Fight or flight neural pathway mapped in mouse brain

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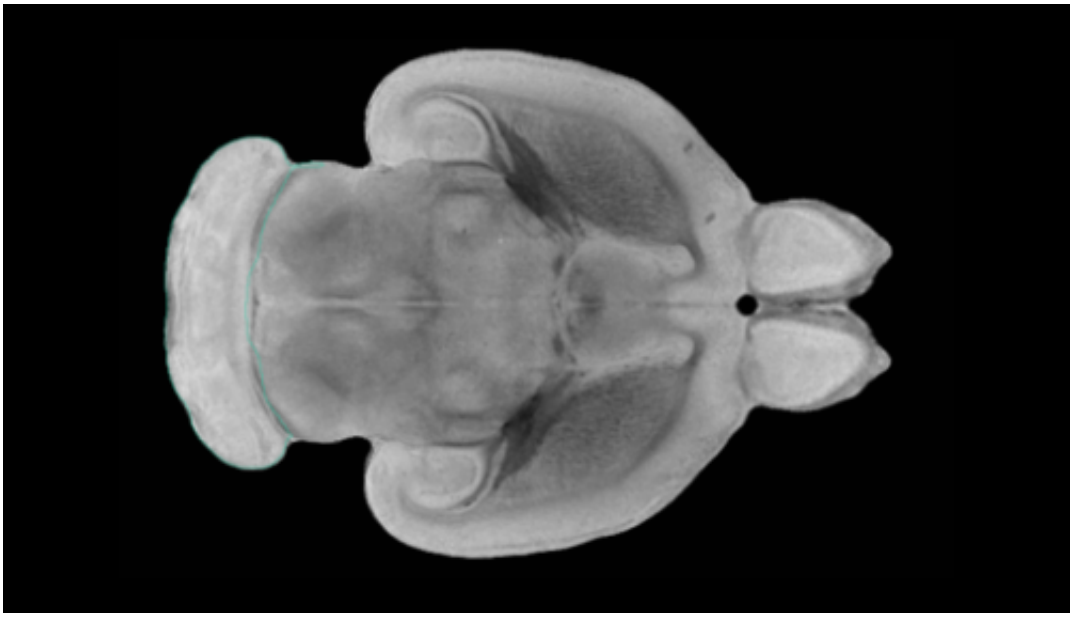

Cerebellum of CIVM postnatal rat brain atlas. Credit: Neurolex

(Medical Xpress)—A team of researchers working at the Chinese Academy of Sciences has succeeded in mapping the neural pathway that is involved when a mouse sees something frightening. In their paper published in the journal *Science*, the team describes how they used optogenetic techniques to stimulate brain parts to trace each step along the network until they were able to map the entire thing.

The fight or flight reflex is common to many animals, including humans

and has been credited with allowing many species to survive. But despite its importance, scientists have not met with much success in figuring out which parts of the human brain are involved and in what order. To learn more, the researchers with this new effort drilled a hole through the skull of test mice and placed a low-power laser above the incision—that allowed for shining light directly onto certain cells in the brain. Brain cells in certain parts of the brain were then genetically modified to respond to the light.

The team started with cells in the retina which have previously been identified as responding to a looming object—from there, messages make their way to the amygdale, the part of the brain responsible for processing emotions and decision-making. The team's task was to find the exact route neural messages took to get there. To find it, they used the laser to stimulate parts of the brain that have been suggested as likely parts of the pathway. One such node on the network is the superior colliculus—directing the laser at it resulted in the mouse freezing in place, one of the ways it responds when sensing a threat. Probing deeper they found that a calcium-binding protein called parvalbumin caused superior colliculus neurons to fire. To test whether they were on the right track, the team played a video of a volleyball moving rapidly towards the screen in front of the mice to cause the fight or flight reflex to activate—brain recordings revealed their suspicions were correct. The team then used the same technique to hop from region to region in the brain until making their way to the amygdale, and in the process created a map showing the entire journey.

The team notes that their results are surprising because of the many nodes that are traversed in the network—common sense would suggest the shortest path would allow for the quickest response. They suggest that by traversing the network, neural messages may be filtered so that a response is only activated when a real threat is present.

More information: A parvalbumin-positive excitatory visual pathway to trigger fear responses in mice, *Science* 26 June 2015: Vol. 348 no. 6242 pp. 1472-1477. DOI: 10.1126/science.aaa8694

ABSTRACT

The fear responses to environmental threats play a fundamental role in survival. Little is known about the neural circuits specifically processing threat-relevant sensory information in the mammalian brain. We identified parvalbumin-positive (PV+) excitatory projection neurons in mouse superior colliculus (SC) as a key neuronal subtype for detecting looming objects and triggering fear responses. These neurons, distributed predominantly in the superficial SC, divergently projected to different brain areas, including the parabigeminal nucleus (PBGN), an intermediate station leading to the amygdala. Activation of the PV+ SC-PBGN pathway triggered fear responses, induced conditioned aversion, and caused depression-related behaviors. Approximately 20% of mice subjected to the fear-conditioning paradigm developed a generalized fear memory.