

MOTION-BIDS: extending the Brain Imaging Data Structure specification to organize motion data for reproducible research

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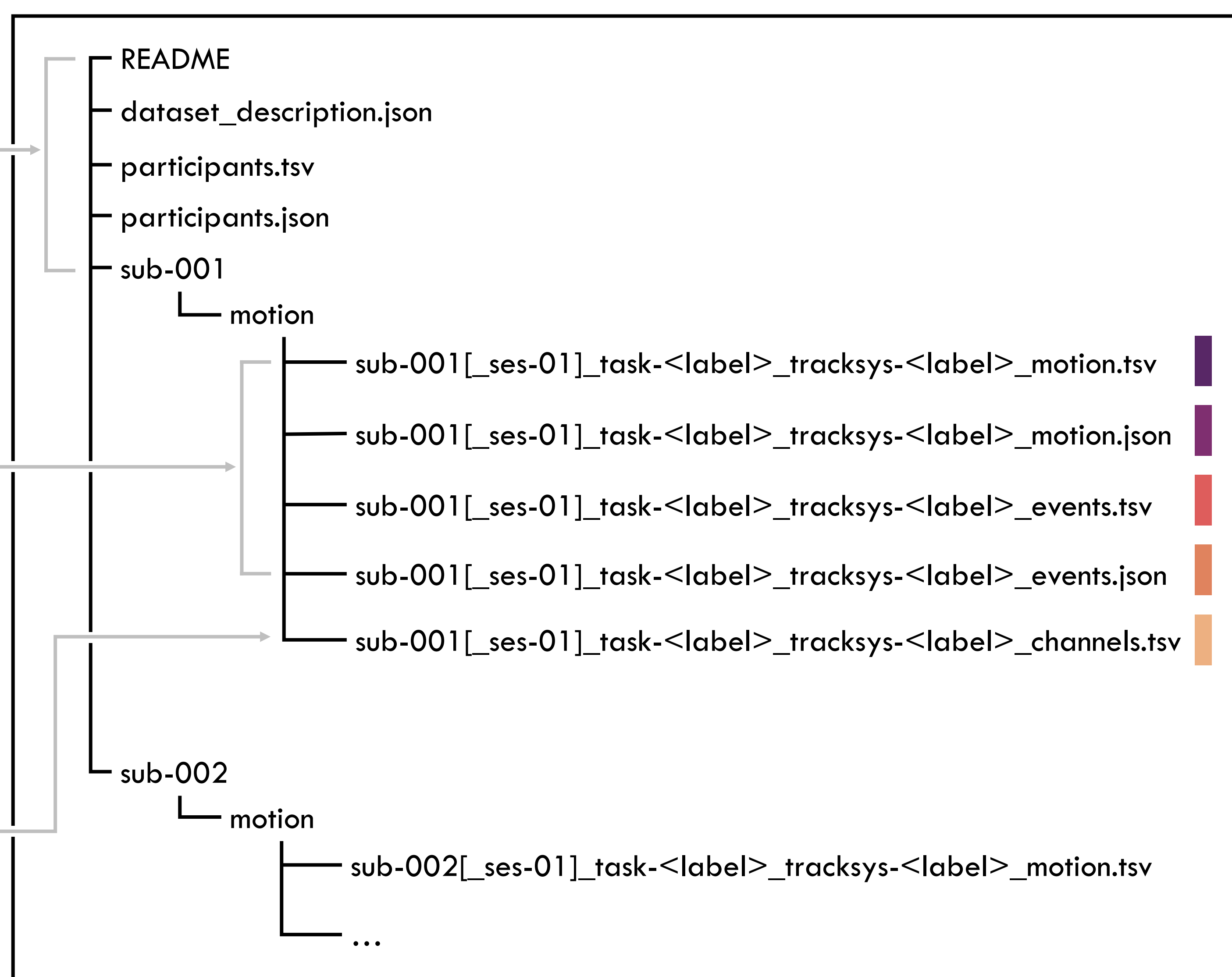
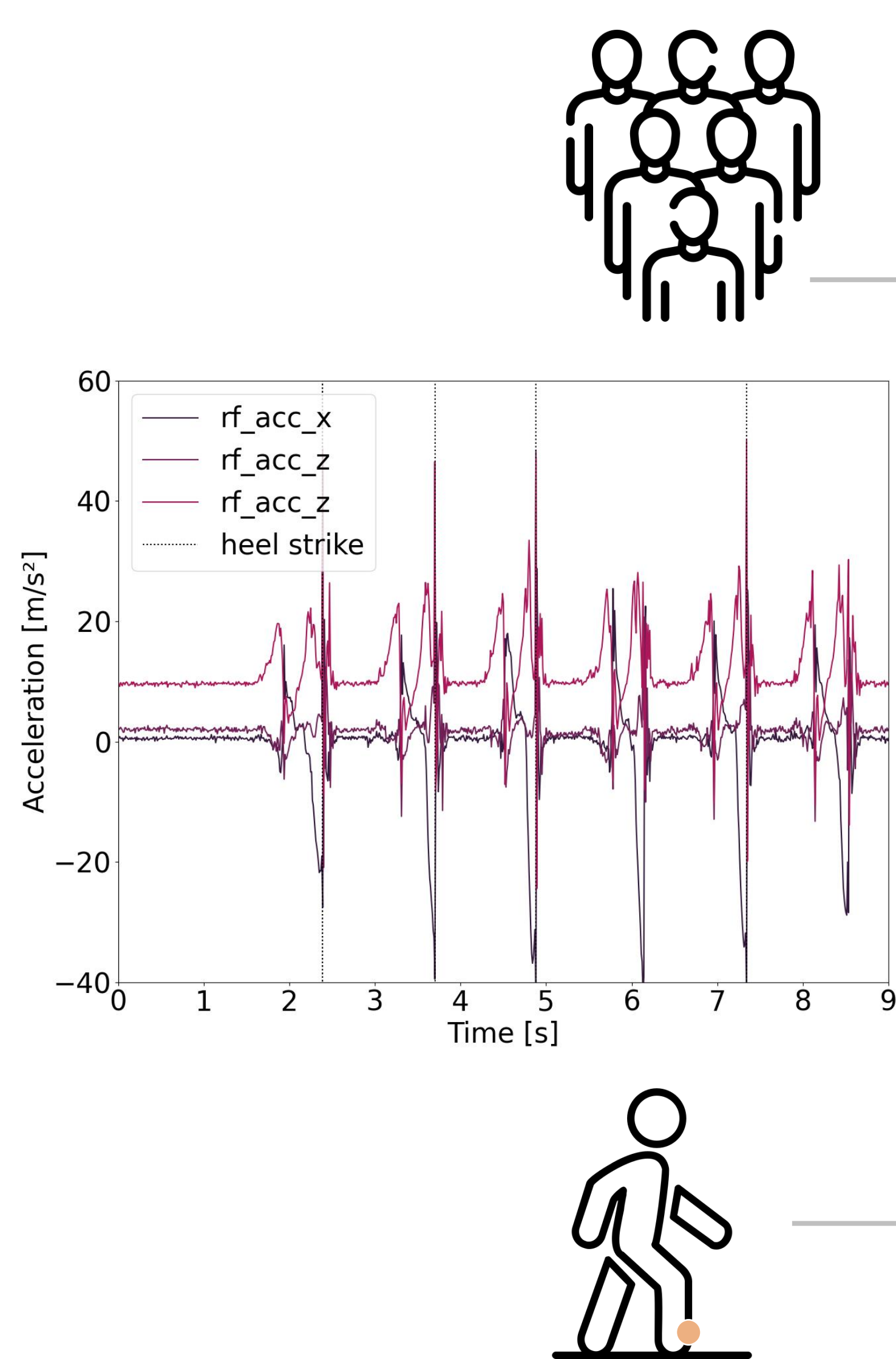
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Introduction

