World Premier International Research Center Initiative (WPI)
FY 2024 WPI Project Progress Report (The center selected in and before FY2020)

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Research Center	International Research Center for Neurointelligence (IRCN)		
Center Director	Takao Hensch	Administrative Director	Mayumi Kimura

Common instructions:
* Unless otherwise specified, prepare this report based on the current (31 March 2025) situation of your WPI center.
* So as to execute this fiscal year's follow-up review on the "last" center project plan, prepare this report based on it.
* Use yen (¥) when writing monetary amounts in the report. If an exchange rate is used to calculate the yen amount, give the rate.

➢ Prepare this report within 10-20 pages (excluding the appendices, and including Summary of State of WPI Center Project Progress (within 2 pages)).

Summary of State of WPI Center Project Progress (write within **2 pages**)

Launched in 2017, IRCN strives to establish Neurointelligence as an emerging interdisciplinary field that seeks developmental principles of human intelligence (HI) through integration of neuroscience, medicine, artificial intelligence (AI) and social science. Traditional AI, while effective for specific tasks, lacks the holistic, adaptive, and interdisciplinary approach that defines Neurointelligence, and artificial deep neural networks (DNNs) only loosely mimic the brain's structure. In contrast, *IRCN specifically emphasizes neural dynamics as the key to HI*: intrinsic (spontaneous) activity, self-organization and unsupervised learning, essential for embodied developing biological systems to adapt to unstructured data. Neurointelligence strives for data- / energy-efficient computation, akin to the human brain (~20 Watts) quite unlike recent large-scale language models (LLM) which consume vast data and MegaWatt-hours for training. Biological brains overcome this through optimized excitatory-inhibitory (E-I) circuit balance, novel synaptic plasticity algorithms, sparse spike-based communication and recurrent networks not found in current artificial architectures.

Progress toward HI: Translational research into mental illness provides a powerful framework for understanding how HI arises. Bridging molecular, neural, behavioral and computational studies across species not only advances novel biomarkers and treatments for mental disorders but also illuminates the neural and genetic architecture of intelligence itself. Pioneering work at IRCN has yielded integrated progress in several areas:

- Excitatory-inhibitory (E-I) balance: inhibitory circuit maturation drives critical periods of brain plasticity (Reh et al, *PNAS* 2020), underlying the rapid acquisition of new skills in development. Moreover, these pivotal fast-spiking cells are hubs of vulnerability in mental illness. Yet remarkably, AI currently ignores inhibition. The Critical Period Team verified accelerated brain trajectories in human infants repeatedly exposed to GABA-active anesthetics (Gabard-Durnam et al, in press). Then focusing on reservoir computing (PIs Hensch, Aihara), they showed the importance of E-I balance for maximal memory capacity and efficient learning (Kanamaru et al, 2023, 2025) – supporting low energy consumption in HI especially with spiking neurons (Sakemi et al; Zhang et al, 2024).

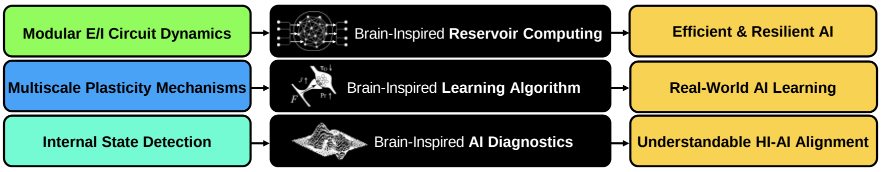
- Robustness to noise: the brain is constantly active even without sensory input, yet our perception remains quite stable. Instead, performance by artificial deep neural networks is easily degraded by noise. Recording calcium signals along stages of the visual pathway in marmosets, PI Ohki's group revealed that an orthogonal (i.e., independent) relationship between the brain's internal noise and stimulus-evoked signals gradually emerges along the visual hierarchy (Matsui et al, *Nat Commun* 2024). This explains how stability of human sensory perception is possible and suggests novel strategies for noise-resistant AI.

- Cognitive flexibility: fluid and flexible 'mind-wandering is a defining feature of HI that is impaired in mental illness and famously lacking in AI. PI Chao's lab provided insight into the "Aha!" moment when a previously incomprehensible problem suddenly becomes clear and obvious. PI Watanabe elaborated energy landscape analysis (ELA) as a robust *lingua franca* for detecting intrinsic dynamics in an unbiased manner across species and AI. It could not only detect rigidity of thought but also help relieve it in autistic subjects (Watanabe & Yamasue, *Nat Neurosci*, in press); likewise using whole-brain fUS imaging in mouse models (*Shank3*$^{+/-}$, social isolation) with other Critical Period Team members (PIs Hensch, Gotoh). Finally, ELA was used to diagnose poor language comprehension despite hyperfluency in artificial LLMs in collaboration with AF Nakajima and PI Aihara (Watanabe et al, *Adv Sci* 2025).

- Attention / sleep: attention underpins most higher cognitive functions in HI (problem-solving, learning, social behavior, etc). The Critical Period Team identified a postnatal window when parenting quality determines lifelong attentional capabilities (Makino et al *Sci Transl Med* 2024). Neglect during this window adversely impacted performance both in mice and children mediated by persistent sleep impairment. In mice, this was linked to dopamine (D2/D4) receptor imbalance specifically within anterior cingulate cortex (ACC), which could be rescued pharmacologically in adulthood. Moreover, in cross-WPI collaboration PI H Kasai and IIIS demonstrated that slow-wave power and sleep amount is increased by broad prefrontal synaptic potentiation even when sleep need is minimal (Sawada et al *Science* 2024). Together, these findings reveal for the first time how experiences along the lifecourse shape cognitive capacities tied to HI and a potential role for "sleep" in AI.

- Sex differences: sex biases HI disorders but AI is gender neutral. The impact of stress early in life on attention (above) or juvenile social isolation on brain structure by PI Emoto's group (Sazhina et al, *NeuroImage* 2025) was found to be sex-dependent. Varied exposure to adversity and sex-specific resilience mechanisms may explain individual differences in cognitive abilities. For harmonious alignment, HI-AI must better appreciate how intelligence arises not solely from genetics but from dynamic interactions between biology, sex and experience over development.

Progress toward brain-inspired AI: In FY2024, we named five Affiliated/Visiting PIs from amongst AF members who have made significant contributions to date to promote AI Incubator capabilities under-one-roof. Principles of brain function identified by IRCN Team Science (left column) are applied to address current gaps in AI capability (right column). Ten projects are now being run (see Section 2).



Leadership reform: Gender balance at the EB level was achieved by appointing new AD Mayumi Kimura and DD Yukiko Gotoh. Toxic environment was addressed by implementing mandatory DEI training (exceeding UTokyo standards). Former PI (now AF) Yoko Yazaki-Sugiyama was awarded the 2025 Tsukahara Prize. AF Okabe (Japan Academy Prize), SAD Iino (Imperial Order of the Sacred Treasure, Gold Rays with Neck Ribbon) and D Hensch (Imperial Order of the Rising Sun, Gold Rays with Neck Ribbon) were honored for their lifetime contribution to Japanese science and globalization.

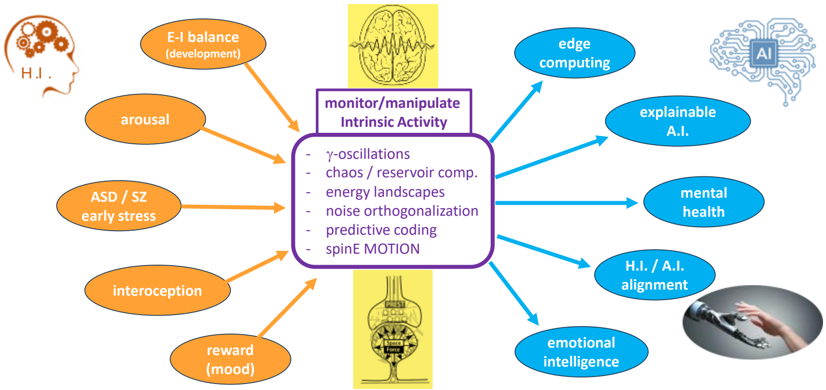
Student access: Project PIs were formally named to the Faculty of Medicine graduate school and Frontiers of Physics and Mathematics (FoPM) program. Neuro-inspired Computation course was revived, international IRCN event held in Italy and new MOUs signed (Scuola Normale, IMT Lucca) and Australia (Sydney Technological University) to broaden our global training network.

Sustainability Plan: At the end of FY2023, EVPs Hiroaki Aihara, Nobuhito Saito and D Hensch signed an agreement for permanent UTokyo budget allocation to IRCN to remain under the UTIAS umbrella in perpetuity. This enabled tenure procedures to begin in FY2024, including IRCN's first Full Professor to PI Watanabe with special budgetary funding for Athlete Cognitive Neuroscience under a new domestic Alliance for Brain Science with RIKEN CBS and Teikyo Univ. (ACRO). New partnerships with corporate (Microsoft, Daikin) and venture capital (Corundum) areas were sought to prepare for the WPI Matching fund proposal in FY2025.

* Describe clearly and concisely the progress being made by the WPI center project from the viewpoints below.
- In addressing the below-listed 1-6 viewpoints, place emphasis on the following:
  (1) Whether research is being carried out at a top world-level (including whether research advances are being made by fusing disciplines).
  (2) Whether a proactive effort continues to be made to establish itself as a "truly" world premier international research center.
  (3) Whether a steadfast effort is being made to secure the center's future development over the mid- to long-term.

1. Advancing Research of the Highest Global Level

* Among the research results achieved by the center, concretely describe those that are at the world's highest level. In Appendix 1, list the center's research papers published in 2024.
* Regarding the criteria used when evaluating the world level of center, note any updated results using your previous evaluation criteria and methods or any improvements you have made to those criteria and methods.

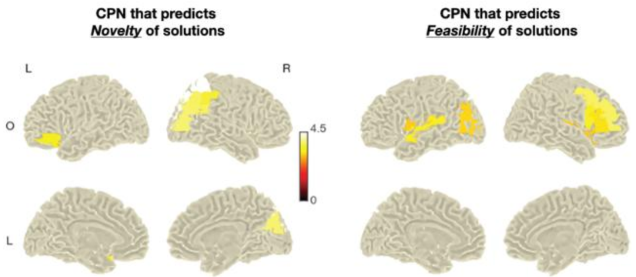


In FY2024, IRCN published 172 papers, one-third appearing in high impact journals. To link HI and AI, a major focus has been on monitoring / manipulating intrinsic states of brain activity (Fig 1). One approach, Energy Landscape Analysis (ELA) was able to reversibly capture the cognitive rigidity both in human autism and its mouse models, providing a powerful common language with which to diagnose dynamics even in artificial large language models (see Section 2 below). Peripheral readouts of intrinsic brain states detected by machine learning also advanced our understanding of social cognition disorders for HI/AI alignment.

Understanding HI through Human Creativity

At the opposite end from mental illness along the diverse HI spectrum lies creativity – the ability to generate ideas that are both novel and useful. Here again, intrinsic "mind wandering" likely plays a vital role in search of the "Aha!" moment when a previously incomprehensible problem or concept suddenly becomes clear and obvious. How does the brain incubate creative insight? The "spreading activation" hypothesis proposes that relevant concepts become more co-active in the brain to facilitate problem solving, while the "selective forgetting" hypothesis states that irrelevant concepts that occupy problem solvers' minds are suppressed. Supported by Daikin, PI Chao's lab has provided the first glimpse into high-resolution brain network dynamics during unconscious neural navigation toward a problem-solving idea. These findings now provide novel biomarkers for creativity and a computational framework for creative AI and will be used to facilitate the design of more creative environments for work and education, especially for school children and the elderly.

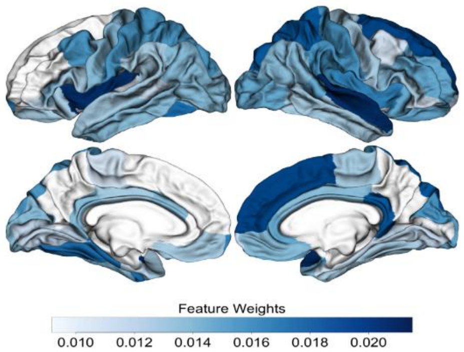
First, PI Chao and colleagues combined a simulation model and crowdsourced behavioral data to demonstrate that an insightful search for solutions is linked to a wider exploration range in the solution space (Chao et al., *Comms Psych*, 2025). They also designed an unsupervised, automated GPT-based evaluation tool to assess creativity performance (Kern et al., *Br J Psych*, 2024) and developed a new creativity task called the Fusion Innovation Test (FIT) to evaluate real-world creative problem-solving (Wu et al., under review). In FIT, participants combine two randomly assigned elements—such as objects (e.g., pet fish) or technologies (e.g., VR headset)—to achieve either self-improvement of individual needs (e.g., reduce loneliness) or Sustainable Development Goals (SDGs) addressing societal issues. Together with their newly identified resting-state Creativity Potential Network (CPN) that encodes brain state flexibility and can predict upcoming creativity performance (Huang et al., under review) environmental parameters can be adjusted (e.g., oxygen delivery) to enhance creativity performance by activating the CPN (Liu et al., in preparation) and DMN, which supports mind-wandering (Su et al., under review) for real-world tasks in corporate settings.



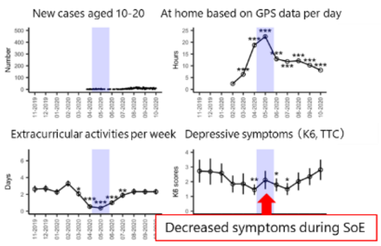
Understanding HI through computational and translational psychiatry

Computational psychiatry in large-scale human MRI datasets

In clinical studies at UTokyo, IRCN previously showed that people with clinical-high risk for psychosis (CHR) show decreased cortical surface area and thickness especially in structurally altered regions for chronic schizophrenia in the worldwide ENIGMA CHR consortium (Jalbrzikowski et al., *JAMA Psych*, 2021). This year, machine learning classification accuracy was tested (Zhu et al., *Mol Psych*, 2024). The XGBoost classifier showed 73% predictive rate between people with CHR who later converted to psychosis (CHR-PS+) in the follow-up period and healthy controls (Fig. 2). It successfully categorized 85% people with CHR who did not transit to psychosis (CHR-PS-) and 73% of those who were unable to follow-up (CHR-UNK) as healthy, suggesting that this classifier can differentiate between CHR-PS+ and PS-/UNK even using brain images before disease onset. The results further showed that the classifier weighted features of cortical surface area but not subcortical volume, revealing that brain images prior to onset show little alteration between CHR-PS+ and healthy controls, again consistent with our primary ENIGMA CHR study.



In multi-site brain MRI studies, we must consider biases of measurement, coming from different machines and protocols, and sampling arising from demographic characteristics of cases and controls. Thus, it has been very difficult to harmonize data by setting a standardized procedure. In addition, brain features often change throughout the life course, especially during the critical period of adolescence. We succeeded in building a classifier diminishing both measurement bias by using a non-linear Bayesian method and age/sex effects by using non-linear statistics. As part of the Brain/MINDS Beyond project, we applied these techniques to an adolescent Japanese cohort. We found that during the course of adolescent brain development, hippocampal volume increased at first episode (Cai et al., 2024). Monthly testing before/during the pandemic revealed fewer depressive symptoms during the first episode compared to before or after the emergency call (Fig. 2), indicating that adolescent stress exposure temporarily decreased during the call, perhaps reflecting increased hippocampal volume.



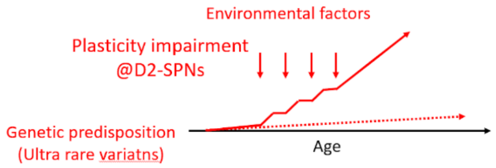
Cai, Koike, et al. *JAMA Netw Open* 2024

Using energy landscape analysis (ELA) with ED Aihara, PI K. Kasai's group further tested the longitudinal trajectory of monthly depressive symptoms (Tatematsu et al. *PLoS Medicine*, in revision). This revealed two clusters (stable, fluctuation) due to emergency stress that were undetectable by conventional statistics or biennial detailed psychological assessment. Notably, the fluctuation cluster showed faster adolescent brain changes in middle prefrontal cortex compared to the stable group, again not different by conventional analysis. Thus, the new mathematical ELA approach is also applicable to longitudinal psychological assessment reflecting biological measures.

Translational psychiatry between human and animal models

In a large-scale human MRI dataset, PI K. Kasai and colleagues identified neuroanatomical subtypes within the schizophrenia population. Using a novel statistical, X-means non-hierarchical clustering analysis, they classified 5,604 subjects (3,078 controls; 2,526 with schizophrenia, bipolar disorder, major depressive disorder, or ASD) based on sub-cortical volumes, and explored whether data-driven clustering results could explain cognitive and social functioning in the sub-cohorts (Okada et al., 2023). Four brain biotypes (BB) were identified and associated with behavior: extremely (BB1) and moderately (BB2) smaller limbic regions, larger basal ganglia (BB3), and normal volumes (BB4). Specifically, BB1 was associated with severe impairment, BB2 / BB3 with mild impairment, and BB4 with normal cognitive and social functioning. Additionally, individuals with schizophrenia were more likely to be classified as BB3 compared to healthy controls or individuals with other disorders.

Pharmacological manipulation of the dopamine D2 receptor pathway in juvenile animals by chronic methamphetamine administration results in an enlargement of the pallidum measured with ultra-high field MRI, mirroring findings in patients, alongside emergence of spontaneous behaviors, specifically task-engagement like behavior even in the absence of reward or other external feedback. Mouse models replicating haplo-insufficiency of ultra-rare genetic variants associated with schizophrenia (e.g., protein localization, ubiquitination, or gene regulation) were also examined. Interestingly, one such risk mutant exhibited spontaneous behavioral abnormalities similar to those observed in the D2 model, including aberrant patterns of dopamine activity detected in the striatum. To objectively capture and analyze such complex behavioral alterations in detail, PI K. Kasai's group applied inverse reinforcement learning algorithms to the observed behavioral data in collaboration with AF Shin Ishii. These AI-driven analyses along with striatal dopamine activity measurement may reveal mechanisms underlying aspects of positive symptoms in schizophrenia.



Earlier in neonatal life, PI Hensch and colleagues identified a novel critical period for the development of attention in mice. In a cover article of *Science Translational Medicine*, Makino et al (2024) reported that fragmented maternal caregiving (induced by limited nesting resources) during the first postnatal week leads to attention deficits only in male mice. Impairments were associated with disrupted sleep, persistent oxidative stress and imbalanced expression of dopamine (D2/D4) receptors specifically in the anterior cingulate cortex (ACC) and not in female littermates. Attention deficits could be mitigated acutely in adulthood by counteracting dopamine drugs, not only after early life stress but also for acute sleep deprivation of control mice. Most notably, attention deficits mediated by sleep loss were replicated in a cohort of human children (age 3-5 years) suffering early adversity, suggesting sex-biased cognitive consequences emerge well before puberty. Interestingly, sex differences in brain morphology after later social isolation stress (Sazhina et al, *NeuroImage* 2025) and sleep pressure induced by global prefrontal synaptic potentiation (Sawada et al, *Science* 2024) from DD Emoto and PI H. Kasai's labs, respectively, point toward a general HI principle.

