Testosterone in male songbirds may enhance desire to sing but not song quality

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For the male canary, the ability to sing a pitch-perfect song is critical to wooing female canaries. As the seasons change, so does song quality and frequency. The hormone testosterone plays a role in this changing song behavior.

Researchers at The Johns Hopkins University have found that introducing testosterone in select areas of a male canary's brain can affect its ability to successfully attract and mate with a female through birdsong. They also found that enhancing song activity based on testosterone in one brain area can change the size of a separate brain area that regulates song quality. These findings could shed light on how testosterone acts in the human brain to regulate speech or help explain how anabolic steroids affect human behaviors.

In a paper recently published in the journal *Proceedings of the National Academy of Sciences*, graduate student and lead author Beau Alward along with senior author Gregory F. Ball, vice dean for science and research infrastructure and professor in the Department of Psychological and Brain Sciences in the Zanvyl Krieger School of Arts and Sciences, found that when male canaries received testosterone in a specific area in the brain, the frequency of the song increased. However, the quality of songs sung did not change in comparison to the male birds that received testosterone throughout the brain.

Hormones such as testosterone coordinate several areas of the avian brain to produce a physiological response, such as birdsong, said Alward.

To determine how testosterone influences birdsong, Alward and Ball divided 20 canaries into two groups to receive a hormone implant.

One group received the testosterone injection in a specific area of the brain, the medial preoptic nucleus, or POM, which controls sexual motivation in many animals as well as in humans. The second group was received with testosterone that acted throughout the brain. A third group received no hormone treatment at all.

Alward said both groups of birds that received testosterone treatment sang but the researchers noticed in some cases the canaries' songs were sung poorly. The birds that only received testosterone to the POM sang at high rates, but could not produce high quality song that is most attractive to females.

"Our data suggests that testosterone needs to act in different areas of the brain to regulate the specific components of this complex social phenomenon," said Alward. "It appears that, like in so many other species, testosterone in the POM can regulate an animal's motivation, in this case, the motivation to sing. However, singing and courting a female is more than just motivation. There is the quality of the song that is required to successfully attract a mate and then the process of attending to the female, or singing to her, when she is there which requires the coordination of multiple brain regions."

Meanwhile, the canaries that received testosterone throughout the brain displayed high-quality typical canary vocalization behavior, consistent with the idea that the hormone acts on several different brain areas to regulate how much as well as how well the birds can sing.

The canary brain is considered a good model for brain study due to its ability to change its neural pathways and synapses in response to changes in behavior, the seasonal environment and injury. For the birds used in

the study, the researchers artificially replicated a springtime environment to study the birdsong and mating habits that occur during the appropriate season. The birds responded to the spring-like conditions with birdsong and mating behaviors as they normally would at that time of the year.

The researchers say these results have broad implications for research concerning how steroid use in humans affects sexual behaviors and how hormones regulate the difference components of speech in humans.

"The hormones in these birds are identical to those in humans and they can regulate brain changes in a similar manner," said Ball.

Another contributor to the research paper was Jacques Balthazart from the University of Liege in Liege, Belgium.

More information: Paper: www.pnas.org/content/110/48/19573.full

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