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Brain imaging reveals circuit changes following early-life unpredictability across species

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Brain imaging reveals circuit changes following early-life unpredictability across species

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Background: The lifetime prevalence among adolescents in the US is estimated to be 46.3% for any mental health disorder and 21.4% for severe disorders. The National Comorbidity Survey Replication study estimated that exposure to early-life adversity may account for 32.4% of psychiatric disorders. A major question is how do early environmental signals shape the brain to promote either vulnerability or resistance to psychiatric illness during adolescence? In particular, how does prenatal variability in maternal mood (i.e. mood entropy) impact structure, function and connectivity in the brain's pleasure/reward system, which is implicated in psychiatric illness?

Methods: We quantified prenatal material mood entropy using a statistical technique designed to capture the degree of unpredictability of the item-by-item responses within several questionnaires that assess mood. We conducted diffusion MRI in a sample of thirty-two 9–11 year old female children who had variable levels of prenatal maternal mood entropy. Diffusion data were processed according to a novel pipeline which used a model-free analysis using Q-space diffeomorphic reconstruction. This approach allowed us to resolve crossing fibers and conduct analyses in a standardized template space. We used graph theoretical approaches to determine network connectivity measures within nodes of the pleasure/reward circuits.

Results: We found that the node strength (a measure of connectedness) of the nucleus accumbens (NAc) was inversely correlated with prenatal maternal mood entropy ($r = -0.4$, $p = .03$), suggesting that lower levels of connectivity between this pleasure/reward hub and other brain regions may be a consequence of higher levels of mood entropy. We additionally found that lower generalized fractional anisotropy (GFA) of the cingulum bundle, a major white matter pathway in the limbic system that connects the medial temporal lobes to the frontal lobes, was associated with higher levels of mood entropy as well ($r = -.06$, $p = .003$). This suggests that this pathway may be compromised as a function of mood entropy.

Conclusions: Evidence suggests that mood entropy is associated with diminished structure and connectivity in the pleasure/reward circuitry as well as cognitive circuitry and may offer clues as the mechanisms by which early life adversity increases vulnerability to adolescent psychopathology.

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