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NEURONAL CIRCUITS

Looking after your own

> Photostimulation of TH$^+$ AVPV neurons in both virgin and postpartum females increased maternal behaviour and also increased circulating oxytocin (OT) levels, suggesting that AVPV neurons directly regulate the release of plasma OT.

Parental behaviour towards offspring involves a variety of complex, innate behaviours, which, in mice, show marked sex differences; virgin and postpartum female mice behave maternally towards pups, whereas male mice typically ignore or are aggressive towards pups. The circuits underlying these differences in behaviour have not been elucidated. Now, Scott and colleagues have discovered a sexually dimorphic neuronal circuit in the hypothalamus that mediates several key aspects of the parental care of offspring.

The hypothalamus has an important role in coordinating sexually dimorphic behaviours, and it contains many sexually dimorphic nuclei. In particular, the anteroventral periventricular nucleus (AVPV) contains a much higher number of tyrosine hydroxylase-positive (TH$^+$) neurons in females than in males, and this number increases further in post-partum females. The co-localization of DOPA decarboxylase (DDC) and TH in these neurons suggests that they can produce dopamine, and because dopamine signalling can increase the interaction between mother and pup, the authors reasoned that TH$^+$ AVPV neurons might be involved in parental behaviour.

The authors bilaterally ablated TH$^+$ AVPV neurons in virgin or postpartum females. In each case, the females exhibited an increased latency to retrieve pups and bring them back to the nest, and they retrieved fewer pups. Conversely, overexpression of TH in AVPV neurons increased maternal behaviour (such as latency to pup retrieval) towards pups in both virgin and postpartum animals. Overall, these findings implicate TH$^+$ AVPV neurons in maternal behaviour and suggest that increased TH levels in these cells promotes pup retrieval.

Next, the authors virally expressed channelrhodopsin-2 in TH$^+$ AVPV neurons of virgin and postpartum females to allow light-induced activation of the TH$^+$ AVPV circuit and hence the assessment of its role in maternal behaviour. Photostimulation of TH$^+$ AVPV neurons in both virgin and postpartum females increased maternal behaviour and also increased circulating oxytocin (OT) levels, suggesting that AVPV neurons directly regulate the release of plasma OT.

Fluorescent labelling of the axonal projections of the TH$^+$ AVPV neurons revealed that they project to the paraventricular nucleus (PVN) OT-expressing and secreting neurons. The authors detected fast excitatory post-synaptic currents in about one third of OT$^+$ PVN neurons following photostimulation of axons arising from TH$^+$ AVPV neurons. These findings indicate that a monosynaptic connection exists between TH$^+$ AVPV neurons and OT$^+$ PVN neurons that could mediate the increased OT release observed after stimulating TH$^+$ AVPV neurons.

The authors repeated the experiments in male mice. Interestingly, selective ablation or optogenetic stimulation of TH$^+$ AVPV neurons, or TH overexpression in these cells, had no effect on parental behaviour in either virgin or parental male mice. However, ablation of TH$^+$ neurons in virgin males and parental males resulted in a non-significant increase in aggression towards pups, and a significant increase in aggression towards male intruders, respectively. Optogenetic activation of these neurons in virgin and parental males reduced aggression, suggesting that TH$^+$ AVPV neurons negatively regulate aggressive behaviour but do not play a major part in parental care behaviour in males.

Overall, these findings reveal a sexually dimorphic brain circuit that regulates parenting behaviour in female mice and aggression in male mice.

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