

Goal 9 R&D Project

Newsletter

02

Maximizing well-being and agency on the basis of interpersonal comparison of brain indicators



Report on “International Symposium for Well-being and Agency - Integration of Brain Science and Social Science -”

On September 29 and 30, 2023, we held the "International Symposium 'Well-being and Agency' - Integration of Brain Science and Social Science -" at the International Science Innovation Building in Kyoto University.

The event, with all lectures and discussions in English, was a great success with 55 attendees in person and 70 participants online.

This symposium was organized by the Moonshot 9 project "Maximizing well-being and agency on the basis of interpersonal comparison of brain indicators" (hereinafter referred to as "Well-being and Agency MS Project").

The "Well-being and Agency MS Project" was launched on May 31, 2022, with the goal of "maximizing people's well-

CONTENTS

01 Report on “International Symposium for Well-being and Agency -Integration of Brain Science and Social Science -”

04 Neuroeconomics symposium
05 Papers
06 Papers
07 Papers / Award



being and agency by creating brain indicators that enable interpersonal comparisons of pleasure and aspiration by 2050.” These brain indicators will make it possible to evaluate and compare various policies on a scientific basis in terms of the "well-being" and "agency" of the people. In order to achieve this goal, the "Well-being and Agency MS Project" will (1) identify “well-being” and “agency” from various objective data (including potential factors) in the real world, and (2) aggregate their psychological aspects that would be accurately decoded from the brain activities of people acting in the virtual reality world in a scientifically valid manner, and (3) clarify the dynamic computational processes in the brain through simultaneous large-scale measurements of multiple neuronal activities. The "integration of brain science and social science" will be realized in this way. In order to publicize this challenging project and to share its starting point with many people who are interested in improving human "well-being" and "agency" all over the world, we held the "International Symposium for Well-being and Agency - Integration of Brain Science and Social Science -".



The symposiasts were all nine Principal Investigators of the “Well-being and Agency MS Project” (Reiko Gotoh (Teikyo Univ.), Hiroki Takikawa (Univ. of Tokyo), Tetsunari Inamura (Tamagawa Univ.), Kaosu Matsumori (Tamagawa Univ.), Madoka Matsumoto (NCNP (Kyoto Univ., currently)), Ralph Adolphs (Caltech), Hiroshi Yamada (Univ. of Tsukuba), Mineki Oguchi (Tamagawa Univ.), Yasuhiro Tanaka (Tamagawa Univ.)), and also included eight world-leading researchers in related research fields (Marc Fleurbaey (CNRS, Princeton University), Paul Glimcher (New York University), Marc Erich Latoschik (Würzburg University), Yunzhe Liu (Beijing Normal University), Adina L. Roskies (Dartmouth College, UCSB), William Stauffer (University of Pittsburgh), Agnieszka Tymula (University of Sydney), and Naoshige Uchida (Harvard University)), who were invited from abroad. It was a marvelous opportunity to bring together the leading researchers in such a wide range of fields to discuss not only neuroscience with rodents, monkeys, and humans, but also virtual reality technology and the social sciences.



At the beginning of the first day, Kenji Matsumoto, Project Manager (PM), introduced the goals and vision of the “Well-being and Agency MS Project” in his opening remarks, and expressed his hope that future generations would remember the symposium as a landmark

event that would have ushered in a new stage of science. Then, Prof. Seiji Kumagai (Faculty of Human and Socio-Economic Studies, Kyoto University), Program Director of the Moonshot Program Goal 9 "Realization of a mentally healthy and dynamic society by increasing peace of mind and vitality by 2050" gave a speech. He explained the overall program and his expectations for the "Well-being and Agency MS Project" to form breakthroughs.