<u>Application of AI to early neurodevelopmental disorders</u>

The BCH satellite pioneered the use of AI to bridge animal data to human patients in neurodevelopmental disorders (Artoni et al, PNAS 2019). A Deep Neural Network (DNN) first trained on spontaneous arousal fluctuations (pupil size changes) from preclinical mouse models of autism spectrum disorder (ASD) was adapted by retraining only its final layers to heart-rate data from rare Rett syndrome patients. This cross-species and cross-modality transfer learning approach enabled detection of neuro-developmental abnormalities in humans with high accuracy, even with small patient cohorts, and before major symptom onset. The study established pupillometry as a robust, noninvasive and quantitative biomarker for early detection of neurodevelopmental disorders more broadly – a landmark example of translational deep learning.

As pupil size dynamics comprise rich information about diverse intrinsic neural activity, mathematical modeling of neural pathways controlling pupil size (sympathetic dilator muscle; parasympathetic sphincter muscle) was pursued. With ED Aihara's group, previous nonlinear series analysis demonstrated strong underlying determinism in pupil dynamics in wildtype mice (n=115) (Svirodova et al, Annu Int Conf IEEE Eng Med Biol Sci 2021). In FY2024, Nobukawa et al (in prep) next proposed an evaluation method for temporal complexity in the instantaneous phase component of pupil size. Whether nonlinearity of the neural pathways (rather than changes in intrinsic activity) potentially distorts pupil behavior was unknown. By analyzing wildtype mice during low- vs high-arousal states, instantaneous phase complexity was indeed found to reflect arousal levels, driven respectively by sympathetic locus coeruleus (LC) and parasympathetic hypothalamic input.

Experimentally in a Rett syndrome mouse model, behavioral normalization of pupil size could be achieved solely through MeCP2 rescue in cholinergic cells (Artoni et al, unpublished), suggesting ACh may be involved in noradrenergic regulation particularly in the LC. Further estimating intrinsic dimensionality of pupil dynamics in the disease model mice could then be informative (e.g., does reduced ACh involvement in the absence of MeCP2 lead to decreased dimensionality). Pupillometry is cost-effective, non-invasive and readily adapted compared to other neuroimaging modalities (e.g., brain scans, complex diagnostic interviews, artificial tasks) for use in clinics / schools.

2. Generating Fused Disciplines

* Describe the content of measures taken by the center to advance research by fusing disciplines. For example, measures that facilitate doing joint research by researchers in differing fields. If any, describe the interdisciplinary research/fused discipline that

have resulted from your efforts to generate fused disciplines. You may refer to the research results described concretely in "1. Advancing Research of the Highest Global Level."

In FY2024, the AI incubator was formally launched with five new Affiliated / Visiting PIs highlighting three fusion research foci across 10 projects addressing major gaps in current AI (below):

<AI Incubator Focus #1> Brain-Inspired Reservoir Computing

Reservoir computing (RC) has recurrent connections, inspired by networks in the brain and offers a computationally efficient machine learning framework by limiting the number of trainable parameters and using simple learning algorithms compared to deep learning. The reduction in computational time for model training leads to energy efficiency. Although the simple architecture of RC allows fast and energy-efficient learning, the learning performance is sometimes inferior. We introduced a kind of attention mechanism (project 2), a self-modulation mechanism, to the RC and achieved state-of-the-art performance with much faster and very energy-efficient learning (Sakemi et al., 2024). Moreover, since spiking neural networks (SNNs) use spike events to code and transmit information, inspired by the spiking neurons in the brain, RC with SNNs is quite energy efficient due to the advantage that power consumption occurs only when spikes are emitted. However, the nondifferentiable nature of SNNs makes calculating backpropagation errors, as in the conventional neural network models, difficult to implement. We trained SNNs using augmented direct feedback alignment, which introduces arbitrary nonlinear functions as backward reservoirs (project 2), to train SNNs and demonstrated its superiority and stability over backpropagation (Zhang et al., 2024). Further, we optimized E-I balance of reservoir networks composed of excitatory and inhibitory neurons, inspired by the E-I balance in the brain (project 1), and found that the memory capacity of the network was maximized (Kanamaru et al., *Neural Computation*, 2023; Kanamaru and Aihara, *arXiv* 2025). We also developed a new method (project 3) to protect deep neural networks from attacks by adding brain-inspired intrinsic noise (Ukita et al., *Neural Networks* 2023). We further developed network structure optimization methods to draw out the full potential of multi-reservoir network models (Li et al., 2024), inspired by the parallel and deep architectures of the brain (project 4). Finally, we introduce MANTIS – a predictive coding framework that integrates bidirectional and hierarchical architecture, multi-timescale dynamics and heterogeneous spiking neurons (project 5). Thus, we apply several characteristics of the brain (E-I balance, spontaneous noise and predictive signals for computation, parallel processing, and extremely low energy using spiking neurons) to RC.

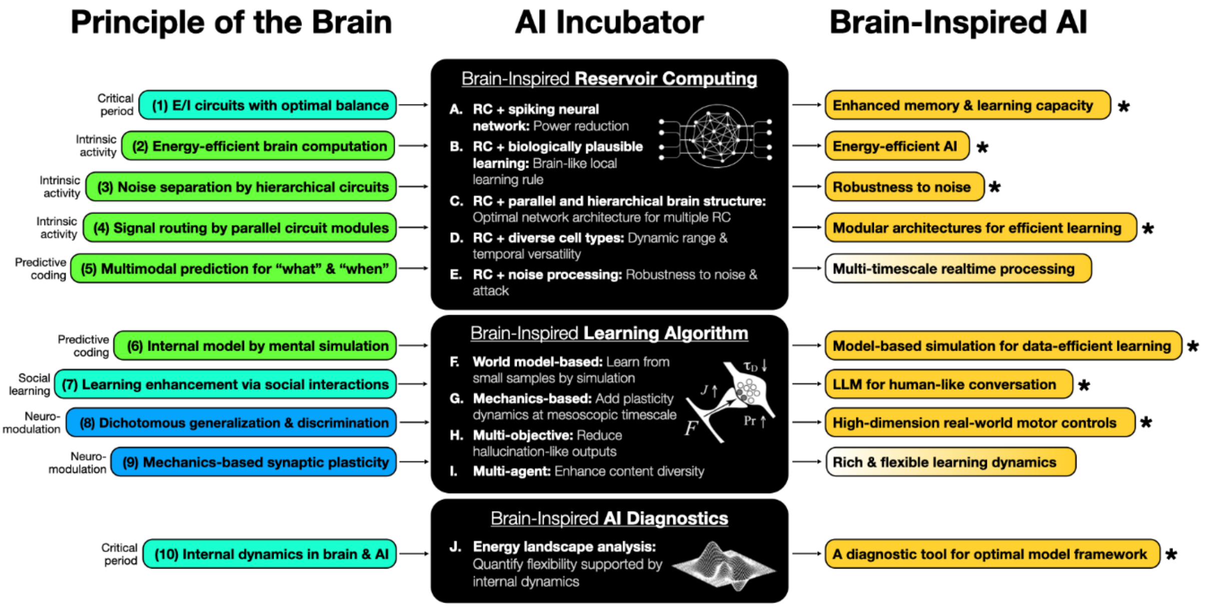
<AI Incubator Focus #2> Brain-Inspired Learning Algorithm

The learning algorithms used in current AI, such as Hebbian and reinforcement learning, are largely inspired by neuroscience findings from decades ago. We aim to incorporate more recent insights into neural plasticity across multiple levels of organization into the following four areas. First, our recent achievements include learning from "mental" simulation with limited data to refine internal models (Project 6). This approach is inspired by intrinsic neural activity observed in animals (Matsui et al., 2024; Yaron et al., 2024) and neuronal cultures (Zhang et al., 2025; Yaron et al., 2025). We have developed a model-based learning algorithm that allows AI to learn efficiently from sparse data, with successful applications in robotics control (Kubo et al., 2025; Watanabe et al., 2025) and computer vision (Katsumata et al., 2024). Second, we are advancing multi-agent learning (Project 7), inspired by social synchrony between individuals, which facilitates self-correction and adaptive behavior. This project enables LLM agents to enrich their dialogue and achieve more human-like conversations (Chu et al., 2024; Chen et al., 2024). Third, another focus is learning to balance generalization and discrimination across multiple objectives (Project 8), drawing inspiration from the dual learning roles of the dopamine system (Iino et al., *Nature* 2020; Urakubo et al., *PLoS Comp. Biol.* 2020) and its dysfunctions (Fujita et al., 2020). We have developed a multi-objective learning algorithm that enables rapid adaptation in real-world motor control tasks while minimizing hallucination (Ohashi et al., 2024; Nakanishi et al., 2025). Finally, we are exploring a novel learning rule (Project 9) based on mechanically driven synaptic plasticity, specifically synaptic "pushing" (Sawada et al., 2024; Ucar et al. *Nature*, 2021). Theoretical advantages of this form of plasticity include dynamic reconfiguration of network computation to balance robustness and sensitivity demands (Xu et al., 2024), and the introduction of timescales that bridge typical short- and long-term plasticity, offering richer and more flexible brain-inspired learning algorithms for AI.

<AI Incubator Focus #3> Brain-Inspired AI Diagnostics

Energy landscape analysis (ELA) extracts a biologically understandable illustration from complex and spatiotemporally high-dimensional data. By submitting whole-brain neural data obtained by fMRI to

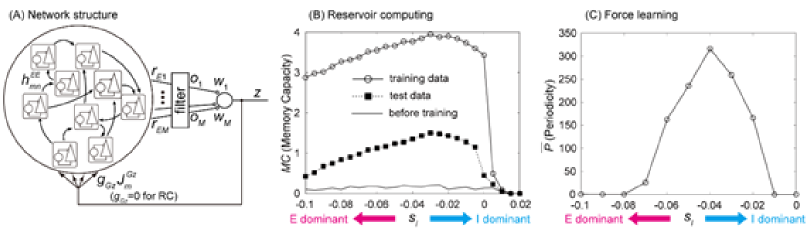
ELA analysis, for example, we can depict collective brain dynamics as a ball moving on a hypothetical energy surface. Moreover, this analysis reveals latent brain states that determine the collective brain dynamics and tells how long each brain state continues and how often brain state transitions occur. This data-driven approach was used in many human studies and identified neural mechanisms behind typical/atypical intelligence and various neuropsychiatric conditions. Furthermore, this analysis is applicable to any type of time-series data recorded from multiple-agent systems, including model animals and machines. This method holds a unique position to bridge the gaps between human intelligence, animal intelligence, and artificial intelligence.



The left column of the figure illustrates the principles of brain function identified by IRCN Team Science, the central column shows how these principles can be applied to current AI, and the right column demonstrates the new AI possibilities enabled by such applications. Projects marked with an asterisk indicate that significant results have already been achieved, and papers have been published. The following sections provide a more detailed explanation of each of the three categories.

(1) E/I circuits with optimal balance
- Principle of the brain: Inhibitory circuit maturation drives trajectories of brain development called critical periods, when circuits are maximally plastic for stable functions that last a lifetime.
- Gaps in current AI: Current deep neural network architectures include neither inhibitory circuits nor their dynamics, retaining plasticity across layers, which is energy inefficient.

- Brain-inspired AI: To examine the role of the E-I balance in the learning during the critical period (CP), we constructed a cortical network model composed of excitatory neurons in layers 2/3 and inhibitory neurons in layer 4. First, we applied the short-term memory task in the reservoir computing to our model. Only the synaptic weights to the readout outside the reservoir network were trained. Hensch and Aihara labs found that the memory capacity of the network was maximized at optimal E-I balance (Kanamaru et al. *Neural Comp*, 2023). Second, we trained our network to generate periodic signals using force learning, by which the synaptic weights inside the reservoir can also be trained. We found that the efficiency of force learning was maximized at optimal E-I balance with a sharper profile. When the inhibitory activities in the network were low, the trained dynamics could not be maintained after the learning. Therefore, the inhibitory neurons are essential in order to realize effective learning and processing. This result shows both the vital role and vulnerability of E-I balance during CP (Kanamaru & Aihara *arXiv*, 2025).



- **Deliverable:** Optimization of Reservoir AI by E-I Balance

(2) Energy-efficient computation in the brain and AI

- Principle of the brain: Current deep learning-based AI, including large language models (LLMs), are approaching the capabilities of the human brain, but they consume large amounts of electrical power, quite unlike the human brain (~20W). AF Takahashi's lab (Ikeda et al., 2023; Ikeda et al., 2025, arXiv) demonstrated that intrinsic activity in dissociated neuronal cultures and spiking neural networks (SNNs) can maintain both criticality and EI balance and prolong the fading memory of past stimuli, suggesting that the brain can achieve memory consolidation and energy-efficient computation as emergent functions of noise-driven intrinsic activity.

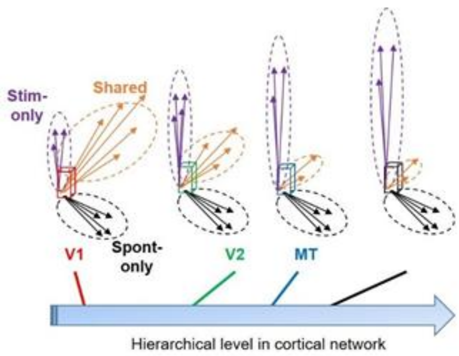
- Gaps in current AI: Current deep learning-based Ais, including LLMs, are energy inefficient and require enormous electrical power and data for learning, that is becoming a social problem. The annual power consumption used for AI is estimated to reach 652 TWh even in 2030, which is influential for carbon neutrality and can hinder further progress in AI.

- Brain-inspired AI: Aihara, Nakajima, Nakayama, Takahashi and Tanaka labs are developing energy-efficient AI using reservoir computing (Ebato et al., 2024; Kabayama et al., 2025, Physical Review E) and spiking neural networks (SNNs) (Sakemi et al., 2024; Zhang et al., 2024). Although the simple architecture of RC allows fast and energy-efficient learning, the learning performance is sometimes inferior to that of other state-of-the-art RNN models. Aihara lab (Sakemi et al., 2024) introduced a kind of attention mechanism to the RC and demonstrated that the learning ability of such RC can achieve state-of-the-art performance with fast and energy-efficient learning. The nondifferentiable nature of spiking neurons makes calculating backpropagation errors, as in the conventional neural network models, difficult to implement. To overcome this problem, Nakajima lab (Zhang et al., 2024) developed a training algorithm that combines reservoir computing and biologically inspired training and trained SNNs using augmented direct feedback alignment, which introduces arbitrary nonlinear functions as backward reservoirs, to train SNNs and demonstrated its superiority and stability over backpropagation and conventional direct feedback alignment. By integrating a mathematical model of the spiking dynamics of actual neurons and reservoir computing, we will develop a new generation of brain-type spiking reservoir with ultra-low power consumption.

- **Deliverable:** Brain-inspired, extremely energy-efficient AI

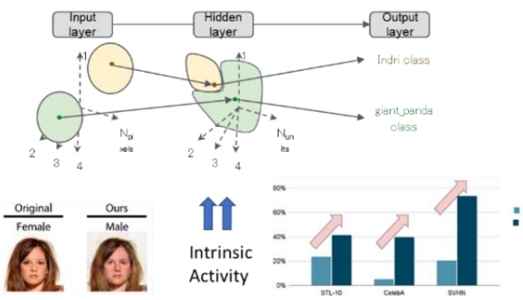
(3) Noise-robust hierarchical computation in the brain and AI

- Principle of the brain: The brain is filled with intrinsic activity. In particular, the intrinsic activity in the primary visual cortex, the input layer of the cerebral cortex, shows structured patterns very similar to visual activity. If we perceive such structured intrinsic activity, our perception will be full of hallucinations. Ohki lab, (Matsui et al., 2024) found that such intrinsic activity is gradually orthogonalized from the visual activity along the hierarchical processing in the higher visual areas of primates. Thus, our brain actively separates the noise (=intrinsic activity) from the signal (=visual activity).



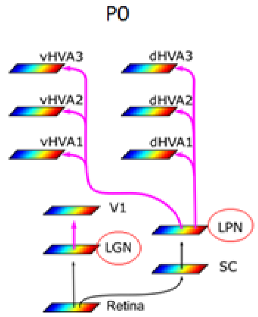
- Gaps in current AI: Current deep learning-based AI, including LLMs, can be easily fooled by adding tiny noise to the input, so-called adversarial attacks. Ohki lab. (Ukita and Ohki, unpublished) found that signal and noise structures gradually become similar along the hierarchical processing in deep learning-based AI, which is opposite to the brain and makes it difficult to separate signal from noise.

- Brain-inspired AI: Ohki lab (Ukita et al., *Neural Networks* 2023) developed a new type of adversarial attack that attacks the hidden layer of deep neural networks. By adding noise to the hidden layer, the performance of the deep neural network against the attacks was dramatically improved. Ohki, Aihara, and Nakayama labs will implement the orthogonalization mechanisms to deep learning-based AI and reservoir computing-based AI and develop neuro-inspired AI that is robust to noise.



- **Deliverable:** Brain-inspired AI that is robust to noise and adversarial attacks.

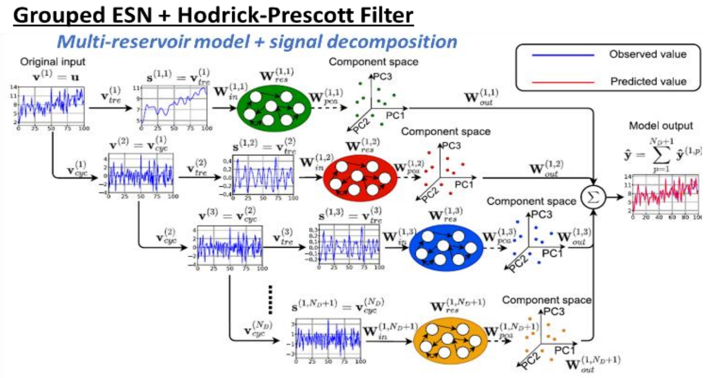
(4) Parallel circuit modules in the brain and AI



- Principle of the brain: Ohki lab (Murakami et al., *Nature* 2022) found that in the early development of the brain, parallel modules are formed from the retina to many visual cortical areas and they send intrinsic activity from the retina to visual areas in parallel. Based on intrinsic activity, hierarchical connections are formed in the later stage. Ohki lab (Murakami et al., in preparation) further found that just after eye opening in juvenile mice, specific visual information with specific spatiotemporal frequency is transmitted from the retina to visual areas via parallel modules, and later in the adult hierarchical connections transmit specific visual information with specific spatiotemporal frequency.

- Gaps in current AI: In the reservoir computing field, multi-reservoir network models that consist of multiple reservoirs in parallel or in series have been studied to improve the performance of standard single-reservoir models with limited scalability. However, it has been underexplored to effectively leverage the multi-reservoir networks and search the best network architectures of the multi-reservoir models.

