

caring behaviours and might be modulated by vomeronasal signalling. This could have been the end of an already interesting story had the authors not found that a large portion of the neurons expressed the neuropeptide galanin. This finding enabled them to develop a tool with which to evaluate the role of these neurons in the regulation of parenting.

The experiments that followed were simple, at least conceptually, and involved two approaches. To disrupt the function of the galanin-expressing neurons in the MPOA, Wu *et al.* genetically engineered these cells to die. In a parallel approach, they engineered the neurons to express the protein Channelrhodopsin-2, which allowed their specific activation in response to light.

The results of these two complementary experiments were striking. First, depletion of MPOA galanin-expressing neurons in virgin females caused them to behave aggressively towards pups. Similarly, sexually experienced males and females showed deficits in parenting behaviour after galanin-expressing neurons were depleted. More remarkably, light stimulation of the neurons in virgin males inhibited their attacks on newborns, and even induced pup grooming (Fig. 1). These impressive data point to a crucial role for galanin-expressing neurons in mediating parental behaviour towards pups, thus linking these neurons to the survival chances of young mice.

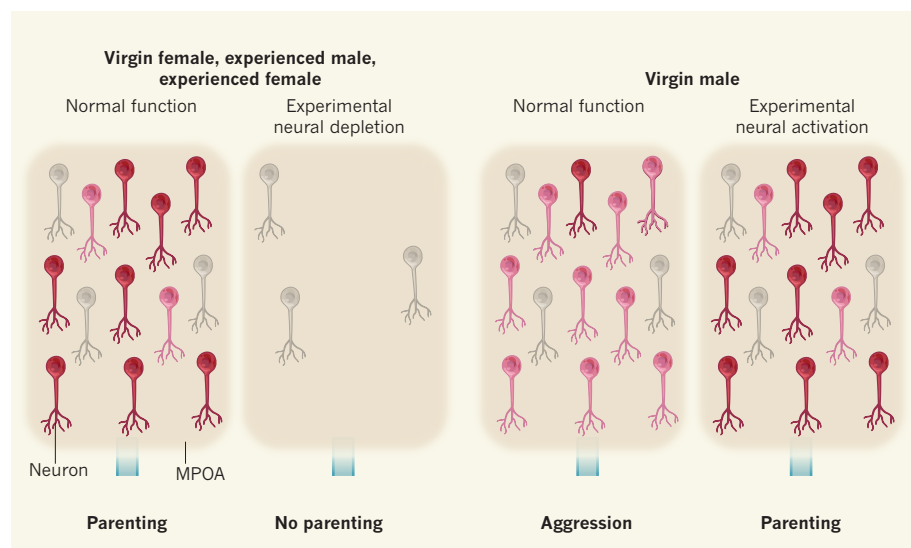
Several neural-circuit models can be built on the authors' findings. To take the simplest, galanin-expressing neurons may act as

a regulatory node that puts the brakes on a default aggressive state promoted by signalling from the vomeronasal organ. Alternatively, these neurons might simply promote parenting behaviour.

But naturally, questions arise. For example, given the known roles of various neuropeptides in modulating behaviour<sup>3</sup>, could galanin itself be more than just a handy genetic marker for these neurons? Supporting this hypothesis, injection of galanin into the MPOA of Syrian hamsters leads to changes in scent-marking behaviour<sup>4</sup>.

It seems that the galanin-expressing circuitry affects more than just parenting behaviour in mice. Wu and colleagues found that some social behaviours unrelated to pups, such as inter-male aggression, were also affected by activation of the neurons. This observation makes the story more complex, but it also opens up the possibility of dissecting the neural circuits that drive distinct behaviours.

The switch between infanticide and parenting behaviour is not specific to rodents — it is pervasive in the animal kingdom, from birds to marine mammals, in both males and females. The best-known example is male lions, which kill young cubs when entering a new social group (in addition to evicting adult males and sub-adults)<sup>5</sup>. What is the advantage of this infanticide? One obvious explanation is that, for the male to maximize the chances of producing his own offspring, it is beneficial to ensure that female lactation ends and ovulation restarts as soon as possible.



**Figure 1 | Modulating parenting behaviours in the presence of pups.** Virgin female mice and sexually experienced males and females show parenting behaviour towards young pups, but virgin males act aggressively towards young. Wu *et al.*<sup>1</sup> investigated the basis for these varying responses in the four groups of mice. They report that the responses are modulated by a group of neurons in the medial preoptic area (MPOA) of the brain that express the protein galanin (inactive galanin-expressing neurons are pink, active ones are red, and neurons that do not express galanin are grey). These neurons are present in all four groups, but in the presence of pups, fewer are active in virgin males. Depletion of galanin-expressing neurons in virgin females or in sexually experienced mice of either sex causes impaired parental responses in the presence of pups and, in some cases, aggressiveness. Conversely, activation of galanin-expressing neurons in virgin males suppresses aggression and induces pup grooming.



## 50 Years Ago

'The Mathematical Association Annual Conference 1964' — Administrative problems of course loomed very large ... It was easy to fail to appreciate the possible influence of the liberal and cultural qualities of mathematics on sixth formers, who were given opportunities to read round their subject. The learning of mathematics was organic and would grow wherever it was given room; like angling, it could "never be fully learnt" ... It was a sombre fact that nearly 25 per cent of persons entering training colleges in 1962 did not possess a pass at the Ordinary Level of the General Certificate of Education in mathematics ... The discussion from the floor represented the confusion which exists in most teachers' minds as to how one can reconcile teaching logic with geometry, when the only logical way seemed to be to start at the middle, work on establishing the standard results, and then work back and establish the premises ... the discussion had shown that Euclid, instead of being found at fault, had proved himself to be too good for the age group for which we tend to use him. Unfortunately we had found nothing to replace him for this age group.

From *Nature* 16 May 1964

## 100 Years Ago

The annual report of the Hampstead Scientific Society ... contains ... a summary of the meteorological statistics for the Hampstead Observatory for 1913 ... For the first time, average meteorological data are included in the report ... From these preliminary averages it would appear that Hampstead is the coldest, rainiest, snowiest, and frostiest, as well as almost the sunniest and foggiest of the stations in the neighbourhood of London.

From *Nature* 14 May 1914