Medical Xpress

Brain's reward circuit activity ebbs and flows with a woman's hormonal cycle

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Fluctuations in sex hormone levels during women's menstrual cycles affect the responsiveness of their brains' reward circuitry, an imaging study at the National Institute of Mental Health, a component of the National Institutes of Health, has revealed. While women were winning rewards, their circuitry was more active if they were in a menstrual phase preceding ovulation and dominated by estrogen, compared to a phase when estrogen and progesterone are present.

"These first pictures of sex hormones influencing reward-evoked brain activity in humans may provide insights into menstrual-related mood disorders, women's higher rates of mood and anxiety disorders, and their later onset and less severe course in schizophrenia," said Karen Berman, M.D., chief of the NIMH Section on Integrative Neuroimaging. "The study may also shed light on why women are more vulnerable to addictive drugs during the pre-ovulation phase of the cycle."

Berman, Drs. Jean-Claude Dreher, Peter Schmidt and colleagues in the NIMH Intramural Research Program report on their functional magnetic resonance imaging (fMRI) study online during the week of January 29, 2007 in the Proceedings of the National Academy of Sciences.

Reward system circuitry includes: the prefrontal cortex, seat of thinking and planning; the amygdala, a fear center; the hippocampus, a learning and memory hub; and the striatum, which relays signals from these areas to the cortex. Reward circuit neurons harbor receptors for estrogen and progesterone. However, how these hormones influence reward circuit

activity in humans has remained unclear.

To pinpoint hormone effects on the reward circuit, Berman and colleagues scanned the brain activity of 13 women and 13 men while they performed a task involving simulated slot machines. The women were scanned before and after ovulation.

The fMRI pictures showed that when the women were anticipating a reward, they activated the amygdala and a cortex area behind the eyes that regulates emotion and reward-related planning behavior more during the pre-ovulation phase (four to eight days after their period began) than in the post-ovulatory phase.

When they hit the jackpot and actually won a reward, women in the pre-ovulatory phase activated the striatum and circuit areas linked to pleasure and reward more than when in the post-ovulatory phase.

The researchers also confirmed that the reward-related brain activity was directly linked to levels of sex hormones. Activity in the amygdala and hippocampus was in lockstep with estrogen levels regardless of cycle phase; activity in these areas was also triggered by progesterone levels while women were anticipating rewards during the post-ovulatory phase. Activity patterns that emerged when rewards were delivered during the post-ovulatory phase suggested that estrogen's effect on the reward circuit might be altered by the presence of progesterone during that period.

Men showed a different activation profile than women during both anticipation and delivery of rewards. For example, men had more activity in a striatum (signal relay station) area during anticipation compared to women and women had more activity in a frontal cortex (executive hub) area at the time of reward delivery compared to men.

Source: NIH/National Institute of Mental Health