RISE RESEARCH INNOVATION SCHOLARSHIP ENTREPRENEURSHIP

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Simultaneous Optical Pupillometry and fMRI for Investigating Sympathetic Nervous System Activity

Northeastern University Center for Translational Neuro-imaging

EKAM THE IMAGE OF DRUG DISCOVERY

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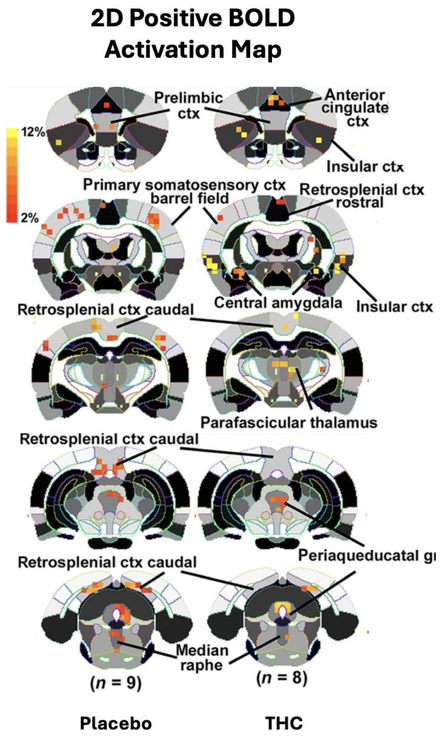
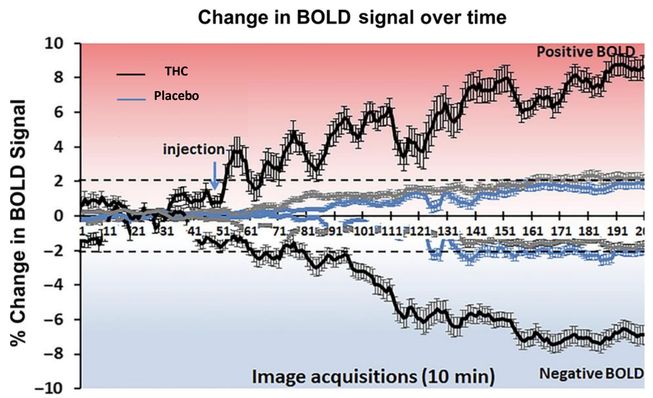
Background

Understanding functional activity during THC exposure is crucial for assessing its effects on the autonomic and central nervous systems. Pupillometry, a technique that measures pupil dilation as an indicator of sympathetic nervous system activity, provides valuable insight into THC's physiological impact. Using pharmacological-fMRI (phMRI) and pupillometry, we examined how THC modulates sympathetic responses by integrating pupillary dynamics with cortical activity. To enhance these studies, we are developing a simultaneous pupillometry-fMRI system with advanced LED-optics and Ca^{2+} imaging. Preliminary results reveal THC-induced **pupil dilation correlates with region-specific BOLD activity**, highlighting pupillometry as a biomarker for central nervous system modulation.

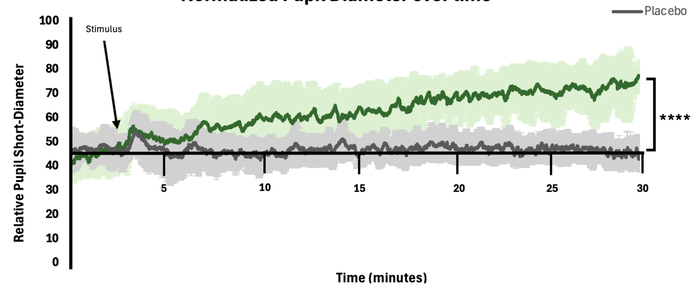
Imaging Results

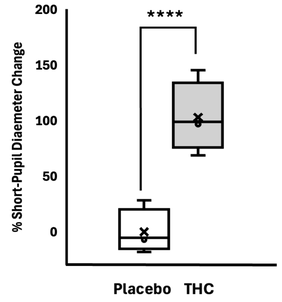




Positive BOLD

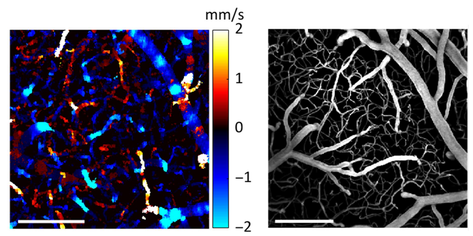
Region of interest(ROI)	Veh Med	0.1 mg Med	1 mg Med	*P* val
Central amygdala	0	7.5	0	0.001
Prelimbic ctx	11	0	10	0.002
Retrosplenial caudal ctx	24	3.5	33	0.012
Ventral posteriolateral thalamus	0	2.5	0	0.017
Primary somatosensory ctx hindlimb	3	0	0	0.023
Parabrachial nucleus	1	7.5	1	0.039
Parafascicular thalamus	0	4	0	0.047
Ventral medial hypothalamus	0	0	0	0.094
Insular ctx	4	33	3	0.104
Primary somatosensory ctx forelimb	0	6.5	0	0.117
Primary somatosensory ctx barrel field	5	2	7	0.229
Median raphe	7	1.5	0	0.35
Retrosplenial rostral ctx	3	8	7	0.446
Anterior cingulate ctx	4	24	11	0.469
Periaqueductal gray	8	9	8	0.724
Raphe linear	0	0	0	0.837
Medial dorsal thalamus	1	0.5	1	0.945





