

1. Development and Measurement of “Maemuki (Forward-looking)” indices

Progress until FY2023

1. Outline of the project

In this R&D item, which aimed to create and measure a forward-looking index, we used a variety of survey platforms to create and measure a MAEMUKI (forward-looking) index. We conducted a large-scale online survey using the draft of the prospective subjective scale, conducted item reduction and factor extraction for the prospective subjective scale, and revised the items for the prospective subjective scale. In a real-world measurement of top athletes, we conducted a prospective scale and multidimensional body measurements for different competitive athletes. In addition, the flow experience items of the prospective scale were adapted into a questionnaire scale that takes cultural differences into account, and an English version was completed. We also developed a model for estimating prospective using laboratory and open data.

2. Outcome so far

● Mechanisms of Embodied MAEMUKI

We conducted a large-scale survey (cross-sectional and longitudinal) using the “Prospective Scale” created in the previous year. In addition, we created several cognitive tasks to evaluate the cognitive function of prospective, and found that some of them were related to mood and memory, which led to the submission of a paper and presentation at an academic conference. We succeeded in creating a machine learning model capable of estimating the amount of illusion and metacognition from individual data on positive illusions (illusion of superiority), the main component of prospective (Matsuyoshi,

Isato, Yamada. 2024). Furthermore, we examined the causal relationship between positive illusions (optimism bias) and mood based on longitudinal large-scale survey data, and found that optimism bias influences mood (Isato et al., 2023).

● Real-world sensing and sports performance evaluation

We conducted a survey and interviews with a large number of athletes using a draft of a prospective scale. In addition, we prepared a measurement system, prepared the environment, and collected data for measurement in athletes’ daily lives and in actual competition situations, in cooperation with athletes and organizations in the sports to be measured. We succeeded in capturing changes in cognitive state from analysis of the blink of an eye of a driver while driving a formula car (Nishizono, Saijo, Kashino, 2023). In addition, EEG analysis during e-sports matches revealed that brain activity directly related to winning and losing appeared just before the match (Minami et al., 2023).

● Circulation and generalization of MAEMUKI through flow experiences

For the creation of flow experience items and examination of cultural differences in the prospective scale, we interviewed students at the California Institute of Technology, examined the validity of the items in Western culture, and selected items that we thought were necessary for the prospective scale. We also integrated the items with the flow scale and completed a provisional English version of the Flow-MAEMUKI Integrated Scale.

For the prospective circulation and generalization experiments, we conducted a preliminary study by creating cognitive and behavioral tasks that produced flow experiences in various situations. We selected multiple flow experience tasks that generate solo/team flow, such as e-games that use

the whole body in addition to tabletop and on-screen games, and e-games developed in collaboration with a company, and conducted multi-module biometric measurements, including EEG, 3D capture, pupil and gaze measurements, and heart rate and respiration measurements.

3. Future plans

Based on the results of FY2023, a tentative version of the “MAEMUKI Scale” will be created as a well-going indicator in FY2024 and beyond, and data will be collected through ongoing multidimensional measurement experiments of the mind, brain, and body. Based on the results of these surveys and experiments, we plan to create a prototype of “Body2Positive,” which estimates subjective “MAEMUKI” from physical information, and link it to technology that can read individual “MAEMUKI” and assist and train people.

R&D item

2. Assistance and training for “Maemuki (Forward-looking mind)”

Progress until FY2023

1. Outline of the project

In this R&D item, we will develop training techniques that enable sustained improvement of the “Maemuki” component and techniques to assist in improving the “Maemuki” component (Fig. 1). We will also accumulate research findings on pharmacological and chemogenetic neurotransmitter manipulation in monkeys, and aim to establish “Maemuki” assist and training techniques that can be used in a manner that is tailored to the individual and situation.

2. Outcome so far

In FY2023, in addition to the construction of a technological foundation for “Maemuki” assistance and training, we accumulated necessary knowledge for establishing physical intervention methods for “Maemuki” mental manipulation and made preparations for applying the research findings on monkeys to humans. In addition, the research on molecular manipulation in monkeys provided us with essential research results for the full-scale launch of molecular manipulation research on “Maemuki” in the future.

● Physical intervention target in gait for “Maemuki” Assist/Training

In order to establish an effective intervention method for the body, it is essential to understand the “Maemuki” relationship between the body and the mind. We continuously recorded gait in daily life for 3 months to examine the characteristics of gait

that are related to mental positivity. We found that several gait characteristics, including walking speed, were related to the “Maemuki” factor. We found an intervention candidate for improving “Maemuki” mind in a gait recording (Results of Dr. Takahiro Hirao’s research group [QST]).

It is known that depressed patients show characteristic gait such as increased depressed posture, decreased vertical head movement, and decreased stride length, compared to non-depressed healthy participants. These gait characteristics may reflect positive and/or negative mental states, but it is unclear which gait is more closely related to mental states, because gait-related movements are chain-like. Dr. Natsuki Sado’s research group (Tsukuba university) first focused on the depressed posture and examined the effects of intentional depressed posture on other gait traits. They found that an increase in depressed posture may lead to a decrease in gait. In this study, they also developed a method to evaluate the degree of depressed posture in detail by quantifying the degree of kyphosis of the thoracic spine.

● Development of molecular manipulation techniques for monkeys

The research group of Dr. Takashi Minamimoto (QST) has constructed a monkey cognitive task that incorporates elements of a cognitive task for humans created by Dr. Makiko Yamada (QST). Furthermore, they developed a paradigm for measuring and evaluating positive bias. With this development, we expect to apply the findings from their research with monkeys to humans.

