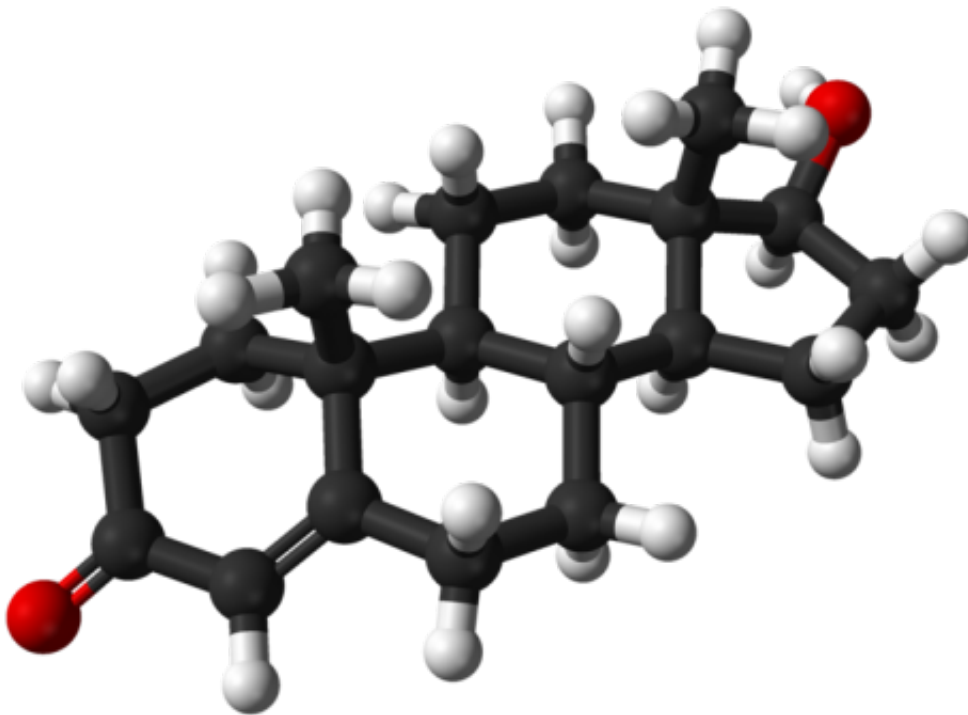


In the largest study of its kind, no evidence that testosterone reduces cognitive empathy

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Ball-and-stick model of the testosterone molecule, $C_{19}H_{28}O_2$, as found in the crystal structure of testosterone monohydrate. Credit: Ben Mills/Wikipedia

It's long been known that autism is far more prevalent in males than in females. What hasn't been understood is why.

"Of course, the primary suspect when we have something that is sharply

differentiated by sex is testosterone," says Gideon Nave, an assistant professor of marketing in Penn's Wharton School.

Yet a new study led by Nave implores scientists to keep looking. In two randomized controlled studies of testosterone administration which were the largest of their kind and included nearly 650 men, Nave and colleagues found no evidence of a link with cognitive empathy, the capacity to read the [emotions of others](#), a trait that is characteristically impaired in people with autism.

They report their findings in the journal *Proceedings of the Royal Society B: Biological Sciences*.

"Several earlier studies have suggested a connection between testosterone and reduced cognitive empathy, but samples were very small, and it's very difficult to determine a direct link," says Amos Nadler of Western University, the first author of the study. "Our results unequivocally show that there is not a linear causal relation between testosterone exposure and cognitive empathy."

Prior to this work, the strongest evidence for a link between testosterone exposure and reduced cognitive empathy came in 2011 in a study that found administering testosterone to healthy women reduced their performance on a test of reading emotions. The results suggested the testosterone impaired their performance. Moreover, the work pointed to the ratio of the length of the participant's second finger to their fourth finger, known as the 2-D:4-D ratio, as a proxy for sensitivity to testosterone. Some believe that the ratio declines with increased in utero exposure to testosterone, though evidence for that connection is mixed.

That study's authors contended that their findings supported the idea that prenatal testosterone exposure created a more masculinized brain that less readily inferred the emotional state of others. The study was used as

support for the "extreme male brain" hypothesis of autism, which contends that autism is an exaggeration of "male" tendencies toward a cognitive style characterized by systemizing over empathizing.

The earlier investigation, however, relied on a sample size of just 16 subjects. And most other research investigating the idea that testosterone is linked to reduced cognitive empathy had relied on correlative rather than causative evidence and had also resulted in inconclusive findings.

To obtain more rigorous data on the connection, Nave, Nadler, and their colleagues conducted two randomized controlled studies in which 643 healthy men received an application of testosterone gel or a placebo and completed questionnaires and behavioral tasks that measured cognitive empathy. Participants were then shown a photo of an actor's eyes and asked to select the emotional state that best described their expression. All participants also had their 2-D:4-D ratio measured.

While the testosterone gel did increase participants' levels of the hormone, the researchers found no evidence that testosterone administration affected performance on tests of cognitive [empathy](#). They also found no relationship between participants' performance on the tests and their 2-D:4-D ratio.

"The results are plain," says Nave. "However, it's important to note that the absence of evidence is not evidence of absence. We found that there is no evidence to support this effect of testosterone, but that doesn't rule out any possible effects. From what we know, though, it seems that if testosterone does have an influence, the effect is complex, not linear. Reality is typically not that simple."

Nadler notes that while the 2011 study included women and the current one included men, one would still expect to find differences if the effect of testosterone were real, especially since men were exposed to more

[testosterone](#) prenatally, which would presumably amplify the effects of administration. And the new study includes more participants than the earlier one by almost two orders of magnitude, augmenting the researchers' confidence in the results.

The extreme male brain theory of autism has received a lot of attention but, Nave notes, "if you look at the literature carefully, there is still not really strong support for it.

"For now, I think we have to embrace our ignorance on this."

More information: Does testosterone impair men's cognitive empathy? Evidence from two large-scale randomized controlled trials, *Proceedings of the Royal Society B*, [rspb.royalsocietypublishing.org1098/rspb.2019.1062](https://rspb.royalsocietypublishing.org/doi/10.1098/rspb.2019.1062)

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