- Brain-inspired AI: Tanaka lab (Li et al., *Applied Soft Computing* 2023) developed a multi-reservoir network model with a parallel architecture, combined with signal decomposition preprocessing, and demonstrated that the model outperforms state-of-the-art reservoir computing models and fully trained recurrent neural network (RNN) models in both computational performance and training cost. The result suggests that processing different kinds of information in parallel pathways, found in the juvenile brain just after eye opening, is effective for enhancing AI models. Tanaka and Fujiwara labs further developed network structure optimization methods for drawing out the full potential of multi-reservoir network models beyond parallel and deep architectures (Li et al., 2024).

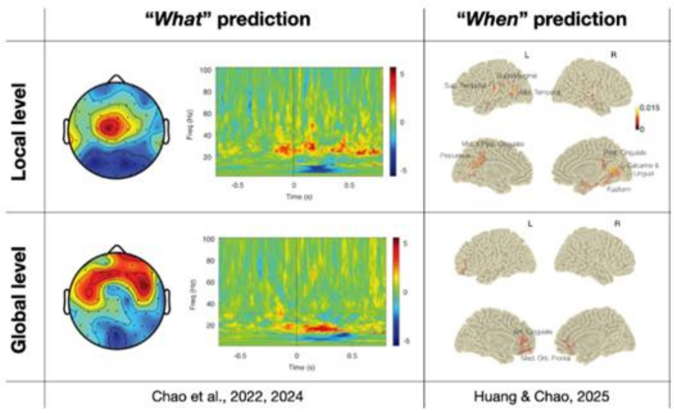


Li, Liu, and Tanaka. "Multi-reservoir echo state networks with Hodrick–Prescott filter for nonlinear time-series prediction." Applied Soft Computing, 135, 110021 (2023).

- **Deliverable:** Brain-inspired designs of optimal AI architecture.

(5) Multimodal prediction object for "what" and "when"

- Principle of the brain: The brain actively generates top-down signals to predict both the content ("what") and timing ("when") of sensory events. Chao and Koike labs have found that these predictive signals integrate information across hierarchical levels and sensory modalities (Chao et al., 2024; Huang et al., 2024), and operate dynamically across multiple timescales (Huang & Chao, in press). We propose the existence of "multimodal prediction objects"—internal representations that allow the brain to learn and integrate spatiotemporal sensory inputs into coherent, multi-timescale top-down predictions, capturing both the expected identity and timing of future events. Our modeling results show that multimodal prediction objects can emerge within networks of spiking neurons comprising diverse cell types, which support heterogeneous, temporally rich dynamics (Yamada et al., in prep).



- Gaps in current AI: Most current AI models focus either solely on predicting what will happen or handle time in a simplistic, stepwise fashion (e.g., next-step or fixed-step forecasting). Additionally, they typically lack bidirectional interactions and rely predominantly on feedforward architectures. In contrast, a multi-timescale top-down predictive coding model implemented with spiking neurons can offer key advantages: (1) it enables the system to prioritize processing of events that deviate substantially from predicted content or timing, thus improving computational efficiency; and (2) it provides an internal generative model that integrates both what and when information across multiple timescales—crucial for real-world sensorimotor tasks involving high-dimensional sensory inputs and continuous motor outputs.

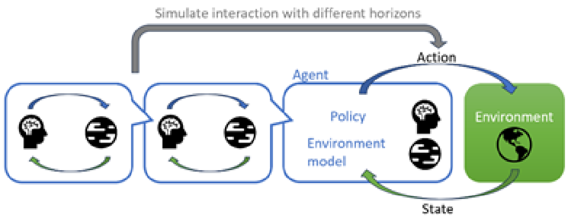
- Brain-inspired AI: Aihara, Chao, Herman labs, along with Nakajima, Takahashi, and Tanaka labs in the AI incubator, will investigate: (1) how different cell types in spiking neural networks can enhance predictive versatility to accommodate a wide range of content and timing; (2) how hierarchical network structures can further improve this versatility.

- Deliverable: "Multi-timescale Adaptive Neural Temporal Inference System" (MANTIS) – a predictive coding framework that integrates bidirectional and hierarchical architecture, multi-timescale dynamics (inspired by reservoir computing), and heterogeneous spiking neurons (modeled with Izhikevich neurons).

(6) Predictive coding and data-efficient learning in the brain and AI

- Principle of the brain: Ohki lab, (Matsui et al., 2024) found that the intrinsic activity in the primary visual cortex, the input layer of the cerebral cortex, shows structured patterns very similar to visual activity. This suggests that the intrinsic activity is not just noise but encodes visual information, and may represent a prior distribution of the outside world and mentally rehearse (or simulate) the outside world even without visual input, which may contribute to our extremely sample-efficient ability to learn one-time events. Chao lab and Takahashi lab found that mismatch between prediction (simulation) and sensory input evokes response in the brain (Yaron et al., in press) and. in dissociated cultures of neurons (Zhang et al., 2025; Yaron et al., 2025).

- Gaps in current AI: Current AI including large language models (LLMs) is extremely data inefficient. LLMs have already learned most of the digitally available text, which is already starting to hinder further progress in AI.

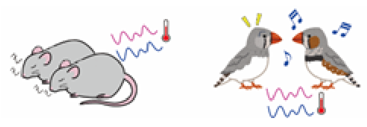


- Brain-inspired AI: Ishii lab developed a model-based reinforcement learning (RL) network and implemented it for robot control. The model-based RL learns world models from past experience, simulates the world based on a small number of samples, learns from simulations and is thus very data efficient. Model-based RL has achieved state-of-the-art performance in benchmark robot control tasks (Kubo et al.,2025). Hierarchical RL embedded with the dynamical system allowed a robot simulator to walk through a variety of terrains with a short training time (Watanabe et al, 2025). Nakayama lab (Katsumata et al., 2024) also developed a sample-efficient deep learning model using generative models.

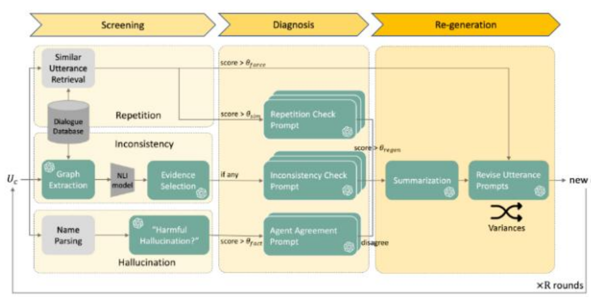
- **Deliverable:** sample-efficient AI that can learn from a small number of samples

(7) Learning by multi-agent interactions in brains and large language models (LLMs)

- Principle of the brain: Resilient communication is an emergent systems property, generated through multi-system interactions of biological, psychosocial and environmental factors, which dynamically affect developing brain networks (particularly during early critical periods) to shape learning capacity. The benefit of social synchrony (i.e. shared neural responses during communication / cooperation) is only now becoming clear through wearable technologies.



- Gaps in current AI: Recent research has leveraged LLMs to power multi-agent simulations, aiming to model complex human behaviors or enhance multi-agent communication and collaboration. However, by analyzing dialogues and memory over multiple sessions, Nakayama lab found significant issues such as repetition, inconsistency, and hallucination, exacerbated by the propagation of erroneous information (Chu et al., 2024).



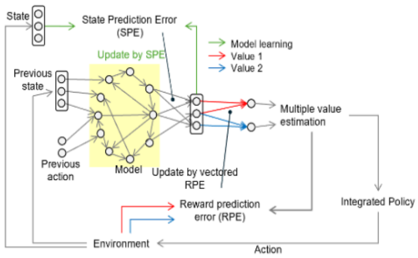
- Brain-inspired AI: Inspired by the resilience of brains generated through multi-system interactions and social synchrony, Nakayama lab proposed a novel Screening, Diagnosis, and Regeneration (SDR) framework that detects and corrects utterance errors through a comprehensive process involving immediate issue identification, evidence gathering from past dialogues, and LLM analysis for utterance revision (Chu et al., 2024. By incorporating our SDR framework to Generative Agents, we enhanced the diversity, consistency, and factualness of the generated dialogues. This work presents a pioneering approach to enhancing dialogue quality in multi-agent simulations.

(8) Multi-objective reinforcement learning

- Principle of the Brain: In the IRCN project, Kasai and Yagishita lab discovered a dichotomous form of generalization-discrimination learning in the ventral striatum (Iino et al., *Nature*, 2020). By constructing a signaling model for D2-expressing SPNs (Urakubo et al., 2020), Ishii lab elucidated the temporal characteristics of discrimination learning. They also modeled possible mechanisms in positive symptoms of psychiatric disorders (Fujita et al., 2020).

- Gaps in current AI: Modern AI systems can exhibit behaviors reminiscent of mental illnesses—most notably, hallucination-like outputs. Moreover, insufficient capacity for generalization often leads to slow learning, particularly in high-dimensional, real-world tasks such as motor controls.

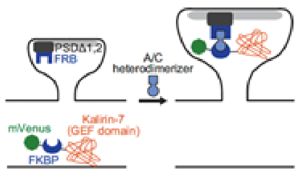
- Brain-inspired AI: To tackle these challenges, Ishii lab developed machine learning methods based on adversarial generative models (Miyato et al., 2018) and successfully integrated them into deep reinforcement learning (RL), enabling robust AIs for autonomous motor control tasks (Ohashi et al., 2024; Nakanishi et al., in prep). Building on these results, the next phase of the IRCN project will focus on realizing AIs via multi-objective, model-based RL—an extension of generalization-discrimination learning that exhibits efficient learning even in high-dimensional, real-world tasks (Fig).



- **Deliverable:** Multi-objective, model-based AI reinforcement learning.

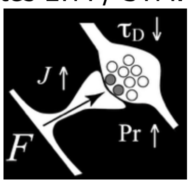
(9) Dual-store recurrent neural networks for flexible multitask computation

- Principle of the brain: Kasai lab has developed novel synaptic chemogenetic tools to precisely manipulate synaptic connections and probe brain function. Our first probe, SynK, showed that globally increasing synaptic connections by enlarging dendritic spines in the medial prefrontal cortex induces slow-wave sleep—a potential mechanism for homeostatic sleep regulation (Sawada et al., Science, 2024). Our second probe, SynC, which prevents naturally occurring spine enlargements throughout the frontoparietal cortex, profoundly disrupts cognitive functions (in preparation), likely due to prevention of the rapid "pushing" effects of dendritic spines on presynaptic terminals (Ucar et al., Nature, 2021).



- Gaps in current AI: Most existing AI systems incorporate only LTM and lack the ability to flexibly combine previously acquired knowledge. To achieve richer and more flexible learning dynamics, it will be critical to develop a mesoscopic-timescale algorithm that mediates or integrates LTM / STM.

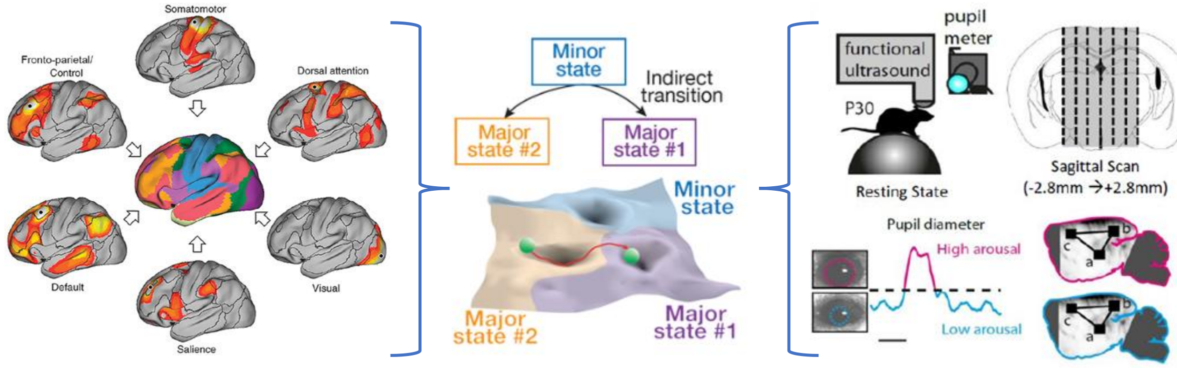
- Brain-inspired AI: The "pushing" effect suggests that, while postsynaptic terminals (J) maintain LTM, presynaptic terminals could serve as substrates (Pr and TauD, where Pr is a release probability and TauD a time constant of recovery from depression) for associative STM. This provides a mechanism to rapidly recombine LTM representations for adaptation to new tasks and enables dynamic reconfiguration of network computation, opening a temporal window between LTM and STM to selectively incorporate new information based on the established modeling framework in Aihara lab (Xu et al., 2024). To test this idea, we have developed a dual-store recurrent neural network (DSRNN) model that incorporates key features of the "pushing" effect (in prep).



- Deliverable: Dual-Store Recurrent Neural Networks for Flexible Multitask Computation.

(10) Dynamics inside brain and artificial intelligence

- Principle of the brain: Intrinsic brain dynamics reflect cognitive and behavioral traits. For example, in collaboration with Professor Sanes at Brown University, Watanabe lab reported a link between early signs of Alzheimer's disease and atypical intrinsic neural dynamics of the default mode network (Murai et al., 2024). Using energy landscape analysis (see a review by Watanabe; Masuda et al., *PLOS Complex Systems*, in press), they also found that the rigidity of whole-brain neural dynamics underpins multiple autistic symptoms and autistic unique intelligence (Watanabe & Rees, *Nature Commun*, 2017; Watanabe & Yamasue, *Nature Neurosci*, in press). Moreover, they revealed that the flexible but often unstable cognition seen in children with ADHD was attributable to their overly flexible brain dynamics (Watanabe & Watanabe, 2023).

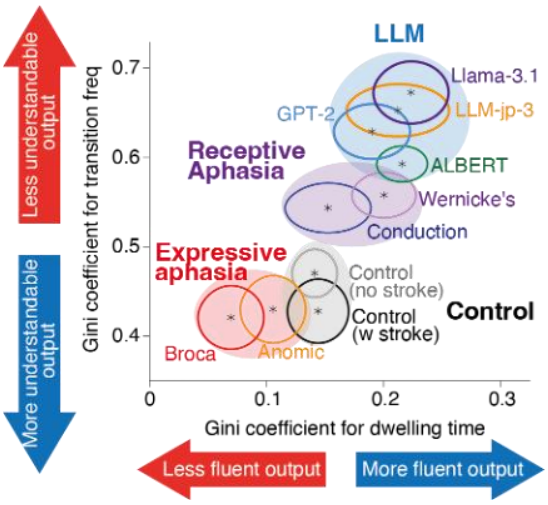


Furthermore, by combining energy landscape analysis with whole-brain functional ultrasound neuroimaging, Hensch, Gotoh, and Watanabe labs recently found that this analysis captures qualitatively the same atypical brain dynamics across different species: genetically-induced autistic mice showed the rigid brain dynamics as seen in autistic humans; such neural rigidity observed in the mice was associated with their autistic behaviors. These observations indicate that collective brain dynamics estimated by ELA could provide a critical perspective to understanding fundamental brain mechanisms that determine intelligence beyond species.

- Gaps in current AI: Current deep neural network dynamics are a black box and unexplainable. Consequently, we often have to evaluate its performance simply based on its series of outputs.

- Brain-inspired AI: As it has linked humans to mice, ELA could be a tool to compare AIs and HI along a common axis, which would help us to understand traits of the internal information processing in the AIs. We have recently demonstrated this by comparing internal neural network activity in large language models (LLMs) with the brain dynamics of aphasic humans (Watanabe, Nakajima, Kuniyoshi, Aihara labs, *Adv Sci*, in press). Watanabe, Nakajima, Kuniyoshi and Aihara labs first examined the brain dynamics of humans with/without various aphasia and identified two indices to distinguish them: one index correlated with speech fluency, and the other indicated how understandable the outputs were.

Then, this team applied the same analysis to deep neural network activity internally occurring in representative LLMs (Google ALBERT, Meta Llama and OpenAI GPT) and found that all the LLMs could be located at places with high speech fluency but poor understandable outputs. These locations were close to receptive aphasia, in which individuals tend to make nonsensical speech fluently. These results indicate that energy landscape analysis could be a tool to investigate the internal information processing in AIs, which would allow us to evaluate the quality of AIs based on their internal mechanisms and make it more speedy to sophisticate AIs in our intended manner.



- Deliverable: Diagnostic tools for LLMs

3. Realizing an International Research Environment

* Describe what's been accomplished in the efforts to raise the center's recognition as a genuine globally visible research institute, along with innovative efforts proactively being taken in accordance with the development stage of the center, including the following points, for example:

- Efforts being developed based on the analysis of number and state of world-leading, frontline researchers (in Appendix 2); exchanges with overseas entities (in Appendix 4); number and state of visiting researchers (in Appendix 5)
- Proactive efforts to raise the level of the center's international recognition
- Efforts to make the center into one that attracts excellent young researchers from around the world (such as efforts fostering young researchers and contributing to advancing their career paths)

3-1. Center's record of attracting and retaining world-class researchers from abroad

Due to the departure of several junior PIs who secured "tenure" opportunities elsewhere towards the end of FY2023, only two of twelve (17%) remaining PIs are non-Japanese. Twelve out of sixty-one (20%) Affiliated Faculty (AF) are foreign as are four of sixteen (25%) Associate Research Fellows (ARF). Among trainees, four of seventeen Research Fellows (24%) and twenty-two of thirty-four (65%) Postdoctoral Fellows from abroad. To strengthen research capacity with institutional diversity, IRCN made international open calls for AI Incubator researchers and a University Research Administrator (URA) in FY2024, attracting diverse candidates and successfully recruiting new foreign scientific members enriching the Center's international working environment into the next fiscal year.

3-2. Center's record of holding international symposia, training courses, retreat, seminar series and others

As COVID-19 came to an end, IRCN restarted opportunities for face-to-face research meetings and outreach activities in FY2024. Our flagship Neuro-Inspired Computation Course was revived in July after a long hiatus for young researchers from both domestic and international institutions, successfully attracting two new international sponsors (i.e., Chen Institute and Frontiers journal). In October, a kickoff Symposium for the new Alliance for Brain Science (UTokyo-Teikyo-RIKEN) was open to the general audience with simultaneous translation. In December, IRCN faculty and trainees traveled abroad to host the MOU signing and IRCN-CNR-Scuola Normale International Symposium in Pisa, Italy. In January, we held the Kavli IPMU - ELSI - IRCN WPI Centers' Joint Symposium. We also conducted many other outreach activities for the general public (details below in 6. Others), including visiting tours by high school students from overseas and a neurodiversity (DEI) film viewing event with the author and director from Italy.

To stimulate our international research environment, we conducted this year again "IRCN Retreat" and continued our weekly hybrid (combination of in-person and online) seminar series "Salons". Regarding the retreat, DD Gotoh and WG members designed the time to inspire new ideas, motivation and aspirations, with the goal of fostering interdisciplinary collaboration and creation of novel joint research initiatives. Free exchange of opinions and knowledge sharing in a relaxed setting distinct from the usual workplace stimulated meaningful personal growth of early-career researchers while fostering collaborative research networks among 70 participants across different laboratories, ultimately contributing to bottom-up advancement of IRCN science and technology, highlighted by the selection of Retreat Brainstorming Awards (more below). Regarding the weekly seminars, thirty-eight such International "Science Salons" were held in FY2024, typically attracting 35-50 participants (every Wednesday @11 am). Forty-three of these speakers (58%) were international or speaking from abroad, one of whom IRCN further nominated to the 2nd Symposium × International Career Seminar organized by the UTokyo graduate training program on the Forefront Physics and Mathematics Program to Drive Transformation (FoPM) and other specialists for an ELSI talk (external) and Faculty Developmental (internal FD) seminar in English.