Dr. Kenichi Inoue’s group (Kyoto University) developed a monkey posture measurement system. By developing an

artificial intelligence algorithm that estimates the 3D positions of feature points on a monkey’s body from multi-camera videos using a constrained triangulation method, they have succeeded in estimating with high accuracy and quantitatively evaluating the posture of monkeys during free behavior in their cages.

Dr. Takashi Minamimoto and Dr. Kenichi Inoue have also developed a technique for manipulating neural activity in monkeys by implanting artificial receptors in the brain (Designer Receptor Exclusively Activated by Designer Drugs: DREADD). They have developed a vector for DREADD receptor that enables long-term and stable chemical genetic manipulation in primates and reported it in a paper (Kimura et al., Nature Communications, 2023).

3. Future plans

We are currently developing a “Maemuki” biofeedback training system for human participants. The system enables “Maemuki” mind training by comprehensively measuring biological signals during walking (gait, EEG, heart rate, respiration, and eye movement) and providing feedback on the degree of “Maemuki” of each individual based on his or her physical body. In the next year, we will first focus on the development of the EEG biofeedback system. We aim to complete the system by incorporating the results of this R&D, including the results of gait-related research.

In our research on monkeys, we plan to accumulate research findings, including findings that can be applied to humans, by verifying the relationship between “Maemuki” mind and physical posture using the cognitive tasks and movement measurement system which has developed.

3. Maemuki (Forward-looking) ELSI and social applications

Progress until FY2023

1. Outline of the project

This R&D item is responsible for the ELSI (Ethical, Legal, and Social Issues) and social application of “Maemuki (forward-looking)”. By accomplishing this R&D item, we will evaluate Maemuki in various social situations and clarify the elements and degree of Maemuki leading to desirable mental states in populations with various attributes and situations (different life stages such as children, adults, and the elderly; different mental states such as palliative care patients and mania and depression). This will contribute to the project’s goal of developing positive estimation and assistive technologies.

The challenge in achieving this goal is that the definition of “Maemuki” is different depending on life stage and health status, and at the same time, it is difficult to conduct an objective evaluation method of Maemuki based on the same criteria because of differences in physical functions and body size. We are also working on the development of Maemuki evaluation and intervention methods that take ELSI into account, with the idea of assisting and training Maemuki in accordance with the individual’s situation and needs.



Fig.1 Evaluation of developmental stage, aging stage, and patient’s Maemuki based on posture.

2. Outcome so far

●Consideration of the significance and ethics of Maemuki

The research group of Dr. Shigeru Taguchi (Hokkaido University) has delved deeper into the theoretical refinement of the “Maemuki” concept. Through reviewing, analyzing, and discussing various literature, they have further explored the significance of the “middle voice” concerning the “Maemuki” concept. This has allowed them to clarify the structure of an attitude that accepts things as they are and a positive attitude mediated by negative elements. The analysis of ELSI revealed a relatively high acceptance of “Maemuki assist technologies.” However, it also showed that there are many negative reactions towards the use of these technologies without the individual’s knowledge.

●The Relationship between Life Stages, Health Status, and Maemuki

The research group of Dr. Maiko Fujimori (National Cancer Center) conducted a study on creating a Maemuki scale for elderly and palliative care patients. The questionnaire survey results indicated no specific biases compared to the general adult population. However, it was suggested that elderly cancer patients scored significantly lower in aspects related to self-growth compared to younger cancer patients. Using natural language processing methods, content analysis identified gratitude related to interpersonal relationships and fulfilling obligations as contributing factors to Maemuki attitudes in cancer patients and the elderly. Additionally, a longitudinal study on palliative care patients suggested that patients who perceive their cancer as potentially curable have a higher one-year survival rate compared to those who perceive it as incurable. In terms of physical measurements related to Maemuki attitudes in the elderly and palliative care patients, data from gait analysis suggested that elderly cancer patients might be physically more fragile compared to younger cancer

patients and healthy elderly individuals. Moreover, an examination of the relationship between body posture and emotions indicated that the physical function scores were lower under physical posture restrictions, and negative moods were higher compared to the normal state.

The research group of Dr. Tetsuya Matsuda (Tamagawa University) conducted an online lifestyle habits survey, Maemuki survey, and physical fitness tests with 1,365 university students. Data-driven analysis was used to examine the relationships between the indicators, revealing a strong connection between a Maemuki attitude, physical fitness, and exercise habits. These results suggest that having a Maemuki attitude is associated with maintaining exercise habits and high physical fitness. Additionally, the group analyzes the relationship between walking patterns, Maemuki attitudes, and lifestyle habits by capturing walking movements on video. They are also developing an AI-based method for automatic motion capture from walking videos.

The research group of Dr. Hidehiko Takahashi (Tokyo Medical and Dental University) is collaborating with other PIs to investigate Maemuki attitudes in mental and neurological disorders. They are exploring methods for evaluating Maemuki attitudes and physical measurements. The study plans to enter a full-scale survey phase starting from the fourth year.

3. Future plans

In the future, data will be enriched for palliative care patients, patients with mental disorders, and individuals in developmental stages. As these data are obtained, patient-specific, life-stage-specific, and developmental age-specific characteristics will be identified, and “Maemuki” evaluation methods for each will be developed. In parallel, the ELSI for “Maemuki” assistive training based on the needs of society will also be studied.