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Environmental scars: Neuroimaging study of the long-term consequences of early adversity on brain structure and function

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A variety of studies have demonstrated that environmental adversity confers risk for externalizing disorders such as attention-deficit hyperactivity disorder (ADHD) and conduct disorder (CD). Growing evidence has highlighted the effect of maternal smoking during pregnancy and poverty in the etiology of externalizing behavior. In contrast to the well-studied influences of environmental adversity on limbic structures, so far, evidence is scarce with regard to the impact on core structures and functions mediating externalizing symptoms.

Given that a hallmark deficit in ADHD comprises dysfunctional response inhibition in the inferior frontal gyrus (IFG) and the anterior cingulate cortex (ACC), the effect of maternal smoking during pregnancy on activity in these regions during a flanker NoGo paradigm was investigated in the first study using data from an epidemiological cohort study followed since birth (*N*=178). Prenatal nicotine exposure resulted in more lifetime ADHD symptoms and less activation in the ACC and the IFG during inhibitory control as well as in a decreased volume in the IFG, after controlling for potential confounders such as sex, parental postnatal smoking, psychosocial and obstetric adversity, maternal prenatal stress, and lifetime substance abuse. IFG and ACC activity were inversely related to lifetime ADHD symptoms and to novelty seeking, respectively.

In the second study, the long-term impact of early life poverty on the orbitofrontal cortex (OFC), as a core region which is structurally compromised in CD, was examined. Using data from the same cohort sample (*N*=167), voxel-based morphometry was applied to study volume differences. Individuals exposed to early life poverty exhibited less orbitofrontal cortex volume irrespective of the adjustment for potential confounders such as sex, parental psychopathology and delinquency, obstetric adversity, parental education, and current poverty. A negative relationship between CD symptoms and OFC volume emerged. Moreover, we replicated previous findings of increased CD symptoms as a consequence of childhood poverty, with this effect being mediated by OFC volume, exposure to life stress and smoking during pregnancy, but not by childhood maltreatment and maternal responsiveness.

In sum, our findings highlight the impact of prenatal and early postnatal exposure to adversity on brain structure and function involved in externalizing psychopathology which suggests that prevention should start as early as possible. To this end, we propose advancing psychoeducation programs for smoking prevention in pregnant women and in those planning to become pregnant, as well as programs aimed at decreasing income-related disparities in young families.