The main session began with interesting talks by Profs. Tanaka and Uchida specializing in rodent neuroscience, Profs. Oguchi and Stauffer specializing in monkey decision making, Prof. Yamada specializing in monkey neuroeconomics, Profs. Glimcher and Tymula specializing in neuroeconomics, and Prof. Adolphs specializing in human



neuroscience. The talks covered a wide range of topics including dopamine signals, neural signals and behavior, value, pleasure, desire, reward, and human neuronal activity from an economic perspective. The discussions were very active not only during the Q&A sessions of the talks, but also during the breaks.

On the evening of the first day, at the restaurant "La Tour" in the Clock Tower Memorial Building, the symbol of Kyoto University, we continued further frank discussions and deepened friendship within the research community approaching well-being and agency.

The morning of the second day began with a session on the humanities and social sciences, where Prof. Roskies (philosophy), Professor Gotoh (normative economics), and Associate Professor Takikawa (computational social science) discussed research issues that have not been adequately approached by neuroscience from their respective perspectives.

In the afternoon, there were talks by Profs. Matsumoto and Liu on human neurophysiology, Profs. Latoschik and Inamura on virtual reality (VR) technology, and Dr. Matsumori on interpersonal comparison of utility, and discussions on various possibilities for integrating the humanities, social sciences, and neuroscience. Prof. Fleurbaey was

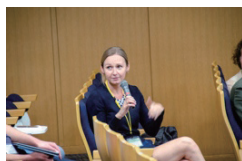
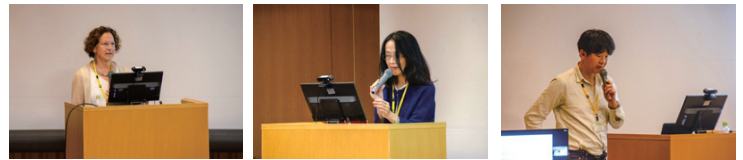
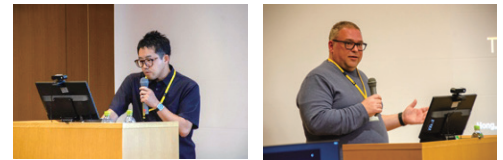
also scheduled to give an online lecture on the measurement of well-being and its interpersonal comparison, but unfortunately he was not able to connect (we all watched his lecture video during

lunch time during the lab tour of Tamagawa University Brain Science Institute two days later), and the time was used for a general discussion. In particular, it was truly groundbreaking that the leading researchers in neuroscience, economics, and philosophy discussed the interpersonal comparison of utility with brain indicators across their disciplines.

The external evaluation committee members, Profs. Takashi Hanakawa (Kyoto University) and Sayaka Oki (University of Tokyo), then gave their comments. They highly appreciated the "Well-being and Agency MS Project" for its approach to a very difficult, yet very interesting and important issue. Finally, PM Matsumoto concluded the symposium with his statement

that it is up to the agency of all the participants in the symposium whether the "hope that this Symposium will be remembered by future generations as a landmark event that will usher in a new phase of science" really comes to fruition, and a commemorative photo of the participants was taken.

Through the "International Symposium for Well-being and Agency-Integration of Brain Science and Social Science - held in Kyoto, a new community has sprouted that aims to integrate neuroscience with the humanities and social sciences, while also utilizing VR technology. With this rare community at its core, this new research trend is expected to develop into a larger trend in the future, further enhancing the significance of science for human beings.



We held a symposium on neuroeconomics entitled ~How does our valuation system operate in the economic sense?~ "Neuroeconomics" started in USA in the early 2000s. Neuroscientists, economists, and psychologists came together to understand the human valuation system in the brain.

In this symposium (Fig1), Prof. Paul Glimcher, a pioneer in this field, and economist Prof. Agnieszka Tymula, President Officer of Society For Neuroeconomics in 2023, presented their latest findings. Neuroscientists, Prof. Masayuki Matsumoto, an expert in the monkey value-based decision making, and Prof. Shinsuke Suzuki, an expert in human fMRI research on the human value-based decision making, also presented their latest advances. We had discussions with about 40 participants, including undergraduate students and company employees.



