

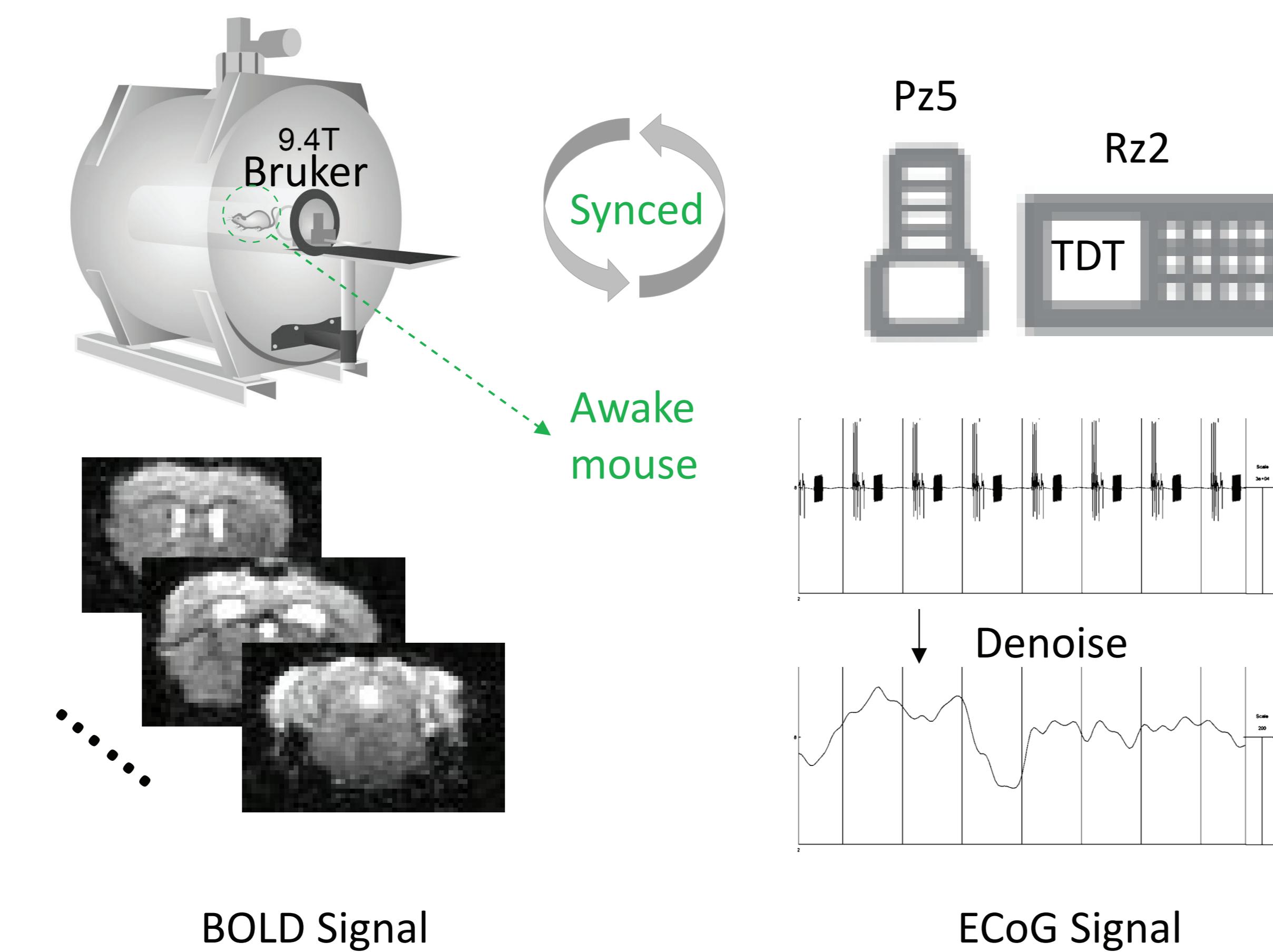
# A study of the resting state brain network dynamics between different arousal levels of mice by simultaneous rs-fMRI and ECoG recording

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## BACKGROUND

In the research field of resting state functional connectomics, although emerging studies have shown the spatial covariation between the resting state functional connectivities and the neuro-electrical signals, how different connectivity patterns are modulated during the resting state and their functional roles both remain unclear. To solve these questions, electrophysiological recording from wide ranges of brain areas is promising, and the additional application of manipulation methods, like the chemogenetics and the optogenetics, is crucial. Rodent studies triumph primate studies when the manipulation methods are applied, especially for the cell type-specific studies. Therefore, efforts have been made to develop the methodology of simultaneous rs-fMRI and ECoG recordings in awake mice.