3-3. Overseas partnerships and collaborative interactions

Apart from the official IRCN Satellite Institution at Boston Children's Hospital, our formal global research network of fifteen overseas and four domestic partner institutions was sustained and expanded to include the Scuola Normale Superiore di Pisa and IMT School for Advanced Studies Lucca, Italy.

For brain circulation, thirty visiting guest researchers from abroad were hosted through the IRCN Guest Researchers Invitation Program, including tenured professors from Brown Univ (US), Nanyang Technological Univ (Singapore), Imperial College London (UK), Univ of British Columbia (CA), Univ of Sydney (AU), to name a few.

4. Making Organizational Reforms

* Describe the system reforms made to the center's research operation and administrative organization, along with their background and results.
* Describe the measures you've taken and results achieved in implementing the center's gender-balance plan. Describe also your measures/results for fostering researchers with a view to achieving your gender plans and for conducting domestic and international promotion activities to attract female researchers to the center.

* If innovated system reforms generated by the center have had a ripple effect on other departments of the host institutions or on other research institutions, clearly describe in what ways.
* Describe the center's operation and the host institution's commitment to the system reforms. (Include measures taken by the host institution to provide a support system and to work toward improving the environment for achieving gender balance.)

4-1. System reforms advanced by WPI program and their ripple effects

Since its establishment under the UTokyo Institutes for Advanced Study (UTIAS), IRCN management and governance operate with complete autonomy and independence, allowing the Center to make its own decisions on personnel affairs and budgeting without interference from UTokyo HQ.

4-1-1. Management system in the center

High-level management of scientific activity and personnel recruitment continues to be overseen by a structure of three complementary 'Offices' as below. Each led by a Deputy Director (DD), is designed to intersect the top-down leadership from the Director, and bottom-up proposals from PIs with professional assistance by IRCN Administration under strong support from UTokyo HQ.

- *Sustainability Office* (DD Kazuo Emoto): manages support, infrastructure and personnel, including WPI budget, grant proposals, strategic recruitment with an emphasis on diversity. To continuously attract talented researchers from around the world, it provides flexibility in salary setting, including merit-based pay increases with rigorous evaluation and appraisal.
- *Synergy Office* (DD Kenichi Ohki): promotes research fusion and Team Science, managing Salons proposed by the Director, PIs and Community Office to foster research fusion.
- *Community Office* (DD Yukiko Gotoh, as of FY2024): coordinates education and outreach activities, such as retreats, summer course, career opportunities for trainees, public events, international workshops, and logistical support for international visitors. The focus on DEI was reinforced by DD Yukiko Gotoh, who also sits on the all- UTokyo D&I committee.

In addition, to provide agile oversight of day-to-day issues spanning academic, technical, and administrative matters, the *Director's Office* (DO) consists of Director Hensch, Special Advisor to the Director (SAD) Dr. Masamitsu Iino and General Manager (GM) Mr. Mitsuhiro Matsumoto of the Administrative Office and newly rejoined Administrative Director (AD) Dr. Mayumi Kimura.

Decision-making structure

IRCN follows a monthly two-step decision-making process. First-stage Executive Board (EB) Committee comprised of D, AD, SAD, DDs and Executive Director (ED) Dr. Kazuyuki Aihara, makes budget plans, considers space allocation, strategic new hiring, initiates MoUs with new collaborative partners, proposes amendments to IRCN Bylaws, and so forth. The EB role in the Center's management system is quite unique compared to other Departmental operating structures in UTokyo.

Second-stage IRCN Steering Committee (SC) makes final decisions and approvals by all PIs as full-voting members, joined by IRCN core facility managers as observers. This ensures that all important decisions and the exchange of underlying concepts are communicated in a timely, efficient and transparent manner each month. It effectively facilitates the proactive participation of PIs and Core Managers in a wide range of activities led by the Sustainability, Synergy and Community Offices.

4-1-2. Core facilities

Four Core Facilities (ES-Mouse/Virus, Imaging, Data Science, Human fMRI) continue to provide professional, cost-effective, and rapid access to research services and cutting-edge technologies. Core Director, PI Haruo Kasai, serves as the key driver formulating the future of the core facilities, including appropriate budgeting through a planned expansion of their services to IRCN researchers, AF, ARF and other collaborators. All core facilities are located in the Faculty of Medicine Building No.1, easily accessible to all IRCN members and guests under a quasi-under-one-roof arrangement.

4-1-3. New approaches that can be rippled to other departments:

a) Internal grant system for young researchers

• Team Science Catalyst Grants FY2024 (led by Sustainability Office):

In response to WG Site Visit suggestions, a seed Grant system was initiated by the Director for each Team Science (5~10M JPY) with priority given to collaboration startup funds for young researchers. It follows the Director's original plan (interrupted by COVID19) to award start-up funds to junior scientists who presented unique multi-disciplinary fusion research ideas at Science Salon in the WPI spirit. Eight proposals (two each from Predictive Coding, Neuromodulation, Critical Period, and Social Learning Teams) were highly evaluated by the EB and approved to be funded. These seeds are expected to bear fruit by facilitating further collaboration with AF members who officially belong to other departments across UTokyo.

• Retreat Brainstorming Awards FY2024 (led by Community Office):
Young scientists were encouraged to submit proposals based on open discussion during the FY2024 Retreat (up to 800,000 JPY/proposal). The committee funded eight (of nine) collaboration proposals. This type of small-scale grant allows young scientists to immediately pilot small experiments or recruit additional probands and will continue into FY2025 with earlier calls to increase the number of IRCN Retreat attendees and stimulate interactions among colleagues.
• Pilot-research support (rescue) grant (led by AD and research-support administration rTeam):
To promote mentorship, AD and rTeam initiated a type of rescue funds for young researchers whose Kakenhi and other grant proposal efforts were unfortunately not awarded. The purpose is to encourage them to resubmit Kakenhi as well as other grants (e.g., Sakigake or Act X) in coming years and also to train them to write more effective proposals with compelling preliminary results. Reviews of applications were conducted by AD and rTeam members with interviews to evaluate their proposals, and two were highly qualified for full funding.

b) Affiliated PI and Visiting Professors for AI Incubator
To revitalize the AI Incubator, IRCN introduced two new official appointments. Three "Affiliated PIs" were nominated and approved by EB and SC from the existing list of UTokyo AFs (Nakayama, Takahashi, Nakajima) who had been most vigorously collaborating with IRCN PIs in developing neuro-inspired AI. Three more from outside UTokyo were given the title of "Visiting Professor" (AF Ishii, Kyoto University; AF Tanaka, Nagoya Tech University; and newly, Dr. Eugene Izhikevich, CEO Brain Corp, San Diego, CA). All AI Incubator Affiliated PIs have recruited young scientists to sit in IRCN and facilitate interaction with Team Science that innovates understanding HI through novel AI.

c) Supporting academic organization
UTokyo opened the opportunity to actively support academic societies, such as providing personnel to help co-host annual conferences. One of the very first examples on campus was IRCN-coorganized 24th Congress of the Japanese Society of Baby Science, held at Fukutake Hall, UTokyo (President, PI Nagai and Vice President, AF Tsuji). By co-sponsoring this congress, IRCN administrators learned how to handle larger-scale international events, diverse circumstances and finance management systems of professional organizations.

4-2. Improving the environment toward Center gender balance
Truly global, cutting-edge, and interdisciplinary research requires the collaboration of researchers with diverse backgrounds and expertise. Since its inception, IRCN has made active efforts to recruit diverse members in terms of nationality, cultural background, native language, research field, and gender. Despite being launched in UTokyo where female PI role models were scarce (only 6.8% of full professors were female in 2017), IRCN successfully attracted 27% female faculty (4 of 15 PIs as of FY2023) through the devoted commitment by the Director. To further offer gender role models, the Director appointed a female AD and a new female DD (alongside two others) as of FY2024, increasing the number of women in Center leadership above 40%. Most importantly, enduring financial support from UTokyo beyond 2027 was secured to enable career growth at IRCN – a severe limitation that led to the departure of three diversity PIs for tenured positions elsewhere in FY2024.

As leader, the Director is ever mindful of group composition (e.g., computation course participants, grant awardees, Salon speakers, etc) for equal opportunities across gender and diverse background. The administration led by the new AD further renewed the nursing space within IRCN, located near the IRCN Babylab. Toxic staff and workplace atmosphere were directly addressed at IRCN by holding mandatory DEI and harassment prevention trainings, which are surprisingly not mandatory within UTokyo. Meanwhile, UTokyo has started to screen all harassment records for new employment in order to preserve a safe workplace environment for gender balance.

5. Efforts to Secure the Center's Future Development over the Mid- to Long-term
* Address the following items, which are essential to mid- to long-term center development:
- Future prospects with regard to the research plan, research organization and PI composition; prospects for achieving gender balance; prospects for fostering and securing of next-generation researchers.
- Prospects for securing resources such as permanent positions and revenues; plan and/or implementation for defining the center's role and/or positioning the center within the host institution's institutional structure
- Measures to sustain the center as a world premier international research center after program funding ends
- Host institution's organizational reforms carried out for the center's autonomous administration simultaneously with the creation of the center.

5-1. Future prospects with regard to the research direction and PI composition including

gender balance issues: Tenure criteria

Following successful financial negotiation by the Director with UTokyo President and EVPs, the EB proceeded to set forth the specific tenure process in a new Bylaw "Arrangement for selection of a tenured Principal Investigator of the IRCN". As part of UTIAS, IRCN is a completely independent Center with autonomy to establish our own criteria and judging system for tenure selection. As a WPI center, we have taken a more international approach. Based on other Western institutions, our process is quite distinct from that of host UTokyo School of Medicine conclave model. Beyond publication track record, tenure criteria emphasize contribution to our unique interdisciplinary fusion research (Team Science) and global visibility. As in the US, numerous external reference letters are collected (EB discussion eventually settling on 10-15 letters) with special instructions for the writers. Other important criteria are related to our Center's ecosystem, like significant fundraising and community aspects (e.g., active participation in working groups, teaching, DEI, outreach activity). Eligible project PIs were notified and invited to apply voluntarily. Thus, IRCN completed its first tenure evaluation in November 2024, with resources secured from our successful budgetary request to the government in FY2023. Following eligible SC member's approval by voting, the Director bestowed a tenured Full Professor position to PI Watanabe starting January 2025.

5-2. Prospects for securing resources

Our successful special budgetary request in FY2023 yielded two permanent positions (Full/Assistant Professor) to lead an Athlete Cognitive Neuroscience Program starting FY2024. After tenure review, PI Watanabe qualified for full Professorship and appointment of an Assistant Professor is underway. In FY2024, IRCN submitted a new special budgetary request another permanent position in the area of cross-cultural social learning. While unsuccessful, this initial proposal was revised and resubmitted with support from other departments (Information Science/Technology and Engineering) to attract senior female scientists to partner across our international networks.

Further, as UTokyo HQ has committed to maintain IRCN as a permanent institute within the UTIAS on the valuable input of the WPI Committee in FY2023. To this end, EVPs Hiroaki Aihara, Nobuhito Saito and D Hensch signed a written agreement in March 2024 on the stepwise increase of UTokyo budget to be allocated to IRCN up to steady-state (¥500 million/year) beyond FY2027.

5-3. Measures to sustain the Center as a WPI research center after funding ends

The WPI subsidy (¥700 million/year) accounts for ~37% of the total IRCN annual budget, gradually weighing less as PIs succeeded in obtaining further competitive research funding. In FY2024, personnel expenses consumed ~¥300 million/year from WPI (36% of total) with 35% and 29% of costs covered by external research grants and UTokyo President's special fund, respectively. Due to this significant growth by successful acquisition of competitive research funds, the President's special commitment (above) of ¥500 million/year in perpetuity ensures IRCN can be sustained without reducing scale under-one-roof with selected core facilities.

Given this assurance, IRCN formally established the AI Incubator with newly named ED Aihara as lead coordinator. Five most relevant AFs were invited as "Affiliated / Visiting PIs" to mentor a new cohort of computational post-docs at the interface of Team Science. The Director has been actively courting candidate sponsors (Corundum Innovation), corporate partners (Microsoft, Daikin) and stakeholders (Prime Minister's Council on Science, Technology and Innovation, CSTI) interested both in fostering AI entrepreneurship and our AI-based pre-symptomatic mental health prediction, diagnosis, and treatment strategies in particular. Since foreign partners scrutinize gender balance, EB membership was reorganized in FY2024 to meet global leadership standards. Training courses in FY2025 were designed alongside sponsors to attract international recruits to IRCN in both Neuro-inspired Computation (Chen Institutes, Frontiers) and entrepreneurship (Corundum).

5-4. Host institution's organizational reforms

Major reforms by UTokyo are seen at IRCN in two areas. First, regarding the personnel system, IRCN and Kavli-IPMU employ a system of flexible salary setting and quick/autonomous decision-making for acquiring international talent, totally different from other departments. This system has now been applied to other newer institutions, e.g., UTOPIA (also UTIAS), which is essential to attract a world-caliber Director, AD, and PI candidates. Second, establishing a bilingual administration was novel and essential, as the official language is English in WPI centers. The cadre of English-speaking admin staff (now >50%) who are allocated by the university has increased with WPI-employed bilingual staff members >80%. While the pace of gender balance remains slow, these lessons from 7.5 years of IRCN reform have inspired the all-UTokyo concept of "College of Design" and the application of "University for International Research Excellence." If the latter is funded, a new Life-Sciences building will be built as home to IRCN and its "core facilities" made broadly available.

6. Others

* Describe what was accomplished in the center's outreach activities last year and how the activities have contributed to enhancing the center's "globally visibility." In Appendix 6, describe concretely the contents of these outreach activities. In Appendix 7, describe media reports or coverage, if any, of the activities.
* In addition to the above 1-5 viewpoints, if there is anything else that deserves mention regarding the center project's progress, note it.

In FY2024, as the COVID-19 pandemic came to an end, IRCN continued to take precautionary measures while expanding its range of activities for researchers both within and outside the institution, events for middle and high school students and for those generally interested in brain. Additionally, we held events to promote Diversity, Equity & Inclusion (DEI). Collectively, these activities significantly contributed to enhancing the Center's global visibility, fostering international collaboration, engaging a broader audience, showcasing the importance / joy of science to society.

6-1. International Symposia

In the second half of FY2024, international IRCN symposia were held both in Japan and abroad. First, the Alliance for Brain Science Inaugural Symposium, entitled "Exploring the Universe of the Athlete's Brain: New Challenges in Cognitive Neuroscience" was held on October 29, 2024 at UTokyo. This event introduced the significance and future plans of the new Brain Alliance on Athlete Cognitive Neuroscience, linking IRCN, RIKEN Center for Brain Science and the Teikyo University Advanced Comprehensive Research Organization. It featured scientists, sports professionals and ~200 participants.

From December 16 to 18, 2024, lab tours and a symposium were held at the Scuola Normale Superiore (SNS) in Tuscany, Italy, fostering new research exchange and international collaboration between IRCN, SNS and CNR. The symposium took place in the historic auditorium of the Palazzo della Carovana, a site with over 460 years of scientific heritage dating back to Galileo. This significant event featured dynamic talks, posters and discussions by ~75 participants spanning diverse fields from human to animal models, and from basic to clinical research. Among these diverse research topics, participants addressed fundamental questions about brain development and learning, as well as shared interests in research techniques and theoretical frameworks. The symposium proved particularly inspiring early-career researchers, offering valuable opportunity to encourage future collaborations and exchange.

6-2. Nurturing Next-Generation Researchers

The IRCN and Chen Institutes restarted "Neuro-Inspired Computation Course" on the convergence of natural and artificial intelligence to equip graduate students and early career researchers with the skills and knowledge to lead future scientific innovation, providing cutting-edge training in the latest research methodologies and technologies. Led by the Director and WG, five IRCN faculty and eight international speakers lectured for 5 days in July, 2024, which attracted ~110 researchers and students from 16 countries. Lectures covered interdisciplinary research in areas such as intrinsic dynamics, network architecture, prediction, plasticity and criticality, multi-agent learning and neuromodulation. Participants were deeply engaged, highlighted by meaningful Q&A sessions. In addition to lectures and discussions, a casual atmosphere at receptions, lab tours, cultural experiences (yakata boat), poster sessions and networking events, encouraged the exchange of opinions in a relaxed setting. This valuable time was used to build research and personal connections across borders, laying future international recruitment.

6-3. Outreach activities for the public

Four outreach events were organized for the general audience. On October 19, 2024, at the Hongo campus "UTokyo Home Coming Day" IRCN featured exhibitions of research achievements and interactive programs. On January 9, 2025, at the UTokyo Sanjo Conference Hall, we hosted a film screening of "*My brother chases dinosaurs*" and rare live chat with the author Giacomo Mazzariol. This movie and book about growing up with a brother who has Down's Syndrome, led to poignant discussion with the families of neurodiverse individuals and experts, focusing on social issues related to neurodiversity and stigma from a DEI perspective. Next was a joint series co-hosted together with Kavli-IPMU and ELSI, entitled "the Origin" under the scope of ancient Greek philosophy and art focusing on the unique approach of basic science. Finally, a series of lectures was held in collaboration with Knowledge Capital on February 4 and 18, 2025, during the "SpringX Supper School." The lectures introduced "The Fascinating World Inside Living Cells" by PI Yasushi Okada, which explored the visible world of cells, and "Focusing on the Fundamental Differences Between the Brain and Artificial Intelligence, Approaching the Origins of the Mind" by PI Haruo Kasai, which delved into the invisible world of the mind. These four popular events attracted even larger audiences than anticipated. To nurture future scientists, we also organized several more events targeting middle and high school students both locally and internationally. In FY2024, two online lectures and three high school Lab Tours were conducted to inspire future "Neurointelligence" researchers.

7. Center's Response to Results of Last Year's Follow-up

* Transcribe the item from the "Actions required and recommendations" section in the site visit report and the Follow-up report, then note how the center has responded to them.
* If you have already provided this information, indicate where in the report.

Actions required and recommendations

1) *Neuro-inspired AI: Revisiting the strategy for neuro-inspired AI is urgent. IRCN should critically examine their approach and strategy toward neuro-inspired AI, considering the rapid progress in the field, and clarify its objectives to maximize its unique contributions at the intersection of neuroscience and AI. The center must clarify its milestones and progresses achieved. It should develop a focused vision that either aligns neuroscience research with modern AI advancements, or pivots towards more approachable directions in AI research. Organizing a workshop to discuss this issue in depth inviting experts from relevant disciplines is recommended.*

Our research plans and progress achieved are fully explained in **Section 2** on pages 5-12, and they are summarized below.

IRCN has been advancing brain-inspired AI research by establishing Team Science and AI Incubator systems. In FY2024, we named five Affiliated Faculty (AF) members who have made significant contributions as AI Incubator Affiliated / Visiting PIs to further strengthen our research capabilities under-one-roof. Currently, based on new neuroscientific insights gained at IRCN, we are conducting research in ten projects, broadly classified into three categories: Brain-Inspired Reservoir Computing, Brain-Inspired Learning Algorithm, and Brain-Inspired AI Diagnosis. Principles of brain function identified by IRCN Team Science are applied to current AI as follows.

