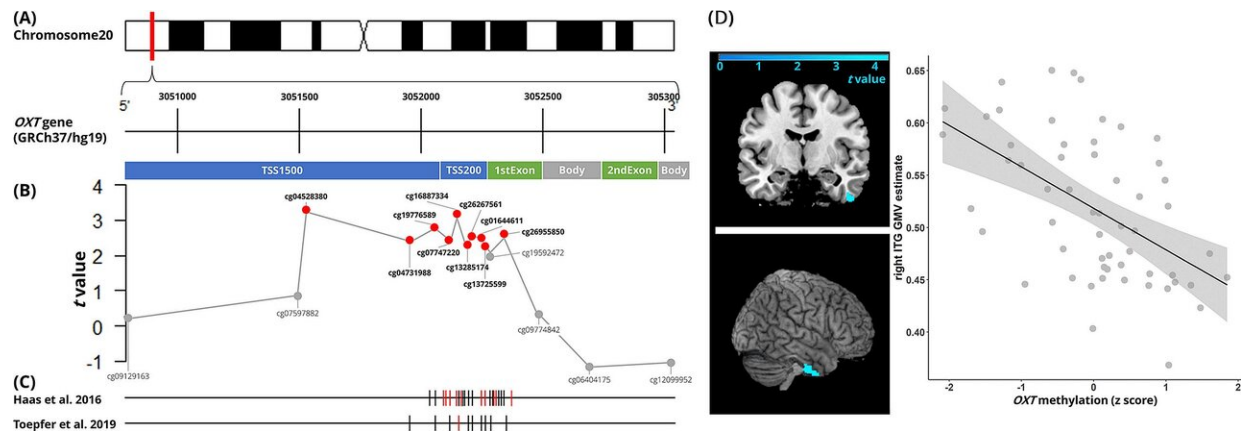


Deep rooted—mother's empathy linked to 'epigenetic' changes to the oxytocin gene

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Methylation of the oxytocin gene (OXT) is positively correlated with personal distress, a negative emotional response to others' negative emotions and an element of empathy (A-D). Credit: Akemi Tomoda from University of Fukui, Japan

Our ability to feel and understand the emotions of others, "empathy," is at the core of our prosocial behaviors such as cooperation and caregiving. Scientists have recognized two types of empathy: cognitive and affective. Cognitive empathy involves understanding another person's emotions on an intellectual level, taking into consideration someone's situation and how they would react (for example, "putting yourself in someone else's shoes"). Affective empathy, on the other hand, is a kind of emotional contagion, where you feel someone's

emotion instinctively after observing their expression or other mood indicators. Both these types strongly predict how parents behave with their children and can subsequently influence child psychological development. Therefore, understanding how empathy is shaped can help us to decipher parental behavior.

When it comes to biological mechanisms of empathy, scientists are particularly interested in oxytocin, the so-called "love hormone." High oxytocin levels predict sensitive parenting, but it isn't clear how the oxytocin-related gene might generate variation in empathy and parental behavior. One possible explanation is epigenetic changes to the gene—a way of altering gene function without changing the actual DNA sequence. Specifically, "DNA methylation"—the addition of a chemical group called the "[methyl](#)" group at specific locations—in the oxytocin gene (called OXT) has been associated with personality traits and [brain](#) structure in humans. This raises a question: can methylation of OXT influence empathy in mothers? A team of scientists at University of Fukui in Japan, led by Prof. Akemi Tomoda, decided to find out, in a study published in *Psychoneuroendocrinology*.

Specifically, the scientists wanted to investigate how methylation of OXT, brain structure, and empathy are related in mothers. For this, they measured OXT methylation through analyses of saliva samples from 57 Japanese mothers who were caring for at least one young child. Moreover, they used an MRI technique called "voxel-based morphometry" to examine the size of brain regions related to OXT methylation, aiming to identify any connections between brain morphology and DNA methylation. This is part of an exciting new field called "imaging epigenetics" that seeks to explain behavior through linking epigenetic changes with brain structures and/or functions. Finally, they used a well-established psychology questionnaire to determine the levels of cognitive and affective empathy they have.

The findings showed that OXT methylation was positively correlated with a mother's "personal distress," relating to harsh parenting. Additionally, OXT methylation was negatively correlated with the volume of gray matter in the right inferior temporal gyrus. In other words, high methylation of the oxytocin gene lowered brain volume in the inferior temporal gyrus while increasing personal distress. "This is the first study to find a correlation between DNA methylation of the oxytocin gene with empathy, and the first to link that methylation with both empathy and variation in brain structure," Prof. Tomoda commented. "So, we've gained very important insight into the relationship between this gene and the phenotype—or the physical manifestation of gene expression."

The researchers also used statistical analyses to find out whether DNA methylation affected changes to brain structure, or vice versa. But they did not find a significant effect of gray matter volume of the inferior temporal gyrus on OXT methylation and empathy. This means that brain structure did not appear to mediate the relationship between epigenetic changes to the OXT gene and empathy.

These findings shed light on the complex processes involved in maternal empathy, which could have a real contribution in understanding psychological development in children. As Prof. Tomoda explains, "Our study really helps to clarify the link between oxytocin gene methylation and parental empathy, as well as the effects on [empathy](#)-related parts of the brain. This understanding augments efforts to better understand maltreated children and contributes to their healthy development."

More information: Daiki Hiraoka et al, Epigenetic modification of the oxytocin gene is associated with gray matter volume and trait empathy in mothers, *Psychoneuroendocrinology* (2020). [DOI: 10.1016/j.psyneuen.2020.105026](https://doi.org/10.1016/j.psyneuen.2020.105026)

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