BOLD (blood oxygenation-level dependent) signal is acquired by using a 9.4T BioSpec scanner. Synchronized ECoG signal is recorded by a MRI compatible TDT recording system. Electrophysiological signal recorded during scanning is largely interfered by the gradient sequence. FMRIB denoising plugin is applied to remove this artifact.

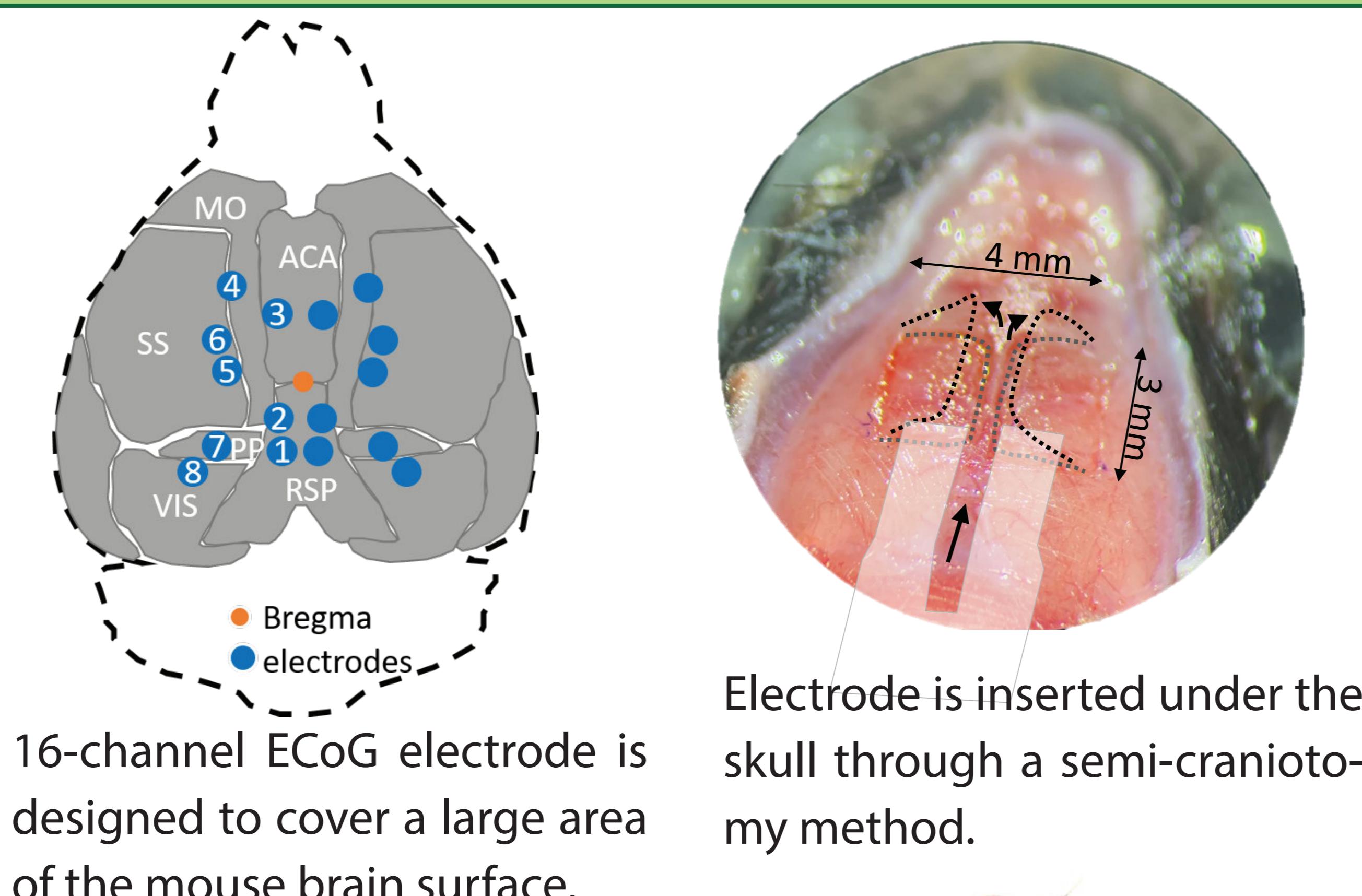
## INTRODUCTION

Converging evidence of PET (positron emission tomography) and fMRI (functional magnetic resonance imaging) studies have revealed the existence of default mode network (DMN) in the human and non-human primate brains. Their existence in mice is still debatable.

