



2023 Helmholtz – OCPC – Programme for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Prediction of depressive symptoms based on insomnia and brain data: A machine-learning approach

Helmholtz Centre and/or institute:

Forschungszentrum Jülich

Project leader:

Dr. Masoud Tahmasian

Contact Information of Project Supervisor: (Email, telephone)

Phone: +49 2461 85990, Email: m.tahmasian@fz-juelich.de

Web-address:

<https://www.fz-juelich.de/en/inm/inm-7>

Department: (at the Helmholtz centre or Institute)

Institute of Neuroscience and Medicine, Brain and Behaviour (INM-7)

Programme Coordinator (Email, telephone and telefax)

Name: Gabriele Weiland

Address: Forschungszentrum Jülich, Corporate Development Department, 52425 Jülich, Germany

Phone: +49 2461 61-3388

Email: g.weiland@fz-juelich.de

Description of the project (max. 1 page):

Sleep is a pivotal brain function to keep the organisms' fitness. A human being's life experiences ascertain mood impairment after night(s) of sleep disturbance. Insomnia and depression are highly interrelated, but we don't know whether and how individuals with insomnia develop depressive symptoms? and what is the neurobiological mechanism of their association? These questions have been surprisingly neglected in previous clinical and neuroimaging studies. Several pieces of evidence showed that insomnia could be a risk factor for depression. Still, most of the existing findings are based on group-level correlations, and personalized predictability of depressive symptoms severity based on insomnia and brain parameters is not well-documented yet. Thus, the main aim of this project is to understand the predictive role of insomnia and brain structure and function in developing depressive symptoms at the individual subject level using state-of-art machine learning models in large-scale samples (UK Biobank, n=35,000). Subsequently, we will perform out-of-sample validation using a few clinical samples in order to test the reproducibility of our findings in other independent samples.



To predict subject-specific depressive symptoms severity, separate categories of features, including insomnia symptoms, multi-modal brain features (gray matter volume, regional homogeneity (ReHo), and Amplitude of Low Frequency Fluctuations (ALFF) from brain parcels (400 cortical gray matter parcels from Schäfer, 32 subcortical parcels from Melbourne, and 37 cerebellar parcels from Buckner atlas) will be included as input features (separately and in combination). Of note, depressive scores will be our target to predict. To avoid any potential leakage, we will divide the participants into training and testing sets and then we will apply nested cross-validation for hyper-parameter tuning. Confound modeling will be carefully evaluated (age, gender, intracranial volume, and body-mass index). To evaluate the clinical utility/relevance of our models, we will evaluate the performance of the machine learning model trained in UKB in a multi-centric clinical dataset (ENIGMA-Sleep consortium) hence examining out-of-cohort generalizability. All phenotypical and neuroimaging data is only available in an anonymous form and does not contain any information that will allow the identification of individual subjects. For the machine learning analysis, we will use the Julearn library (<https://juaml.github.io/julearn>), local powerful computing clusters in Jülich Research Center, and DataLad which is a state-of-art open-source distributed data management system, developed mainly in our institute. This project has critical health impact towards personalized medicine and may alert the clinicians regarding the sleep intervention to decrease the burden of depression.

Description of existing or sought Chinese collaboration partner institute (max. half page):

We already have collaboration with Prof. Xu Lei from the Sleep and NeuroImaging Center, Southwest University, Chongqing (<http://www.leixulab.net/lei.asp>) and Dr. Ji Chen from Department of Psychology and Behavioral Sciences, Zhejiang University, Hangzhou, Zhejiang (<https://person.zju.edu.cn/en/jchenlab#>) through the ENIGMA-Sleep consortium. In our collaboration, we aim to implement an individual classification model based on machine learning approach to separate subjects with and without insomnia symptoms using 1400 subjects from the ENIGMA-Sleep consortium across seven international sites.

Required qualification of the postdoc:

- PhD in computer science, biomedical engineering, bioinformatics, data science, or neuroscience/psychology.
- Experience: substantial programming experience in Python and R and machine learning analysis
- Additional skills: big data analysis, good knowledge of neuroscience.
- Language requirement: fluency in writing and speaking English.