R&D Theme

Comprehensive understanding of utility representation in primate brain for interindividual comparison

Progress until FY2022

1. Outline of the project

We found that subjective value is distributed and encoded by neurons in various areas of the reward system and published this finding in a leading international journal, providing an important scientific basis for this project. In addition, we examined information representation of the intensity of desire in neuronal activity and confirmed a significant increase in osmotic pressure after feeding (Project 4-1). In addition, we constructed experimental setups to examine the neural representations of subjective reward value and hierarchical cognition and began training monkeys in each behavioral task. We also conducted human behavioral and fMRI experiments to examine the relationship between hierarchical cognition and prosociality and published an international paper. (Project 4-2).

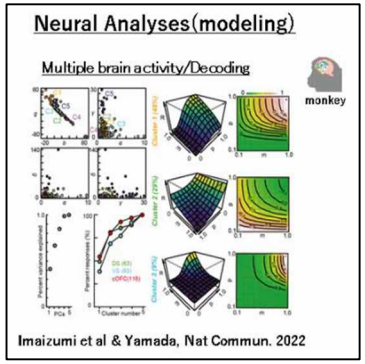
2. Outcome so far

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

We estimated the parameters that individual neurons in brain regions involved in reward processing (medial and central orbitofrontal areas, ventral striatum, dorsal striatum) 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) (Project 4-1).

(2) Research and development aimed at establishing an objective evaluation method for thirst

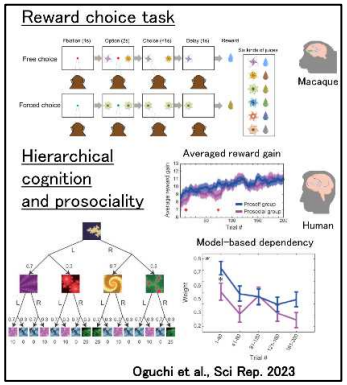
We collected blood samples from four water-restricted monkeys before and after feeding, with no water absorption during feeding, and measured osmolality and observed a significant increase in it. (Project 4-1).



(1) Development and training of behavioral tasks to elucidate the neural basis of the subjective value of reward

New experimental setups were constructed for simultaneous recording from multiple cortical and subcortical regions using multi-contact electrodes. We developed a procedure to approach the hippocampus and recorded neural activity there. We next constructed a reward choice task and a category inference task to investigate the neural basis of the subjective value of rewards and hierarchical cognition, respectively, and began training three monkeys in total.

In addition, we conducted human behavioral and fMRI experiments on the relationship between hierarchical cognition and social decision-making and published a part of the results (Proselfs depend more on model-based than model-free learning in a non-social probabilistic state-transition task. Oguchi M, et al. Sci Rep. 2023, 13(1), 1419). In the fMRI experiment, we constructed a new donation task and took fMRI data from undergraduate students. (Project 4-2)



3. Future plans

We aim to establish the biological plausibility of the inter-individual comparisons by establishing an identification technology for collective activity analysis of multiple brain regions involved in the neural representation of utility, and to establish a behavioral data analysis that enables subjective comparison between humans and monkeys. In addition, we aim to measure blood ghrelin concentration, which is an indicator of hunger, in order to establish an objective evaluation method for craving. After these, we will identify the biological principles that create human joy and aspirations (project 4-1).

To reveal the brain mechanisms that represent the subjective value of rewards using macaque monkeys, we will conduct multi-cellular recordings simultaneously from multiple cortical and subcortical areas while the monkeys performing a reward task that mixes free and forced choices. We will further explore the hierarchical dynamics in the brain that represent subjective values using the devaluation method and pathway-selective chemogenetic manipulation. This study intended to mediate the translation of findings from inter-individual comparisons of neural representations of reward value in rodents to human understanding. (Project 4-2)

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