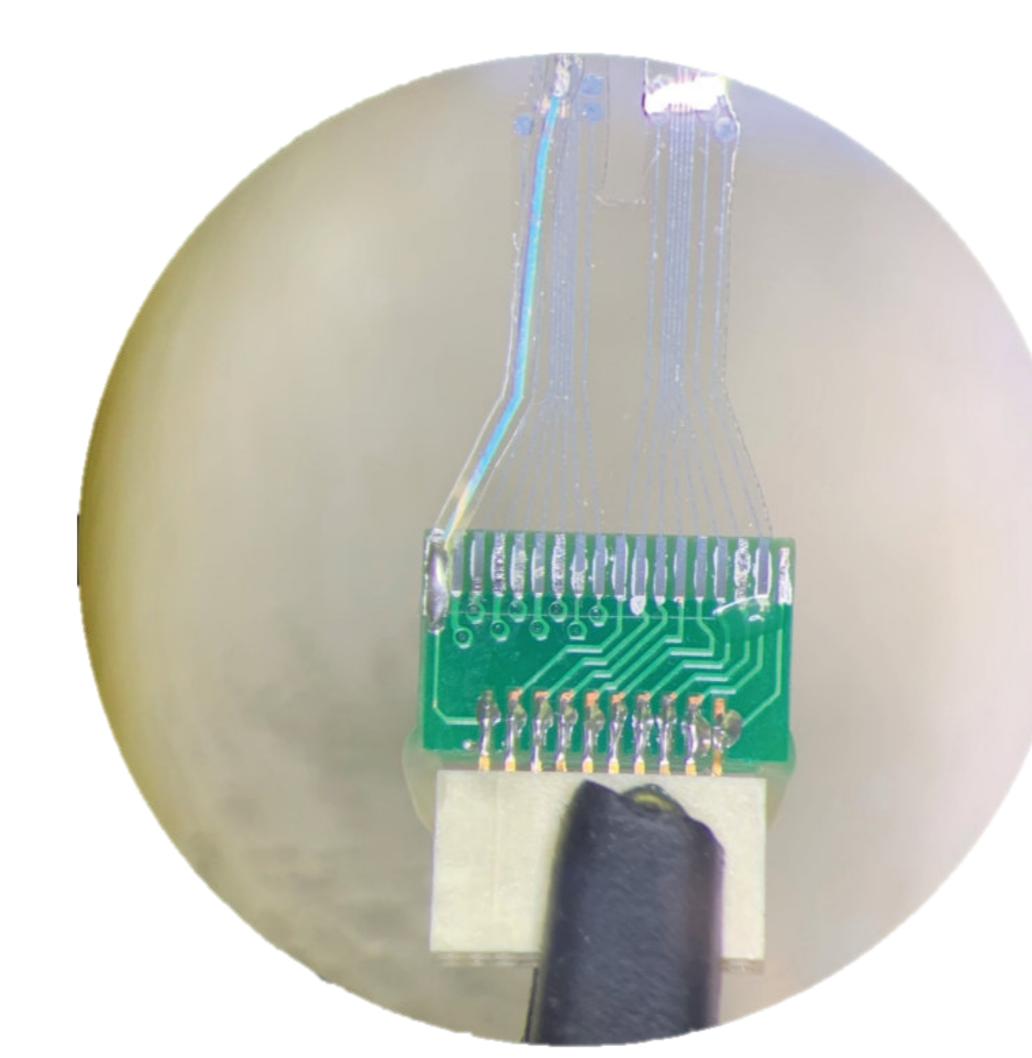
Brain regions involved in the DMN are relatively more active during the relaxed state than during the task-engaged state. Till now, their functional roles and neural origins are still to be revealed. To solve these questions, techniques by combining brain-wide fMRI and electrophysiological recording will be useful.

Comparing to non-human primates, rodents are much more accessible for the neuroscience studies. Based on our previous work (Han et al., Neuroimage 2019), we aimed to study the neural mechanisms underlying the mouse brain resting state connectivity. In this study, we developed the simultaneous fMRI and electrocorticographic (ECoG) recording paradigm for awake mice.

## METHODS



16-channel ECoG electrode is designed to cover a large area of the mouse brain surface.