- Brain-Inspired Reservoir Computing: Reservoir computing (RC) has recurrent connections, inspired by the network in the brain and offers a computationally efficient machine learning framework by limiting the number of trainable parameters and using simple learning algorithms compared to deep learning. The reduction in the computational time for model training leads to energy efficiency. Although the simple architecture of RC allows fast and energy-efficient learning, the learning performance is sometimes inferior. We overcame this shortcoming by applying novel characteristics of the brain (E-I balance, spontaneous noise and predictive signals for computation, parallel processing, and extremely low energy using spiking neurons) to RC.

- Brain-Inspired Learning Algorithm: The learning algorithms used in current AI, such as Hebbian learning and reinforcement learning, are largely inspired by neuroscience findings from decades ago. We aim to incorporate more recent insights into neural plasticity across multiple levels of organization into the following four areas: (1) "mental" simulation with limited data to refine internal models, (2) multi-agent learning, (3) learning to balance generalization and discrimination across multiple objectives, and (4) exploring a novel learning rule based on mechanics-driven synaptic plasticity, specifically synaptic "pushing".

- Brain-Inspired AI Diagnostics: Energy landscape analysis extracts a biologically understandable illustration from complex and spatiotemporally high-dimensional whole-brain neural data obtained by functional MRI. We applied the same analysis to deep neural network activity internally occurring in representative LLMs (Google ALBERT, Meta Llama and OpenAI GPT) and found that all the LLMs could be located at places with high speech fluency but poor understandable outputs. These locations were close to receptive aphasia, in which individuals tend to make nonsensical speech fluently. Thus, this analysis would allow us to evaluate the quality of AIs based on their internal mechanisms and make it speedier to sophisticate AIs in our intended manner.

Furthermore, Neuro-inspired Computation course was rekindled post-COVID, inviting experts from relevant disciplines, discussing the issues about neuro-inspired AI, and attracting many talented students and speakers.

2) *Origin of human intelligence: IRCN should clearly describe its progress and overall strategy toward understanding the origin of human intelligence. We strongly recommend that the center develops a grand design and research strategy to elucidate the origin of human intelligence.*

Translational research into mental illness provides a powerful framework for understanding how HI arises. Bridging molecular, neural, behavioral and computational studies across species not only advances novel biomarkers and treatments for mental disorders but also illuminates the neural and genetic architecture of intelligence itself. Pioneering work at IRCN has yielded integrated progress in several key areas:

- Excitatory-inhibitory (E-I) balance: inhibitory circuit maturation drives critical periods of brain plasticity (Reh et al, *PNAS* 2020), underlying the rapid acquisition of new skills in development. Manipulations of E-I balance in mouse models reliably shift the timing of such trajectories and was notably verified in humans in a longitudinal study of infants at BCH repeatedly exposed to GABA-active anesthetics (Gabard-Durnam et al, in press). Moreover, these pivotal fast-spiking cells are hubs of vulnerability in mental illness. Yet remarkably, AI currently ignores inhibition. The Critical Period Team (PIs Hensch, Aihara) showed the importance of E-I balance for maximal memory capacity and efficient learning by reservoir computing (Kanamaru et al, 2023, 2025) – supporting low energy consumption in HI especially with spiking neurons (Sakemi et al; Zhang et al, 2024).

- Robustness to noise: the brain is constantly active even without sensory input, yet our perception remains quite stable. Instead, performance by artificial deep neural networks is easily degraded by noise. Recording calcium signals along stages of the visual pathway in marmosets, PI Ohki's group revealed that an orthogonal (i.e., independent) relationship between the brain's internal noise and stimulus-evoked signals gradually emerges along the visual hierarchy (Matsui et al, *Nat Comms* 2024). This explains how stability of human sensory perception is possible and suggests novel strategies for noise-resistant AI.

- Cognitive flexibility: fluid and flexible 'mind-wandering is a defining feature of HI that is impaired in mental illness and famously lacking in AI. PI Chao's lab has provided insight into the "Aha!" moment when a previously incomprehensible problem/concept suddenly becomes clear and obvious. High-resolution brain network dynamics during unconscious neural navigation may inspire both environments to foster it in HI and novel predictive AI architectures. PI Watanabe elaborated energy landscape analysis (ELA) as a powerful computational approach that faithfully captures intrinsic brain dynamics in an unbiased manner. Applying ELA across modalities (MRI, EEG), his lab could not only detect but also relieve rigidity of thought in autistic subjects, using real-time targeted brain state-dependent feedback (Watanabe & Yamasue, *Nat Neurosci*, in press). With other Critical Period Team members (PIs Hensch, Gotoh), ELA was fruitfully applied to whole-brain data using innovative functional ultrasound (fUS) imaging in mouse models (*Shank3*$^{+/-}$, social isolation) to further probe circuit mechanisms. This further inspired a creative application of ELA to diagnose artificial LLMs in collaboration with AF Nakajima and PI Aihara (Watanabe et al, *Adv Sci* 2025), showing that LLMs lie beyond Wernicke's aphasia in poor language comprehension despite hyperfluency. Thus, ELA has proven to be a robust *lingua franca* for detecting intrinsic dynamics across species and AI.

- Attention / sleep: attention underpins most higher cognitive functions in HI (problem-solving, learning, social behavior, etc). The Critical Period Team identified a postnatal window when caregiving quality determines lifelong attentional capabilities (Makino et al *Sci Transl Med* 2024). Parental neglect during this window adversely impacted both mice and human children mediated by persistent sleep impairment. In mice, this was linked to dopamine (D2/D4) receptor imbalance specifically within ACC, which could be rescued in adulthood pharmacologically (patent pending). Moreover, in cross-WPI collaboration PI H Kasai and IIIS demonstrated that slow-wave power and sleep amount is increased by broad prefrontal synaptic potentiation even when sleep need is minimal (Sawada et al *Science* 2024). Together, these findings reveal for the first time how experiences along the lifecourse shape cognitive capacities tied to HI and a role for sleep in AI.

- Sex differences: sex biases are prevalent in disorders of HI, but AI is gender neutral. The impact of early life stress on attention (above) or juvenile social isolation stress on brain structure in adolescent mice by PI Emoto's group (Sazhina et al, *NeuroImage* 2025) was found to be sex-dependent. Varied exposure to adversity and sex-specific resilience mechanisms may explain individual differences in cognitive abilities. For harmonious alignment, HI-AI must better appreciate how intelligence arises not solely from genetics but from dynamic interactions between biology, sex and experience during development.

3) Organization reform: UTokyo has a responsibility to show bold and ambitious actions for organization reform as a Japan's leading university by using two WPI centers.

IRCN is part of The University of Tokyo Institutes for Advanced Study (UTIAS), a unique organization that actively promotes UTokyo's world-class research and strives for its application to the benefit of society. Apart from sibling WPI, Kavli-IPMU, UTIAS is comprised of two other institutes: Tokyo College and The University of Tokyo Pandemic preparedness, Infection and Advanced research center (UTOPIA). From its inception on January 1, 2011, UTIAS provides autonomy and independence to each institution for their governance that has allowed WPI-IRCN to make its own decisions, as described in the sections of 5-1 and 5-4. All new attempts learnt from both IRCN and Kavli-IPMU are reflected in the UTokyo's new initiative to start College of Design (https://design.adm.u-tokyo.ac.jp) from autumn 2027, where all courses are taught in English for international students. This is a major reform that will emphasize UTokyo's obligation, reforming administrative organizations equipped with strong international capabilities and creating a new, diversity- and internationalization-conscious personnel system that supports the recruitment of world-class talent, fosters young international researchers, and ensures a vibrant intellectual environment as WPI Centers operate daily.

4) Diversity: Diversity is not satisfactory and should be improved as a priority challenge. IRCN should continue its effort to add PIs with diversity in both internationality and gender in mind.

To converge on a new discipline, one must first have diversity. UTokyo had limited experience with diverse faculty recruitment, and even less so for retention. After a strong launch with seven diversity PIs (4 female, 3 foreign), three left for tenured posts elsewhere at the end of FY2023. This reflected pandemic isolation and delayed tenure path establishment, despite a UTokyo IRCN Taskforce created in January 2022 immediately following midterm review (grade: A+). Consequently, UTokyo has promised to permanently support IRCN under the UTIAS umbrella as an independent center beyond 2027, enabling tenure procedures and long-term fundraising efforts. Mandatory DEI training was introduced and toxic staff replaced. Gender balance, at the EB level now exceeds 40%, by strategic appointment of DD Yukiko Gotoh and AD Mayumi Kimura replacing two male members. Only three female ADs are found among 18 WPI Centers; two of whom are at UTokyo (Kavli-IPMU, IRCN), reflecting UTokyo's policy to accelerate the growth of female leadership.

5) Graduate education and fostering young scientists: Access to students in other schools including physical sciences and engineering is still limited. Stronger initiatives are needed to obtain cross-appointments for junior project PIs in appropriate departments.

The Graduate School of Medicine of UTokyo agreed to offer teaching appointments starting FY2024. Three junior project PIs who had been initially hired with WPI funds now have visible access to graduate students. Other graduate schools (e.g., science, engineering) have been slow to follow. However, the promised operating budget after the 10^{th} year from UTokyo HQ secures autonomy for tenure without cross-appointment. In addition, IRCN established a new Affiliated PI system, appointing three non-medical UTokyo faculty members and two from other universities, under one roof. This allows our core PIs to collaborate tightly with Affiliated PIs to welcome young scientists who belong to other graduate courses into the unique IRCN Team Science ecosystem. We anticipate this practical path will erode the barriers to other schools within UTokyo.

Appendix 1　FY 2024 List of Center's Research Results and Main Awards

1. Refereed Papers

- List only the Center's papers published in 2024. (Note: The list should be for the calendar year, not the fiscal year.)

(1) Divide the papers into two categories, A and B.
  A. WPI papers
    List papers whose author(s) can be identified as affiliated with the WPI program (e.g., that state "WPI" and the name of the WPI center (WPI-center name)). (Not including papers in which the names of persons affiliated with the WPI program are contained only in acknowledgements.)
  B. WPI-related papers
    List papers related to the WPI program but whose authors are not noted in the institutional affiliations as WPI affiliated. (Including papers whose acknowledgements contain the names of researchers affiliated with the WPI program.)

    Note: On 14 December 2011, the Basic Research Promotion Division (the Basic and Generic Research Division at present) in MEXT's Research Promotion Bureau circulated an instruction requiring paper authors to include the name or abbreviation of their WPI center among their institutional affiliations. From 2012, the authors' affiliations must be clearly noted.

(2) Method of listing paper
- List only refereed papers. Divide them into categories (e.g., original articles, reviews, proceedings).
- For each, write the author name(s); year of publication; journal name, volume, page(s) (or DOI number), and article title. Any listing order may be used as long as format is consistent. (The names of the center researchers do not need to be underlined.)
- If a paper has many authors (say, more than 10), all of their names do not need to be listed.
- Assign a serial number to each paper to be used to identify it throughout the report.
- If the papers are written in languages other than English, underline their serial numbers.
- Order of Listing
  A. WPI papers
    1. Original articles
    2. Review articles
    3. Proceedings
    4. Other English articles

  B. WPI-related papers
    1. Original articles
    2. Review articles
    3. Proceedings
    4. Other English articles

(3) Submission of electronic data
- In addition to the above, provide a .csv file output from the Web of Science (e.g.) or other database giving the paper's raw data including Document ID. (Note: the Document ID is assigned by paper database.)
- The papers should be divided into A or B categories on separate sheets, not divided by paper categories.

(4) Use in assessments
- The lists of papers will be used in assessing the state of WPI project's progress.
- They will be used as reference in analyzing the trends and whole states of research in the said WPI center, not to evaluate individual researcher performance.
- The special characteristics of each research domain will be considered when conducting assessments.

(5) Additional documents
- After all documents, including these paper listings, showing the state of research progress have been submitted, additional documents may be requested.

A. WPI papers
(1) Original articles

1. Yang, YW; Zhang, CM; Liu, ZN; Aihara, K; Zhang, CC; Chen, LN; Wei, W, 2024, BRIEFINGS IN BIOINFORMATICS, 26(1), bbae608, http://dx.doi.org/10.1093/bib/bbae608, WOS:001361915000001, MCGAE: unraveling tumor invasion through integrated multimodal spatial transcriptomics

2. Sakemi, Y; Nobukawa, S; Matsuki, T; Morie, T; Aihara, K, 2024, COMMUNICATIONS PHYSICS, 7(1), 29, http://dx.doi.org/10.1038/s42005-023-01500-w, WOS:001142019600001, Learning reservoir dynamics with temporal self-modulation

3. Fujita, T; Li, AH; do, QV; Otsuka, T; Jeong, SG; Hwang, WJ; Takesue, H; Inaba, K; Aihara, K; Hasegawa, M, 2024, IEEE ACCESS, 12, 136011-136024, http://dx.doi.org/10.1109/ACCESS.2024.3450539, WOS:001327281400001, Applying Coherent Ising Machines for Enhancing Communication Efficiency in Large-Scale UAV-Aided Networks

4. Otsuka, T; Li, AH; Takesue, H; Inaba, K; Aihara, K; Hasegawa, M, 2024, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, 73(1), 707-723, http://dx.doi.org/10.1109/TVT.2023.3300920, WOS:001166813500059, High-Speed Resource Allocation Algorithm Using a Coherent Ising Machine for NOMA Systems

5. Peng, H; Chen, P; Yang, N; Aihara, K; Liu, R; Chen,LN, 2024, NATIONAL SCIENCE REVIEW, nwae441, https://dx.doi.org/10.1093/nsr/nwae441, One-core neuron deep learning for time series prediction

6. Masuda, N; Aihara, K; MacLaren, NG, 2024, NATURE COMMUNICATIONS, 15(1), 1086, http://dx.doi.org/10.1038/s41467-024-45476-9, WOS:001227314600040, Anticipating regime shifts by mixing early warning signals from different nodes

7. Jeong, YD; Hart, WS; Thompson, RN; Ishikane, M; Nishiyama, T; Park, H; Iwamoto, N; Sakurai, A; Suzuki, M; Aihara, K; Watashi, K; op de Coul, E; Ohmagari, N; Wallinga, J; Iwami, S; Miura, F, 2024, NATURE COMMUNICATIONS, 15(1), 7112,

http://dx.doi.org/10.1038/s41467-024-51143-w, WOS:001304522300028, Modelling the effectiveness of an isolation strategy for managing mpox outbreaks with variable infectiousness profiles

8. Kitagawa, K; Kim, KS; Iwamoto, M; Hayashi, S; Park, H; Nishiyama, T; Nakamura, N; Fujita, Y; Nakaoka, S; Aihara, K; Perelson, AS; Allweiss, L; Dandri, M; Watashi, K; Tanaka, Y; Iwami, S, 2024, PLOS COMPUTATIONAL BIOLOGY, 20(3), e1011238, http://dx.doi.org/10.1371/journal.pcbi.1011238, WOS:001190675900001, Multiscale modeling of HBV infection integrating intra- and intercellular viral propagation to analyze extracellular viral markers

9. Nakamura, N; Aihara, K; Iwami, S; Tsubokura, M, et. al. (total 33 co-authors), 2024, PLOS DIGITAL HEALTH, 3(5), e0000497, https://dx.doi.org/10.1371/journal.pdig.0000497, WOS:001417442100001, Modeling and predicting Individual variation in COVID-19 vaccine-elicited antibody response in the general population

10. Ito, MI; Honma, Y; Ohnishi, T; Watanabe, T; Aihara, K, 2024, PLOS ONE, 19(4), e0301462, http://dx.doi.org/10.1371/journal.pone.0301462, WOS:001239204800006, Exogenous and endogenous factors affecting stock market transactions: A Hawkes process analysis of the Tokyo Stock Exchange during the COVID-19 pandemic

11. Xu, MY; Hosokawa, T; Tsutsui, KI; Aihara, K, 2024, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 121(49), e2409487121, http://dx.doi.org/10.1073/pnas.2409487121, WOS:001377404500005, Dynamic tuning of neural stability for cognitive control

12. Ebato, Y; Nobukawa, S; Sakemi, Y; Nishimura, H; Kanamaru, T; Sviridova, N; Aihara, K, 2024, SCIENTIFIC REPORTS, 14(1), 8631, http://dx.doi.org/10.1038/s41598-024-59143-y, WOS:001205253900085, Impact of time-history terms on reservoir dynamics and prediction accuracy in echo state networks

13. Park, H; Yoshimura, R; Iwanami, S; Kim, K; Ejima, K; Nakamura, N; Aihara, K; Miyazaki, Y; Umeyama, T; Miyazawa, K; Morita, T; Watashi, K; Brooke, CB; Ke, R; Iwami, S; Miyazaki, T, 2024EA, ELIFE, 13, RP96032, http://dx.doi.org/10.7554/eLife.96032.1, Stratification of viral shedding patterns in saliva of COVID-19 patients

14. Shen, X; Sasahara, H; Imura, JI; Oku, M; Aihara, K, 2024EA, IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTATIONAL INTELLIGENCE, http://dx.doi.org/10.1109/TETCI.2024.3442824, WOS:001297357600001, Re-Stabilizing Large-Scale Network Systems Using High-Dimension Low-Sample-Size Data Analysis

15. Inoue, D; Yamashita, H; Aihara, K; Yoshida, H, 2024, IEEE ACCESS, 12, 188739-188754, http://dx.doi.org/10.1109/ACCESS.2024.3514162, WOS:001380707700047, Traffic Signal Optimization in Large-Scale Urban Road Networks: An Adaptive-Predictive Controller Using Ising Models

16. Taguchi, Y; Nakaya, T; Aizawa, K; Noguchi, Y; Maiya, N; Iwamoto, C; Ohba, K; Sugawara, M; Murata, M; Nagai, R; Kano, F, 2024, FEBS OPEN BIO, 14(4), 695-720, http://dx.doi.org/10.1002/2211-5463.13784, WOS:001178540500001, Peptide mimetic NC114 induces growth arrest by preventing PKCδ activation and FOXM1 nuclear translocation in colorectal cancer cells

17. Chao, ZC; Komatsu, M; Matsumoto, M; Iijima, K; Nakagaki, K; Ichinohe, N, 2024, COMMUNICATIONS BIOLOGY, 7(1), 851, http://dx.doi.org/10.1038/s42003-024-06545-3, WOS:001266319100001, Erroneous predictive coding across brain hierarchies in a non-human primate model of autism spectrum disorder

18. Huang, YT; Wu, CT; Koike, S; Chao, ZC, 2024, ENEURO, 11(5), 50242024, http://dx.doi.org/10.1523/ENEURO.0050-24.2024, WOS:001257597900003, Dissecting Mismatch Negativity: Early and Late Subcomponents for Detecting Deviants in Local and Global Sequence Regularities

19. Ohki, T; Chao, ZC; Takei, Y; Kato, Y; Sunaga, M; Suto, T; Tagawa, M; Fukuda, M, 2024, PSYCHIATRY AND CLINICAL NEUROSCIENCES, 78(9), 507-516, http://dx.doi.org/10.1111/pcn.13702, WOS:001253949000001, Multivariate sharp-wave ripples in schizophrenia during awake state

20. Huang, YT; Wu, CT; Fang, YXM; Fu, CK; Koike, S; Chao, ZC, 2024, COMMUNICATIONS BIOLOGY, 7(1), 965, http://dx.doi.org/10.1038/s42003-024-06677-6, WOS:001288299900005, Crossmodal hierarchical predictive coding for audiovisual sequences in the human brain

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(4) Other English articles

172. Y, Zhang; K, Inoue; M, Nakajima; T, Hashimoto; Y, Kuniyoshi; K, Nakajima, 2024, NEURIPS 2024 WORKSHOP MACHINE LEARNING WITH NEW COMPUTE PARADIGMS, https://openreview.net/forum?id=YhRzDXOSBp, Training Spiking Neural Networks via Augmented Direct Feedback Alignment

2. Invited Lectures, Plenary Addresses (etc.) at International Conferences and International Research Meetings

- List up to 10 main presentations during FY 2024 in order from most recent.
- For each, write the date(s), lecturer/presenter's name, presentation title, and conference name.

