Brain Stimulation 18 (2025) 278–279

Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: www.journals.elsevier.com/brain-stimulation

Big non-invasive brain stimulation data (Big NIBS data): An open-access platform and repository for NIBS data

Dear Editor,

Methods of non-invasive brain stimulation (NIBS) are widely used in research and clinical settings. However, unlike other fields of neuroscience, such as neuroimaging and electroencephalography [1,2], there is currently no centralised mechanism for the public sharing of NIBS data. This greatly hampers our ability to share/re-use NIBS data and uncover knowledge about the brain through 'big data' analyses. The present paper reports the launch of 'Big NIBS data' – a free and open-access platform for NIBS researchers, and a public repository for NIBS data (https://bignibsdata.com). Here, we give an overview of Big NIBS data, outline its structure and objectives, and describe how NIBS researchers can utilise the platform.

Big NIBS data was originally created as the 'Big TMS Data Collaboration' in 2020 with the publication of our two initial studies that pooled theta-burst and single/paired pulse TMS data across 35 prior studies [3,4]. Informal data collection continued with a mailing list of over 100 TMS researchers until 2023, when we initiated the Big NIBS data project in collaboration with multiple Deakin University (Australia) departments to build a public repository and data sharing pipeline. Deakin University owns the platform, hosts the data repository, and will provide ongoing support to ensure its sustainability.

The major objectives of Big NIBS data are to: 1) provide a repository for users to upload their de-identified individual participant NIBS data and code; 2) provide a repository for users to download de-identified individual data and code across different NIBS studies to perform 'big data' analyses on specific research questions; and 3) provide a centralised platform where NIBS researchers can connect, communicate, and collaborate.

Big NIBS data is comprised of three environments: the Big NIBS data website, the Big NIBS data repository, and the Big NIBS data Slack workspace (https://bignibsdata.slack.com) - a forum where users can post questions and collaborate. The website is the central access point for Big NIBS data, with links to the repository and Slack workspace, and instructions for data upload and download (Fig. 1). These instructions include the type of files to upload and how these should be formatted prior to submission. The data repository is stored within Deakin University's instance of 'Figshare For Institutions'; a repository platform published by Digital Science (UK). Data can be accessed from: https://dro.deakin.edu.au/BigNIBSdata, following the steps in Fig. 1 and instructions at: https://bignibsdata.com/how-to-get-data/. We ask that users pre-register their project (https://bignibsdata.com/pre-registered-projects/) if they would like to use the data for a scientific publication (if for teaching or exploratory purposes, there is no need to pre-register). This will help to keep a track of ongoing projects and avoid duplication of efforts. The repository submission portal enables users to upload data of up to 20GB that can then be passed through an editorial review process. Once approved, the repository generates a unique DOI for each submission, enabling individual data uploads to be identified and located.

Metadata that describe a dataset is inputted by the user at the time of submission to allow data to be findable, accessible, interoperable, and reusable (following FAIR principles) [5]. The submission form includes fields customised to NIBS data, such as the type of NIBS, outcome/dependent variable (e.g., MEP amplitude, clinical rating scales), population (e.g., healthy participants, Alzheimer's disease), document type (data and/or code), and associated data description (e.g., structural MRI, EEG), among others. While Big NIBS data is not designed to be a repository for other types of neuroscience data (such as MRI or EEG, given that these repositories already exist), it is important that these data can be made available alongside the NIBS data. Therefore, users are encouraged to upload these associated data to an existing repository (e.g., OpenNeuro), and then copy the URL from this submission into the 'associated data description' field in the metadata during their data upload in Big NIBS data. This saves double handling/uploading of these associated data and recognises that many excellent repositories have already been established for these data types. Behavioural/clinical data that can easily be included alongside NIBS data (e.g., reaction time or symptom score data in spreadsheets) can be uploaded to Big NIBS data. Most crucially for any public repository, data must be properly de-identified prior to sharing to Big NIBS data. Different countries have different requirements for de-identification, so the uploader must abide by these when submitting. Perhaps most clearly in terms of de-identification guidelines, the Health Insurance Portability and Accountability Act of 1996 (HIPAA) in the USA lists 18 personal identifiers to be removed to de-identify data, in which case it is no longer considered protected health information (unless the researcher has knowledge that the data could be re-identified) and can be shared freely (safe-harbor method). This is a complex issue that requires ongoing discussion, yet we can take guidance from other fields, such as neuroimaging, where established data sharing practices are already in place [1,2]. As with other repositories, users can request that their uploaded data be removed from Big NIBS data after submission. The full terms of use, created in collaboration with Deakin University's legal, copyright, and intellectual property departments, are available at: https://bignibsdata.com/terms-of-use/.