Speakers

**2023/10/03 Tsukuba
MS9 symposium**

Paul Glimcher New York University (ポール グリムチャー ニューヨーク大学 米国)
 「How Cortical Networks Achieve Efficient Representations and How This Conditions Choice Behavior.」

Agnieszka Tymula University of Sydney (アグニエスカ チムラ シドニー大学 オーストラリア)
 「History-dependent risk attitudes and economic disadvantage」

Masayuki Matsumoto University of Tsukuba (松本 正幸 筑波大学 日本)
 「Distinct roles of the orbitofrontal cortex, ventral striatum and midbrain dopamine neurons in economic decision-making」

Shinsuke Suzuki Hitotsubashi University (鈴木 真介 一橋大学 日本)
 「Constructing value signals for food rewards: determinants and the integration」

Neuroeconomics

Program

- 14:00-14:05 Opening remarks
- Session I (Chair: Hiroshi Yamada)
- 14:05-14:35 Agnieszka Tymula
- 14:35-15:05 Shinsuke Suzuki
- 15:05-15:30 tea break
- Session II (Chair: Jun Kunimatsu)
- 15:30-16:20 Paul Glimcher
- 16:20-16:50 Masayuki Matsumoto
- 16:50 Close










Fig.1 Speakers and program



Prof. Paul Glimcher (left) and participants (right)

1-1

Toward Supporting System as a "Gratitude" for People in Adversity



Principal Investigator (PI)

Reiko Gotoh
Faculty of Economics,
Teikyo University
Professor

The postwar welfare state has tried to reconcile two incompatible logics: the identification (and exclusion) of evil and injustice and the acceptance of survival as a right. The hinge of the two logics is the mechanism of compensation and reparation (usually mediated by money). The fact that humanity has created such a mechanism, along with the development of the idea of human rights, is unquestionably a moral progress. However, under the logic of monetary centralization, this hinge was fragile and could easily be broken. Both the absolute positive values of dignity and justice and the absolute negative values of evil and injustice could be compared, substituted, and traded under the principle of profit-maximizing behavior (and by the same token, cost-minimizing behavior). The purpose of this paper is to extract the weaknesses of the liberal theory of justice condensed in the incentive problem (fishing out the incentive to work through rewards), and to sketch out hints for resisting the monetary centralization logic based on Rawls' chance argument, Sen's capability theory, Parfit's non-identity problem, the Greek tragedy "Oedipus the King," etc. The purpose of this article is to sketch out some hints for resisting the logic of monetary centralization. In conclusion, a mechanism of "support as a thank you" to those who live in adversity is proposed, taking Nietzsche's words, "It is not permissible to wish that it had never to have been," as a starting point for non-resistance.

Reiko Gotoh. "Prospects for theory of justice based on de-unification logic." *Philosophy (Tetsugaku): Annual Review of the Philosophical Association of Japan*, 74, 31-46, 2023

3-2

Functional Human Brain Imaging Reveals Brain Activity for Extremely Challenging Tasks



Principal Investigator (PI)

Madoka Matsumoto
Human Brain Research Center,
Graduate School of Medicine,
Kyoto University
Specially Appointed Associate
Professor

People sometimes enjoy the challenge of extremely difficult tasks that test their skills. In collaboration with Prof. Kou Murayama (University of Tübingen) and colleagues, we investigated brain activity during challenges of different difficulty levels using human brain functional imaging. The ventral striatum/pallidum of the basal ganglia showed increased neural activity when the participants performed the tasks that were almost impossible to accomplish. However, under conditions in which monetary rewards were given in relation to task performance, a decrease in neural activity was observed, consistent with the level of enjoyment felt in response to the task. These results suggest that part of the human "aspiration" to challenge oneself, even when no benefit is expected, is generated in the brain.

