Teen brains over-process rewards, suggesting root of risky behavior, mental ills

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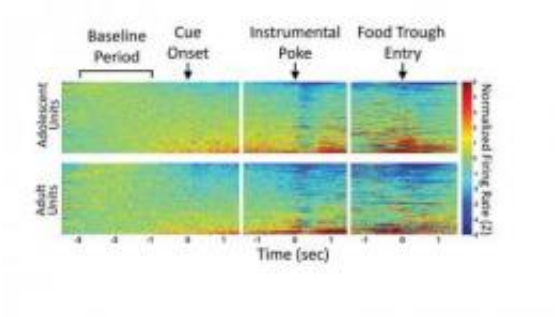


Each row represents the activity in a neuron at key times during the task. At the time of reward, nearly one-third of adolescent neurons became excited (shown in red) though the level of inhibition (in blue) changed marginally. Adult neurons registered much higher inhibitory activity and less excitation. Credit: B. Moghaddam

University of Pittsburgh researchers have recorded neuron activity in adolescent rat brains that could reveal the biological root of the teenage propensity to consider rewards over consequences and explain why adolescents are more vulnerable to drug addiction, behavioral disorders, and other psychological ills.

The team reports in the Journal of Neuroscience that electrode recordings of adult and adolescent brain-cell activity during the performance of a reward-driven task show that adolescent brains react to rewards with far greater excitement than adult brains. This frenzy of

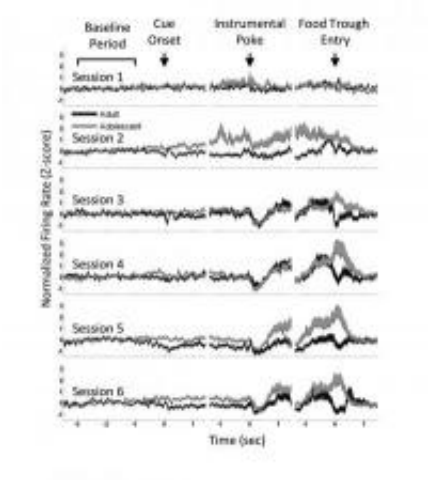
stimulation occurred with varying intensity throughout the study along with a greater degree of disorganization in adolescent brains. The brains of adult rats, on the other hand, processed their prizes with a consistent balance of excitation and inhibition.

The extreme difference in brain activity provides a possible physiological explanation as to why teenagers are more prone than adults to rash behavior, addiction, and mental diseases, said lead researcher Bita Moghaddam, a professor of neuroscience in Pitt's School of Arts and Sciences. She and coauthor David Sturman, a Pitt neuroscience doctoral student, observed the disparate reactions to reward in individual neurons in the orbitofrontal cortex, a brain region that weighs payoff and punishment to plan and make decisions.

"The disorganized and excess excitatory activity we saw in this part of the brain means that reward and other stimuli are processed differently by adolescents," Moghaddam said. "This could intensify the effect of reward on decision making and answer several questions regarding adolescent behavior, from their greater susceptibility to substance abuse to their more extreme reactions to pleasurable and upsetting experiences."

In addition, malfunctions in the orbitofrontal cortex have been observed in cases of schizophrenia, mood disorders, and other psychological disturbances, Moghaddam said. The type of erratic activity in the cortex that she and Sturman observed could aggravate these conditions at a time when the maturing brain is vulnerable.

"The symptoms of these illnesses generally begin to appear during adolescence," Moghaddam said. "Adolescence is a period of behavioral and psychiatric vulnerabilities, so the disorganized brain activity and excess excitation could push a brain already predisposed to mental disorders too far, triggering the onset of symptoms."



Adult and adolescent neural activity was similar at first. When a reward was expected (sessions 3-6), adolescent brain activity spiked, followed by a slow decrease after the sugar pellet was received (food trough entry). Adults experienced a similar rapid increase in activity followed by a quick return to baseline. Credit: B. Moghaddam

The study is the first to record and compare individual neuron activity in adult and adolescent brains during the performance of a task. Moghaddam and Sturman presented adult and adolescent rats—which exhibit behavioral and biological similarities to adult and teenage humans—with three holes to poke their noses through; the rats each received a sugar pellet when they chose the center hole.

Brain activity in the adolescents was similar to that of the adults most of the time but striking differences arose when the younger rats retrieved rewards. As each of the adult rats collected a sugar pellet, the orbitofrontal cortex neurons showed the normal increase in both excitation and inhibition, with consistent levels of each impulse throughout the study.

Adolescents, on the other hand, exhibited surges of excitation that ranged from twice to four times the levels in adults. At the same time, the inhibitory impulses in the adolescents' brains barely changed from the low levels they experienced before receiving the sugar pellet.

Provided by University of Pittsburgh