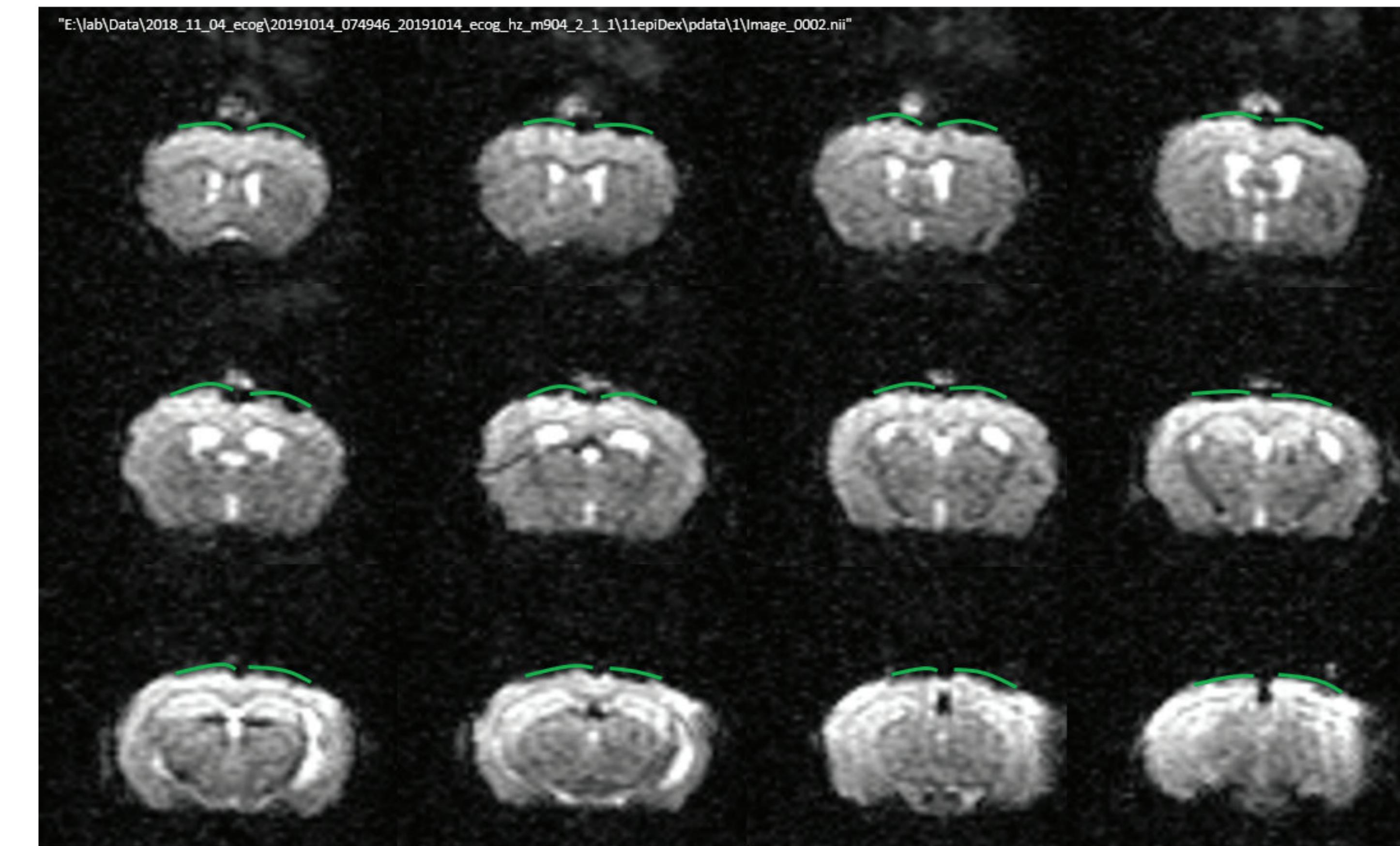


Home-made MRI compatible electrode is customized to minimize EPI image distortion.

