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We use this collection and it's working

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Abstract

This collection contains five protocols detailing methods used in **Bouabid, S. et al. (2025) "Distinct spatially organized striatum-wide acetylcholine dynamics for the learning and extinction of Pavlovian associations"**.

Files

 SEARCH

Protocol



NAME

🔗 Fabrication and calibration of multi-fiber arrays to monitor dopamine release in the mouse striatum

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NAME

Stereotaxic injections of viral vectors and chronic optical fiber implants in mouse brains

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Multi-fiber photometry in head-fixed mice performing a dual-cue delay Pavlovian association

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🔗 Micro-CT scanning for post-implant localization of multi-fiber arrays in mouse striatum

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Confocal microscopy to assess TelC and iGluSnFR expression in fixed mouse brain slices

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Protocol references

Dombeck, D., Harvey, C., Tian, L. et al. **Functional imaging of hippocampal place cells at cellular resolution during virtual navigation.** Nat Neurosci 13, 1433–1440 (2010).

Vu, M.-A.T., Brown, E.H., Wen, M.J., Noggle, C.A., Zhang, Z., Monk, K.J., Bouabid, S., Mroz, L., Graham, B.M., Zhuo, Y., et al. **Targeted micro-fiber arrays for measuring and manipulating localized multi-scale neural dynamics over large, deep brain volumes during behavior.** Neuron 112 , 909–923.e9 (2024).

Jing, M., Li, Y., Zeng, J., Huang, P., Skirzewski, M., Kljakic, O., Peng, W., Qian, T., Tan, K., Zou, J., et al. (2020). **An optimized acetylcholine sensor for monitoring in vivo cholinergic activity.** Nat Methods 17 , 1139–1146.

Patriarchi, T., Cho, J.R., Merten, K., Howe, M.W., Marley, A., Xiong, W.-H., Folk, R.W., Broussard, G.J., Liang, R., Jang, M.J., et al. (2018). **Ultrafast neuronal imaging of dopamine dynamics with designed genetically encoded sensors.** Science 360 , eaat4422.

Zhang, Y., Zhao, S., Rodriguez, E., Takato, J., Han, B.-X., Zhou, X., and Wang, F. (2015). **Identifying local and descending inputs for primary sensory neurons.** J Clin Invest 125 , 3782–3794.

Marvin, J.S., Scholl, B., Wilson, D.E., Podgorski, K., Kazemipour, A., Müller, J.A., Schoch, S., Quiroz, F.J.U., Rebola, N., Bao, H., et al. (2018). **Stability, affinity, and chromatic variants of the glutamate sensor iGluSnFR.** Nat Methods 15 , 936–939.

Metscher, B.D. (2009). **MicroCT for developmental biology: A versatile tool for high-contrast 3D imaging at histological resolutions.** Dev. Dyn. 238, 632–640. 10.1002/dvdy.21857.

Wang, Q., Ding, S.-L., Li, Y., Royall, J., Feng, D., Lesnar, P., Graddis, N., Naeemi, M., Facer, B., Ho, A., et al. (2020). **The Allen Mouse Brain Common Coordinate Framework: A 3D Reference Atlas.** Cell 181, 936–953.e20. 10.1016/j.cell.2020.04.007.