stages across the year already had higher testosterone levels at Time 1 than boys of the same pubertal stage cohort who did not advance in pubertal stage. Apparently, within-stage hormone level differences reflect, in part, individual differences in rate of maturation.

We explored the rate issue by examining hormone-behavior relations with statistical control for the variance that hormone levels share with pubertal stage, as well as with control for both chronological age and pubertal stage (i.e., timing and rate of maturation).

Given this background, here is a summary of our findings. Most relations involved adrenal and gonadal axis hormones: for boys, primarily adrenal androgens and sex steroids; for girls, primarily adrenal androgens and gonadotropins.

Starting with boys, the general pattern of concurrent and predictive relations with adjustment indicates that better adjustment was associated with lower adrenal androgen levels (primarily androstenedione) and higher sex steroid levels. On average, these hormone levels accounted for between 15 and 25 percent of the variance in adjustment. Recall that the various hormone levels increase during puberty. According to individual and pubertal stage hormone profiles, it is the ascendance or predominance of gonadal axis over adrenal axis hormones, or more mature endocrine status, that was associated with better adjustment.

When we controlled hormone levels for age and/or pubertal stage, hormone levels continued to be significantly related to most adjustment measures. In many cases, chronological age accounted for additional variance (together with hormone levels, for up to 45%), indicating that the hormone correlates associated with better adjustment held in particular for boys of more mature endocrine status and relatively lower age. These findings suggest also that, for boys, a faster rate of increase in hormone levels has positive implications.

The predictive Time 1 and Time 2 hormone correlates associated with better adjustment at Time 3 were primarily lower adrenal androgen (androstenedione) levels. However, the best predictor of better adjustment at Time 3 was the Time 1 and Time 2 combination of lower age and higher pubertal stage, which may be conceptualized as earlier maturation.

Turning to girls, the general pattern of concurrent and predictive relations with adjustment indicates that better adjustment was associated primarily with lower adrenal androgen levels (androstenedione) and lower gonadotropin levels; and, in a few instances, with lower sex steroid (estradiol) levels. On average, these hormone levels, typical for girls at lower pubertal stages, accounted for between 10 and 15% of the variance in adjustment. According to individual and pubertal stage hormone profiles, relatively low gonadotropin and adrenal androgen levels in our sample differentiated pubertal stage 1 to 3 groups from pubertal stage 4 and 5 groups. (Menarchial status dichotomizes the girls in our sample into the same groupings.) The hormone-behavior relations findings for girls, therefore, may be due to threshold or saturation effects, with hormone influences becoming salient only during the later stages of puberty.

Concurrent hormone levels controlled for age usually were not related to adjustment, which suggests that concurrent hormone correlates reflect primarily developmental or maturational variation. However, hormone levels controlled for pubertal stage, or for both age and stage, and hormone levels controlled for both age and stage continued to be related to adjustment. This set of findings suggests that, for girls, a slower rate of increase in hormone levels has positive implications.

The predictive Time 1 and Time 2 hormone correlates associated with better adjustment at Time 3 also were primarily lower gonadotropin levels and both higher and lower adrenal androgen levels (lower androstenedione and higher DHEA or DHEAS levels) -- again, primarily hormone levels typical for girls in the lower pubertal stages. These relations generally held for hormone levels controlled for age and/or pubertal stage.

Overall, for both boys and girls, concurrent hormone-adjustment relations were fewer at each successive assessment. As the sample as a whole matured across the one-year period, endocrinologically and physically, the correlates were not always the same, but formed a consistent pattern.

In summary, in a sample of normal adolescents, the rise in pubertal hormone levels was associated with better social-emotional adjustment for boys, especially for boys for whom puberty began relatively early. In contrast, the rise in pubertal hormones was more likely to be associated with poorer social-emotional adjustment for girls.

Our thoughts on sex differences for hormone-behavior relations findings will be covered by Gale Inoff-Germain. I will touch briefly on directionality and on the generality of our findings.

Our findings are correlational. We do not dismiss the possibility of bidirectional influences. Just as hormones may affect adjustment, adjustment may affect the endocrine system. George Chrousos, one of our collaborators, whose research focuses on the adrenal axis, for example, has suggested that the higher adrenal androgen levels that are associated with poorer adjustment may, in part, reflect increased adrenal function in response to psychological stress. Increased adrenal function, usually indicated by high cortisol levels, and perhaps also by high androstenedione levels, may, in turn, suppress gonadal axis activation and thereby delay the onset of puberty and/or affect the rate of pubertal maturation. An example of such effects in the extreme is social dwarfism. At a subtle level, such effects may operate also in a sample of normal adolescents. This hypothesis obviously needs to be tested in a longitudinal study of prepubertal children.

As to the generality of our findings, we studied a sample of normal boys and girls, across ages 9 to 15. Certain of our findings are not expected to hold in samples of older adolescents, in narrower pubertal stage or age samples, or in special population samples. Obviously, our work needs to be extended and replicated, and we hope that many of you will join in the enterprise.

Selected References

Gross, R. T., & Duke, P. M. (1980). The effect of early versus late physical maturity on adolescent behavior. Pediatr. Clin. North Am.. 27, 71-77.

Marshall. W. A., & Tanner, J. M. (1969). Variations in the pattern of pubertal changes in girls. Arch. Dis. Child, 44, 291-303.

Marshall, W. A., & Tanner, J. M. (1970). Variations in the pattern of pubertal changes in boys. Arch. Dis. Child, 45, 13-23.

Nottelmann, E. D., Susman, E. J., Inoff-Germain, G., Cutler, G. B., Jr., Loriaux, D. L., & Chrousos, G. P. (1987). Developmental processes in early adolescence: Relationships between adolescent adjustment problems and chronologic age, pubertal stage, and puberty-related serum hormone level. Journal of Pediatrics, 110, 473-480.

Nottelmann, E. D., Susman, E. J., Dorn, L. D., Inoff-Germain, G., Loriaux, D. L., Cutler, G. B., Jr., & Chrousos, G. P. (1987). Developmental processes in early adolescence: Relations among chronologic age, pubertal stage, height, weight, and serum levels of gonadotropins, sex steroids, and adrenal androgens. Journal of Adolescent Health Care, 8, 246-260.

PUBERTAL STAGE 3 COHORT