<u>Neural Wireless Recording Technologies</u>

SFN Satellite Session – Sponsored by Triangle BioSystems

October 19, Hyatt Regency McCormick Place, 6:30pm – 8:00pm

Advancements in Wireless Technologies for small animal neurological testing make it possible for new studies to be obtained without the weight and constraints of wires for the animal. Come and see how wireless technologies can improve the quality of your lab experiments as seen in these recent customer projects; and allow a greater scope of testing possibilities. The satellite session agenda is as follows:

- **James Morizio, PhD. Of Triangle BioSystems**
  Wireless Technologies Overview, Technology Review and Advancements

- **Henry Yin, Ph.D. of Duke University**
  Using the 15-channel wireless system, we recorded single-unit and multi-unit neural activity as well as local field potentials from the substantia nigra of two mice while they moved freely in a closed chamber. The position and velocity of the movements were tracked and recorded along with the neural activity. Significant correlations between neural activity and behavior (slow-wave sleep, movement, and position) were found. This represents to our knowledge the first use of multi-channel and wireless recording technology in freely moving mice.

- **Frederic Ambroggi, Ph.D. of Ernest Gallo Clinic & Research Center**
  The ventral part of the striatum, nucleus accumbens (NAc), is involved in decision making. Previous studies demonstrated how NAc neurons can *drive* reward-related behavior in animals. We investigated if these neurons could also encode information necessary to *stop* a goal-directed behavior. For this purpose we designed a maze where rats had to run over an electrified shock grid to obtain a reward. Two auditory cues informed the rats whether the shock was on. On these trials, the intensity of the shock was titrated so that each rat decided to cross the grid on about 50% of the time. This allows us to compare the neuronal spiking of NAc neurons on go and no go trials. We will present single unit activity recorded in this task with a TBSI 15 channel wireless system that allowed rats to navigate freely in the maze without the movement restriction of a cable attached to a head stage.

- **Dane Grasse and Karen Moxon Ph.D. of Drexel University**
  Little is known about the network process(es) underlying spontaneous seizure initiation. The purpose of this experiment is to study the single neuron and network behavior prior to and during the initiation of spontaneous seizures in a kainic acid model of epilepsy in the rat. This has the eventual goal of identifying early markers that indicate an imminent seizure, and developing a seizure prediction algorithm to be used in clinical studies. The kainic acid model reproduces many of the features of human temporal lobe epilepsy, including lengthy periods of time between seizures (~2 seizures per week in the rat). Therefore recordings must be made for >24 hours at a time in order to gather enough seizure data. Since standard tethered recording techniques would be problematic in this paradigm, data is captured through a 31 channel wireless headstage amplifier leaving the rat free to move. Signals broadcast to the receiver are sampled at 40 kHz with a NI-DAQ card and written to hard drive. These signals are recorded in wideband (0.8 Hz – 6 kHz) and digitally filtered offline into high frequency for action potentials and low frequency for local field potentials. Unnecessary or irrelevant data is deleted while relevant data is kept for analysis. Using these experimental methods, we have been able to capture single neuron behavior in a freely moving rat during spontaneous epileptic seizures.

- **Kristin Kerr of Brown University**
  In this study, 15 and 31 channel TBSI wireless headstages were used in conjunction with microdrive assemblies to record single unit activity from the postrhinal cortex in rodents. Recordings were obtained while animals foraged for food pellets in an exploratory chamber with salient spatial cues. Single units were analyzed for spatial correlates and comparisons were made across different foraging conditions in which the location of available spatial cues was manipulated.

- **Sabyasachi Roy of The Johns Hopkins School of Medicine**
  The neural basis of vocal control and auditory feedback has long interested neuroscientists and biomedical engineers alike. Our lab has focused on studying the cortical neural activity in the common marmoset (*Callithrix Jacchus*) to unravel this basic sensory-motor system. This new world primate is highly vocal making it an ideal model to study cortical control during vocalizations. Traditional neurophysiological experiments on vocal production and feedback have involved either restrained subjects or tethered setups that severely restrict the behavior of the subject. However marmoset vocalizations are primarily elicited when the subject is free roaming and in a natural behavior state. Therefore a robust neural telemetry system is absolutely essential in enabling cortical single unit neural recordings from free roaming marmosets. We are currently integrating wireless multi-channel single unit neural recording techniques with vocal behavior experiments. The wireless headstage is attached to a 16 channel electrode array placed in the pre-motor area of adult marmosets. These experiments are conducted in RF and acoustically shielded chambers to ensure high data reliability. The application of neural telemetry coupled with interactive vocal experiments will greatly advance our understanding of primate vocal control and auditory feedback.

- **Shaomin Zhang of Zhejiang University, China**
  To study decoding information in the neural system, invasive brain-machine interfaces (BMIs) in rat were investigated. In this paper we developed a remote control training system for rat navigation. The system consists of an integrated PC control program with functions of signal communication, parameter setting and data file management, a transmitter and a receiver based on Bluetooth modules, and a stimulator controlled by a microprocessor. Stimuli delivered into the rat brain through a wireless micro-stimulator brought the rat to bear virtual cues or rewards and follow the commands to move right, left and forward in 3D obstacle environments. Using wireless neural recording system, the activities of neural ensemble could be recorded in free-moving small animals when they were performing “press-lever” tasks. When rat pressing the level with its forelimb, the value of pressure senor on lever and neural ensemble activities were synchronously recorded. After analyzing the neural activities with several novel decoding methods, the pressure on the lever could be well predicted from the activities of neural ensemble in primary motor cortex. Rats could use their “thoughts” to control robotic arm to get rewards without any forelimb pressing. The invasive brain-machine interfaces in rat are helpful to further explore the relationship between stimulation and responses in the neural network in free-moving statues. The experiment results provide some new tools to brain-machine interfaces technologies.

- **James Morizio, Ph.D. of Triangle BioSystems**
  The Future of Wireless Technologies and Closing Comments