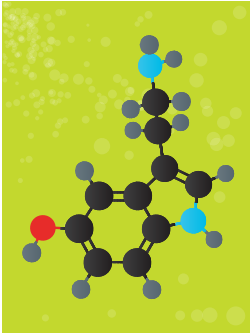


OUTSIDE JEB

Testosterone rapidly boosts male goldfish's eyesight

VISUAL PROCESSING



'Sex steroids' are not just made in the gonads, impacting behaviour by gradually changing gene transcription across hours to days. Instead, they can lead a double life. Steroids such as testosterone and oestradiol are also manufactured in the brain, where they operate at warp speed (within minutes) to rapidly influence everything from copulation in quails and rodents, to hearing in zebra finches and singing in midshipman fish. In goldfish, males pumped with testosterone spend more time visually inspecting a female. As goldfish use visual cues for sexual discrimination, an interesting question is whether the ability of testosterone to bolster male goldfish's gaze is mediated by directly improving their vision.

To address this question, a recent study from the lab of Richmond Thompson at Bowdoin College, USA, tested how tweaking male goldfish's steroid hormones impacted their visual processing by measuring changes in activity in their retina, the light-sensitive cells in the back of the eye.

Shanna Yue and her colleagues first placed individual male goldfish (*Carassius auratus*) in tanks, where they slept in solitude during the night. Just before daybreak, Yue stealthily injected the sleeping males with testosterone and, as soon as the morning lights came on, she plopped a female goldfish into the males' bachelor pad for a brief meet-and-greet. Shortly after the dawn rendezvous, Yue removed the males and measured how visually attentive they had been during the encounter.

To approximate visual engagement, Yue counted how many neurons in the male's retina expressed c-Fos. c-Fos is a protein created when cells have recently been stimulated such that more c-Fos in the retina would indicate a male that was more visually active during a female's visit to his tank. She found that the steroid-treated males had more c-Fos in their retina, suggesting that testosterone increased visual responsiveness to females during their interaction.

However, male goldfish's improved visual acuity may instead be due to increased oestradiol levels. The enzyme aromatase

can rapidly restructure testosterone into oestradiol, which is able to quickly alter sensory perception through oestrogen receptors. As goldfish retinas contain high levels of both aromatase and oestrogen receptors, Yue plugged the oestrogen receptors in a new set of males while also pumping them with testosterone. If oestradiol mediates improved vision, then presenting males with testosterone while blocking oestrogen receptors should prevent any changes in c-Fos levels. Indeed, blocking the oestrogen receptors prevented testosterone from boosting c-Fos levels in males' retinas, suggesting that the conversion of testosterone to oestradiol rapidly facilitates improved goldfish vision.

Overall, this study reveals that sex steroids can impact social processing in male goldfish at (relatively) high speeds by bolstering visual processing. By improving male goldfish's vision, testosterone may enhance courtship behaviour, leading to increased reproductive success, and ensuring love at first sight.

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Yue, S., Wadia, V., Sekula, N., Dickinson, P. S. and Thompson, R. R. (2017). Acute effects of sex steroids on visual processing in male goldfish. *J. Comp. Physiol. A*. doi: 10.0.1007/s00359-017-1220-6.

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