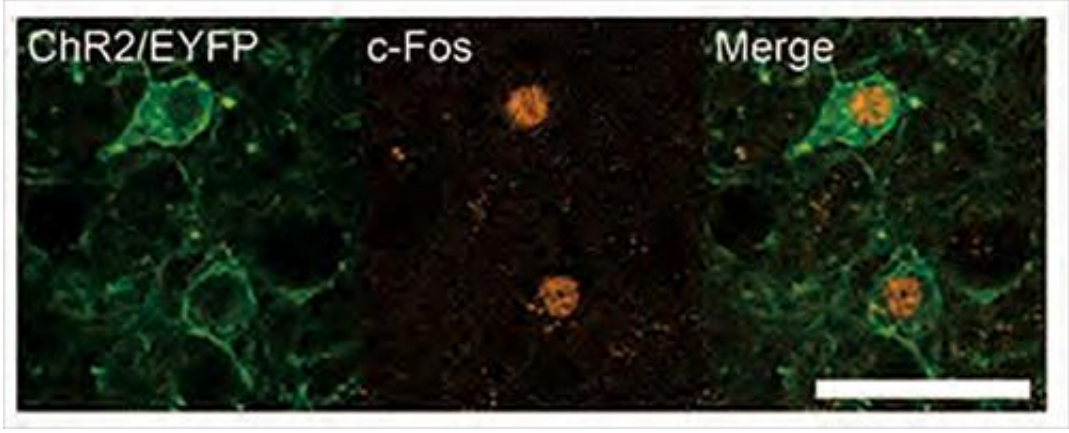
Parenting in the animal world: Turning off the infanticide instinct

September 30 2015



A confocal fluorescent photomicrograph of a section of the cMPOA is shown. Neurons with ChR2-EYFP (green) show c-Fos immunoreactivity (red) induced by light stimulation. Scale bar = 50 um. Credit: RIKEN

Many bachelor mammals, including lions, mountain gorillas, monkeys, and mice, attack and kill the offspring of other males—a form of infanticide—yet display parental behavior once they themselves become fathers. Now, scientists at the RIKEN Brain Science Institute in Japan have discovered two small brain regions that control which of these very opposite behaviors a male mouse will exhibit. Detailed in *The EMBO Journal*, the experiments show how activity patterns in two forebrain regions determine whether males have the urge to act paternally towards mouse pups or to attack them.

Infanticide in the animal kingdom can often be attributed to an unlearned male reproductive strategy—by eliminating newborn pups fathered by other males, a virgin male mouse will free up a female for his own mating attempts. After mating and living with a pregnant female, a male mouse will switch behavior and begin taking care of the offspring—even if they are not his. To investigate how this switch occurs, scientists examined brain activation patterns that are induced by parenting and infanticide.

Adult male mice were exposed to mouse pups, and their pup-directed behavior—paternal or infanticidal—was recorded. Scientists then measured the level of c-Fos—an indicator of recent neuronal activity—in nine forebrain regions to find out if activity in these brain regions was related to the behaviors. They found that c-Fos expression in the cMPOA was associated with paternal behavior, while expression in the rhomboid nucleus of the BSTrh was associated with infanticidal behavior. In fact, past behavior could be determined simply by looking at the c-Fos expression patterns.

"We were surprised at how accurately c-Fos expression patterns in the cMPOA-BSTrh area could categorize this social behavior," says Team Leader Kumi Kuroda. "Amazingly, retroactive classification was 95%?97% accurate."

To test whether the cMPOA and BSTrh are necessary for the two types of behaviors, the research team conducted several more experiments. First, they found that lesioning the BSTrh inhibited infanticidal behavior in virgin males. Next they performed a complimentary experiment, showing that lesioning the cMPOA abolished parental behavior and actually induced fathers to attack newborn pups.

The team also conducted tests using wire mesh to prevent infanticide or parental acts. "c-Fos expression patterns in these regions were just as

accurate at predicting attempted behaviors," explains Kuroda. "Along with the lesion results, this indicates that the cMPOA and BSTrh are responsible for the urge, or drive, behind these very different social acts."

To understand how these two regions affect each other, the team examined the neural connections between them. They found that most connections were inhibitory, traveling from the cMPOA to the BSTrh. Because inhibiting the BSTrh through lesions had reduced infanticide, and because c-Fos expression analysis also showed that cMPOA is strongly activated during mating, the researchers hypothesized that the natural switch from infanticidal behavior to parenting should involve activating the cMPOA.

To test this, they used optogenetic light stimulation over several days to selectively activate the cMPOA neurons that project to the BSTrh in virgin males. As expected, this significantly reduced the amount of infanticide. However, the switch was not immediate, and unexpectedly depended on how many days the mice were treated.

"There are several next steps that need to be taken," says Kuroda. "We think that social experience with a female must lead to paternal behavior through enhanced activity in the cMPOA, but we need to determine how this happens. We also want to investigate the function of these brain regions in primates, and are currently doing so in marmosets. This is particularly important because currently we do not know of any regions in the primate brain that are related specifically to parenting behaviors."

More information: Tsuneoka Y, Tokita K, Yoshihara C, Amano T, Esposito G, Huang AJ, Yu LMY, Odaka Y, Shinozuka K, McHugh TJ, Kuroda KO. Distinct preoptic-BST nuclei dissociate paternal and infanticidal behavior in mice. *EMBO Journal*, DOI: 10.15252/embj.201591942

Provided by RIKEN