Multivariate Guide to Magnetic Resonance Imaging and Optogenetic Control of VTA Activation

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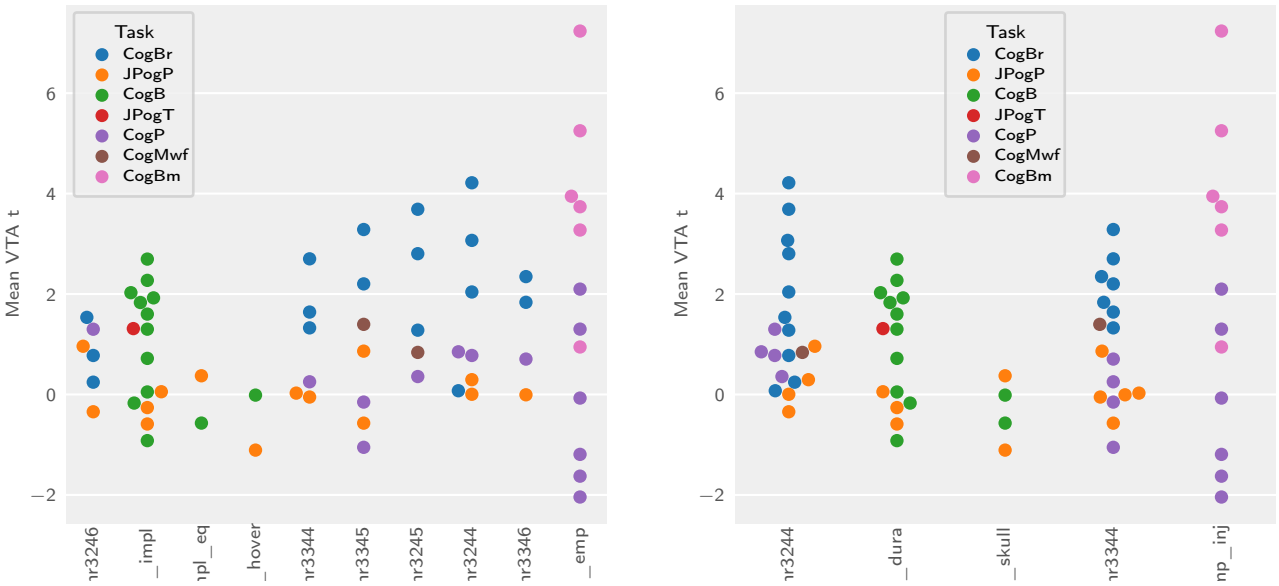
Abstract — Given the need for inter-subject and inter-study comparability, spatial map registration to a standardized space is indispensable to Magnetic Resonance Imaging (MRI), and in particular functional MRI (fMRI). Mouse MRI workflows commonly utilize high-level interfaces optimized for human data — and adapt the data to the interface rather than vice-versa. Quality control (QC) is commonly performed by interactive operator inspection, making it infrequent, open to bias, slow, and unreproducible. In this paper we present a novel registration workflow accessible via both Bash and Python, which uses the full flexibility of low-level interfaces from one of the most popular normalization toolkits (ANTs). We provide an optimized set of parameters for mouse brain registration, and propose a standard space suited to harmonize mouse brain data across modalities. Additionally, we present QC workflows, which can automatically assess the registration quality of current as well as past processed datasets. With regard to both structural and functional considerations, we showcase the capabilities of this novel workflow compared to a legacy workflow (representative of common practices — which we detail and comment). We find that our workflow outperformes the legacy workflow by orders of magnitude across several metrics.

Results

Supplementary Materials



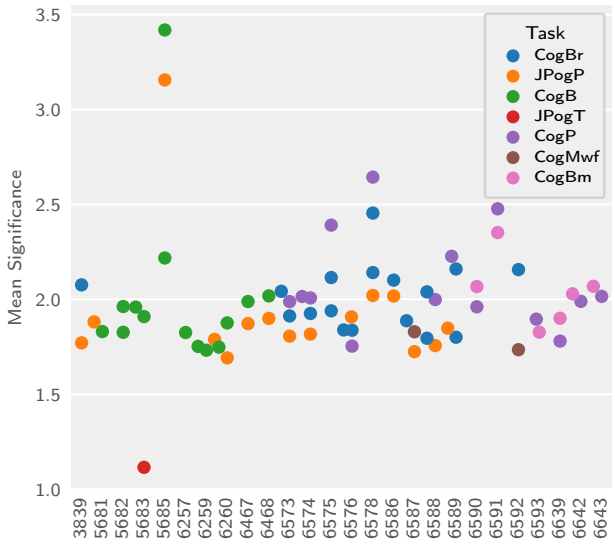
(a) Implant coordinate comparison.

(b) Injection site comparison.

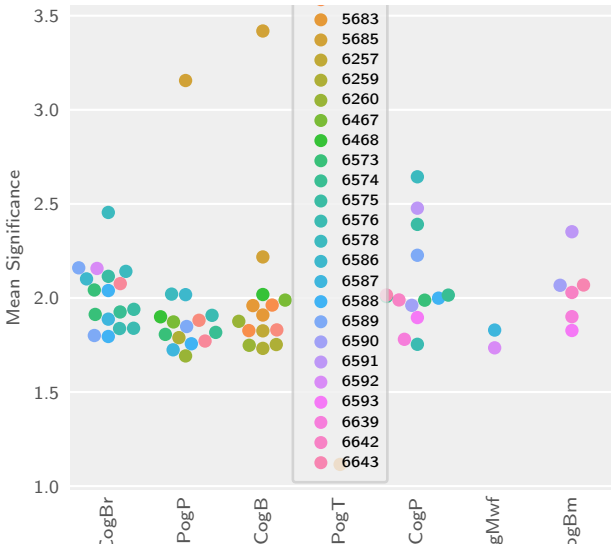
(c) Implant coordinate comparison.

