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Introduction

One of the prevailing problem we face in brain machine interfacing is a loss of neural recordings over time, which is either due to reaction at the brain electrode interface and/or failure of silicon-based devices. In three non-human primates (M. Radiata) we have compared the stability of neural recordings from standard micro-wire (MW) array (32 microelectrodes per array, inter-electrode spacing ~500 μm), the cyberkinetics (CK) array (100 microelectrodes per array, interelectrode spacing ~400 μm at tip) and multisite ceramic array by Karen Moxon (KM, 8 microelectrodes on single shank, interelectrode spacing ~200 μm) implanted in the somatosensory cortex. We did neural ensemble recordings while monkey is chaired with head restrained and used automatic spike sorting algorithm to sort the waveforms. These sorted waveforms are used for further analysis.

Methods

Surgical Implantation

Microelectrode implants were performed on Isoflurane-anesthetized monkeys in a sterile surgical environment. Monkey 'gol' was implanted with CK array in area 1-2 of right somatosensory cortex in the region representing left ear upto ulnar side of hand, and MW array in area 1 of left somatosensory cortex in the region representing right forearm and hand. Monkey 'gra' was implanted with CK array in area 1-2 of right somatosensory cortex. Monkey 'pep' was implanted with MW arrays in area 2 of left somatosensory cortex and also in left motor cortex. CK array shank length was 1 mm and implanted using mechanical implant device. MW and KM arrays were implanted using stereotaxic device by guiding manually (~10 μm/sec) upto 0.9-1.1 mm and 1.8-2.3 mm depth, respectively.

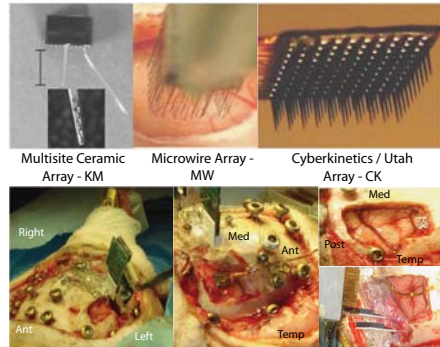


Fig 1: Arrays and implants

Neuronal Recordings

All the recordings were made on awake, head-restrained animal sitting on a primate chair. The naive monkey would sit idle while recording is going on ('gol' and 'gra') or trained monkey working on reaching task with KinARM (BKin Technologies) robotic manipulandum on which the right hand is restrained ('pep'). The recordings were made with one or two externally synced 128-channel Multi-channel Acquisition Processor units (Plexon Inc). To avoid the waveform sorting bias by operator, before the beginning of the first recording session for the day, all the channels are auto-configured using plexon-made algorithm which would set the gain and threshold according to the waveform quality for each channel and then collect 500-1000 waveform templates and define the units based on this template data. These settings are not changed manually unless the threshold is set very low (as in case of channel with very low signals) where the threshold is set to little higher level in order to prevent data loss because of excessive information.

Results

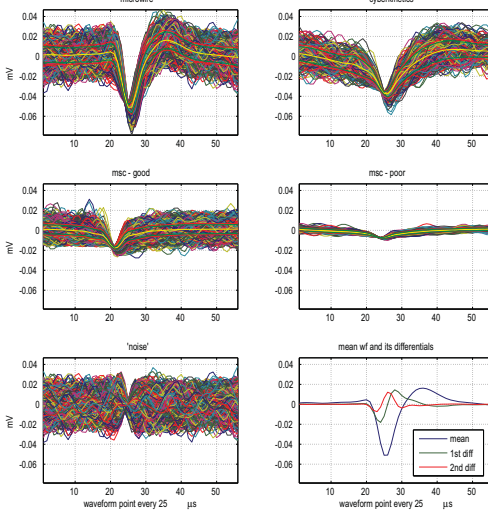


Fig 2: Typical waveforms

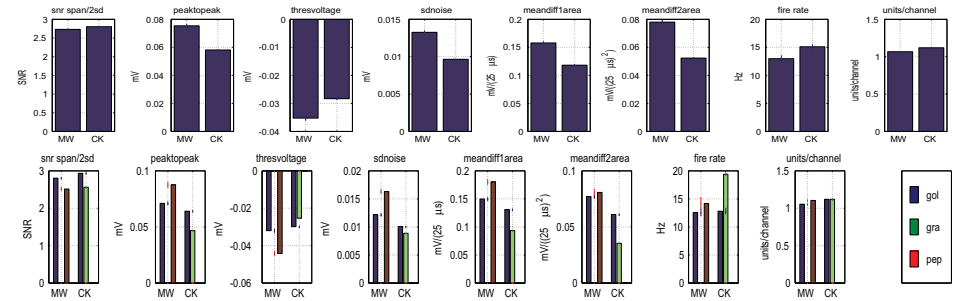


Fig 3: Summary (above) and Monkeywise(below) performance of arrays

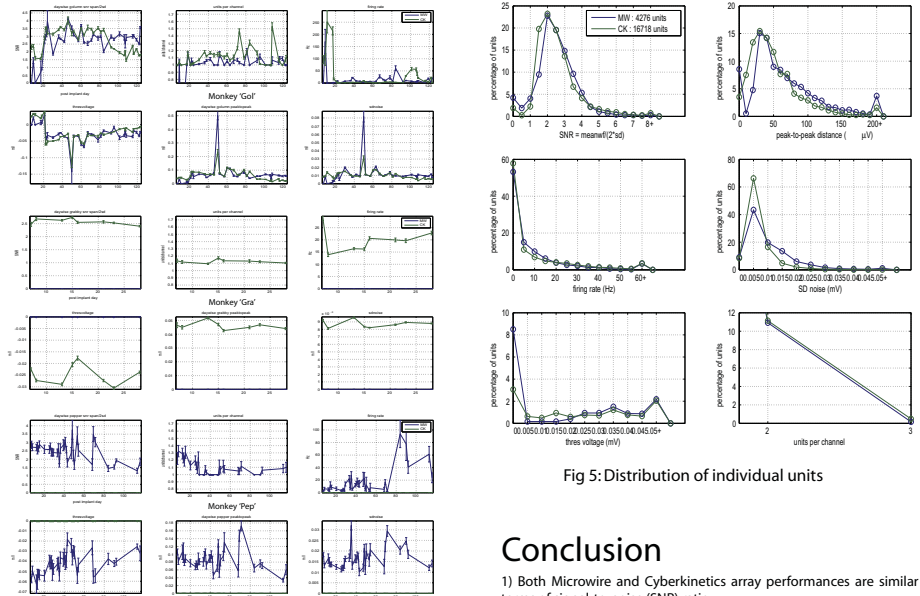


Fig 4: Daywise performance - MEA implantation is day 1 'gol' - top 2 rows, 'gra' - middle 2 rows, 'pep' - bottom 2 rows note that 'gra' has only CK and 'pep' has only MW and that KM part of this analysis is not shown here

Fig 5: Distribution of individual units

Conclusion

- 1) Both Microwire and Cyberkinetics array performances are similar in terms of signal-to-noise (SNR) ratio.
- 2) Microwire array give higher peak-to-peak values compared to cyberkinetics array
- 3) Cyberkinetics array gives higher units per channel count compared to Microwire array