IMAGING AND MANIPULATING SINGLE NEURONS IN FREELY BEHAVING RATS

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1. INTRODUCTION

Long-term imaging and optogenetic manipulation of neuronal activity can help to reveal the underlining circuitry of the brain. Moreover, correlating the optical measurements with behavioral observations can shed light on the specific function of each neuron. To this end, multiple groups have developed 1- and 2-photon fiberscopes for the imaging and holographic photoactivation in freely behaving mice [1, 2]. Yet, there are no reports of behavioral experiments using a fiberscope.

In pursuit of this idea we have developed a system for imaging single neurons in freely-behaving rats while photoactivating or inhibiting them. 1-photon wide-field fluorescence of GCaMP7f or jRGECO1 expressing cells is recorded with a camera together with an image fiber and a gradient-index (GRIN) lens. By employing a spatial-light-modulator (SLM) we can selectively photoactivate or inhibit single neurons. To overcome the stress-induced tension in the fiber while the animals are moving we have built a commutator which renders the field-of-view invariant over rotation.

2. RESULTS

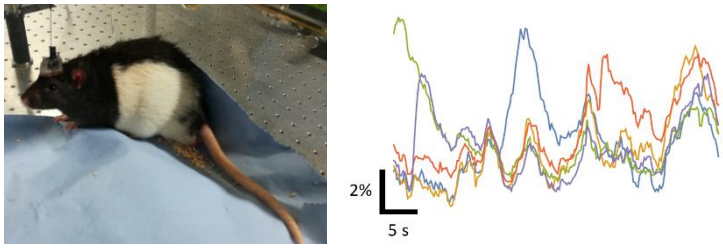

Figure 1, left: a freely-behaving rat with a fiberscope implanted. Right: calcium traces of GCaMP7f neurons imaged with the fiberscope.

The gentle wide-field illumination together with the commutator allow us to perform long-term behavioral experiments. Calcium traces obtained with the system and preliminary data showing our ability to photoactivate single neurons will be presented.

[1] V. Szabo; C. Ventalon, V. De Sars, J. Bradley, and V. Emiliani, “Spatially Selective Holographic Photoactivation and Functional Fluorescence Imaging in Freely Behaving Mice with a Fiberscope”, *Neuron*, **84**, 6, 1157-1169 (2014).

[2] B.N. Ozbay, G.L. Futia, M. Ma, V. M. Bright, J. T. Gopinath, E. G. Hughes, D. Restrepo, and E. A. Gibson, “Three dimensional two-photon brain imaging in freely moving mice using a miniature fiber coupled microscope with active axial-scanning”. *Sci Rep*, **8**, 8108 (2018).