Goal9 Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050. Development of "*Jizai Hon-yaku-ki* (At-will Translator)" connecting various minds based on brain and body functions



R&D item

1. Interpreting mental states through brain and autonomic nerves

Progress until FY2023

1. Outline of the project

In our R&D Item 1, we develop **technologies to interpret our mental states through brain and autonomic nervous activities**. That will broaden our ways of non-verbal communication.

The primary task of our R&D Item 1 is to instantiate **sensing technologies worthy of use in everyday communication**. For instance, fMRI offers rich information yet is costly and time-consuming; polygraphs are handy yet are far from precise in decoding one's mental state. Interpretation of one's mental state through electroencephalography (EEG) has yet to be established.

Here, our R&D Item 1 aims to develop precise and





Rich, but expensive Handy, but inaccurate **multi-dimensional mind sensing based on brain and au tonomic nervous activities** combined with behavioral data. Our goal is to offer a reliable mind-interpretation method

2. Outcome so far

suitable for everyday use.

1. Etablished a method for simultaneously recording both depth and surface EEG signals in monkeys

- 2. Clarified the importance of the interaction between the vagus nerve and brain activity in maintaining mental states
- 3. Constructed a machine learning model to distinguish aversive states
- 4. Discovered novel EEG characteristics associated with autism tendencies



Outcome 1 — illustrative summary Image provided by Prof. Ken-Ichiro Tsutsui (Tohoku U)

Outcome 1: We established a method for simultaneously recording brain activity from deep and surface areas in monkeys. Utilizing this approach, we are identifying the brain regions where mental states manifest in activity and advancing the establishment of basic principles for reading mental states from brain activity.

Outcome 2: We found that the vagus nerve, which transmits information from the organs to the brain, interacts with brain activity to shape normal emotions. This is a significant discovery for understanding mental states such as stress and anxiety.



Outcome 2 — illustrative summary Source: https://www.tohoku.ac.jp/japanese/2024/01/press20240110-02-stress.html

Outcome 3: We constructed a machine learning model to differentiate between the states of mice (normal or aversive) based on brain activity recorded from both deep and surface regions of the brain.

Outcome 4: We discovered novel frequency characteristics of EEG, derived from the analysis of EEG data obtained from humans during rest, which serve as new indicators related to autism tendencies.

So far, we are conducting researches to unravel the relationship between neuronal activities and one's mental state by combining animal and human experiments.

3. Future plans

Based on these animal/human researches, our R&D Item 1 will further develop sensing technologies to interpret human mental states reliably. We also plan to combine these findings with our R&D Item 2 (exosomes) to offer a multidimensional interpretation of one's mental state. (Tohoku U: K.I. Tsutsui, T. Sasaki & NIPS: K. Kitajo)