Date(s)	Lecturer/ Presenter's name	Presentation title	Conference name
2024/06/27	Yasushi Okada	Challenging the frontiers of single-molecule or super-resolution live cell imaging.	IUPAB2024
2024/07/04	Yukie Nagai	Predictive Processing: Illuminating and Modeling Cognitive Development	The IEEE World Congress on Computational Intelligence (Keynote talk)
2024/07/20	Haruo Kasai	Mechanical Synaptic transmission revealed by optogenetics and optochemistry	Keynote Lecture, Optogenetics Gordon Research Seminar (Lucca, Italy).
2024/07/26	Kazuyuki Aihara	Data-Driven Analysis of Nonlinear Spatiotemporal Dynamics and its Applications	The 10th Shanghai International Symposium on Nonlinear Sciences and Applications (Shanghai NSA `24)
2024/07/26	Yukiko Gotoh	Regulation of neural stem cell fate during mouse neocortical development	Special Lectures, NEURO2024
2024/07/30	Yoko Yazaki-Sugiyama	Learning to communicate by listening to others	Plenary talk, the 15th International Congress of Neuroethology,
2024/09/23	Yukie Nagai	Embodied Predictive Processing: New Horizons in Cognitive Developmental Robotics	The 40th Anniversary of the IEEE Conference on Robotics and Automation (Keynote talk)
2024/10/17	Yukie Nagai	Cognitive Developmental Robotics: Bridging Disciplines to Uncover Intelligence	IROS 2024 Forum on Empowering Diverse Voices in Robotics (Keynote talk)
2024/11/07	Yukiko Gotoh	Temporal regulation of neural stem cell fate during neocortical development,	EMBO COB workshop "Molecular mechanisms of developmental and regenerative biology"
2025/03/24	Haruo Kasai	Awake Brain States Require Dendritic Spine Enlargement: Insights from Synaptic Chemogenetics	Dendrites: Molecules, structure and function, Gordon Research Conference (Ventura, USA).

3. Major Awards

- List up to 10 main awards received during FY 2024 in order from the most recent.
- For each, write the date issued, the recipient's name, and the name of award.
- In case of multiple recipients, underline those affiliated with the center.

Date	Recipient's name	Name of award
2024/04/29	Masamitsu Iino	The 2024 Spring Decoration of the Order of the Sacred Treasure, Gold Rays with Neck Ribbon
2024/07/03	Shigeo Okabe	Medical Award of The Japan Medical Association
2024/09/25	Yukie Nagai	Forbes JAPAN Women In Tech 30

2024/11/03	Takao Hensch	The Order of the Rising Sun, Gold Rays with Neck Ribbon for foreign
2025/01/05	Irena Lovcevic	Peter Jusczyk Best Paper Award 2024
2025/03/06	Yoko Yazaki-Sugiyama	Tsukahara Award
2025/03/14	Shigeo Okabe	The Japan Academy Prize

Appendix 2 FY 2024 List of Principal Investigators

NOTE:

*Underline names of principal investigators who belong to an overseas research institution.

*In the case of researcher(s) not listed in the latest report, attach a "Biographical Sketch of a New Principal Investigator"(Appendix 2a).

*Enter the host institution name and the center name in the footer.

<Results at the end of FY2024> **Principal Investigators Total: 12**

Name	Age	Affiliation (Position title, department, organization)	Academic degree, specialty	Effort (%)*	Starting date of project participation	Status of project participation (Describe in concrete terms)	Contributions by PIs from overseas research institutions
Center Director Takao Kurt Hensch	58	Director, Project Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Molecular and Cellular Biology, Center for Brain Science, Harvard University Professor, Neurology, Kirby Center, Boston Children's Hospital	Ph.D. Neurophysiology	80	2017/10/1	Often stays at the Boston Children's Hospital. Stays at UTokyo five times (each >1 week) in FY2024. Communicates often by >20 emails daily, and almost nightly video conferences to promote IRCN's sustainability, synergy, community and global visibility.	Manages and directs Center operations
Kazuo Emoto	56	Deputy Director, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Department of Biological Sciences, Graduate School of Science, the University of Tokyo	Ph.D. Neural Network	80	2017/10/1	Stays at the Graduate School of Science next to the Center building, and participates in the Center's activities as Deputy Director and an Executive Board member	
Yukiko Gotoh	60	Deputy Director, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Molecular Biology, Department of Pharmaceutical Sciences, Graduate School of Pharmaceutical Sciences, the University of Tokyo	Ph.D. Neural Stem Cells	80	2017/10/1	Stays at the Graduate School of Pharmaceutical Sciences and participates in the Center's activities as Deputy Director and an Executive Board member	

Kenichi Ohki	53	Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Integrative Physiology, Physiology, Department of Functional Biology, Graduate School of Medicine, the University of Tokyo	M.D. & Ph.D. Neuroscience	80	2017/10/1	Stays at the Center and participates in the Center's activities as Deputy Director and an Executive Board member	
Kazuyuki Aihara	70	Deputy Director, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study University Professor, the University of Tokyo	Ph.D. Biological Information Systems	80	2017/10/1	Stays at the Center and participates in the Center's activities as Executive Director and an Executive Board member	
Haruo Kasai	68	Project Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study	M.D. & Ph.D. Neurophysiolo gy	100	2017/10/1	Stays at the Center and participates in the Center's activities	
Yasushi Okada	56	Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Cell Biology, Cell Biology and Anatomy, Department of Molecular Cell Biology, Graduate School of Medicine, the University of Tokyo Professor, Department of Physics, Graduate School of Science, the University of Tokyo Deputy Director, RIKEN Center for Biosystems Dynamics Research	M.D. & Ph.D. Bioimaging	32	2017/10/1	Usually stays at the Center and participates in the Center's activities	

Kiyoto Kasai	54	Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Neuropsychiatry, Clinical Neuroscience, Department of Neuroscience, Graduate School of Medicine, the University of Tokyo	M.D. & Ph.D. Neuroimaging and Early Intervention for Schizophrenia	80	2017/10/1	Stays at the University of Tokyo Hospital and participates in the Center's activities	
Shoji Takeuchi	52	Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study Professor, Department of Mechano-Informatics, Graduate School of Information Science and Technology, the University of Tokyo	Ph.D. Biohybrid Systems	80	2017/10/1	Stays at the Graduate School of Information Science and Technology and participates in the Center's activities	
Takamitsu Watanabe	43	Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study	M.D. & Ph.D. Cognitive Neuroscience	100	2020/4/1	Stays at the Center and participates in the Center's activities	
Yukie Nagai	50	Project Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study	Ph.D. Engineering	100	2019/4/1	Stays at the Center and participates in the Center's activities	
Zenas C. Chao	49	Associate Professor, International Research Center for Neurointelligence, the University of Tokyo Institutes for Advanced Study	Ph.D. Biomedical Engineering	100	2019/9/1	Stays at the Center and participates in the Center's activities	

*Percentage of time that the principal investigator devotes to working for the center vis-à-vis his/her total working hours.

Principal investigators unable to participate in project in FY 2024

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken

Appendix 3-1 FY 2024 Records of Center Activities

1. Researchers and center staff, satellites, partner institutions

1-1. Number of researchers in the "core" established within the host institution

- Regarding the number of researchers at the Center, fill in the table in Appendix 3-1a.

Special mention

- Enter matters warranting special mention, such as concrete plans for achieving the Center's goals, established schedules for employing main researchers, particularly principal investigators.
- As background to how the Center is working on the global circulation of world's best brains, give good examples, if any, of how career paths are being established for the Center's researchers; that is, from which top-world research institutions do researchers come to the Center and to which research institutions do the Center's researchers go, and how long are their stays at those institutions.

1. **The first tenure PI position:** IRCN has acquired two permanent positions, as a professor and an assistant professor, which was guaranteed by our successful budgetary request to the government (Gaisan-yokyu fund). Under the newly established IRCN tenure evaluation criteria, PI Watanabe has filled the qualification of the tenured professor, remaining permanently in IRCN to lead the Athlete Cognitive Neuroscience Program starting in FY2024. He has become the first tenure PI/Professor who got promoted from a project PI.

2. **AI Incubators:** IRCN officially established the framework of AI Incubators in order to facilitate AI incubation Initiative with 5 newly affiliated PIs (APIs) chosen from AFs within and outside UTokyo. Among five APIs, two are non-UTokyo faculty, therefore IRCN also has established "Visiting Professorship" given to them, while another visiting professor was invited as a special advisor for the AI Incubator project. Each API was profited to hire a post-doc to exclusively work on AI Incubator projects which accelerate Team Science. The call for the candidates was globally open, attracting best brains in the world.

3. **Grant systems for young researchers:** IRCN has started three different grant systems to facilitate bottom-up collaborations at the level of young researchers. These were called Team Science Catalysis Grants, Retreat Brainstorming Awards, and Pilot-Research Support (rescue) Grants, respectively (see more in the report 4-1-3). All of them were created to encourage the autonomous initiative among newly arrived young researchers who were eager to establish their own careers within IRCN.

1-2. Satellites and partner institutions

- List the satellite and partner institutions in the table below.
- Indicate newly added and deleted institutions in the "Notes" column.
- If satellite institutions have been established overseas, describe by satellite the Center's achievements in coauthored papers and researcher exchanges in Appendix 4.

<Satellite institutions>

Institution name	Principal Investigator(s), if any	Notes
Boston Children's Hospital	Takao Kurt Hensch	

< Partner institutions>

Institution name	Principal Investigator(s), if any	Notes
The Agency For Science, Technology And Research (A*STAR)		
Istituto Italiano di Tecnologia (IIT)		
RIKEN Center for Advanced Intelligence Project (AIP), RIKEN Center for Biosystems Dynamics Research (BDR)	Yasushi Okada	

RIKEN Center for Brain Science (CBS)		
Edwin O. Reischauer Institute of Japanese Studies at Harvard University	Takao Hensch	
Asian Consortium on MRI studies on Psychosis	Kiyoto Kasai	
Okinawa Institute of Science and Technology Graduate University		
The University of British Columbia		
Collège de France		
CIFAR, The Canadian Institute for Advanced Research	Takao Hensch	
Institute of Neuroscience (ION), Center for Excellence in Brain Science and Intelligence Technology, Chinese Academy of Sciences		
Stockholm University		
KTH Royal Institute of Technology		
Karolinska Institutet		
Tsinghua University		
Bielefeld University		
École normale supérieure		
Teikyo University Advanced Comprehensive Research Organization		A newly signed MoU
Scuola Normale Superiore (SNS)		A newly signed MoU
IMT School for Advanced Studies Lucca		A newly signed MoU

1-3. Postdoctoral Positions through Open International Solicitations

- In the columns "number of applications" and "number of selections," put the total number (upper) and the number and percentage of overseas researchers in the < > brackets (lower).

Fiscal year	Number of applications	Number of selections
FY 2024	66	11
	〈 46, 67 %〉	〈 5, 45 %〉

2. Holding international research meetings

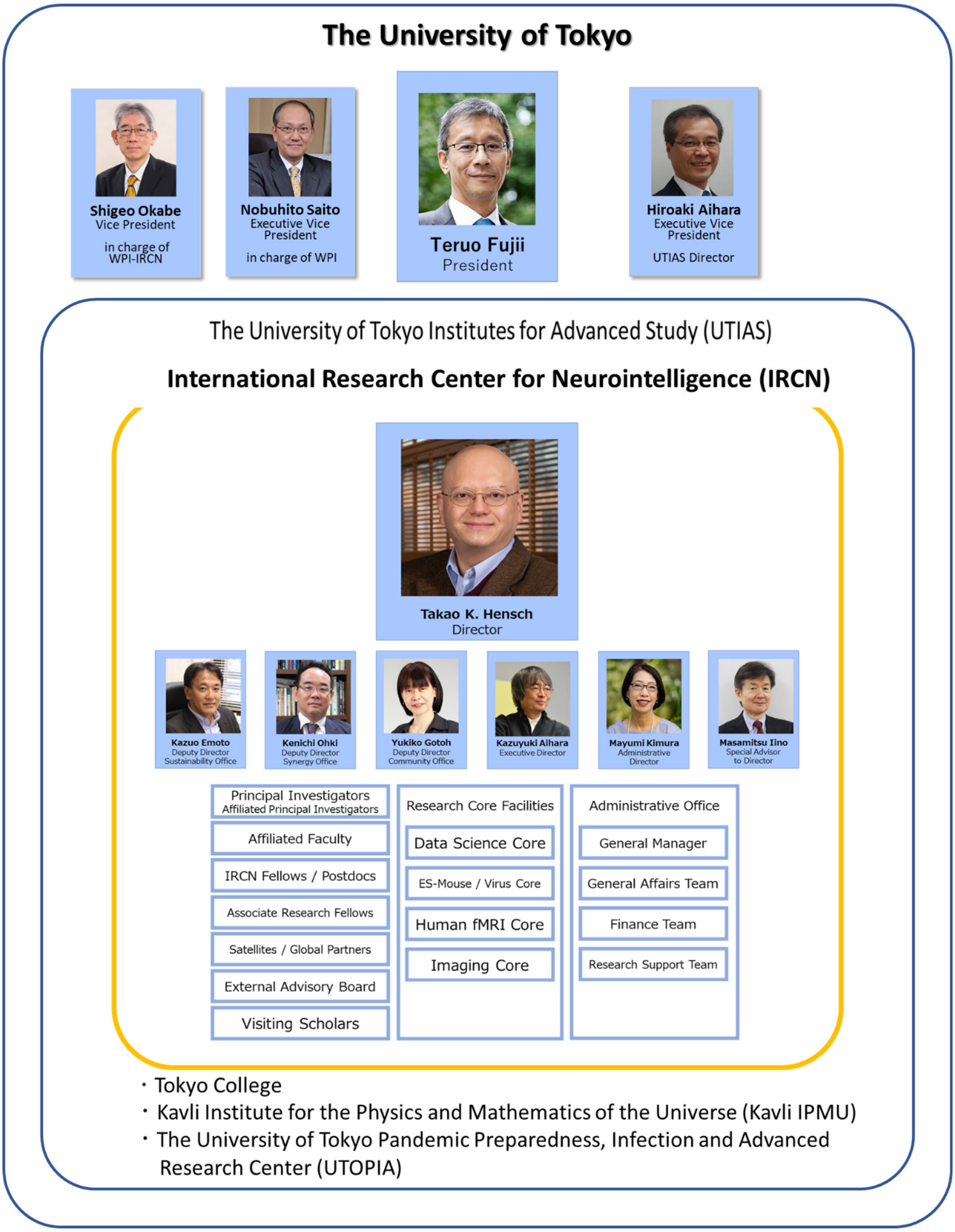
- Indicate the number of international research conferences or symposiums held in FY2024 and give up to three examples of the most representative ones using the table below.

FY 2024: 3 meetings	
Major examples (meeting titles and places held)	Number of participants

IRCN and Chen Institute Joint Course on Neuro-inspired Computation Venue: Fukutake Hall, UTokyo Hongo Campus	From domestic institutions: 72 From overseas institutions: 38
The first Symposium for Alliance for Brain Science [UTokyo-Teikyo-RIKEN] "A Venture into the Universe of the Athlete's Brain from a Cognitive Neuroscience" Venue: Fukutake Hall, UTokyo Hongo Campus	From domestic institutions: 143 From overseas institutions: 3
WPI-IRCN - Scuola Normale Superiore joint symposium “Roots of Neurodiversity” Venue: Scuola Normale Superiore (SNS), Pisa, Italy	From domestic institutions: 13 From overseas institutions: 62

3. Diagram of management system

- Diagram the center's management system and its position within the host institution in an easily understood manner.
- If any new changes have been made in the management system from that in the latest "center project" last year, describe them. Especially describe any important changes made in such as the center director, administrative director, head of host institution, and officer(s) in charge at the host institution (e.g., executive vice president for research).



4. Campus Map

- Draw a simple map of the campus showing where the main office and principal investigator(s) are located.

5. Securing external research funding*

External research funding secured in FY2024

Total: 1,024,600,350 yen

- Describe external funding warranting special mention. Include the name and total amount of each grant.

* External research funding includes "KAKENHI," funding for "commissioned research projects," "joint research projects," and for others (donations, etc.) as listed under "Research projects" in Appendix 3-2, Project Expenditures.

