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Enhancing Prosthetic Design: Characterization the Sensory Capabilities of the Macrosieve Electrode Using a Rat Model

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There are nearly two million amputees living in the United States today. Predominant causes of amputation include vascular problems caused by diabetes, combat or vehicular trauma, and cancer. Current prosthetic technology does not provide the rich sensory feedback afforded by the body's natural somatosensory and proprioceptive pathways. In the absence of such feedback, excessive visual attention is required.

Truncated peripheral nerves retain the ability to transmit sensory signals to the brain. Prosthetics interfaced with the peripheral nervous system via implanted electrodes can close the feedback loop, enabling more intuitive control of these devices. Our group has recently developed the macrosieve electrode (MSE), which provides fine subfascicular selectivity and mechanical stability, making it an ideal candidate for this task.

My research this summer focuses on measuring detection thresholds for various configurations of MSE activation, i.e., the smallest activating current that is detected with a 75% success rate. Due to the invasive and irreversible nature of MSE implantation, an animal model, namely a rat sciatic model, is necessary. Rats are surgically implanted with an MSE on their sciatic nerve. Wires from the MSE are then routed to the skull and wired to a connector that is part of a headcap secured to the rat's skull. The connector allows us to activate specific nerve regions interfaced with the MSE during training and testing.

Detection thresholds will be determined using a Go/No-Go task paradigm. Within a Skinner Box, a rat inserts its nose into a nose-poke device, and holds it there until stimulus onset (randomized interval). If the rat withdraws its nose within 500 ms of stimulus onset, it receives a reinforcement of sweetened water. Premature withdrawal (i.e., before stimulus onset) results in a 10 s punishment during which the lights are extinguished.

Training will begin with auditory stimuli. Rats that successfully learn this version of the task will be implanted. After recovery, they will resume behavioral training with the addition of electrical stimulation of the sciatic nerve. Over time, auditory stimuli will be phased out, leaving only the electrical stimuli. At this point, proper testing will begin.

Our measurements will establish whether a given current level elicits sensory percepts equally throughout the nerve; whether thresholds change over time post-implantation; and whether thresholds are similar across multiple rats.