Forskerlinjen

Project description: "Brain relatedness"

Introduction:

Are kids with more similar brains also more similar in psychological traits and abilities? This project aims to answer this fundamental question by for the first time by combining a novel method from genetics with a large neuroimaging dataset.

Background:

Researchers often rely on group comparisons when assessing the effects of brain structure on psychological traits and abilities, e.g. comparing men to women, young individuals to older individuals, patients to controls, and so on. While this is advantageous in that it offers an easy to grasp interpretation of results, it is disadvantageous in that we often lose the ability to say something about the effects of variation in brain structure between *individuals*. In genetic studies, heritable factors are estimated by evaluating to what extent individuals with similar genomes have similar psychological traits. In the same way, we seek to develop a new method that quantifies the behavioral effects of *individual brain-to-brain similarities*. If successful, this approach can inform us how both brain structure and genes affect different *phenotypes*, such as mental health, personality, cognition and intelligence.

The student will work with a large-scale sample of brain scans, twin data, and trait-level data from pre-adolescents age 9-10 (the ABCD sample; n = 11.878). The transition from childhood to adolescence is characterized by large physical and psychological changes, including changes in brain structure, and we consider it possible that individual level variation might be of particular importance at this stage of life. The specific focus and design of the project, including choice of psychological traits and/or abilities of interest, will be decided together with the student.

Research questions:

What is the relationship between individual brain-to-brain similarities and similarities in psychological traits and abilities?

Objectives and method:

To evaluate to what degree measures of structural brain similarities can explain similarities in psychological measures between individuals, we will use brain imaging data already collected and processed by the ABCD consortium. The imaging data contains measures such as the thickness, area and volume of different parts of the brain, including cortical regions, subcortical structures and white matter. Our idea is to see whether similarities between individuals in these measures are also related to similarities in traits. As an example, if person A and person B have close to similar cortical thickness in many regions, do they also behave similarly in any way? We can then evaluate how much of overlap, or correlation, in psychological traits can be explained by factors related to brain structure. Moreover, if the overlap in factors for brain structure corresponds to overlap in genetic and environmental factors.

Handling large scale imaging data requires the use of a programming language such as R, Matlab or Python. If the student has no prior experience with programming languages, they should be motivated to learn this and expect that some time will be needed to

familiarize themselves with programming. This is a highly sought-after skill in science and will prove an invaluable resource when writing a thesis or starting a research career.

Student assignments:

The learning goals and assignments for the student will include:

- Handle and prepare large-scale existing data for statistical analysis
- Use novel methodology from genetics on structural MRI data
- Present findings at research group meetings and/or a research conference
- Write and submit an empirical article

All tasks will be performed with guidance from the supervisors.

The project is suitable for students interested in genetics, neuroscience and quantitative methods. All needed data is already available and ready, making the project highly feasible within 1 year.

About the research environment:

The student will be part of research groups both in the **PROMENTA Research Center** and the **NORMENT Center of Excellence**. The project will be led and supervised by postdoc **Espen M. Eilertsen**. Eilertsen is part of the Neighborhood Genetics group at the PROMENTA Research Center. He has a background both in cognitive neuroscience (MA) and behavioral genetics (PhD), and has developed the method to be used in the proposed project, and is thus an optimal supervisor for the proposed project. The co-supervisors for the project will be PhD student **Andreas Dahl** in the BRAINMINT and Multimodal Imaging group in NORMENT; Professor **Eivind Ystrøm**, group leader of the Neighborhood Genetics group at the PROMENTA Research Center; and Professor **Christian K. Tamnes**, group leader of the Neurocognitive Development group at the PROMENTA Research Center and part of the Multimodal Imaging group in NORMENT. Dahl has detailed knowledge about the dataset to be used and imaging methods, Ystrøm has experience in developmental behavioural genetics, while Tamnes has expertise in developmental cognitive neuroscience and neuroimaging

Other collaborators will also be involved, including Professor **Lars T. Westlye**, group leader of the Multimodal Imaging group at NORMENT, and **Dag Alnæs**, researcher at the Multimodal Imaging group at NORMENT.

The student will participate in weekly meetings in both the PROMENTA Research Center and in NORMENT. The student will as such have ample learning opportunities.

Supervision:

- Main supervisor: Postdoc Espen M. Eilertsen
- Co-supervisors: PhD student Andreas Dahl, Professor Eivind Ystrøm, and Professor Christian K. Tamnes

The student will receive weekly scheduled individual supervision, guiding the student through the different phases of the research project, from design, methods, statistical analyses, write-up and publication.

Ethical approvals and data:

To answer the above described research questions, we will use data from an unprecedented large and rich dataset developmental neuroimaging dataset, the Adolescent

Brain Cognitive Development (ABCD) Study (https://abcdstudy.org/). The ABCD Study is an ongoing single cohort study of 11,878 youths recruited at age 9-10 years at 21 sites, planned as a 10-year longitudinal study. The baseline data and the first longitudinal neuroimaging wave are completed. The study embraces an open science model and is designed to freely and continuously share the entire expanding dataset with the research community. We have already downloaded the needed data on TSD, so all data will be available for the student from the start of the scholarship period. The project is approved by the Regional Committee for Medical and Health Research Ethics (REK). All data is de-identified and stored and processed on TSD.

Method selection in the ABCD Study has been performed by expert workgroups in different domains. The project protocol includes very comprehensive biannual assessments of demographic factors, physical and mental health (including current and past medications), substance use, neurocognition, structural and functional brain imaging, genomics/epigenetics, pubertal hormones and other biomarkers, and cultural and social variables. In addition, there are more focused annual assessments. Below, we briefly present the structural brain imaging. The full ABCD protocol is available online (https://abcdstudy.org/scientists-protocol.html).

The methods and procedures in the neuroimaging component of the ABCD Study were selected, optimized and harmonized across 21 data collection sites to measure aspects of brain structure and function using different MRI techniques. Specifically, acquisition methods were harmonized to be compatible across three 3 Tesla scanner platforms: Siemens Prisma, General Electric 750 and Phillips. The protocol includes 3D T1- and T2 weighted images, and diffusion weighted images (DWI) for measurement of brain structure; and resting state (rs-fMRI) and task-based fMRI (task-fMRI) for measurement of brain function. For the proposed project, we will focus on the 3D T1-weighted magnetization-prepared rapid acquisition gradient echo scan, which is obtained for cortical and subcortical segmentation of the brain. The data has already been quality controlled and processed using FreeSurfer, and measures of brain structure are thus already available for the student from project start.

Tentative article:
"Individual brain-to-brain similarities explain similarities in levels of internalizing and externalizing symptoms in children"
or
"Individual brain-to-brain similarities explain similarities in cognitive abilities in children"

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