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Carbon Fiber Multielectrode Arrays for Multiplexing Neurotransmitter Detection in Heterogeneous Brain Regions

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Abstract

FSCV, or fast scan cyclic voltammetry, is an electrochemical technique that measures the oxidation and reduction of various molecules and proteins. Analytes are oxidized/reduced at specific voltages which serve as a “molecular fingerprint” for detection. Carbon fiber microelectrodes (CFMEs) have been extensively used to measure neurotransmitters with FSCV due to their ability to adsorb cationic monoamine neurotransmitters such as dopamine and serotonin, which are increased extracellularly be cocaine and amphetamine. Although this method provides high temporal and spatial resolution, only single channel potentiostats and electrodes have been primarily utilized. More recently, the need and use of carbon fiber multielectrode arrays has risen to target multiple brain regions simultaneously. Previously, we characterized a novel carbon fiber multielectrode array (MEA), a 4-channel electrode, and found it comparable to the single channel CFME in sensitivity and selectivity. The MEA, along with a commercial potentiostat, had the additional capability of multiplexing neurotransmitter measurements in-vitro by multi-waveform application. We utilized the multielectrode array and four-channel potentiostat to measure potassium-stimulated release in the caudate putamen in coronal mouse brain slices *ex-vivo*. This method yielded a sensitivity of 3.33 nA/μM with concentrations detected as low as 100 nM. In the present study we used the MEA to detect neurotransmitters in the brain using electrical stimulation and potassium-chloride induced neurotransmitter release. We mapped out endogenous levels of neurochemicals such as dopamine, serotonin, and adenosine in regions including the ventral tegmental area, caudate putamen, raphe nuclei, and substantia nigra. This was accomplished by targeting the areas using mouse brain atlas coordinates and inserting the electrode into different brain slices. Successful sampling of neurotransmitter concentrations will aide in understanding complex brain heterogeneity, the dynamic neurochemical environment, complex behaviors, and how disease states or drugs affect separate brain areas concurrently. Specifically, we will use this method to measure the effects of psychostimulants such as cocaine and amphetamine on extracellular levels dopamine and other monoamine neurotransmitters.