Goal9 Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050. Maximizing well-being and agency on the basis of interpersonal comparison of brain indicators

#### R&D item

# 4. Comprehensive understanding of utility representation in primate brain for interindividual comparison

## Progress until FY2023

## 1. Outline of the project

We have obtained evidence to understand how pleasure and aspiration evolved and drove us to achieve goals in the brain. Particularly, both monkeys and humans feel similarly during the gamble; after lucky win they feel more likely to win. Our findings were reported at the high-ranked scientific journal (Project 4-1). We developed behavioral tasks to examine the subjective value of reward and desire, as well as the neural representation of hierarchical cognition in monkeys, and began recording neural activity. We also conducted fMRI experiments in humans to examine interactions between hierarchical cognition and social preferences and found that prosocials and proselfs use their brains differently. (Project 4-2).

#### 2. Outcome so far

(1) Research and development in identifying neural representations of utility

We estimated the parameters that individual neurons in brain regions involved in reward processing have when representing expected subjective value and selected the best model. The results were published in an international journal (Imaizumi Y, et al. and Yamada H. Nat Commun. 2022, 13(1): 5855).

(2) Research and development aimed for monkeyhuman interspecies comparison of utility estimated from behavior

By conducting similar behavior measurement experiments in monkeys and humans, we directly

compared the gambling behavior of them and showed that their value judgments very similar. are (Dvnamic prospect theory: Two core decision theories coexist in the gambling behavior of monkeys and humans. Tymula A



et al, and Yamada H. Sci Adv. 2023, 9(20): eade7972.) (Project 4-1).

(3) Research and development to elucidate neural indices of subjective value of reward

To investigate the neural basis of the subjective value of reward, we developed and improved a free and forced choice task of multiple types of juices, trained two monkeys, and started recording neural activity.

(4) Research and development to elucidate neural indices of hierarchical representation of aspiration

We have also developed and improved a category inference task to investigate the neural basis of hierarchical

Free & forced reward choice task and neural recording cognition and are now Fixation Condition 1st rew training two monkeys. In addition. to examine the interaction between



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hierarchical cognition and social preferences, we

developed a donation task and conducted fMRI experiments. We found that the prosocials and proselfs showed contrasting behavioral tendencies and neural representations. This study received an excellent poster award (23rd Winter Workshop of "Brain and Mind Mechanisms"). (Project 4-2)

Here begins our new MIRAI

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### 3. Future plans

We established the biologically plausible model for the inter-individual comparisons by developing an identification technic for collective activity analysis of multiple brain regions involved in the neural representation of utility. Now, we aim to measure blood ghrelin concentration, which is an indicator of hunger, in order to establish an objective evaluation method for craving. Then, we will identify the biological principles that yield human pleasure and aspiration (project 4-1).

To reveal the brain mechanisms that represent the subjective value of rewards, we will conduct multicellular recordings simultaneously from multiple cortical and subcortical areas while the monkeys perform free and forced reward choice tasks. We will further explore the hierarchical dynamics in the brain using the devaluation method and pathway-selective chemogenetic manipulation. This study intended to mediate the translation of findings from interindividual comparisons of neural representations of reward value in rodents to human understanding. (Project 4-2)

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