R&D item

2． Neurofeedback

Progress until FY2023

1. Outline of the project

In this project, we are developing technology aimed at creating a new society where machines coexist with humans. To achieve this goal, we have developed visualization devices capable of sufficiently capturing the transition of mental states. Furthermore, by utilizing this neurofeedback system, we aim participants to acquire a balance of dynamism and stability in brain networks, unaffected by external influences.

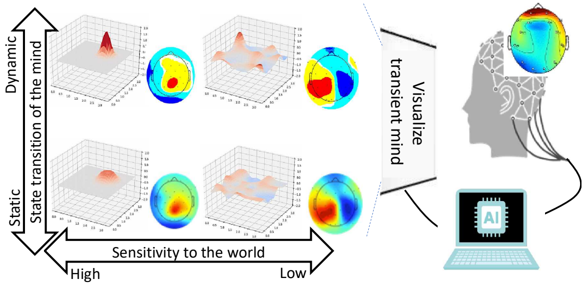

Figure 1: Schematic diagram of this R&D proposal

2. Outcome so far

“Visualization of brain state transitions”

By extracting common EEG states, referred to as templates, in advance, the transition of brain states is grossly visualized as transitions between these templates. We enhanced the spatiotemporal expression from conventional four templates (polarity-ignored ABCD) to ten polarized states (ABCDE±) reflecting transitions between topographical polarities (Figure 2, left). This model enabled the differentiation between young and elderly individuals (Figure 2, right, blue: young-dominant, red: elderly-dominant).

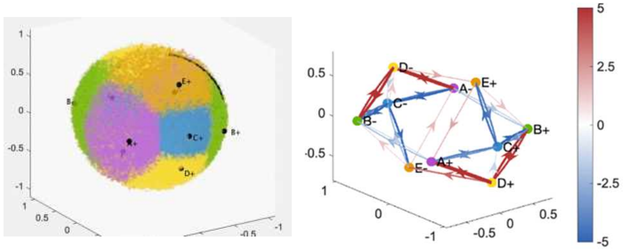

Figure 2: ten polarized states (ABCDE±) (left)
and the difference between young and elderly (right)

“Feedback Technology Development”

By defining brain states in advance, such as EEG microstates, it becomes possible to pursue real-time feedback learning. To capture the instantaneous transitions between the ten polarized states, we achieved high temporal resolution in the neurofeedback system. Furthermore, participants have commenced training for the validation of the neurofeedback system's effectiveness.

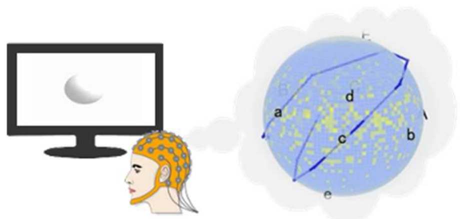

Figure 3: the system detects instantaneous transitions

“Machine Learning of Brain State Transitions”

We examined the performance of a Wilson-cowan-based generative model that simulates brain activities and of a data-driven model based on a pairwise-maximum-entropy model (pMEM). A source localization method was used for facilitating the communication between the models and also for extracting attractors that have neuroscientific relevance.

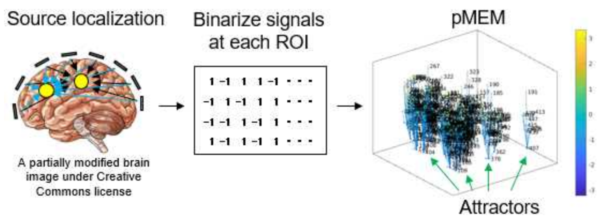

Figure 4: pMEM using source localization as its input

3. Future plans

We have implemented "detection of transitions between polarized 10 states" and defined specific transitions to be targeted for reinforcement in training. Consequently, there has been a significant improvement in the expression of dynamics compared to existing systems. Additionally, we are concurrently investigating the quantification of transitions between attractors using machine learning, with the intention of integrating this knowledge into future neurofeedback training. By combining these insights, we aim to implement neurofeedback that promotes peace of mind and ultimately strive for outcomes that can be beneficial to society as a whole.