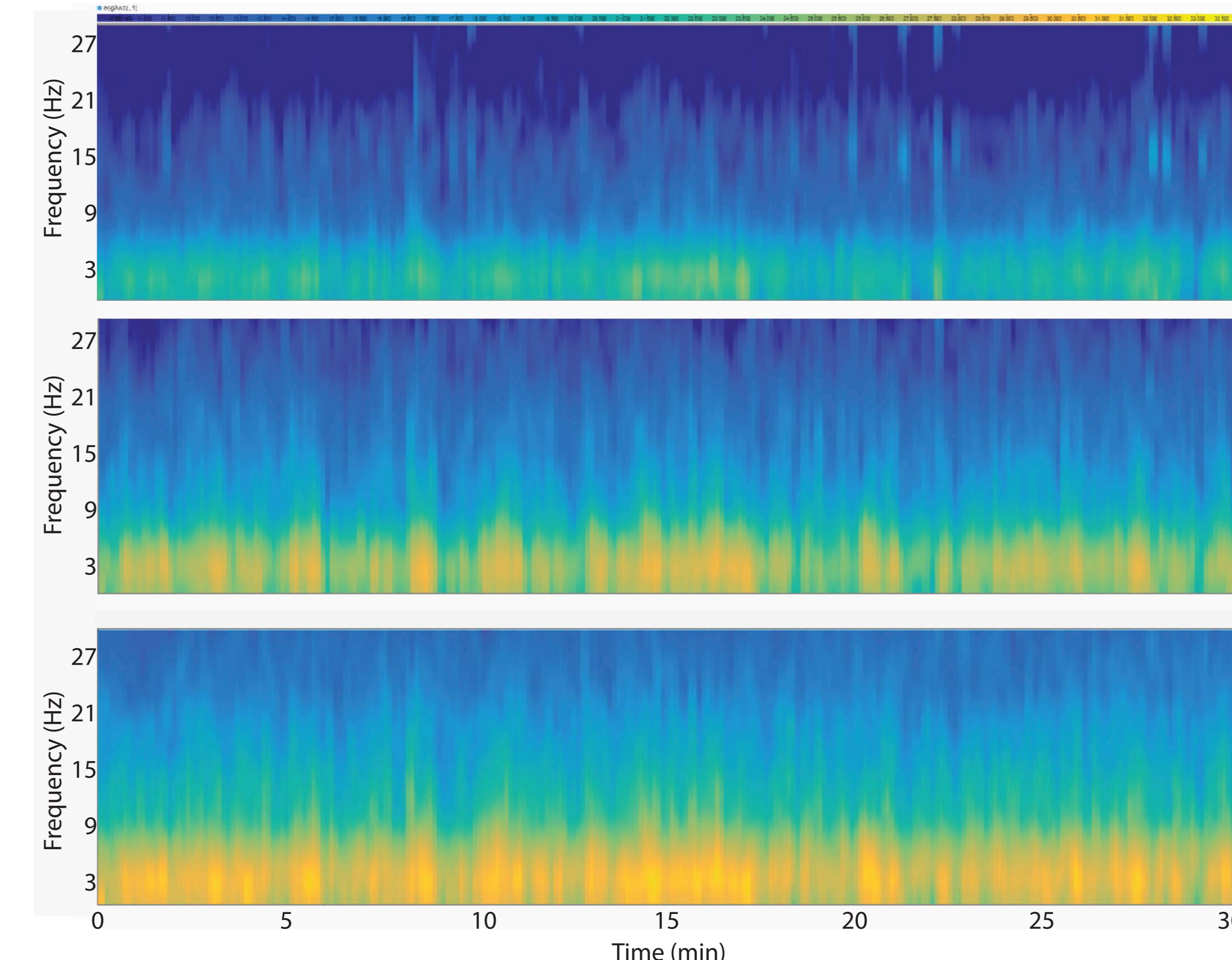


ECoG signals were recorded from awake and head-fixed mice.

## RESULTS



fMRI images using EPI sequence showed relatively high signal-noise-ratio and low distortion after six weeks of electrode implantation. TR, 1000 ms; slice thickness, 0.4 mm. Green curves show the electrode positions.



Time frequency analysis of the ECoG signals recorded from three brain regions showed different activity patterns both spatially and temporally. Panels from top to bottom showed 30-minutes recording results from the Retrosplenial area, the Somatomotor area, and the Somatosensory area, respectively. First, raw signals of 24k Hz sampling rate recorded during fMRI scanning were denoised by using the FMRIB plugin to remove the gradient artifact. Then the processed signals were down-sampled to 1k Hz and band-passed from 0.1 Hz to 70 Hz.

## SUMMARY

Brain never rests, even in the resting state. Till now, the ultimate functions of the resting state activities, the modulation of different connectivity patterns are still mysteries. This study developed a method to record synchronized BOLD signal and ECoG signal from awake mouse brains. Functional images by using EPI sequence from awake mice showed relatively high signal noise ratio and low distortion. ECoG signals recorded from three different brain regions, the Retrosplenial area, the Somatomotor area, and the Somatosensory area showed different activity patterns both spatially and temporally.

## FUTURE DIRECTION

Through recording the synchronized BOLD and ECoG signals from awake mice, the goal is to benefit from cell-type specific manipulations by chemogenetics and optogenetics. In following studies, we will focus on manipulating different sub-cortical nucleus, in order to modulate the arousal levels of mice. By analyzing the co-variation of BOLD signal and ECoG signal, our aim is to understand the functional roles of the resting state activities.

## ACKNOWLEDGEMENT

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