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Sarah Izabel

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Mapping New Olfactory Bulb Neurons at the Single-cell Level Using Iron Oxide-Assisted MRI



¹Laboratory of Functional and Molecular Imaging, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD

²Department of Humanities and Sciences, Virginia Commonwealth University, Richmond, VA

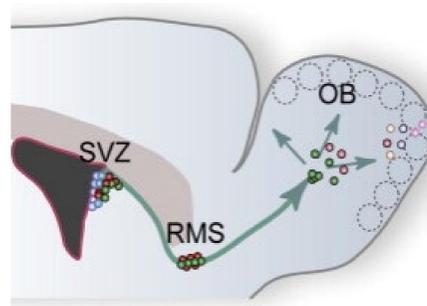


Abstract

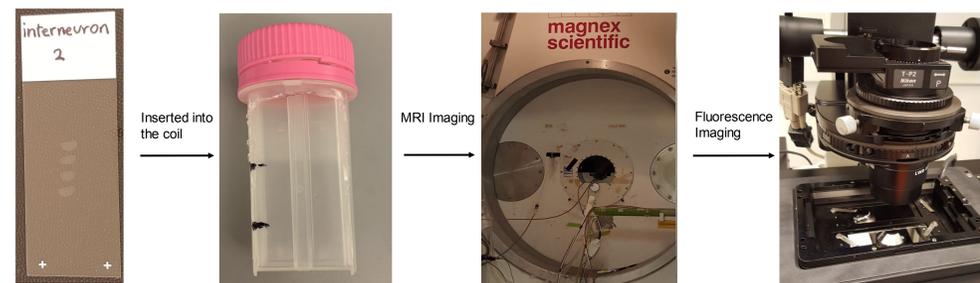
Neurogenesis in the subventricular zone (SVZ) of adult mammalian brains persists throughout life. Precursor cells that are continuously born in the SVZ migrate long-distance to the olfactory bulb (OB), where they differentiate into specific neurons. The distribution of new neurons in the OB has been studied via histological and intravital techniques, which are limited longitudinally and in depth of imaging. In the past decade, *In vivo* studies using magnetic resonance imaging (MRI) have shown the possibility of detecting single cells and tracking new neurons in the OB, where precursor cells were labelled with iron oxide. In this study, neural progenitor cells in the SVZ were labeled using micro-sized iron oxide particles (MPIOs) and their migration to the OB was detected with MRI. MPIO was confirmed to be present in new neurons via immunohistochemistry and MRI signals were overlapped with MPIOs showing that MPIO-generated MRI contrast can be used to detect single neuronal cells in the OB.

Adult Neurogenesis in the SVZ

The subventricular zone (SVZ) is where neurogenesis takes place in adult mammals. Progenitor cells migrate long distance via the rostral migratory stream (RMS). In the OB these immature precursor cells differentiate into specific subtype of interneurons, which are thought to play a crucial role in odorant input processing and environmental adaptation.

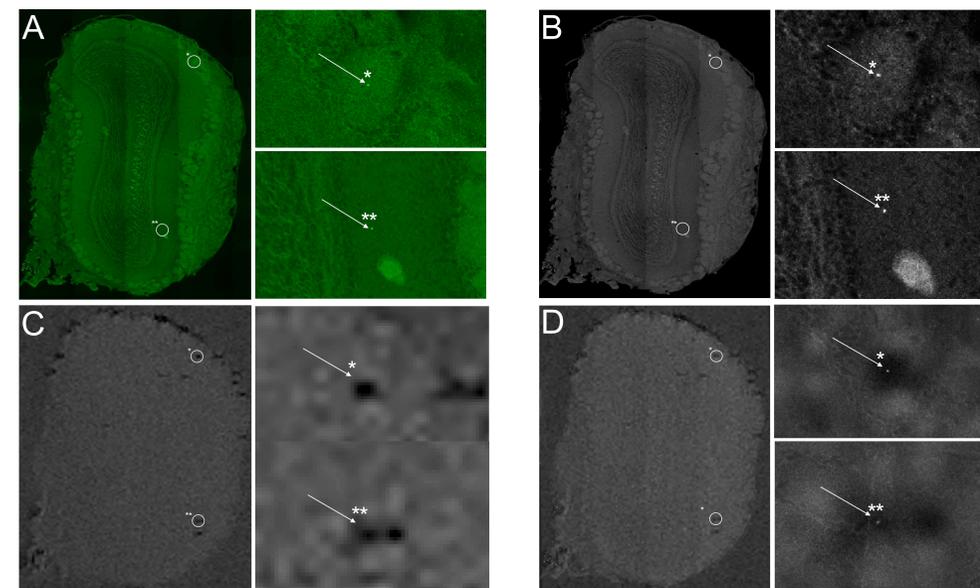


Methods for identifying MPIOs in the OB



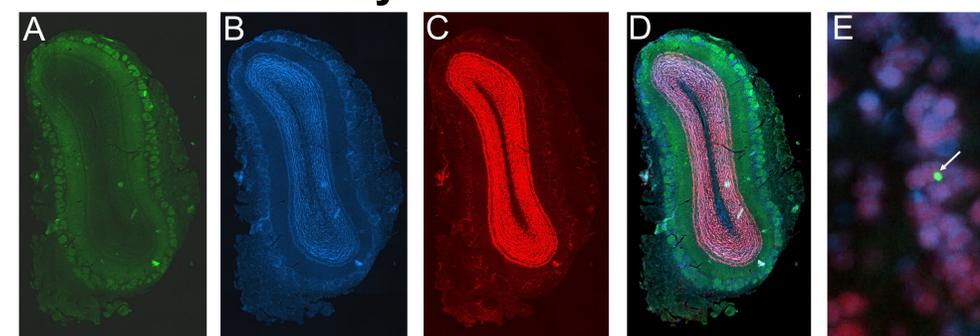
Workflow for identification of MPIOs in OB sections by both MRI and Fluorescent imaging

