Microelectrode electrophysiology: Extending the Brain Imaging Data Structure to intracellular and extracellular recordings in animal models

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ABSTRACT

The Brain Imaging Data Structure (BIDS) has facilitated data sharing and tool development in human neuroimaging. We present an extension for microelectrode electrophysiology recordings in animal models, addressing the unique requirements of intracellular and extracellular recordings. This extension introduces two new data types: 'icephys' for intracellular and 'ecephys' for extracellular recordings, supporting diverse recording modalities from patch-clamp to high-density silicon probes. Building on existing BIDS principles and prior electrophysiology extensions, we specify metadata for probes, electrodes, and channels, with particular attention to metadata required for spike sorting analysis. The extension adopts NWB (Neurodata Without Borders) and NIX (Neuroscience Information Exchange) as data formats, ensuring comprehensive metadata capture while maintaining compatibility with existing analysis ecosystems. We provide example datasets covering common use cases and demonstrate integration with established tools including [Which tools?]. This standardization enables reproducible analysis pipelines, facilitates data sharing through repositories like DANDI, G-Node and EBRAINS, and bridges scales from cellular to systems neuroscience.

Background & Summary

Microelectrode electrophysiology encompasses techniques for recording electrical activity from individual neurons to local field potentials, providing crucial insights into neural computation. Recent technological advances, including high-density silicon probes and standardized probe designs through the Neuropixels project, have dramatically increased data acquisition rates and experimental complexity.

While comprehensive data formats exist for neurophysiology (NWB; NIX), the field lacks standardized organization principles for datasets, metadata specifications, and directory structures. This fragmentation impedes data sharing, with surveys indicating [ADD SURVEY DATA] of researchers struggling to share or reuse electrophysiology data due to inconsistent formats and missing metadata.

BIDS has successfully standardized human neuroimaging data organization [cite], with over 850 datasets on OpenNeuro [cite] and adoption by major repositories. Prior BIDS extensions for human electrophysiology (EEG [cite], MEG [cite], iEEG [cite]) established patterns for organizing time-series neural data, while the Microscopy extension [cite] introduced critical metadata fields for animal data.

Microelectrode recordings present unique challenges: (1) electrode scales spanning orders of magnitude (sub-micron tips to millimeter arrays), (2) diverse probe geometries requiring specialized coordinate systems, (3) spike sorting as an essential preprocessing step requires specific metadata,

Here we present BEP032, extending BIDS to microelectrode electrophysiology, with a focus on animal models. This extension: [summarize key contributions]

Methods

Community Development Process

The development of BEP032 began in [DATE] through the INCF Working Group on Standardized Data Structures.

Figures & Tables

Figure 1. Overview of the BIDS microelectrode electrophysiology extension. (a) Directory structure showing icephys and ecephys datatypes. (b) Metadata inheritance hierarchy. (c) Relationship between probes, electrodes, and channels. (d) Integration with analysis tools and repositories.

Table 1. Required and optional files for microelectrode electrophysiology recordings

Table 2. Required metadata fields and their descriptions

Table 3. Channel types for microelectrode recordings

Table 4. Example datasets demonstrating the specification