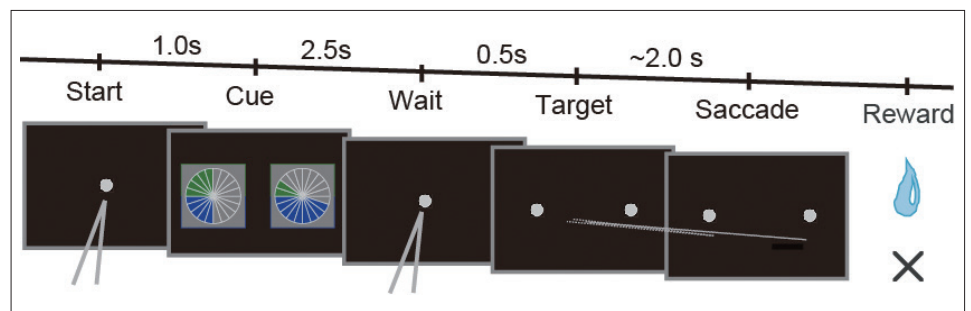
Michiko Sakaki, Stefanie Meliss, Kou Murayama, Yukihiro Yomogida, Kaosu Matsumori, Ayaka Sugiura, Madoka Matsumoto, Kenji Matsumoto. "Motivated for near impossibility: How task type and reward modulate task enjoyment and the striatal activation for extremely difficult task." *Cognitive, Affective, & Behavioral Neuroscience* 2023 Feb;23(1):30-41. doi: 10.3758/s13415-022-01046-4.

4-1 Unexpected Wins in Both Humans and Monkeys Increase Risk Taking



Principal Investigator (PI)
Hiroshi Yamada
 University of Tsukuba,
 Institute of Medicine
 Associate Professor

Researchers from the University of Tsukuba developed "Dynamic Prospect Theory," which integrates the most popular model in behavioral economics - prospect theory and a well-established model from neuroscience - reinforcement learning theory. In doing so, we created a dynamic model that successfully explains decision-to-decision changes in the gambling behavior of humans and monkeys. In particular, we found that after unexpected wins both humans and monkeys tend to behave as if they thought that they are more likely to win again. Using the dynamic prospect theory model, we were able to determine that the change in behavior, driven by a change in the perception of probabilities rather than by a change in valuation of rewards.



Gambling task : A sequence of events in choice trials. Two pie charts representing the available options were presented to the monkeys and humans on the left and right sides of the screen. Monkeys chose either target by fixating on the side where it appeared to obtain juice rewards (0.1-1.0 ml). Humans chose either target to obtain money (\$1~\$5).

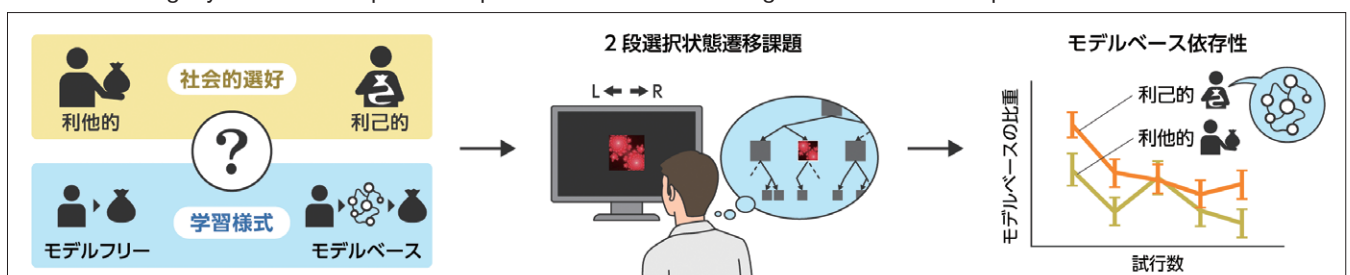
Tymula A, Wang X, Imaizumi Y, Kawai T, Kunimatsu J, Matsumoto M, Yamada H. Dynamic prospect theory: Two core decision theories coexist in the gambling behavior of monkeys and humans. *Sci Adv.* 2023 May 19;9(20):eade7972.

