The Neural Nanoprobe: Physically Decoupling the Neural Recording Site From the Headstage

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The ability to record neural ensembles from awake, behaving animals is one of the most important and successful components of the neuroscience experimental toolbox. However, even the most advanced modern systems have limitations due to the physical coupling of the recording site with the headstage. These systems can only record from a limited number of structures at any one time and have particular difficulty recording large ensembles from animals with thin skulls (e.g., mice, songbirds). Current systems cannot record from fragile structures (spinal cord, peripheral nerves and ganglia) during behavior because the wire electrodes would shred the fragile nerves as the animal moves. We propose the concept of a neural nanoprobe that is physically decoupled from a separately implanted waystation. Because the nanoprobes are not connected to the waystation by physical wires, multiple nanoprobes could be placed in multiple neural structures, all transmitting to a single, separate waystation. Because the nanoprobes effectively float in the cellular matrix, they are safe to put in fragile structures. The waystation does not need to be implanted in the fragile structures; it only needs to be electrically coupled to them. The first step to the realization of this device is a low-power, high-fidelity method for communicating between the nanoprobe and the waystation. In this abstract, we report a successful test proving the viability of using the brain itself as the conducting medium through which the nanoprobe and waystation can communicate. Initial tests show that neural signals from multiple transmission sites can be sent to a single, separated receiver. We first identified the current-loss of sine-waves transmitted through live (anesthetized) brain tissue. We found negligible current-loss across frequencies ranging from 100 kHz–50 MHz across distances as much as 15 mm. As these frequencies are larger than any known frequencies used by neural signals, they are unlikely to interfere with neural function. We next measured the ability to transmit and receive pre-recorded neural signals (sampled at 20 kHz), using pre–recorded signals to determine the fidelity of transmission. The two different signals were transmitted, received, and successfully demodulated with high-fidelity, even with transmission currents as low as 2 μA. Both the transmitters and the receiver each had their own battery power supply to ensure that they used separate, floating grounds. Finally, to ensure that the intra-brain communication signals did not interfere with neural activity, we recorded extra-cellular potentials before, during, and after the test. No changes were observed in spike shape, spike frequency, bursting, or other cellular properties, demonstrating the safety of this technique. Supported by a grant from the Institute for Engineering in Medicine (U Minnesota) and training grant support from T90-DK070106. Corresponding author; email: redish@umn.edu

Molecular Imprinted Polymer for a Purfication Device

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Molecular imprinting is a well established technology that mimics biological recognition systems using artificial materials. This involves synthesizing a nanostructured polymeric host in the presence of a target molecule to generate complementary binding sites that are selective for a molecule of interest. The technique offers a platform for developing simple and inexpensive systems with a vast array of applications such as; chromatography, separation, catalysts purification, solid phase extraction, biosensors, medical diagnostics and drug delivery. Elevated levels of some proteins in the blood can lead to a number of medical conditions. Incorporating these polymers into a device for blood purification to remove such molecules can be used as a means to combat these problems. Protein imprinting was studied from a novel perspective using protein coated micro crystals (PCMCs). PCMCs are nanostructured particles made via a rapid 1-step process developed by Moore et al. (2001). The use of a novel PCMCs strategy in molecular imprinting has allowed the retention of selected protein native conformation in organic media and the creation of access pores lined with nanocavities which facilitate protein extraction and re-introduction into the imprinted polymer. This technique has enabled us to overcome many of the challenges faced when using conventional imprinting methodology, such as protein insolubility in aprotic solvents, protein insolubility in aprotic solvents, protein denaturation and aggregation as a result of polymerization conditions and the permanent entrapment of the protein template in the cross linked polymer network.

