Short winter days trigger aggression hormones differently based on sex

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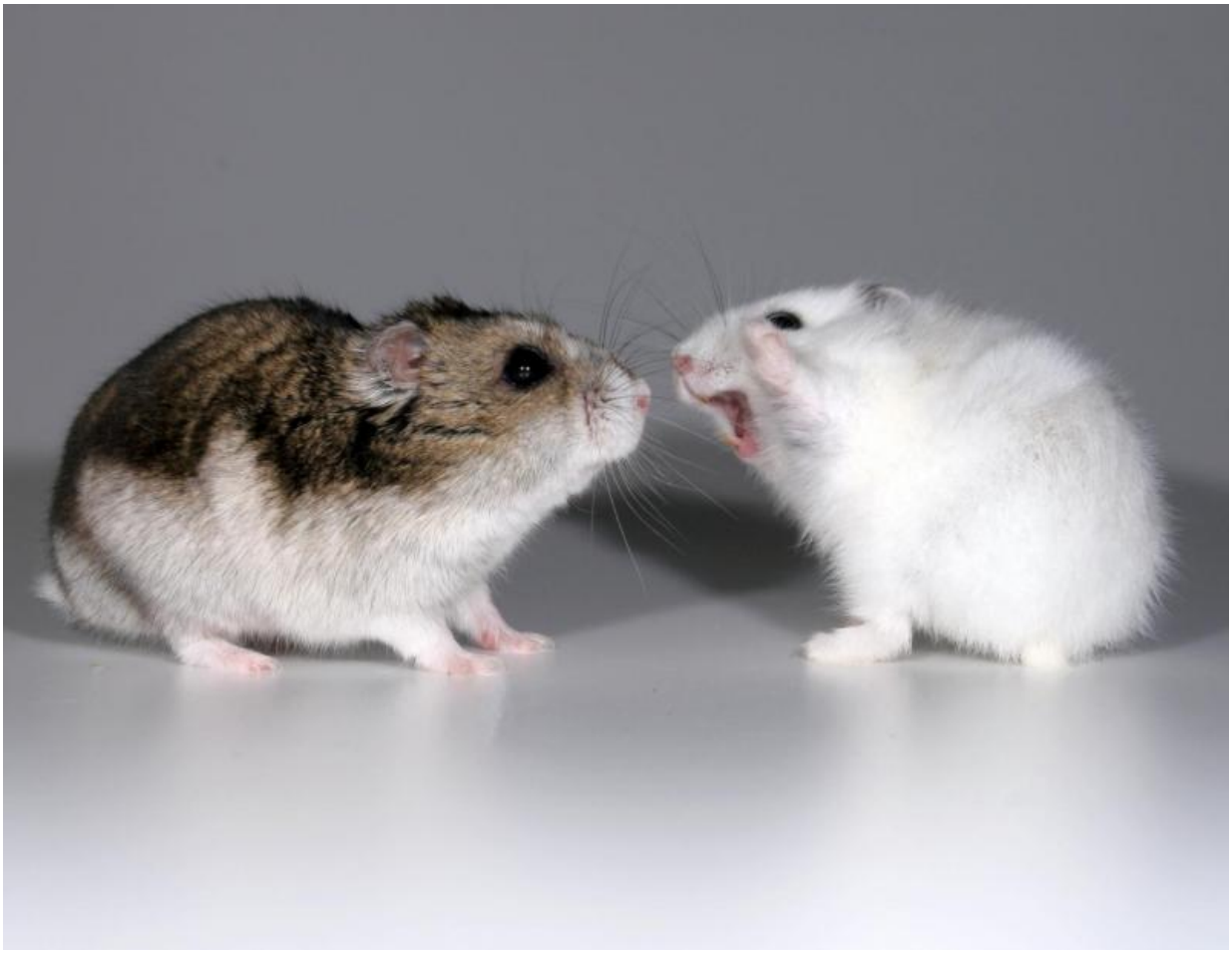

A female hamster displays aggressive behavior. Credit: Frank Scherbarth

Indiana University researchers have discovered a hormonal mechanism

in hamsters that connects short winter days with increased aggression in females, and that it differs from the mechanism that controls this same response in males.