JSPS
Grant-in-Aid for Transformative Research Areas: 95,520,000 yen
Grant-in-Aid for Scientific Research on Innovative Areas: 960,000 yen
Grant-in-Aid for Specially Promoted Research: 3,160,000 yen
Grant-in-Aid for Scientific Research S: 69,320,000 yen
Grant-in-Aid for Scientific Research A: 4,710,000 yen
Grant-in-Aid for Scientific Research B: 8,500,000 yen
Grant-in-Aid for Scientific Research C: 4,119,352 yen
Grant-in-Aid for Challenging Research: 2,225,000 yen
Grant-in-Aid for Early-Career Scientists: 5,763,588 yen
Grant-in-Aid for Research Activity Start-up: 5,458,648 yen
Grant-in-Aid for JSPS Research Fellows: 1,220,550 yen
Fostering Joint International Research: 100,000 yen

JST
Moonshot Research and Development Program: 173,609,040 yen
CREST: 133,517,000 yen
FOREST: 11,797,500 yen
JST-Mirai Program: 52,990,400 yen
SIP: 640,000 yen

AMED
Brain/MINDS 2.0: 224,299,000 yen
AMED-CREST: 83,200,000 yen

HFSPO
HFSP Research Grants: 20,069,272 yen

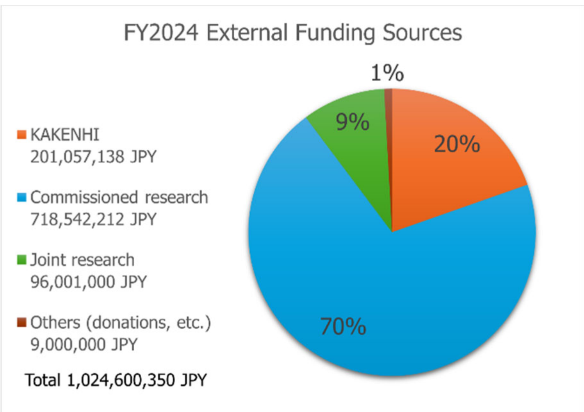
NCGM / ROIS
SIP: 8,480,000 yen

Other commissioned research grants: 9,940,000 yen

Beyond AI (collaborative research with Softbank): 38,240,000 yen

Collaborative research with Daikin: 57,761,000 yen

Others (donations, etc.): 9,000,000 yen



FY2024 Major External Funding
KAKENHI
Grant-in-Aid for Transformative Research Areas
Grant-in-Aid for Scientific Research (S)
JST
Moonshot Research and Development Program
CREST
AMED
Brain/MINDS 2.0
AMED-CREST
HFSPO
HFSP Research Grants
Joint Research
Beyond AI (SoftBank Corp.)
DAIKIN Industries, Ltd

Appendix 3-1a FY 2024 Records of Center Activities

Researchers and other center staff

Number of researchers and other center staff

* Fill in the number of researchers and other center staff in the table blow.
* Describe the final goals for achieving these numbers and dates when they will be achieved described in the last "center project."

a) Principal Investigators

(full professors, associate professors or other researchers of comparable standing)

(number of persons)

	At the beginning of project	At the end of FY 2024	Final goal (Date: March 31, 2027)
Researchers from within the host institution	12	11	10
Researchers invited from overseas	2	1	1
Researchers invited from other Japanese institutions	0	0	0
Total principal investigators	14	12	11

b) Total members

	At the beginning of project		At the end of FY 2024		Final goal (Date: March 31, 2027)	
	Number of persons	%	Number of persons	%	Number of persons	%
Researchers	27		130		65	
Overseas researchers	5	19	35	27	23	35
Female researchers	5	19	18	14	18	28
Principal investigators	14		12		11	
Overseas PIs	3	21	2	17	3	27
Female PIs	4	29	2	17	3	27
Other researchers	13		90		40	
Overseas researchers	2	15	17	19	10	25
Female researchers	1	8	12	13	10	25
Postdocs	0		28		14	
Overseas postdocs	0	0	16	57	10	71
Female postdocs	0	0	4	14	5	36
Research support staffs	0		31		20	
Administrative staffs	3		21		10	
Total number of people who form the "core" of the research center	30		182		95	

	At the beginning of project		At the end of FY 2024		Final goal (Date: March 31, 2027)	
	Number of persons	%	Number of persons	%	Number of persons	%
Doctoral students	0		9		13	
Employed	0	-	2	22.2	5	38.5

※b) The number of doctoral students in the lower table can be duplicated in the upper table of overall composition.

Appendix 3-2 Project Expenditures

1) Overall project funding

* In the "Total costs" column, enter the total amount of funding required to implement the project, without dividing it into funding sources.

* In the "Amount covered by WPI funding" column, enter the amount covered by WPI within the total amount.

* In the "Personnel," "Project activities," "Travel," and "Equipment" blocks, the items of the "Details" column may be changed to coincide with the project's actual content.

(Million yens)

Cost items	Details (For Personnel - Equipment please fill in the breakdown of fiscal expenditure, and the income breakdown for Research projects.)	Total costs	Amount covered by WPI funding
Personnel	Center director and administrative director	36	36
	Principal investigators and Special Advisor to Director (no. of persons):12	175	36
	Other researchers (no. of persons):18	97	97
	Research support staff (no. of persons):7	24	24
	Administrative staff (no. of persons):26	153	66
	Subtotal	485	259
Project activities	Gratuities and honoraria paid to invited principal investigators	0	0
	(no. of persons):OO	0	0
	Cost of dispatching scientists (no. of persons):OO	0	0
	Outreach activities	6	5
	Core Facilities' operation cost	66	66
	Research startup cost (no. of persons):2	42	42
	Cost of satellite organizations (no. of satellite organizations):1	125	93
	Cost of international symposiums (no. of symposiums):2	2	2
	Rental fees for facilities	80	73
	Cost of consumables	11	4
	Cost of utilities	10	9
	Other costs	53	47
	Subtotal	395	341
Travel	Domestic travel costs	2	1
	Overseas travel costs	33	28
	Travel and accommodations cost for invited scientists	15	15
	(no. of domestic scientists):OO	0	0
	(no. of overseas scientists):12	15	15
	Travel cost for scientists on transfer	0	0
	(no. of domestic scientists):OO	0	0
	(no. of overseas scientists):OO	0	0
	Subtotal	50	44
Equipment	Depreciation of buildings	0	0
	Depreciation of equipment	56	56
	Subtotal	56	56
Other costs	Other costs	70	0
	Subtotal	70	0
Research projects (Detail items must be fixed)	Project supported by other government subsidies, etc. *1	33	
	KAKENHI	201	
	Commissioned research projects, etc.	719	
	Joint research projects	96	
	Ohers (donations, etc.)	9	
	Subtotal	1058	0
Total		2114	700

Costs (Million yens)

WPI grant in FY 2024	0
Costs of establishing and maintaining facilities	0
Establishing new facilities	0
(Number of facilities: , OO m²)	
Repairing facilities	0
(Number of facilities: , OO m²)	
Others	0
Costs of equipment procured	56
Goggle-type visual presentation device	20
(Number of units:1)	
Name of equipment	0
(Number of units:OO)	
Others	36

*1. Management Expenses Grants (including Management Enhancements Promotion Expenses (機能強化経費)), subsidies etc., indirect funding, and allocations from the university's own resources.
*2 When personnel, travel, equipment (etc.) expenses are covered by KAKENHI or under commissioned research projects or joint research projects, the amounts should be entered in the "Research projects" block.

*1 運営費交付金（機能強化経費を含む）、各種補助金、間接経費、その他大学独自の取組による学内リソースの配分等による財源
*2 科研費、受託研究費、共同研究費等によって人件費、旅費、設備備品等費を支出している場合も、その額は「研究プロジェクト費」として計上すること

2) Costs of satellites

(Million yens)

Cost items	Details	Total costs	Amount covered by WPI funding
Personnel	Principal investigators (no. of persons):OO		
	Other researchers (no. of persons):OO		
	Research support staff (no. of persons):OO		
	Administrative staff (no. of persons):OO		
	Subtotal	0	0
Project activities	Subtotal	125	93
Travel	Subtotal		
Equipment	Subtotal		
Research projects	Subtotal		
Total		125	93

Appendix 4 FY 2024 Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY 2024 that were coauthored between the center's researcher(s) in domestic institution(s) (include satellite institutions) and overseas satellite institution(s). List them by overseas satellite institution in the below blocks.
- Transcribe data in same format as in Appendix 1. Italicize the names of authors affiliated with overseas satellite institutions.
- For reference write the Appendix 1 item number in parentheses after the item number in the blocks below. Let it free, if the paper is published in between Jan.-Mar. 2025 and not described in Appendix 1.

Overseas Satellite 1 **Boston Children's Hospital** (Total: 2 papers)

1) [App 1 list #24] Makino, Y; Hodgson, NW; Doenier, E; Serbin, AV; Osada, K; Artoni, P; Dickey, M; Sullivan, B; Potter-Dickey, A; Komanchuk, J; Sekhon, B; Letourneau, N; Ryan, ND; Trauth, J; Cameron, JL; *Hensch, TK*, 2024, SCIENCE TRANSLATIONAL MEDICINE, 16(768), eadh9763, http://dx.doi.org/10.1126/scitranslmed.adh9763, WOS:001331710200005, Sleep-sensitive dopamine receptor expression in male mice underlies attention deficits after a critical period of early adversity

2) [App 1 list #127] Desowska, A; Coffman, S; Kim, I; Underwood, E; Tao, A; Lopez, K L; Nelson, CA; *Hensch, TK*; Gabard-Durnam, Laurel; Cornelissen, Laura, 2024, NEUROIMAGE CLINICAL, 42, 103614, https://doi.org/10.1016/j.nicl.2024.103614, WOS:001242439300001, Neurodevelopment of children exposed to prolonged anesthesia in infancy: GABA study interim analysis of resting-state brain networks at 2, 4, and 10-months old

2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY 2024. Enter by institution and length of exchange.
- Write the number of principal investigator visits in the top of each space and the number of other researchers in the bottom.

Overseas Satellite 1: Boston Children's Hospital

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024	0	0	0	0	0
	0	0	0	0	0

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024	0	5	0	0	5
	2	1	0	0	3

Overseas Satellite 2:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

<From satellite>

	Under week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

Appendix 5 FY 2024 Visit Records of Researchers from Abroad

* If researchers have visited/ stayed at the Center, provide information on them in the below table.
* Enter the host institution name and the center name in the footer.

Total: 30

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
1	Jerome Sanes	72	Professor, Brown University	USA	Ph.D., Neuroscience	・2015-2016 Fulbright Scholar Award, Franco-American Commission ・2018 President's Award for Excellence in Faculty Governance, Brown University, and more.	15 May – 15 June 2024	Conduct human neuroimaging research on brain mechanisms underlying voluntary movement, motor skill learning and cognitive flexibility. Also, helped accelerate collaborations between IRCN and international research institutes.
2	UGUR Emre	44	Associate Professor, Bogazici University	Turkey	Ph.D., Computer Engineering	・2021 The Young Scientist Award of the Science Academy (BAGEP), ・2021 The Excellence in Teaching Award by the Faculty of Engineering	19 June – 23 July 2024	Collaborate with PI Nagai on learning mechanisms in cognitive developmental robotics.
3	DUMANSKA Hanna	41	PI of the Vision Research Group, Bogomoletz Institute of Physiology National Academy of Science	Ukraine	Ph.D., Biophysics	PI of the Vision Research Group Department of Neuronal Network Physiology, Bogomoletz Institute of Physiology National Academy of Science of Ukraine. Main focus is visual sensory processing in physiology and pathophysiology context.	6 July - 21 July 2024	Attended the IRCN and Chen Institute Joint Course on Neuro-inspired Computation and gave a poster presentation on "The role of protein kinase C in hypoxia-induced injury of retinocollicular neurotransmission".
4	Eva Lauren Dyer	N/A	Associate Professor, Georgia Institute of Technology	USA	Ph.D., Electrical Engineering	Dyer’s research interests lie at the intersection of machine learning, optimization, and neuroscience. Her lab develops computational methods for discovering principles that govern the organization and structure of the brain, as well as methods for integrating multi-modal datasets to reveal the link between neural structure and function.	12 July – 28 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of Towards a foundation model for neural data".
5	Sho Tsuji	40	Associate Professor, Department of Cognitive Studies, Ecole Normale Superieure	France	Ph.D., Psycholinguistics	・2023-2026 Human Frontier Science Program ・2022 LEAP fellow ・2021 Jacobs Foundation Fellowship ・2020 World Economic Forum Young Scientist	12 July – 31 Aug 2024	Collaborate with researchers from the IRCN Baby Lab to discuss each project and promote research. Attended the 24th Congress of the Japanese Society of Baby Science as a chair.
6	Dmitry Krotov	N/A	Research Staff Member, MIT-IBM Watson AI Lab IBM Research	USA	Ph.D., Physics	A physicist working on neural networks and machine learning and a member of the research staff at the MIT-IBM Watson AI Lab and IBM Research in Cambridge, MA.His research focuses on the computational properties of neural networks. Particularly, in implementing ideas coming from neuroscience and physics in modern AI systems.	14 July – 21 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of "Associative Memory in Artificial and Biological Neural Networks".

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
7	CONSORTI Alan	30	Post Doc, Boston Children's Hospital	USA	Ph.D., Neuroscience	2019: Awarded with an International PhD fellowship, 'Pegaso Scholarship'- Tuscany Region, Italy. 2017: Medal Awarding Ceremony for outstanding laureates (with honors), University of Pisa, Italy.	14 July - 24 July 2024	Attended the IRCN and Chen Institute Joint Course on Neuro-inspired Computation and gave a poster presentation on "Top-down processing and perceptual learning: role of the lateromedial secondary visual cortex in a mouse model of visual perceptual learning".
8	VALENCIA Xavier Manuel	N/A	Research Assistant, Boston Children's Hospital	USA	BA, Neuroscience	Research Assistant in the F.M. Kirby Neurobiology Center/Neurology Department at Boston Children's Hospital (BCH)	14 July - 24 July 2024	Attended the IRCN and Chen Institute Joint Course on Neuro-inspired Computation and gave a poster presentation on "Viral OTX2 down regulation ameliorates severe Rett Syndrome symptoms by targeting hypermaturated parvalbumin-interneurons".
9	KURTH Anno Christopher	N/A	Researcher, Forschungszentrum Julich	Germany	Ph.D., Computational Neuroscience	Kurth's scientific work focuses on both: the simulation technology for and the usage of spiking neural networks to investigate cortical dynamics.	14 July - 27 July 2024	Attended the IRCN and Chen Institute Joint Course on Neuro-inspired Computation and gave a poster presentation on "Data-driven Architecture Reconstructions of Local Cortical Circuits".
10	Pawel Herman	45	Associate Professor, KTH Royal Institute of Technology	Sweden	Ph.D., Computer Science	・Member of the Board of Stockholm University Brain Imaging Centre (SUBIC) ・Member of the Board of Inno-Brain AB, Sweden Co-founder and member of the Board of Cortechs AB, Sweden	15 July – 20 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of "Towards holistic pattern processing in cortex-like neural networks".
11	Simon Schultz	N/A	Professor, Imperial Collage London	UK	Ph.D., computational neuroscience	Director of the Centre for Neurotechnology at Imperial College London. Main research focus is on understanding the brain mechanisms underpinning episodic memory, working memory and related cognitive functions.	15 July – 20 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of "Neurotechnology for studying the neural circuit basis of memory and its disorders".
12	TONG SONG	33	Post Doc, Tsinghua University	China	Ph.D., Psychoinformatics	2022-2024, Postdoctoral international exchange program, China Postdoctoral Science Foundation. 2022-2024, Shuimu Tsinghua Scholar, Tsinghua University. 2022-2024, Postdoctoral for Basic humanities, Tsinghua University.	15 July – 22 July 2024	Attended the IRCN and Chen Institute Joint Course on Neuro-inspired Computation and gave a poster presentation on "Informatics Approaches to Human Facial Attractiveness Perception, Visual Attention, and Automated Psychological Hypothesis Generation".

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
13	Aron Keith Barbey	N/A	Professor, University of Nebraska	USA	Ph.D., Psychology	Barbey's research investigates how intelligence emerges from the network organization and dynamics of the human connectome, adopting an interdisciplinary approach that combines methods from the psychological, computational, and brain sciences. An important goal of his work is to establish a sound foundation for clinical research that aims to remediate disturbances of brain function in psychiatric illness and traumatic brain injury.	16 July - 21 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of "Advancing the Science and Engineering of Intelligence: From Network Neuroscience to Interventions for Precision Health".
14	Naoshige Uchida	N/A	Professor, Harvard University	USA	Ph.D., Molecular Biology	Uchida's research focuses on the neurobiology of decision-making and learning, including neural computation in the midbrain dopamine system, functions of the cortico-basal ganglia circuit, foraging decisions and motor learning. His research combines quantitative rodent behaviors with multi-neuronal recordings, two-photon microscopy, computational modeling, and modern tools such as optogenetics and viral neural circuit tracing.	16 July – 22 July 2024	Gave a lecture at "IRCN and Chen Institute Joint Course on Neuro-inspired Computation" on the theme of "Reinforcement learning and dopamine".
15	Kenji Koyano	N/A	Post-Doctoral Fellow, National Institute of Mental Health (NIMH)	USA	Ph.D., Medicine	2014-2015 Research Fellowship from Uehara Memorial Foundation 2008-2011 JSPS Research Fellowship for Young Scientists (PD) 2005-2008 JSPS Research Fellowship for Young Scientists (DC1) 2004-2005 First-class scholarship from JASSO 2003-2004 First -class scholarship from Japan Scholarship Foundation	22 July – 30 July 2024	Participate "NEURO2024". Gave a talk at "IRCN seminar" on the theme of "Encoding and Plasticity in Macaque Face Patches".
16	Raymond Ng	N/A	Professor, Department of Computer Science, University of British Columbia	USA	Ph.D., Computer Science	2022 Named as one of the world's top-75 academic data science leaders by the MIT-based CDO magazine 2022 UBC Killam Research Prize (UBC's most prestigious prize for senior faculty members) 2021 Elected in the Royal Society of Canada as a fellow	29 July - 2 August 2024	Collaborate with PI Aihara to discuss the future joint research plan.Discussed the future plans for the AI Incubator project at the WPI Site Visit.
17	Luonan Chen (陳　洛南)	62	Professor, Center for Excellence in Molecular Cell Science, CAS	China	Ph.D., Electrical Engineering	Founding director of Institute of Systems Biology, Shanghai University Founding president of Computational Systems Biology Society of China Chair of Technical Committee of Systems Biology at IEEE SMC Society	1 August – 7 August 2024	Collaborate with PI Aihara and researcher from IRCN to discuss the Moonshot project.
18	Victoria Leong VIK EE	N/A	Professo, Nanyang Technological University	Singapore	Ph.D., Psychology	A pioneer in the use of dyadic-EEG and in the development of dyadic sociometric predictive models for infant cognition and developing executive function. The FABBS Early Career Impact Award and the Nanyang Research Award	22 Aug – 26 Aug 2024	Gave a keynote speech at The 24th Congress of the Japanese Society of Baby Science "Baby Science with AI" on the theme of 'Dyadic Sociometrics: Precision Assessment of Infant Development in a Social Interactive Context' Had meetings with Director Hensch and PI Nagai.