Applications

Our integrated pupillometry-fMRI platform has broad applications in neuroscience and biomedical research. It enables precise monitoring of sympathetic nervous system activity and brain function, making it valuable for studying neurovascular coupling, autonomic regulation, and drug action in-vivo. Moving forward, integration of OCT and 2-photon imaging has implications for collecting both macro and mirco-level imaging data. Beyond neuroscience, it may inform clinical research in anesthesia monitoring and psychiatric assessments. The integration of MR-compatible physiological sensors furthers potential for multimodal imaging studies, improving our understanding of brain-body interactions in both preclinical and translational research.



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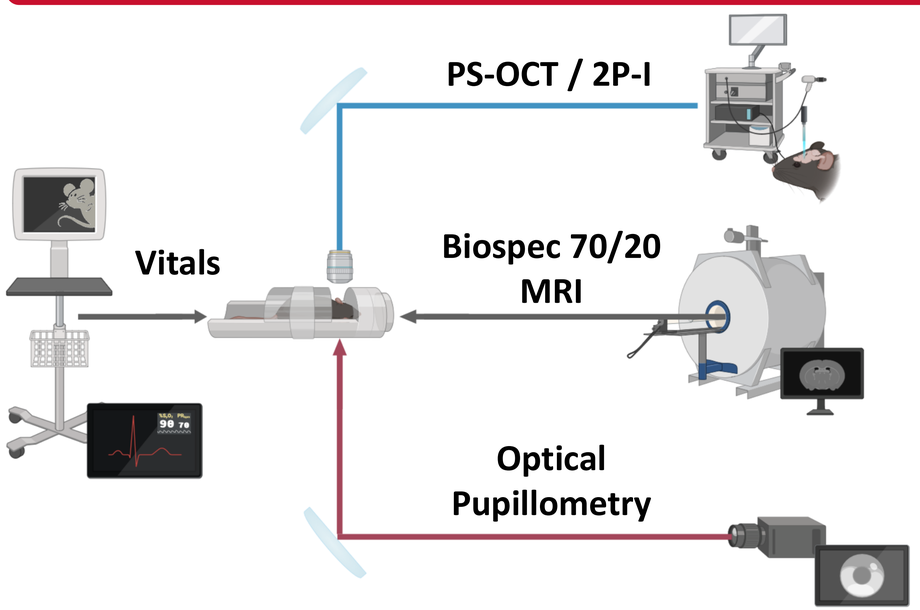
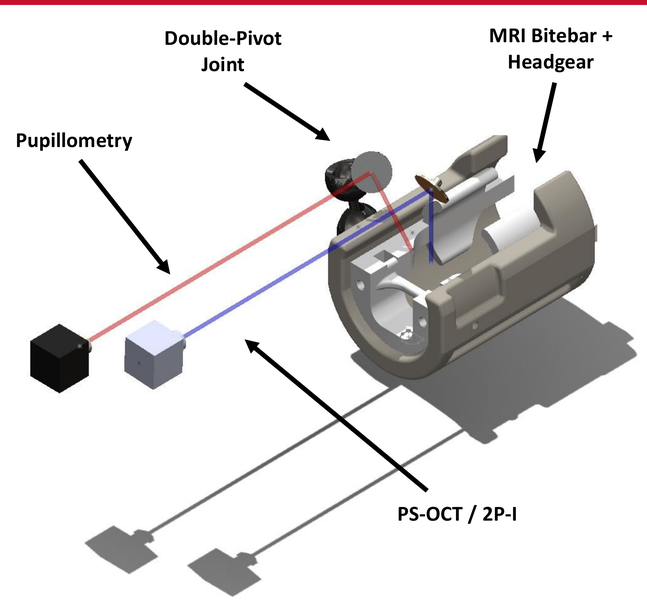
Methods





- **fMRI:** Synchronized pharmacological fMRI captures BOLD signals during stimuli.
- **Pupillometry:** High-speed IR-based system tracks pupil dilation as a proxy for sympathetic activity.
- **OCT / 2-Photon Imaging:** Advanced optical imaging techniques provide high-resolution visualization of cortical hemodynamics and neuronal calcium dynamics in region specific areas.
- **MR-Compatible Vitals:** Integrated sensors continuously monitor SPO_2, ECG, and temperature during MR sessions.

Acknowledgments

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