Mapping Brain-Wide Inputs to Two Distinct Thalamic Nuclei

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Anterior (ATN) and parafascicular (PF) nuclei are the two most unique thalamic nuclei based on their single cell RNA-sequencing transcriptomic signatures. ATN has been implicated in learning, memory, and spatial navigation, while PF contributes to both fine and course motor actions. While the outputs of these two structures have been fairly well characterized, the regions that provide input to these nuclei are not yet known.

**Figure 1:** The thalamus and its many nuclei, with the anterior thalamic nucleus (ATN) colored blue, and the parafascicular (PF) nucleus colored green.

**Figure 2:** Rationale:
- Anterior (ATN) and parafascicular (PF) nuclei are the two most unique thalamic nuclei based on their single cell RNA-sequencing transcriptomic signatures. ATN has been implicated in learning, memory, and spatial navigation, while PF contributes to both fine and course motor actions. While the outputs of these two structures have been fairly well characterized, the regions that provide input to these nuclei are not yet known.

**Methods**
1. Prepare tracing mice by injecting Cre-dependent rabies helper virus into nuclei of interest
2. Inject mCherry to infect helper neurons restricted to nuclei
3. Perfusion, brain isolation, and sectioning
4. Immunohistochemistry - GFP staining
5. Whole-brain analysis
   - Confirm ATN/PF-restricted rabies starter cells
   - Image representative coronal sections covering entire brain sample
   - Align individual sections to the standard mouse brain atlas
   - Quantify rabies virus* cells in each brain region
   - Rank-order neuron counts and analyze in regards of function

**Results**
- PF upstream neurons concentrated in M2 region
- ATN upstream neurons concentrated in RSA region

**Conclusions and Future Work**
- The supplementary motor cortex (M2), cingulate cortex (Cg1), and retrosplenial cortex (RSA) were chosen as highest inputs to ATN based on their total neuron counts and known implications in spatial navigation, learning, and memory.
- The superior colliculus (InG), M2, and anterior pretectal nucleus (APTD) were chosen as highest inputs to PF based on their implications in fine and course motor actions.
- This work sets the stage for future input-specific circuit manipulations during mouse behavioral tasks, as well as serving as a resource for the entire thalamic neuroscience field.

**References and Acknowledgements**

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