MPIOs generate hypointense signals in the OB



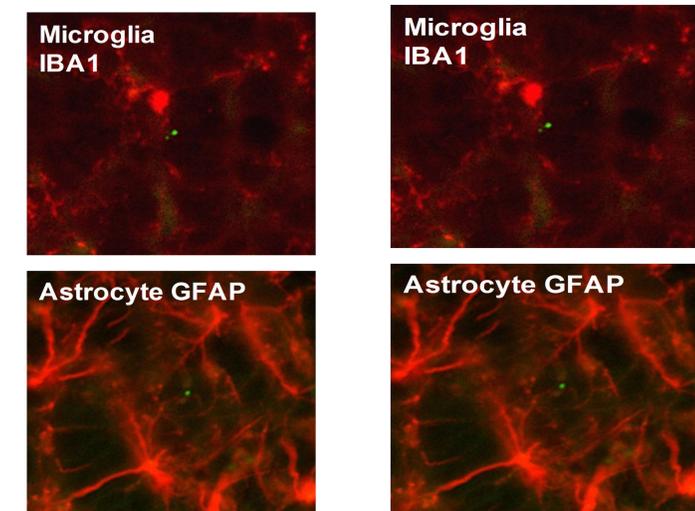
A. Fluorescent image of the olfactory bulb (MPIOs marked with intense green fluorescent spots, arrowed) . **B.** Fluorescent image in grey scale. **C.** MRI image of the same olfactory bulb (hypointense spot, arrowed). **D.** Overlap of olfactory bulb of fluorescent under MRI images. ***/****Highlighted in all zoomed images is the MPIOs in identifiable area of the olfactory bulb

MPIOs mostly label neurons in the OB



Florescent labeling of the olfactory bulb, identifying MPIOs. **A.** MPIO is pre-labeled and expressed in green. **B.** Dapi staining of cell bodies for all present cells. **C.** NeuN staining of mature neurons. **D.** Overlap of all labels. **E.** Zoomed image of a single MPIO in overlap.

MPIOs are not internalized by astrocyte and microglia



Immunohistochemistry shows that, in the OB, most particles are not within microglia or astrocytes.

Conclusions and Future Directions

MRI Imaging and immunohistochemical analysis showed that MPIOs can be used to identify single neurons in the olfactory bulb of adult rats. The selectivity of the neurons labeled in the OB may open an avenue for investigating adult neurogenesis and its roles in neurological disorders. Using MRI as a complementary tool to other *in vitro* and *in vivo* methods in future studies, will elucidate the effects of odorant stimuli on the distribution of new neurons at single-cell level.

Acknowledgements

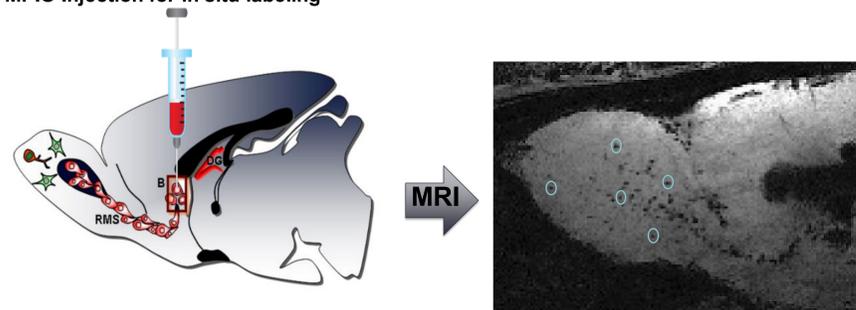
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References

- [1] Khodosevich K., Alfonso J., & Monyer H. (2013). Dynamic changes in the transcriptional profile of subventricular zone-derived postnatally born neuroblasts. *Mechanisms of Development*, 130(6-8), 424-432.
- [2] Pothayee N., Koretsky's Lab. Poster Presentation. Olfactory Activity Level Alters Migration Dynamics of Subventricular Zone Neuroblasts.
- [3] Pothayee N., Cummings D.M., Schoenfeld T.J., Dodd S., Cameron H.A., Belluscio L., & Koretsky A.P. (2017). Magnetic resonance imaging of odorant activity-dependent migration of neural precursor cells and olfactory bulb growth. *NeuroImage*, 158, 232-241.
- [4] Shapiro E.M., Gonzalez-Perez O., Manuel Garcia-Verdugo J., Alvarez-Buylla A., & Koretsky A.P. (2006). Magnetic resonance imaging of the migration of neuronal precursors generated in the adult rodent brain. *NeuroImage*, 32(3), 1150-1157.

MRI as a longitudinal tool for tracking long-distance cell migration in the OB

MPIO Injection for *in situ* labeling



Past studies have shown that micron sized iron oxide particles (MPIOs), a potent MRI contrast agent, can be used to labeled the migrating immature neurons from the SVZ into the RMS and the OB. The injection of MPIOs into lateral ventricles allows the particles to be endocytosed by precursor cells. The migration of the immature neurons can be visualized in live animals by MRI, which enables longitudinal experiments and allows for the assessment of the migration dynamic.