(d) Injection site comparison.

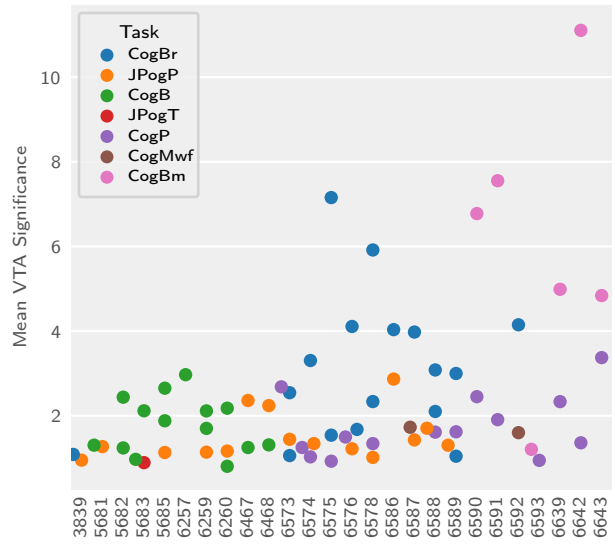
Figure 1: Multivariate (protocol and operative feature) comparisons of signal intensity in the VTA region of interest.



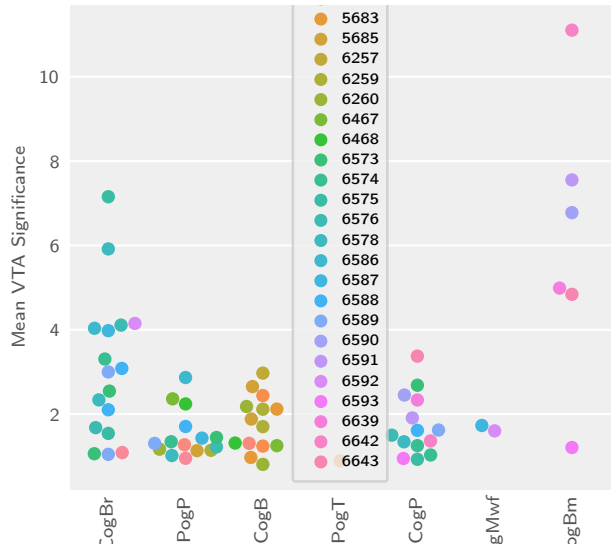
(a) Whole brain significance across subjects. .



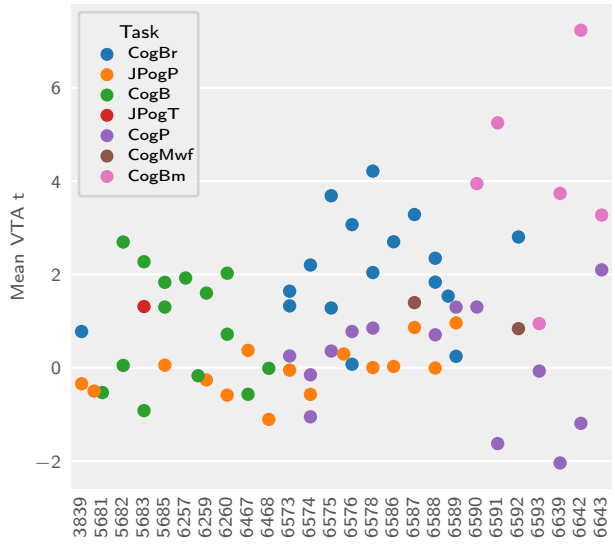
(b) Whole brain significance across stimulation protocols. .



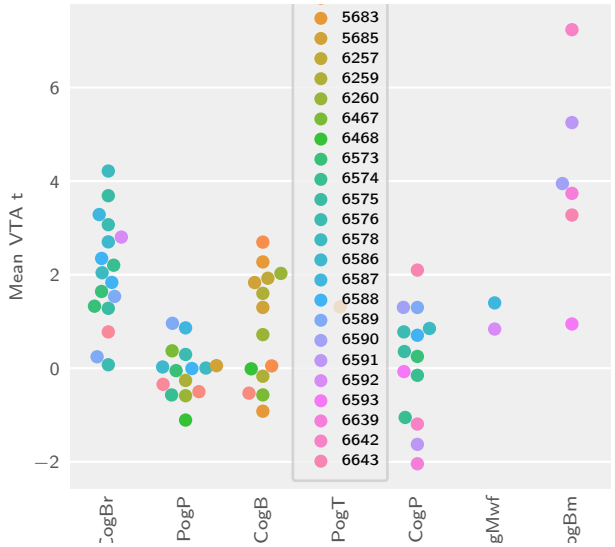
(c) VTA significance across subjects. .



(d) VTA significance across stimulation protocols. .



(e) VTA signal intensity across subjects.



(f) VTA signal intensity across stimulation protocols.

Figure 2: Multivariate (subject and stimulation protocol) comparisons of significance and signal intensity at the whole-brain level or restricted to the VTA region of interest.