Goal9 Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050.

Integration of Asian humanities and brain informatics to enhance peace and compassion of the mind

#### R&D item

## 1. Data-driven modeling

### Progress until FY2023

#### 1. Outline of the project

To construct a model for categorizing personality types driven by data, we began building the "High-Low Mixed Database" (Figure 1). Specifically, for the "low" part, we formulated survey items and daily behavior measurements using smartphones and conducted the first large-scale survey. For the "high" part, we conducted brain imaging data measurement experiments.

#### 2. Outcome so far

#### Item 1: Data-driven modeling

(1) Formulation of the Basic Design of the "High-Low Mixed Database"

Based on the successful identification of subtypes of healthy individuals across various psychiatry symptom axes, we formulated nine types of clinical evaluation scales for large-scale surveys using the internet and smartphones. In collaboration with item 2 and the Social Implementation R&D item, we decided on questionnaires related to serenity and vitality. After a preliminary survey, we finalized the specifications and conducted the first large-scale survey and behavior measurement experiments following ethical approval.



Figure 1: High-low mix database

(2) Construction of a Data-Driven Model for Categorizing Personality Types Related to Serenity and Vitality

For the "high" data, we formulated MRI imaging protocols in collaboration with item 3 and collected structural images (T1-weighted, T2-weighted, diffusion-weighted images), functional images (resting-state), and fieldmap images for correction from 26 individuals. Additionally, we conducted behavior tasks to measure cognitive function and individual traits in decision-making, which are considered intermediate data between "low" and "high" data. The acquired MRI data was stored in the constructed database system (XNAT).

# Item 2: Large-scale survey using the Internet and smartphones

In collaboration with item 1 and 3 as well as Social Implementation R&D item, we formulated and conducted preliminary surveys of online questionnaires and behavior measurement experiments with 2,068 participants. From the questionnaire respondents, 130 individuals were selected for behavior measurement experiments. Following the preliminary survey, we finalized the specifications and conducted the first large-scale survey with 7,044 participants and behavior measurement and experience sampling experiments with 301 participants.



Figure 2: Behavior Measurement and Experience Sampling Using Smartphones

#### Item 3: Optimization of data-driven analysis

We built a docker pipeline for unified preprocessing of the data stored in the constructed database system. Using this analysis code, we analyzed both open and newly acquired data, confirming the removal of the influence of head motion artifacts. We used the hierarchical supervised/unsupervised learning developed as a candidate algorithm for subtype classification from brain images. The results of subtype classification using functional connectivity, which is helpful in distinguishing major depressive disorder, identified significant differences in individual characteristics (life satisfaction) and cognitive functions (attention) related to serenity and vitality between subtypes. These subtype differences were not due to head motion artifacts or the specific number of optimal functional connections.



Figure 3: Relationship Between the Number of Functional Connections and Subtype Differences in Characteristics Related to Depression

#### 3. Future plans

We will conduct the second large-scale survey to complete the "High-Low Mixed Database" by storing questionnaire, behavior measurement data, brain images, and cognitive tasks. We aim to find stable individual trait types within the constructed database.