4-2 Proselfs deliberate more than prosocials – an approach to the mechanism of prosociality



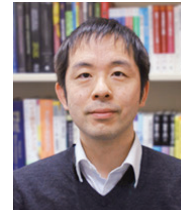
Principal Investigator (PI)
Mineki Oguchi
 Tamagawa University,
 Brain Science Institute
 Project Associate Professor

In social decision-making, proself individuals prioritize their own gain, while prosocial individuals respect the others' interests. In this paper, we tested the hypothesis that these individual differences in social preference are due to differences in the "learning styles" on which they depend. After measuring participants' social preferences, we asked them to perform a "two-step choice state transition task" to assess the balance between model-free (related to intuitive judgments) and model-based (related to deliberative judgments) learning systems, and found that proselfs tended to rely on model-based and prosocials on model-free learning systems. This finding supports the hypothesis that individual differences in social preference depend on those in learning styles and has important implications for understanding the mechanisms of prosocial behavior.



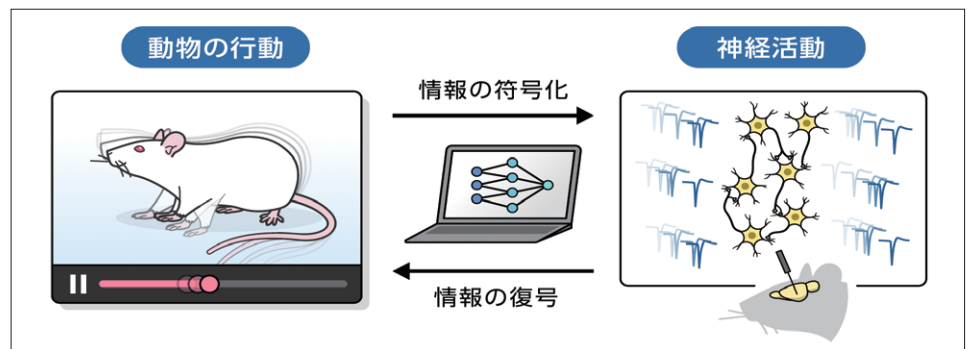
Oguchi, M., Li, Y., Matsumoto, Y., Kiyonari, T., Yamamoto, K., Sugiura, S., & Sakagami, M. (2023). Proselfs depend more on model-based than model-free learning in a non-social probabilistic state-transition task. *Scientific reports*, 13(1), 1419. <https://doi.org/10.1038/s41598-023-27609-0>

5-1 Rodent: cortical representation of skilled movement is stable over several days off



Principal Investigator (PI)
Yasuhiro Tanaka
 Tamagawa University,
 Brain Science Institute
 Associate Professor

In the primary motor cortex, certain neurons became correlated with the extensively trained movement. Some of these neurons well retained this correlation even after training cessation. When these neurons were suppressed, the learned motor skills became unstable. This collaborative study, conducted with Professor Masanori Matsuzaki from the Graduate School of Medicine at The University of Tokyo, suggests that certain cortical neurons may play a long-term role in coordinating learned movements. The refined mathematical methodologies and innovative techniques developed in this study will be further employed to explore the subjective value and agency inferred from behavioral and neural data.



T Shinotsuka*, YR Tanaka*, S-I Terada*, N Hatano, and M Matsuzaki. "Layer 5 Intratelencephalic Neurons in the Motor Cortex Stably Encode Skilled Movement." *Journal of Neuroscience* 43, no. 43 (October 25, 2023): 7130–48. <https://doi.org/10.1523/JNEUROSCI.0428-23.2023>

Award

PI Yamada won the Impact Award at the MS9 Retreat Conference poster session.

PI Hiroshi Yamada received the Impact Award at the poster session of the Moonshot Goal 9 retreat held on 28 May 2023.

