Reviewing past neuroscience research that explores the neural mechanisms of aggression

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Aggression is a common behavior both among humans and other animals, which is known to be particularly important for defense, protection and survival. While psychologists and neuroscientists have been investigating aggression for several decades, recent technological advances have enabled the collection of increasingly precise and insightful data that has helped to identify many of the neural mechanisms associated with aggressive behaviors in different species.

Researchers at New York University School of Medicine recently reviewed some of the most recent findings of studies investigating the neural underpinnings of aggression in order to delineate what the neuroscience research community has so far discovered about this crucial behavior. In their paper, published in *Nature Neuroscience*, they delineate a 'core aggression circuit' composed of four subcortical brain regions that have been found to be linked to the manifestation of aggressive behaviors in multiple animal species.

"There have been significant advances in technology in the past 10 years, for instance, enabling the precise recording and manipulation of specific sets of cells in brain regions of interest," Julieta E. Lischinsky and Dayu Lin, the two authors of the review paper, told Medical Xpress. "These advances allowed neuroscientists to address a number of fundamental questions related to the study of aggression. In our article, we provide an overview of these advances and how they are paving the way towards a better understanding of the brain regions, cells and circuits responsible for aggression, as well as how it can be altered by the internal state of the animal."

In their review paper, Lischinsky and Lin tried to identify the fundamental principles and neural mechanisms underlying aggressive behaviors across a wide range of animal species. To do this, they analyzed past study findings and looked at the similarities and differences between how aggression manifests in three main types of animals, namely rodents, songbirds and primates.

Based on past observations, the researchers delineated what they refer to as a core aggression circuit (CAC); a set of four subcortical brain regions that are particularly active while animals are exhibiting aggressive behaviors. Lischinsky and Lin also highlight the existence of two parallel circuits that appear to drive motor actions of aggression. These include a circuit that involves the medial hypothalamus and the midbrain, which has been linked with innate aggressive actions (e.g., biting in mice) and a circuit that contains the hypothalamus, dopamine cells in the ventral tegmental area and ventral striatum, which appears to drive aggressive behaviors that are acquired over time (e.g., specific types of singing in songbirds).

"The relative importance of these aggression-

driving circuits varies across species," Lischinsky and Lin explained. "In our paper, we also use past findings to describe the key circuits for controlling aggression. The hippocampus-lateral septum circuit is considered the major top-down control for rodents and birds, while the prefrontal cortex plays a more important role in modulating aggression in primates potentially through its primate-specific direct projection to the medial hypothalamus and its dense connection to the midbrain."

The recent paper authored by Lischinsky and Lin provides an overview of the main biological features of aggression across species and the neural substrates that are now known to play a key role in aggressive behaviors. While it does not present any new evidence, it could prove to be highly valuable for neuroscientists who are conducting research related to aggression, as it offers a clear summary and representation of the neural circuits associated with this particular behavior based on what neuroscientists have discovered about it so far.

"Our paper summarizes past findings that show how the same subcortical regions in the core aggression circuit are implicated in aggressive behaviors across species, despite the differences in aggression observed in these species," Lischinsky and Lin said. "This highlights how understanding the circuitry in other species such as rodents and songbirds can be very informative for uncovering the complexity of human aggression."

Although the majority of past studies investigating the neural underpinnings of aggression were carried out on animals, some of the findings could also apply to humans. As aggressive outbursts are associated with numerous psychiatric conditions, including conduct disorder and schizophrenia, the evidence that Lischinsky and Lin review in their paper could ultimately contribute to the development of more effective pharmacological or psychological treatments for these conditions, which are specifically designed to reduce aggressive behavior.

"Our plans for future investigation are to better understand more precisely the connectivity among CAC regions and their top-down control at the neuronal population level that results in aggressive actions," Lischinsky and Lin said. "We are also interested in how the circuit we delineate in our paper is modified in the short- and long-term by the internal state of the animals such as by energy level, reproductive state and experience, among others."

More information: Neural mechanisms of aggression across species. *Nature Neuroscience*(2020). DOI: 10.1038/s41593-020-00715-2.