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
19	Sho Tsuji	40	Associate Professor, Department of Cognitive Studies, Ecole Normale Superieure	France	Ph.D., Psycholinguistics	2023-2026 Human Frontier Science Program 2022 LEAP fellow 2021 Jacobs Foundation Fellowship 2020 World Economic Forum Young Scientist	21 Oct – 9 Nov 2024	Collaborate with researchers from the IRCN Baby Lab to discuss each project and promote research.
20	Tiina Parviainen	N/A	Associate professor, University of Jyvaskyla Director, Center for Interdisciplinary Brain Research (CIBR)	Finland	Ph.D., Neuroscience	https://www.jyu.fi/en/people/tiina-parviainen	27 October - 30 October 2024	Had a meeting with Director and CISTI. Participated in the YIPS symposium. Had a seminar talk at IRCN Salon.
21	Izhikevich Eugene	57	Brain Corp, San Diego, CA	USA	Ph.D., Mathematics	・2022-now Chairman of the Board of Directors, Brain Corp, San Diego, CA ・2009-2022 Founder and CEO, Brain Corp, San Diego, CA ・2006-now Founder and Editor-in-Chief of Scholarpedia, the peer-reviewed encyclopedia	30 Oct - 24 Dec 2024	・Research on the future of AI and robotics ・Research on the construction of computational neuroscience models
22	Luonan Chen (陳　洛南)	62	Professor, Center for Excellence in Molecular Cell Science, CAS	China	Ph.D., Electrical Engineering	Founding director of Institute of Systems Biology, Shanghai University Founding president of Computational Systems Biology Society of China Chair of Technical Committee of Systems Biology at IEEE SMC Society	25 Nov – 1 Dec 2024	Collaborate with PI Aihara to discuss the DNB theory of pre-disease in noise data.Gave a talk at ICCBB2024 on "Dynamical Data Science and AI for Biology and Medicine"
23	Sho Tsuji	40	Associate Professor, Department of Cognitive Studies, Ecole Normale Superieure	France	Ph.D., Psycholinguistics	2023-2026 Human Frontier Science Program 2022 LEAP fellow 2021 Jacobs Foundation Fellowship 2020 World Economic Forum Young Scientist	28 November – 7 December 2024	Collaborate with researchers from the IRCN Baby Lab to discuss each project and promote research.
24	Jerome Sanes	72	Professor, Brown University	USA	Ph.D., Neuroscience	・2015-2016 Fulbright Scholar Award, Franco-American Commission ・2018 President's Award for Excellence in Faculty Governance, Brown University, and more.	1 Dec – 15 Dec 2024	Conduct human neuroimaging research on brain mechanisms underlying voluntary movement, motor skill learning and cognitive flexibility. Also, helped accelerate collaborations between IRCN and international research institutes.
25	Hanako Yoshida (吉田　華子)	53	Professor, University of Houston	USA	Ph.D., Developmental Psychology	・2019 University of Houston Faculty Excellence Award: Undergraduate Research Mentor Award ・2006 The Irving Saltzman Award, the recognition of outstanding graduate career given by Department of Brain and Psychological Sciences, Indiana University	15 Dec 2024– 10 Mar 2025	Collaboration with PI Nagai on early cognitive development and learning processes through social interactions.
26	Luonan Chen (陳　洛南)	62	Professor, Center for Excellence in Molecular Cell Science, CAS	China	Ph.D., Electrical Engineering	Founding director of Institute of Systems Biology, Shanghai University Founding president of Computational Systems Biology Society of China Chair of Technical Committee of Systems Biology at IEEE SMC Society	27 Jan – 2 Feb 2024	Collaborate with PI Aihara to discuss the DNB theory of pre-disease in noise data.Gave a talk at ICCBB2024 on "Dynamical Data Science and AI for Biology and Medicine"

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
27	Izhikevich Eugene	57	Brain Corp, San Diego, CA	USA	Ph.D., Mathematics	・2022-now Chairman of the Board of Directors, Brain Corp, San Diego, CA ・2009-2022 Founder and CEO, Brain Corp, San Diego, CA ・2006-now Founder and Editor-in-Chief of Scholarpedia, the peer-reviewed encyclopedia	14 Jan - 30 Mar 2025	・Research on the future of AI and robotics ・Research on the construction of computational neuroscience models
28	Giulia Belgiovine	31	Postdoctoral Researcher,Italian Institute of Technology	Italy	Ph.D., AI and Robotics	・Brain, Minds & Machines 2023 Fellowship ・Best Artificial Intelligence Application for Robotics Award (Italian Institute of Robotics and Intelligent Machines Conference 2020) ・Best Paper Award:International Conference of Social Robotics 2020	2 Feb －30 Mar 2025	Collaboration with PI Nagai on decoding group cognition: modelling users' state during group dynamics for adaptive multiparty HRI
29	Manish Simali	N/A	Central University of Rajasthan	India	Ph.D., nonlinear dynamics and complex systems	・Professor, Department of Physics, Central University of Rajasthan, Ajmer, India (Dec 2015 - onwards)	26 Feb – 9 March 2025	Collaboration with PI Aihara and his group members. Also he gave a seminar on emergent states of environmentally coupled oscillator
30	SHINE James Macquarie	N/A	The University of Sydney	Australia	Ph.D., system neurobiology	Recently awarded an inaugural $1.2M Robinson Fellowship from the University of Sydney, designed to retain and cultivate the most outstanding ECRs.	16 Feb – 20 Feb 2025	Collaborate with PI Watanabe on research to understand the mechanisms of cognition and attention using functional brain imaging. Also he gave a lecture to the UTokyo students, and interatcted with other researchers.

Appendix 6 FY2024 State of Outreach Activities

* Fill in the numbers of activities and times held during FY2024 by each activity.
* Describe the outreach activities in the "6. Others" of Progress Report, including those stated below that warrant special mention.

Activities	FY2024 (number of activities, times held)
Lectures, seminars for general public	31
Teaching, experiments, training for elementary, secondary and high school students	5
Open houses	7
Participating, exhibiting in events	6
Press releases	12
Publications of the popular science books	3

*If there are any rows on activities the center didn't implement, delete that (those) row(s). If you have any activities other than the items stated above, fill in the space between parentheses after "Others" on the bottom with the name of those activities and state the numbers of activities and times held in the space on the right. A row of "Others" can be added, if needed.

Outreach Activities and Their Results

List up to three of the Center's outreach activities carried out in FY 2024 that have contributed to enhancing the brand or recognition of your Center and/or the brand of the overall WPI program, and describe its concrete contents and effect in narrative style. (Where possible, indicate the results in concrete numbers.)

Examples:
- As a result of using a new OO press-release method, a OO% increase in media coverage was obtained over the previous year.
- By holding seminars for the public that include people from industry, requests for joint research were received from companies.
- We changed our public relations media. As a resulting of using OO to disseminate information, a OO% increase in inquiries from researchers was obtained over the previous year.
- As a result of vigorously carrying out OO outreach activity, ¥OO in external funding was acquired.

1) Getting high school students engaged

Fostering the next generation of global scientific talent is a core mission of WPI, and engaging young minds through outreach is key to achieving this goal. In FY2024, IRCN offered a range of inspiring programs for high school and middle school students and their educators, aiming to cultivate curiosity and promote deeper understanding of brain science and interdisciplinary research.

(1) On April 22, 2024, 24 students from Princess Chulabhorn Science High School Chiang Rai (Thailand) and Tokyo Gakugei University Senior High School visited IRCN. This marked the first time IRCN welcomed visiting high school students from abroad.

(2) On July 24, 2024, 25 students from the Biology Club of Nada Junior and Senior High School visited IRCN and engaged in hands-on activities with cutting-edge research tools.

(3) On August 6, 2024, 228 people attended the UTokyo Open Campus online event "Meet the Young Scientists!" co-hosted with the Tokyo Metropolitan Board of Education.

(4) On October 19, 2024, IRCN showcased its research in brain science and AI at the UTokyo Homecoming Day, drawing attention from students and the general public alike.

(5) On March 22, 2025, 189 participants joined the online seminar "Mysterious and Interesting Brain Mechanisms" designed for female middle and high school students.

2) Engaging with the general public

Public engagement is a cornerstone of the WPI's mission to promote mutual understanding between science and society. In FY2024, IRCN organized a series of outreach events designed to share the latest insights in brain science with the broader public and encourage inclusive dialogue around the future of science and society.

(1) On January 9, 2025, IRCN hosted a public symposium titled "Building a Society Where Individuals with Developmental Disorders Can Thrive: Empathy and Acceptance from the Perspective of Those with Lived Experience." A total of 111 people attended. This was IRCN's first DEI-focused public program.

(2) On January 25, 2025, the 10th joint public lecture "Questions of Origins" was held in collaboration with WPI-ELSI and Kavli WPI-IPMU. It attracted 143 attendees on-site and 103 online viewers.

(3) As part of the IRCN × Knowledge Capital SpringX Super School series, two engaging lectures were delivered by IRCN researchers.
This series served as a dynamic platform for connecting cutting-edge neuroscience research with a diverse general audience, including young learners and working professionals.
– On February 4, 2025, Dr. Yasushi Okada gave a talk that attracted 54 on-site attendees, 120 online participants, and received 5,435 views on YouTube (as of April 15).
– On February 18, 2025, Dr. Haruo Kasai's lecture drew 136 online participants and has garnered 3,168 YouTube views (as of April 15).

3) Books and articles targeted to public audiences

『デジタル脳クライシス　AI時代をどう生きるか』 ("Digital Brain Crisis – How to Live in the Age of AI")
Sakai, K. (Affiliated Faculty Member)
朝日新聞出版 (Asahi Shimbun Publications, Tokyo), ISBN 978-4022952837
Published on October 11, 2024

『東大塾　脳科学とAI』 ("University of Tokyo Extension Lecture Series: Neuroscience and AI")
Sakai, K. (Editor, Affiliated Faculty Member)
東京大学出版会 (University of Tokyo Press, Tokyo), ISBN 978-4-13-063369-7
Published on November 5, 2024

「嗅覚の分子メカニズム」
("Molecular Mechanisms of Olfaction" in: New Developments in FoodTech Creating Deliciousness, Chapter 2)
Touhara, K. (Affiliated Faculty Member)
シーエムシー出版 (CMC Publishing), ISBN 978-4-7813-1811-0
Published on July 18, 2024

Appendix 7 FY 2024 List of Project's Media Coverage

* List and describe media coverage (e.g., articles published, programs aired) in FY2024.

* Enter the host institution name and the center name in the footer.

	Date	Types of Media (e.g., newspaper, magazine, television)	Description
1	2024/4/5	Mylienews (Website)	[Y. Okada] Nakatani Foundation Hosts 2023 Nakatani Prize Laureates Seminar; RIKEN's Yasushi Okada Encourages Science-Loving High School Students to Become Researchers 中谷財団、2023年度中谷賞大賞受賞者セミナーを開催、理化学研究所の岡田康志氏が研究者を目指す科学好きの高校生にエール
2	2024/04/07	Sankei News (Website)	[Y. Okada] Yasushi Okada, a physicist at the University of Tokyo, takes on the challenge of "The World of the Microscopic" by developing the world's fastest ultra-high resolution microscope 東大の物理学者、岡田康志が挑む「微小の世界」 世界最高速の超解像顕微鏡実現
3	2024/04/18	Nikkei Shimbun (Website)	[K. Aihara] University of Tokyo and Rikkyo University Develop Efficient Algorithm to Estimate Exogenous and Endogenous Factors in Stock Trading 東大と立教大、株式取引の外生的・内生的要因を推定する効率的なアルゴリズムを開発
4	2024/04/26	Nikkei Shimbun (Newspaper)	[K. Touhara] The University of Tokyo, The University of Osaka, and NICT present "The Influence of Words on the Brain's Perception of Smell in Human Olfactory Information Process" 東大・阪大・NICT、「言葉がヒトの匂いの脳内情報処理に与える影響」について発表
5	2024/05/02	Excite News (Website)	[K. Aihara, Y. Sakemi] Chiba Institute of Technology and UTokyo Team Enhance Echo State Network with Neuron Time History Optimization 千葉工業大学・東京大学などの研究チーム、ニューロンの時間履歴項調整によるダイナミクスの最適化がエコーステートネットワーク性能向上の
6	2024/05/07	Mynavi News (Website)	[K. Aihara, Y. Sakemi] Chiba Institute of Technology and the University of Tokyo confirm the key to improving the performance of ESN, a type of reservoir computing 千葉工業大学と東大、リザバー計算の一種「ESN」の性能向上の鍵を確認
7	2024/05/20	NHK Journal (Radio)	[Y. Nagai] Special Issue "Robotics for Understanding Developmental Disorders" 特集「ロボット工学で発達障害解明を」
8	2024/05/23	The Inamori Foundation website （Website）	[A. Hoshino] 2024InaRIS Fellows Introduction Video 2024InaRISフェロー紹介動画
9	2024/06/10	Nikkei Shimbun (Website)	[K. Kasai] UTokyo and others have confirmed that inappropriate use of the internet during adolescence increases the risk of psychotic symptoms and depression. 東大など、思春期におけるインターネットの不適切使用が精神病症状および抑うつのリスクを高めることを確認
10	2024/06/10	Mynavi News (Website)	[K. Kasai] Inappropriate use of the internet during adolescence increases the risk of psychotic symptoms and depression, according to the UTokyo and others 思春期のインターネットの不適切使用が精神病症状や抑うつリスクを高める、東大などが確認
11	2024/06/11	MIT Technology Review (Website)	[K. Kasai] Inappropriate use of the internet during adolescence can lead to mental health problems 思春期のインターネット不適切使用、メンタルヘルスの不調を招く
12	2024/06/12	Qlife Pro (Website)	[K. Kasai] Risk of psychotic symptoms and depression increases with "inappropriate internet use" during adolescence 思春期の「インターネット不適切使用」で精神病症状・抑うつリスク増
13	2024/07/03	Mainichi Shimbun （Newspaper）	[A. Hoshino] "Visiting my alma mater" Interview Article 「母校をたずねる」 インタビュー記事

14	2024/07/10	Nikkei Shimbun (Website)	[K. Kasai] Tokyo Metropolitan Institute of Medical Science and UTokyo Confirm that Prolonged Young Carer Status in Adolescence Increases Risk of Mental Health Issues 都医学総合研究所と東大、思春期にヤングケアラーの状態が長く続くと精神的な不調を抱えやすくなることを確認
15	2024/07/12	Nikkei Shimbun (Website)	[T. Watanabe] UTokyo clarifies that non-memory symptoms of Alzheimer's disease are related to abnormal activity in the cerebral network 東大、アルツハイマー型認知症の非記憶系症状は大脳ネットワークの活動異常と関連していることを解明
16	2024/07/16	Andla (Website)	[K. Kasai] Confirmation that young people who are in the state of being a young carer for a long time during adolescence are more likely to suffer from mental health problems/The University of Tokyo 思春期にヤングケアラーの状態が長く続くと精神的な不調を抱えやすくなることを確認/東京大学
17	2024/07/18	QLifePro (Website)	[K. Kasai] Long-term adolescent young caregivers at high risk of mental disorders - Tokyo Metropolitan Institute of Medical Science and others 思春期の長期ヤングケアラー、精神的不調を抱えるリスク「高」－都医学研ほか
18	2024/07/23	Top Researchers (Website)	[H. Takeuchi] Uncovering a Novel Neuroplasticity Mechanism Discovered in the Olfactory Circuit 嗅覚回路で発見した、新たな神経可塑性メカニズムを解明する
19	2024/07/25	Bunkyo Degital (Website)	[N. Okada] Identifying subjective and objective symptoms of depression using fMRI for the first time in the world - The University of Tokyo うつの自覚症状と他覚的評価を発見　世界で初めてfMRIで特定　東大
20	2024/07/25	NIkkei Biotechnology and Business (Website)	[N. Okada] Tokyo University discovers brain circuitry related to the discrepancy between subjective and objective evaluations of depression - Subjective and objective evaluations are related to brain networks - 東京大、うつの自覚症状と他覚的評価のかい離に関わる脳回路を発見――自覚・他覚の優位性と脳内ネットワークとが関連――
21	2024/07/25	Nikkei Shimbun (Website)	[N. Okada] The University of Tokyo discovers brain circuitry related to the gap between subjective and objective evaluations of depression symptoms 東大、うつの自覚症状と他覚的評価のかい離に関わる脳回路を発見
22	2024/08/05	QLifePro (Website)	[Z. Chao] Unraveling some of the unstable prognostic factors for autism in monkeys and discovering individual differences - NCNP and others 自閉症の不安定な予測メカニズムの一端をサルで解明、個人差も発見－NCNPほか
23	2024/08/26	Mainichi Shimbun (Website)	[K. Aihara, S. Iwami] Isolation of EMPOX patients to be lifted “after PCR test” - Recovery varies エムポックス発症者の隔離解除は「PCR検査で」 回復にばらつき
24	2024/08/27	Nikkei Shimbun (Website)	[K. Aihara, S. Iwami] A simulator has been developed to verify the timing for ending the isolation of EMPOX-infected individuals, Nagoya University and others. 名大など、エムポックス感染者の隔離を終了するタイミングを検証するためのシミュレータを開発
25	2024/08/27	NIkkei Biotechnology and Business (Website)	[K. Aihara, S. Iwami] How should the isolation of people infected with MOPX, such as those at Nagoya University, be ended? - Development of a simulator to verify the timing of the end of isolation - 名古屋大など、エムポックス感染者の隔離はどのように終了するのが良い？ ～隔離終了タイミング検証のシミュレータを開発～
26	2024/09/13	Asahi Shinbun (Website)	[S. Tsuji] AI study, learning from babies: Exploring the secret to efficiently learning language AIの学習、赤ちゃんから学ぶ　効率よく言葉を覚える秘訣を探る
27	2024/09/27	Nikkei Shimbun (Website)	[H. Kasai] Developing a mathematical model that predicts the relationship between synaptic and brain activity, as well as a molecular tool that strengthens the connections between nerve cells in the brain, at universities such as Tsukuba University and the University of Tokyo. 筑波大・東大など、脳の神経細胞同士の結びつきを増強する分子ツールとシナプスと脳の活動の関係を予測する数理モデルを開発
28	2024/10/01	Mynavi News (Website)	[H. Kasai] Tsukuba University and others have discovered a mechanism for controlling the amount and quality of sleep. 筑波大など、睡眠の量と質を一定に制御するための仕組みを発見

29	2024/10/22	Nikkei Shimbun (Newspaper)	[K. Aihara] Japanese Contribution to the Foundation of the Nobel Prize "AI Machine Learning"
30	2024/11/06	Neuroscience news (Website)	[K. Ohki] About this sensory perception and neuroscience research news
31	2024/11/08	Medical Press (Website)	[T. Hensch, Y. Makino] Delving into the causes of attention deficits: Childhood adversity, lost sleep and dopamine
32	2024/11/09	Neuroscience news (Website)	[T. Hensch, Y. Makino] Childhood Stress Disrupts Attention, Sleep, and Dopamine Balance in Adults
33	2024/11/20	Nikkan Kogyo Shimbun (Website)	[Y. Okada] RIKEN and others developed biosensor platform for high-precision observation of molecular concentrations 理研など、分子濃度を高精度に観察 バイオセンサー設計基盤開発
34	2024/11/20	OPTRONICS ONLINE (Website)	[Y. Okada] RIKEN developed a biosensor platform for generating fluorescence-lifetime 理研ら，蛍光寿命バイオセンサー生成基盤を開発
35	2024/11/20	Nikkan Kogyo Shimbun (Website)	[Y. Okada] Biosensor for high-precision observation of molecular concentrations - RIKEN and others 分子濃度　高精度に観察　バイオセンサー　理研などが設計基盤
36	2024/12/01	NIKKEI The STYLE (Newspaper)	[Y. Nagai] Living with a Unique Brain: Understanding Neurodiversity with AI-Based Neural Analysis ユニークな脳を生きる AIで脳波読み多様な個性理解へ
37	2024/12/03	EE times japan (Website)	[G. Tanaka] Researchers developed transistor that mimics the behavior of biological neural tissue 生体神経組織の動作を模倣するトランジスタを開発
38	2024/12/04	IDEAS IDEAS(Website)	[K. Ohki] Orthogonalization of spontaneous and stimulus-driven activity by hierarchical neocortical areal network in primat
39	2024/12/04	Nikkei Shimbun (Newspaper)	[K. Ohki] Elucidating the mechanism by which cerebral neural circuits separate activities generated by the brain itself from those generated by inputs from the outside world - The University of Tokyo and Doshisha University 東大と同志社大学　脳自身が生み出す活動と外界からの入力による活動を大脳神経回路が分離するメカニズムを解明
40	2024/12/04	Nipponese Nipponese (Website)	[K. Ohki] Primate Study Reveals Neural Mechanisms Separating Signal and Noise in the Brain 霊長類の研究により、脳内で信号とノイズを分離する神経機構が解明される
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