 DOI: 10.3217/978-3-99161-050-2-113

Large-scale fMRI dataset for the design of motor-based Brain-Computer Interfaces

E.J. Aarnoutse[1], M.S. Bom[1], A.M.A. Brak[1], M. Raemaekers[1], N.F. Ramsey[1,2], M.J. Vansteensel[1], M.P. Branco[1]*

[1]*Department of Neurology and Neurosurgery, UMC Utrecht Brain Center, University of Utrecht, the Netherlands,* [2]*Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, The Netherlands*

*P.O. Box 85060, 3508 AB Utrecht, the Netherlands. E-mail: m.pedrosobranco@umcutrecht.nl

Introduction: Motor based Brain-Computer Interfaces (BCIs) can potentially be used to help children and young adults with severe communication impairment due e.g. Cerebral Palsy [2]. For implanted BCIs, the precise identification of electrode target areas prior to implantation is crucial for optimal performance. Functional Magnetic Resonance Imaging (fMRI), commonly used to map sensorimotor cortical organization, has been shown to predict BCI performance [1]. To date, it is unknown whether BCI targets can be determined adequately in younger age groups. Here we present the first large-scale fMRI dataset of 155 (able-bodied) children and adults performing a standardized set of motor and somatosensory tasks. Public availability of this dataset can lead to better insight into feasibility of identifying BCI targets for implanted BCIs in the younger population.

Material, Methods and Results: Data was collected from 155 participants (mean age: 35.5±21.3, range: 6-89; 11.6% (18) under age 12; 8.4% (13) aged 12-17; 49.7% (78) females, 88.5% (139) right-handed and 1.9% (3) ambidextrous). 63 participants were admitted to the hospital for diagnostic procedures related to their medication-resistant epilepsy (N = 60) or surgical removal of a tumour (N = 3). The remaining 92 participants were healthy volunteers in studies on functional mapping of movement. All participants and/or their parents gave written informed consent.

The dataset includes a total of 471 fMRI runs (repeated in various participants) involving the hand and fingers, tongue, and other limbs, such as the arms or legs. Participants performed one of six tasks: Motor2Class, Motor2ClassKids and Sensory2Class were block design tasks with two conditions: rest and active. The Motor3Class task is a block design task with one rest and two active conditions, being executed movements and imagined movements. The Mapping3Fingers task mapped the thumb, index and little finger using an event-related design. The Mapping5Fingers task likewise mapped thumb, index finger, middle, ring and little finger. Structural and functional images were acquired on either a 1.5T ACS-NT Philips scanner (20 runs), a 3T Achieva Philips scanner (434 runs) or a 7T Achieva Philips scanner (17 runs). For functional scans, a PRESTO (1.5T and 3T) or EPI (7T) pulse sequence was used. Data was converted to Brain Imaging Data Structure (BIDS). Data quality validation revealed that 30 participants had more than 10% motion outliers and 17 participants had framewise displacement larger than 4 mm. The dataset can be downloaded from the open public repository at https://openneuro.org/datasets/ds005366/ and the code used for validation is available in https://github.com/UMCU-RIBS/PANDA-fmri-dataset-validation.

Conclusion: This dataset is particularly relevant to study developmental patterns in motor representation on the cortical surface and for the design of paediatric motor-based implanted BCIs.

Acknowledgments and Disclosures: This research was supported by the Dutch Research Council (PANDA project, grant 19072), Dutch Technology Foundation UGT7685, EU ADV-320708 and USA NIH NIDCD U01DC016686. The authors declare no conflicts of interest to disclose.

References:

[1] Leinders, S., Vansteensel, M. J., Piantoni, G., Branco, M. P., Freudenburg, Z. V., Gebbink, T. A., Pels, E. G. M., Raemaekers, M. A. H., Schippers, A., Aarnoutse, E. J., & Ramsey, N. F. (2023). Using fMRI to localize target regions for implanted brain-computer interfaces in locked-in syndrome. Clinical Neurophysiology, 155, 1–15. https://doi.org/10.1016/j.clinph.2023.08.003

[2] Bergeron, D., Iorio-Morin, C., Bonizzato, M., Lajoie, G., Orr Gaucher, N., Racine, É., & Weil, A. G. (2023). Use of Invasive Brain-Computer Interfaces in Pediatric Neurosurgery: Technical and Ethical Considerations. Journal of Child Neurology, 38(3–4), 223–238. https://doi.org/10.1177/08830738231167736

 Published by Verlag der Technischen Universität Graz