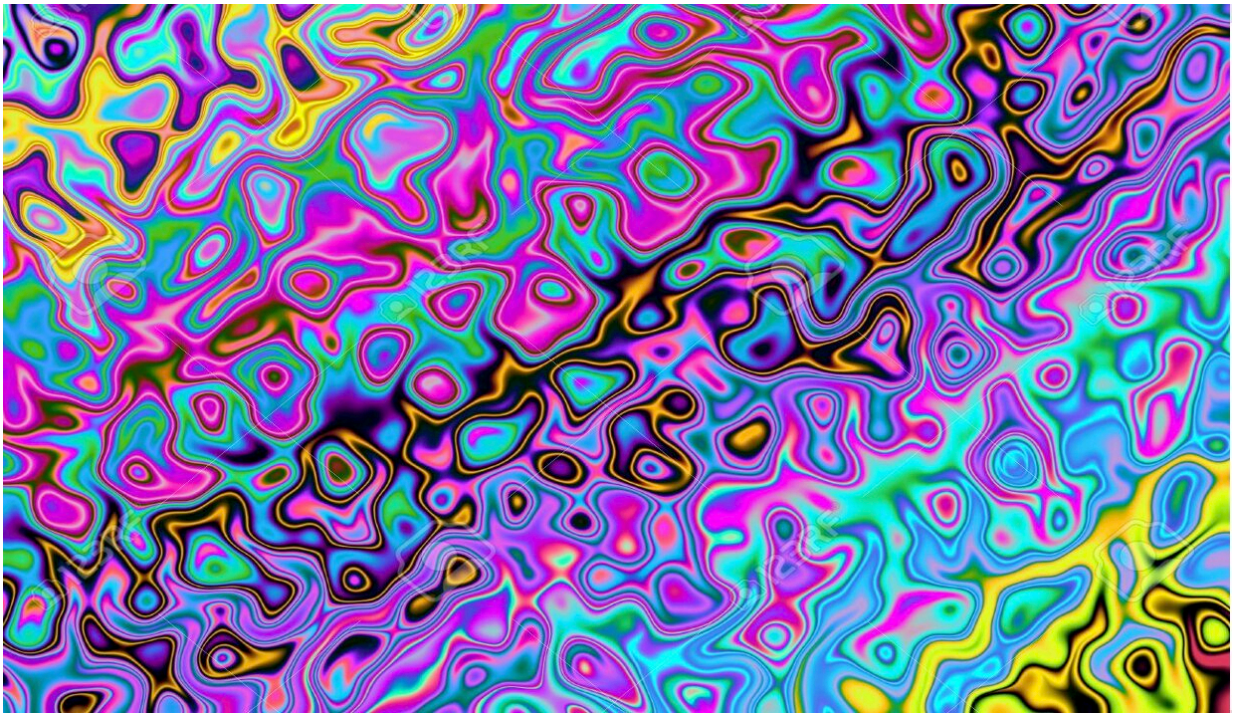
Study finds parents' unpredictable behavior may impair optimal brain circuit formation

June 2 2022



Abstract visualization of unpredictable chaotic patterns of sensory signals from parents and environment. The UCI studies suggest that such patterns are not optimal for the development of stable and refined connections among brain cells, which are required for mental and cognitive health. Credit: School of Medicine / UCI

Researchers at the University of California, Irvine are conducting pioneering research into the concept that unpredictable parental

behaviors, together with unpredictable environment, such as lack of routines and frequent disasters, disrupt optimal emotional brain circuit development in children, increasing their vulnerability to mental illness and substance abuse.

In an article published online today in *Science,* Dr. Tallie Z. Baram, corresponding author and UCI distinguished professor in the Departments of Anatomy & Neurobiology, Pediatrics, Neurology, and Physiology & Biophysics; and Matthew T. Birnie, first author, a UCI postdoctoral researcher, describe the principles of emotional brain circuit formation gleaned from animal studies, and their impact on children's cognitive development and mental health.

"This perspective starts from basic principles of how the brain's sensory—audio and visual—and motor circuits are established and refined, and we apply those to emotional circuits that govern reward-, stress- and fear-related behaviors. It's not only positive or negative parental signals, but also the patterns of these behaviors and especially their predictability or unpredictability, that are linked to adverse outcomes such as poor emotional control in later life. The latter are indicators of higher risks for mental illness, post-traumatic stress disorder and substance abuse," said Baram.

The formation of sensory brain circuits involves an initial phase of genetically and molecularly driven actions, including neuronal migration and the establishment of synapses. Complex emotional and cognitive human behavior involves many decisions and actions and are also executed by brain circuits. These higher-order circuits include the interactions of the prefrontal cortical areas, thalamic nuclei, hippocampus, amygdala and hypothalamic nuclei, and subcortical regions of the brain. They receive numerous streams of information which promote activity of the neurons in the circuits. This activity is required for maturation of the components and refinement of the

integrative connections. In early life, as these emotional circuits are developing, parents are the proximate primary environment: They are the source of information that influences the child's brain maturation.

Studies of mice reared by dams displaying unpredictable behavior sequences (but the same total amount of care) during the early postnatal period show that maternal behaviors influence synaptic connectivity in key brain nodes, including those that contribute to stress. Research involving infants and children suggests that unpredictable patterns of maternal behaviors are associated with later deficits in emotional control and behaviors. These effects persist even after correction for other early-life variables such as maternal sensitivity to the infant's needs, socioeconomic status and maternal depressive symptoms.

"What's significant about this research is that it identifies new targets for intervention and helps us think of measures we can put in place to best support the development of mentally and cognitively healthy children," Baram said. "Unpredictability is actionable, because we can aim to inform and educate parents, caregivers and others about the importance of predictable signals and environments to infants' and children's brain maturation."

Baram and her team are continuing to build on their research at the UCI Conte Center. "We are conducting mechanistic studies in experimental rodents and monitoring infants, children and adolescents in the center. We are now ready to test our discoveries in large scale, 'real-world' research," she said.

More information: Matthew T. Birnie et al, Principles of emotional brain circuit maturation, *Science* (2022). DOI: 10.1126/science.abn4016. www.science.org/doi/10.1126/science.abn4016

Provided by University of California, Irvine