In behavioral research, motion data is crucial for understanding cognitive processes and health conditions like Parkinson's disease. Advancements in technology now allow for the integration of motion data with neuroimaging techniques, enhancing studies in human neuroscience and brain-body interactions.

MOTION-BIDS is intended as a standard for organizing motion (meta) data in neuro- and behavioral science, building on the **Brain Imaging Data Structure (BIDS)**. Motion-BIDS is compatible with a wide range of motion tracking systems.

MOTION-BIDS focuses on **time-series** data of **position or orientation** in physical and virtual spaces, **including derivatives** like acceleration and angular velocity.



Goal

The contribution of MOTION-BIDS to reproducible research with motion data is threefold:

- (1) It provides a flexible way to define what is construed as a single motion **tracking system**, agnostic to the type of recording system used.
- (2) Users **MUST** share metadata central to interpreting motion data.
- (3) By embedding motion data in the BIDS framework, it facilitates the management of motion data along with other data modalities in a harmonised and **time-synchronised manner**.

0,2634511	0,092295	0,0086682	0,9305117	0,690106	0,8098815
0,694520	0,1918243	0,8437273	0,3975710	0,885496	0,8952724
0,0766395	0,2587211	0,5434792	0,2822837	0,2789791	0,2326254
0,5779993	0,0456141	0,0490745	0,9408899	0,1533421	0,6683652
0,054556	0,7915927	0,5871733	0,4669577	0,9754468	0,0480541
0,966024	0,1962834	0,7114406	0,3389448	0,7194495	0,4384892
0,984172	0,5079461	0,1180168	0,7966978	0,1753768	0,4886533
0,9883907	0,1557346	0,8002013	0,6334882	0,7526906	0,8529441
...

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{
  "SamplingFrequency": 60,
  "SamplingFrequencyEffective": 60.19,
  "TaskName": "BIDS Motion fictive example",
  "TrackingSystemName": "imu1",
  "TaskDescription": "walking and talking",
  "MotionChannelCount": 6,
  "SubjectArtefactDescription": "n/a",
  "TrackedPointsCount": 2,
  "ACCELChannelCount": 3,
  "GYROChannelCount": 3,
  "Manufacturer": "BWSensing",
  "ManufacturersModelName": "BW-imu600",
}
```

onset	duration	trial_type
2.45	0.1	heel_strike
3.81	0.1	heel_strike
4.95	0.1	heel_strike
6.11	0.1	heel_strike
7.24	0.1	heel_strike

```
{
  "trial_type": {
    "LongName": "Foot Heel Strike",
    "Description": "Moment when heel touches ground after the swing phase"
  }
}
```

name	component	type	tracked_point	units	placement
imu1_rf_acc_x	x	ACCEL	rf	m/s ²	right_foot
imu1_rf_acc_y	y	ACCEL	rf	m/s ²	right_foot
imu1_rf_acc_z	z	ACCEL	rf	m/s ²	right_foot
imu1_rf_gyro_x	x	GYRO	rf	rad/s	right_foot
imu1_rf_gyro_y	y	GYRO	rf	rad/s	right_foot
imu1_rf_gyro_z	z	GYRO	rf	rad/s	right_foot

Summary

MOTION-BIDS addresses the fundamental aspects of motion data rather than providing specific solutions for each recording system. By standardizing metadata fields and a common data format, it enhances the **interoperability** of motion data sets and the **reproducibility** of research. This standardization facilitates the development of software tools that are agnostic to the type of motion tracking system used. Open-source toolboxes like EEGLAB, FieldTrip, and MNE-Python, which can be used with motion capture data, support BIDS-formatted motion data for joint analysis with electrophysiology data.

However, Motion-BIDS faces challenges, such as the difficulty in sharing precise sensor placement and detailed definitions of spatial axes. MOTION-BIDS is considering solutions for these issues and aims to be compatible with other ongoing efforts in the field. The framework does not prescribe any nomenclature for documenting sensor placement or orientation on body parts, which varies depending on the motion tracking system and the processing applied by the recording software. Reference frames used in motion data can be complex and are not explicitly defined in the current version of MOTION-BIDS.



References:

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2. Poldrack, R. A., Markiewicz, C. J., Appelhoff, S., Ashar, Y. K., Auer, T., Baillet, S., ... & Gorgolewski, K. J. (2023). The past, present, and future of the brain imaging data structure (BIDS). Arxiv.
3. Gorgolewski, K. J., Auer, T., Calhoun, V. D., Craddock, R. C., Das, S., Duff, E. P., ... & Poldrack, R. A. (2016). The brain imaging data structure, a format for organizing and describing outputs of neuroimaging experiments. Scientific data, 3(1), 1-9.