The work, which advances basic knowledge on the connection between certain sex hormones and aggression, could go on to advance research on the treatment of inappropriate aggression in humans.

The study appears online Nov. 18 in the *Proceedings of the Royal Society B*. The research is a collaboration between the IU Bloomington College of Arts and Sciences' Department of Biology and Department of Psychological and Brain Sciences.

"This study reveals a ripe area for research," said Nikki Rendon, a Ph.D. student in biology and lead author on the study.

"The results show for the first time that melatonin acts directly on the adrenal glands in females to trigger a 'seasonal aggression switch' from hormones in the gonads to hormones in the adrenal glands—a major contrast to how this mechanism works in males."

Other IU authors were Gregory Demas, professor of biology, and Dale Sengelaub, professor of psychological and brain sciences.

Rendon is a member in the lab of Demas, who was part of the team that first discovered a connection between shorter days and aggression in animals.

Demas' earlier research also found that wintertime aggression in hamsters arises not from sex hormones in the gonads—ovaries in females and testes in males, which grow less active during shorter days—but rather the adrenal glands, located at the top of the kidneys.

Melatonin is a hormone that rises in the body during darkness and lowers during daylight. The hormone from the adrenal gland is dehydroepiandrosterone, or DHEA, a sex steroid shown to affect aggression levels in mammals and birds, and possibly humans. Professional sports competitions have banned the use of DHEA in athletes.

In another previous study, Demas' lab found that melatonin—in concert with a hormone secreted by the brain's pituitary gland called adrenocorticotropic, or ACTH—increases the output and enhances the effects of DHEA from adrenal glands in males.

In contrast, Rendon and colleagues' new study reveals that melatonin acts directly on the adrenal glands in females to trigger the release of DHEA, without the need for the pituitary hormone.

DHEA can be converted to androgens and estrogens, which affect aggression in both males and females. In females, DHEA appears to compensate for low levels of estradiol—a form of estrogen—that occurs during the winter.

Evolutionarily, wintertime aggression may confer an advantage during periods of scarce food.

"This study, which builds upon our previous work investigating the connection between short days and aggression in males, shows noteworthy hormonal mechanisms in females and provides important new insights into the role of sex in these mechanisms," Demas said.

The research was conducted in Siberian hamsters, or Phodopus sungorus, a species with a similar adrenal system to humans. About 130 hamsters were exposed to long days for a week, after which 45 were exposed to shorter days for 10 weeks. A random subset also received an injection of

ACTH.

A highly territorial species, the hamsters were then placed in situations where one hamster was perceived as an intruder into the other's territory, sparking aggressive actions and short physical fights. The scientists then tracked certain actions, such as the time until an attack, the number of attacks and the length of the attacks, to assign an "aggression score."

The female hamsters exposed to shorter days had increased levels of both melatonin and DHEA—and higher aggression scores—along with physical changes in their adrenal glands.

Females exposed to longer days did not experience these changes, including those that had received an injection of ACTH, which is known to trigger the release of DHEA.

Collectively, the results show that melatonin is the primary regulator of aggression in females.

"It's growing increasingly clear that sex hormones play an important role in controlling aggression in both males and females—but females, human and non-human, are traditionally vastly understudied in the sciences," Rendon said. "By conducting this research on females, we are increasing our understanding of hormones and social behavior in a field currently dominated by discussions on testosterone regulating aggression in males."

More information: The Agonistic Adrenal: Melatonin Elicits Female Aggression via Regulation of Adrenal Androgens, *Proceedings of the Royal Society B*: *Biological Sciences*, rspb.royalsocietypublishing.or … .1098/rspb.2015.2080

Links to earlier, related studies by Gregory Demas:

www.ncbi.nlm.nih.gov/pubmed/12191643
www.ncbi.nlm.nih.gov/pubmed/10964524

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