JOHN CURTIS GOWAN

Spatial Ability and Testosterone

Many years ago when I taught secondary mathematics, I was continually faced with a puzzling observation. While gifted adolescents tended to show strong correlation between ability and grades, solid geometry was an exception. In that subject two additional requirements seemed necessary: malesness and tallness. Unscientific as this observation was, it fueled in me an enduring curiosity about why spatial ability was such a maverick in the human structure of intellect.

For many years there was very little research in this area, but in the 1970s the precise research of Professor Julian Stanley of Johns Hopkins in his study of mathematically precocious youth turned up the curious fact that boys far outnumbered girls in this effort. A short summary of this effect is found in *The American Psychologist* (1982) in a letter from Stanley and Benbow from which we quote the following:

> Hyde's (August 1981) gender-differences article cites the first report our now 10-year-old Study of Mathematically Precocious Youth (SMPY) issued. That report was based on the 223 boys and 173 girls in the first of our eight talent searches thus far; to date these searches have involved a total of approximately 34,000 students 11-13 years old. Even with the girls *matched* with the boys on scores on in-grade mathematics tests and with a tendency for only the better-motivated girls to enter the talent searches, boy-girl ratios we have found on the mathematical part of the College Board's Scholastic Aptitude Test (SAT-M) are as follows: 2:1 at $\geq$ 500, 5:1 at $\geq$ 600, and 17:1

> at ≥ 700 (Benbow & Stanley, 1980, 1981; cf. Fox, 1976, p. 184). The last-named ratio is climbing, because in our persistent recent nationwide search for youths who before reaching their 13th birthday score at least 700 on SAT-M we have found 61 boys and 0 girls. The 7 girls reaching that criterion in our earlier seeking participated in the January 1978, 1979, or 1980 talent searches; none was found in the other five searches, the latest of which (January, 1981) attracted 7,371 girls and 7,306 boys.

Those wishing further information on this matter will find it under Fox (1976) and Benbow and Stanley (1980, 1981).

Having established the existence of a psychological effect, it is now our task to account for the phenomenon. It turns out that the cause is the physiological androgen, testosterone. The evidence is entirely medical, and the fact that none of these medical researchers have a vested interested in psychological sex-differences in spatial relations make their testimony that much more convincing. (It should be noted that this information came to light in 1982.)

The first witnesses are Drs. Daniel Hier and William Crowley, writing in the *New England Journal of Medicine* (1982):

> Several lines of previous evidence have suggested that androgens affect cognitive abilities. In an effort to characterize this defect, we compared 19 men with idiopathic hypogonadotropic hypogonadism with 19 control men and with five men with acquired hypergonadotropic hypogonadism that had developed after puberty. The 19 patients with idopathic hypogonadism had markedly impaired spatial ability in comparison to either controls or subjects with acquired hypogonadism ($p < 0.05$). Moreover, the spatial ability of the patients correlated positively with their testicular volume ($p < 0.05$). Androgen-replacement therapy in six of the patients did not improve their spatial ability.
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> The impairment of spatial ability in men with the idiopathic form of hypogonadotropic hypogonadism, the lack of such an impairment in men with the acquired form, and the failure of exogenous and androgens to correct the deficits in the idiopathic form suggest that androgens exert a permanent organizing influence on the brain before or at puberty in boys.

Even more compelling is the testimony of Professor Norman Geschwind of Harvard Medical School since it connects testosterone not only with spatial ability in particular but increased lateralization of the brain in general.

This aspect, of course, may affect creativity. As Jean Marx reported in *Science* (1982), in a speech on autoimmunity in left-handers, which asserts that testosterone is the cause of increased dyslexia in males, Geschwind has uncovered some very interesting relationships between physiological and psychological variables—"According to Geschwind both the autoimmunity and the neurological effects may result from excess production...of testosterone in the fetus." He also found that fetal testes "secrete large amounts of the hormone" which "affects the development of brain structures." Earlier Geschwind and a colleague had shown that anatomical differences in the hemispheres could underlie the usual language dominance of the left over the right. For example, "an area of the brain cortex involved in speech is markedly larger in the left hemispheres of most people." In rats, Geschwind and another colleague later showed "part of the cortex in the right hemisphere of male rats is thicker than the same region in female rats," and "castration of the males causes their brains to become more like that of females."

In conclusion, Geschwind thinks that "testosterone slows the growth of the left hemisphere, in effect favoring the greater development of the right." In consequence, "males end up right-handed less often than females." Testosterone may have additional effects on the right hemisphere. "There may be a multiplicity of effects depending on when (in child development) you have an excess of testosterone." He says: "Excess testosterone in addition to slowing the development of the left half of the brain leads to a higher incidence of autoimmunity in left-handers by suppressing the development of the thymus gland in the fetus." But the thymus gland is the site of the T-lymphocytes, whose function is to fill foreign cells which may invade the body, with the result of "the inappropriate attack on the immune system of the body."

While Geschwind is primarily a pathologist, he recognizes that "the pathology of these disorders is a pathology of superiority as well as inferiority," as you often find remarkable talents, such as spatial ability. While he does not mention them, other talents such as mathematical skill and creative ability may also be among the increased laterality which testosterone affords to males.

In a review article on this fast-breaking subject, Marilyn Ferguson writing in *Brain Mind Bulletin* (1982) noted:

> Male sex hormones may affect the ability to mentally visualize and manipulate objects, key components of mathematical skills, widely considered to be more innate in males than females.

Having reviewed some of the medical evidence presented here, she concludes:

> If this is so, females would be at a biological disadvantage for spatial ability.

It appears to this writer that recent medical advance has conclusively settled a question which has perplexed educators for some time. Let us hope that educators can teach themselves by this advance and avoid the lunacies of the Reavis animal school where great efforts were expended teaching the squirrel to swim and the tortoise to fly. Let us honor each subgroup of our society for the talents it possesses differentially (as we now do in athletics), and use the talents of each for a better life for all.

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John Curtis Gowan.
Address: 1426 Southwind Circle, Westlake Village, California 91361.