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Bilkent University - Department of Electrical and Electronics Engineering

Advanced Neurotechnology for Addiction

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Dopamine (DA), which is a catecholamine neurotransmitter released by DA neurons, is associated with addiction and is responsible for many biological functions including cognition, learning, motor control, motivation, and reward. Although previous studies were helpful to understand the general mechanism of the reward system within the midbrain area, the underlying mechanisms at the molecular and cellular levels during early maturation in response to perinatal substance abuse were not investigated and integrated. Thus, there remains an unmet need to develop novel technologies to better understand the molecular and cellular mechanism underlying the midbrain reward pathway in response to perinatal substance abuse during early maturation.

Our preliminary data suggests that dopamine neurons, in response to nicotine exposure during pregnancy, were significantly activated, allowing the release of unusually high levels of dopamine in the prefrontal cortex. Active dopamine, known as the feel-good hormone, is a neurotransmitter that carries information between neurons and regulates emotional responses, particularly those related to rewards, which could play a part in addiction. We hypothesize that the impacted (altered) dopamine pathways could result in babies being born addicted to nicotine.

To monitor the neural activation within the sub-regions of the VTA, we recently proposed and developed a novel microimaging device that can be directly implanted into the brain. We believe that our approach will help us to better understand the effect of maternal nicotine and alcohol exposure on DA neurons within the sub-regions of the VTA at both cellular and molecular levels during early maturation. Subsequently, this could expand our understanding of the reward pathway and can lead to the development of novel drugs to assist with substance abuse cessation.

Bio: Dr. Akay is the John S Dunn Endowed Professor of the Biomedical Engineering Department at the University of Houston. He earned his BS and MS degrees in Electrical Engineering (EE) from Bogazici University, Istanbul, Turkiye. Then, he pursued and obtained his PhD in Biomedical Engineering (BME) from Rutgers University, NJ, the United States, He received honorary doctorates from Aalborg Silesian and Pécs Universities and professorship from the Technical University of Crete. He has authored more than 20 books and 180 journal papers, along with 200 conference papers and abstracts and delivered over 200 keynote and plenary talks at respected international conferences, including IEEE ICASSP twice. He is a recipient of the IEEE EMBS Career, Early Career and Service Awards, an IEEE Third Millennium Medal, and the prestigious Zworykin Award from the International Federation for Medical and Biological Engineering (IFMBE). He is a life fellow of IEEE, fellow of the Institute of Physics (IOP), the International Academy of Medical and Biological Engineering (IAMBE), the American Institute for Medical and Biological Engineering (AIMBE), and the American Association for the Advancement of Science (AAAS).

His research focuses on the development of novel therapeutics for the treatment of Cancer, neurotechnology for addiction and pain, brain cancer chips, and coronary occlusion.