

Towards Designing a Multi-Modal Neuronal Recording for a Non-Human Primate – an EEG/SEP Study

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Abstract— An electrode cap was developed to record electroencephalography (EEG) and somatosensory evoked potentials (SEP) on a trained awake Rhesus macaque. The results proved that EEG and SEP can be reliably recorded from a trained awake macaque using an electrode cap enabling further studies on electrode sensitivity using a macaque model.

I. INTRODUCTION

Understanding the conduction of currents from cortical sources to measuring electrodes is paramount in interpreting EEG results. The measuring sensitivity of electrodes in multiple depths is not well understood. We will use Rhesus macaques to model and measure the intra-subject differences in surface, sub-dermal, cortical and intra-cortical measurements. As the first step we present a customized macaque 10-20 surface electrode cap and recorded EEG and SEP from an awake macaque trained for this purpose. Such caps have been used before to record EEG, but not SEP on awake macaques [1,2,3].

II. MATERIAL AND METHODS

The selected Rhesus macaque’s head was measured and a Styrofoam model was produced of it based on the measurements. An elastic 256 channel EEG cap (Compumedics Neuromedical Supplies, Abbotsford, Australia) was customized to fit the macaque head geometry and ear locations using the model. 20 Ag-AgCl surface rubber-cup electrodes were attached to the cap complying as close as possible with the human 10-20 system locations [4]. The setup allowed us to record 18 channels of EEG with a reference to Cz. A male macaque (12.5 kg) with three chronically implanted head posts to restrain his head in a primate chair received left arm median nerve 3 mA, 4 ms electrical stimulation pulses with 5.1 and 15.1 Hz rates (Viasys Healthcare, PA, USA) while EEG was sampled at 1 kHz (Blackrock Microsystems, Utah, USA).

Altogether there were 1654 and 1395 EEG epochs time locked to the stimuli with an inter-stimulus-interval of 196 ms and 66 ms for the 5.1 Hz and 15.1 Hz stimulation rates, respectively. Signal-to-noise ratio of SEPs was improved by excluding outlier epochs due to artifacts and using ensemble averaging.

III. RESULTS

After training the macaque was relaxed wearing the EEG cap. 16 of the 18 channels yielded good quality EEG and SEP results. The most EEG power was in the 0 – 15 Hz band. Some artifacts due to eye movement and muscle activation were present. In 5.1 Hz stimulation the cortical components P10-N20 were clearly and consistently identified from the left hemisphere with maximal amplitudes in C3 and T3 near the somatosensory cortex. The right hemisphere yielded lower amplitude and less consistent results. In 15.1 Hz stimulation the periodic presentation of sensory stimuli induced a sustained higher amplitude response of corresponding frequency [5].

IV. DISCUSSION

The results proved that EEG and electrical stimulation evoked SEP can be reliably recorded from a trained awake macaque using a customized electrode cap. To compare Ferrari reported 36 % subject exclusion rate using electrode caps on infant monkeys to record EEG, but all were not because of the cap [3]. This has been an initial step towards studying EEG/SEP recording sensitivity between surface, sub-dermal, cortical, intra-cortical electrodes.

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REFERENCES


