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Molecular imaging finds link between low dopamine levels and aggression

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Out of control competitive aggression could be a result of a lagging neurotransmitter called dopamine, say researchers presenting a study at the Society of Nuclear Medicine's 2012 Annual Meeting. During a computer game against a putative cheating adversary, participants who had a lower capacity to synthesize this neurotransmitter in the brain were more distracted from their basic motivation to earn moneyand were more likely to act out with aggression.

For many people, anger is an almost automatic response to life's challenges. In clinical psychiatry, scientists look at not only the impact of aggressive behavior on the individual, their loved ones and the community but also the triggers in the brain that lead to aggressive response. The neurobiology of aggression is not well understood, but scientists are aware of a relationship between the neurotransmitter serotonin and certain aggressive behaviors. The objective of this study was to explore whether higher levels of another brain chemical called dopamine, involved in pleasure and reward, increased aggressive response in its subjects. To scientists' surprise, it was not as they first theorized.

"The results of this study were astonishingly opposite of what was previously hypothesized," says Ingo Vernaleken, M.D., lead author of the study and research scientist for the department of psychiatry at RWTH Aachen University in Aachen, Germany. "Subjects with more functional dopaminergic reward-systems were not more aggressive in competitive situations and could concentrate even more on the game.

Subjects with lower dopaminergic capacity were more likely to be distracted by the cheating behavior."

In this study, 18 healthy adults in their twenties were tested for aggression using the psychological behavioral task known as the point subtraction aggression paradigm (PSAP). Participants were asked to play a computer game that required them to press a bar multiple times with the incentive of winning money, but they were also told that an adversary in the next room who is able to cheat may steal some of their winnings. What the paranoid participants did not know was that there was no adversary. The computer program is designed to perform randomized deductions of the subjects' monetary reward to simulate the cheating competitor.The participant had three choices to react: punish the cheater, shield against the adversary by repeatedly pressing a defense button, or continue playing the game in order to maximize their ability to win cash, which indicated resilience.

"The PSAP focuses on aggressive reaction within a competitive situation," says Vernaleken. "Aggression and its neurobiological mechanisms in humans have been only moderately investigated in the past. Furthermore, most of the previous studies mainly covered the more reactive part of aggression, which merely reflects impulsive behavior and appears to be associated merely with the serotonin system. This investigation focuses on the association with the dopaminergic reward-system, which reflects goal-directed aggression."

Subjects' brains were imaged using positron emission tomography, which provides a range of information about physiological functions inside the body, depending on the imaging probe used. In this investigation, F-18 FDOPA, a biomarker that lights up enzymes' ability to synthesize this transmitter, was used and the uptake of this drug in the brain was analyzed to gauge the correlation between the participants' dopamine synthesis capacity and aggressive behavior.

Results of the study showed a significant impact on aggressive response in areas in the brain where dopamine synthesis was present, especially in the basal ganglia, which among other functions include the motivation center. Minimized aggression was associated with higher dopamine levels in both the midbrain and the striatum, which plays a role in planning and executive function. People with greater capacity for dopamine synthesis were more invested in the monetary reward aspect of the PSAP, instead of acting in defense or with aggression against their perceived adversary, whereas subjects with lower capacities had a higher vulnerability to act either aggressive, defensive or both.

"Thus, we think that a well-functioning reward system causes more resilience against provocation," says Vernaleken. "However, we cannot exclude that in a situation where the subject would directly profit from aggressive behavior, in absence of alternatives, the correlation might be the other way around."

Further research is required to explore the link between dopamine and a range of aggressive behavior. More insight into these relationships could potentially lead to new psychological therapies and drug treatments to moderate or prevent aggressive response.

Provided by Society of Nuclear Medicine

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