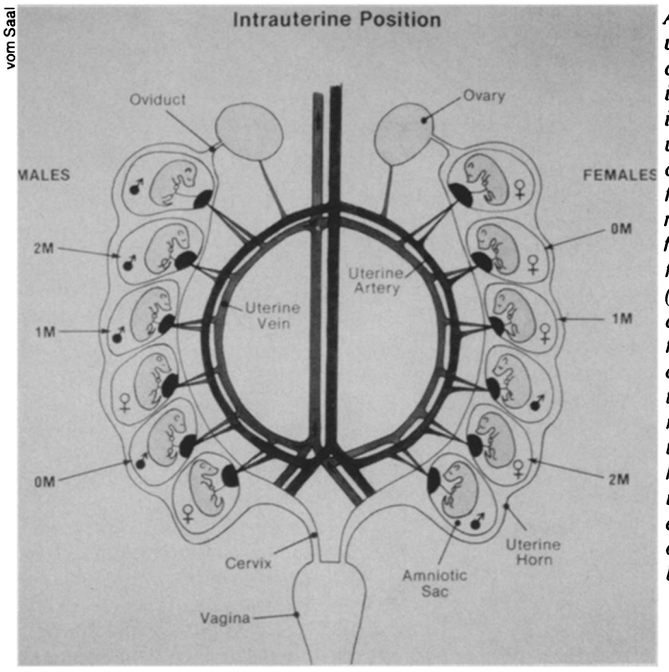
Masculine/feminine behavior: New views



Aspects of sexual development differ among mice according to their neighbors in the tightly packed womb. It is a matter of chance whether a fetus is between two male fetuses (2M), two females (0M) or one fetus of either sex (1M). During the last days before birth, female fetuses produce more estrogen than do males, and males produce more testosterone. These hormones reach the immediate neighbors and influence development of their adult behaviors.

As the concept of the "he-man" is faltering as a human role model, some biologists are also modifying their images of the he-mouse, he-ferret and he-monkey. New data on experimental animals indicate that the physical and behavioral traits that have been regarded as typically male cannot always be separated from those considered to be feminine. Even the copulatory behaviors of normal males and females under special conditions may overlap, so that it is necessary to think not in terms of sex-specific behaviors, but in terms of probability of a behavior being expressed.

"We are questioning the main line of thinking about sexual dimorphism," says Thomas O. Fox of Harvard Medical School in Boston. At the meeting in Boston last week of the Society for Neuroscience, scientists presented evidence challenging the current "dogma" of how sexual differences develop.

This dogma, according to Fox, is that male sex hormones during prenatal or neonatal development determine a constellation of traits characteristic of males and preclude another constellation of traits typical of females.

Aggression, for example, has been considered a typical male trait. "Males are aggressive, females are not, and testosterone [the male sex hormone] is the reason," Joseph F. DeBold of Tufts University in Medford, Mass., says in summarizing one aspect of the dogma. In his recent work, however, DeBold has observed that female rodents as well as males have aggressive behavior. But the pattern is characteristically different. "Females are aggressive, but the aggression comes out under different hormonal and environmental conditions," he says.

Male rodents primarily attack other males, whereas females attack intruders of either sex. DeBold finds that male aggressive behavior depends on testes and testosterone, while female aggression is more environmentally determined. A female is most likely to be aggressive if she is in her established territory, and her behavior does not change if her ovaries are removed or if she is given testosterone.

If a newborn female is given testosterone, she develops the characteristic male aggressive pattern. So the hormone during development does not create aggression per se but rather a more specific behavioral pattern.

Much of the current thinking about the development of sex differences is based on experiments using rodents. How representative are these convenient laboratory subjects? Michael J. Baum of the Massachusetts Institute of Technology in Cambridge, has now examined sexual behavior in ferrets, which are carnivores similar to minks. "Ferrets follow different rules than rodents," he concludes.

Rodents show two aspects of sexual differentiation. First, male hormones, androgens such as testosterone, induce the development of a set of masculine characteristics. Then, a little later, these hormones inhibit the development of the typical feminine traits.

Baum finds clear evidence that in male ferrets, as in rodents, androgens are important in the first aspect, called masculinization. But he does not find evidence of any subsequent defeminization process. Adult male ferrets still have the potential, the "wiring," for typically female behaviors, not usually expressed. For example, adult males given appropriate female hormone can express typically female behaviors, such as the receptive sexual posture called lordosis, Baum reports.

Male dogs and sheep, like rodents, appear to lose this potential for expressing feminine traits; rhesus monkeys, like ferrets, seem to experience less defeminization, Baum says.

In another research approach, pharmacological doses of sex hormones given to pregnant females alter the behavior of their offspring (SN: 5/16/81, p. 309). Now Frederick S. vom Saal of the University of Missouri in Columbia is taking advantage of a more natural situation where animal fetuses experience different levels of sex hormones.

In mice, a fetus in the uterus with two male neighbors, which vom Saal calls 2M, has a higher testosterone:estrogen ratio than a fetus with two females alongside. A female that was flanked by a male as a fetus enters puberty later than normal, ends her reproductive life earlier and is less sexually receptive to males. Also, the 2M female attacks intruders more intensely, and when attacked is more likely to win. Thus, vom Saal speculates that under adverse conditions she is more likely to successfully raise her young than a female who had female neighbors in utero.

Males also reflect their fetal neighborhood. Having male neighbors enhances masculinization of certain traits. Parts of the reproductive apparatus are larger and the 2M animals are more aggressive toward intruders. Yet other forms of behavior appear more masculine in the male between two female fetuses. These animals display more sexual behavior toward females and are more vicious toward young babies, whereas the males 2M are highly parental, vom Saal says. In both male and female mice, those with one fetal neighbor of each sex show intermediate levels of the traits.

"Intrauterine position [in rodents] provides an extra dimension of variation," vom Saal says. He suggests this dimension may be important in evolution. "It's not a matter of normal versus deficits," he says. "Variability itself is a biological necessity." When a pregnant mouse is stressed, her pups show less variability. They all behave as if they had been 2M in utero.

Says Fox: "In my personal opinion, study of sexual dimorphism is a very infant field. What is done in the research has followed social attitudes." The current social attitudes include more liberal views of sex and sex roles. Vom Saal agrees that scientists twenty years ago, having different social attitudes, observed some of the same behavioral interactions in animals but came to different conclusions. Fox says that this research is important not only in basic biology, learning how hormones direct development, but also in medicine. Knowledge of sex hormone actions may indicate when physicians should limit therapeutic use of hormones in pregnant women and infants. —*J.A. Miller*