A Turn-Key Fast Scan System for Detection of In Vivo Dopamine Release

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Introduction

- Continuous Fast Scan Cyclic Voltammetry (FSCV) is a technique wherein biogenic amine signatures are detected by rapidly cycling the voltage on an implanted carbon fiber electrode and recording the amperometric change resulting from specific oxidation and reduction events (Figure 1).
- Previous systems have documented FSCV recording for detection of dopamine\(^1\), noradrenaline\(^2\), and serotonin\(^3\) using both tethered\(^4\) and wireless\(^5\) recording devices.
- We have developed a complete turn-key system comprising a 34 µl recording electrode, hardware and software to continuously record FSCV data from freely moving animals.

Methods

- Young (age 3-4 months) Sprague Dawley rats and young (age 2-3 months) C57BL/6J mice were surgically implanted with a carbon fiber electrode (Figure 2) placed in the striatum region. A single Ag/AgCl reference electrode was implanted in the contralateral cortex.
- All animals were housed under a 12 hour light 12 hour dark cycle persisting throughout the experiment with food and water available ad lib. All surgical procedures were previously approved by the University of Kansas ACUC.
- All rats were fitted with a plastic recording enclosure designed to fit on the head of the animal and protect the electronics, carbon fiber electrode and reference electrode (Figure 3a). Mice were connected to a lightweight tether and swivel following implantation.
- After a one week recovery period, the carbon fiber electrode and reference were connected to Pinnacle’s 8501 wireless FSCV system (rats, Figure 3b) or Pinnacle’s 8504 tethered FSCV system (mice). To enhance biogenic amine release in some animals, an amphetamine box was administered (4 mg/kg). Dopamine was detected using continuous FSCV wherein the voltage was rapidly cycled on the carbon fiber electrode between -0.4 V and -1.1 V at a rate of 400 V/s. The resulting oxidation and reduction peaks were recorded using the PAL 8500 software suite.

Results

- Continuous FSCV traces were successfully collected over periods up to 90 minutes in length.
- Rats tolerated the wireless head enclosure well and exhibited normal behavior (feeding, rearing and exploration) during testing periods.
- Using this system, dopamine signature traces were detected during spontaneously released transient pulses in a striatum of an anesthetized rat (Figure 4).
- Application of a 400 µA stimulus to the substantia nigra region resulted in clearly distinguishable dopamine peaks in the striatal region of an anesthetized rat (Figure 5).
- FSCV traces of dopaminergic release in the striatum of a freely moving rat following amphetamine injection (4 mg/kg) were clearly detectable (Figure 6).
- Dopamine release in the striatum of a mouse was also detected following amphetamine injection (Figure 7).
- Simultaneous video tracking of behavior demonstrated correspondence between dopamine release and stereotypy behaviors.

Conclusions

- The system is capable of long-term continuous monitoring of dopamine in both the wireless and tethered configurations.

References


Support

This research was supported by the National Institute of Mental Health grant #1RO1MH084020-01 and The Defense Advanced Research Projects Agency (DARPA) grant #W911NF0910288, awarded under the DARPA/DARPA BrainQuest Project. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of the National Institute of Mental Health or the National Institute of Mental Health or the views of The Institute of Health.