In addition to individual-participant NIBS data, we encourage users to upload their analytical code to Big NIBS data. Unlike MRI [6], there are no universal guidelines for the pre-processing or analysis of NIBS data. Pre-processing NIBS data involves considerations of data management from the practical, such as the simple reading in and labelling of data in statistical software, to the technical, such as creating derivative variables, reshaping data to allow alternative analyses, and dealing

https://doi.org/10.1016/j.brs.2025.02.011
Received 2 February 2025; Received in revised form 10 February 2025; Accepted 18 February 2025
Available online 20 February 2025

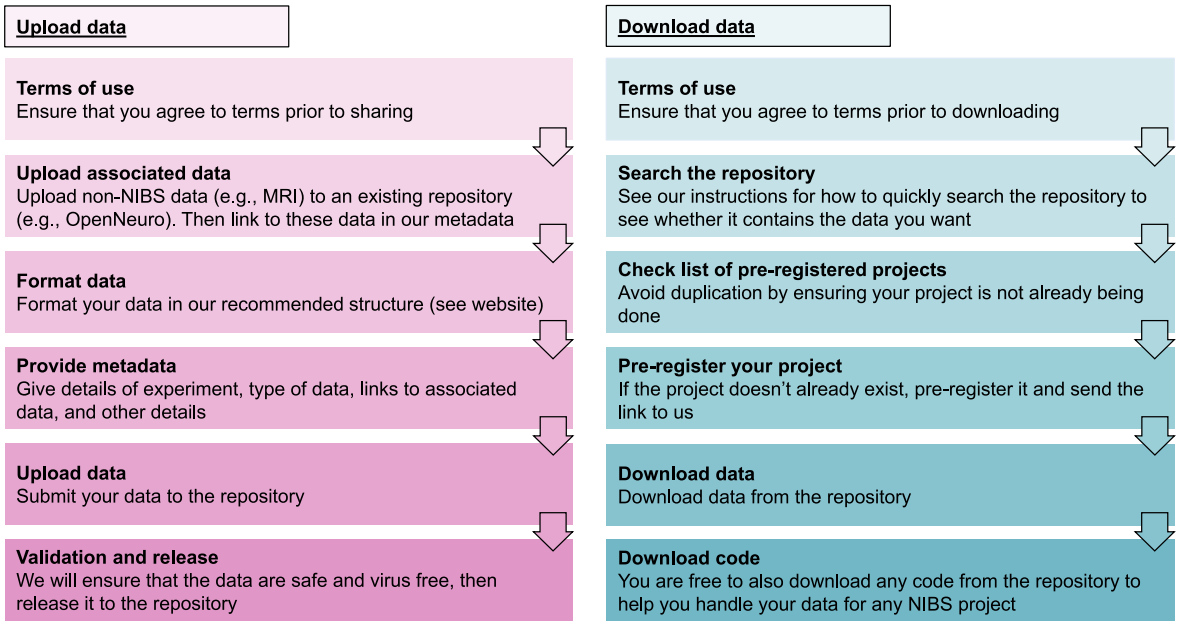

Fig. 1. Overview of the data upload and download processes on the Big NIBS data repository.

with data that violate statistical assumptions. The sharing of code allows for the crowdsourcing of these issues by demonstrating how to perform these functions and analyses. This will save time, reduce errors, and build towards more standardised NIBS practices.

With the present paper, we take a step towards open and organised data sharing practices in NIBS, which until now has been informal and confined to small-scale independent research projects [3,4]. We foresee that the first projects using Big NIBS data will combine individual participant data across prior clinical and electrophysiological studies. Proof of principle of this approach can be seen from our initial published studies [3,4] and a recent preliminary analysis across five prior clinical trials on the therapeutic effect of repetitive TMS on post-traumatic stress disorder symptoms (https://bignibsdata.com/post-traumatic-stress-disorder-preliminary-findings/). These 'large-scale' analyses can provide better insight about the clinical efficacy of NIBS protocols, explain inter-individual variability, and show which electrophysiological outputs are atypical in brain disorders, among other possibilities, many of which we will not yet have foreseen. This launch can be considered the initial version of Big NIBS data, and we hope that with community involvement and future advancements Big NIBS data will expand and evolve. Updates or changes to Big NIBS data processes in the future will be continually posted to our website.

CRediT authorship contribution statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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