# World Premier International Research Center Initiative (WPI) FY 2023 WPI Project Progress Report (The center selected in and before FY2020)

| Host Institution | The University of Tokyo                                    | Host Institution Head   | Teruo Fujii   |
|------------------|--|-------------------------|---------------|
| Research Center  | International Research Center for Neurointelligence (IRCN) |                         |               |
| Center Director  | Takao Hensch   | Administrative Director | Nobukazu Toge |

Common instructions:

\* Unless otherwise specified, prepare this report based on the current (31 March 2024) 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)

**Center Vision:** The International Research Center for Neurointelligence (IRCN) seeks new principles of brain development to better understand mental disorders and innovate novel artificial intelligence (A.I.). The dramatic rise in generative A.I. over the past 18 months challenges us to reassess the role for our small academic Center in a landscape dominated by heavily resourced big tech companies. We are inspired by the seminal example of UTokyo Professor *Emeritus* Shun-ichi Amari, whose mathematical insights into stochastic gradient descent in the 1960s became the cornerstone for modern Deep Neural Networks (DNNs) decades later. Likewise, our mission remains to elucidate basic neuroscience principles, especially in the developing brain, to <u>seed</u> next generation A.I. long into the future. More near-term understanding and treatment of mental illnesses must rely on <u>translating</u> their biological origins to the clinic aided now by the power of A.I. Finally, as we learn to co-exist with A.I., the problem of <u>alignment</u> between man and machine will depend upon the accurate and ethical implementation of H.I. principles.

**High-level Research:** In FY2023, IRCN scientists published 174 articles (27% in high profile journals, such as Nature publishing, Cell Press, PNAS, Science, eLife, etc), including 111 WPI original and 47 WPI-related papers. Our talented PIs received several awards including an HFSP Young Investigator Award to PI Sho Tsuji, the Nakaakira Tsukahara Prize to DD Kenichi Ohki, and the 16<sup>th</sup> Nakatani Foundation Award Grand Prize to PI Yasushi Okada. Incoming DD Yukiko Gotoh was honored both by the Japanese Biochemical Society (Samuro Kakiuchi Memorial Award) and the Takeda Prize for Medical Science. Numerous honorary and invited lectures were given around the world by IRCN investigators (see Appendix 1).



**Interdisciplinarity:** Our 15 PIs integrated actively across five Teams established in FY2022 that capture the strength of our faculty, spanning neurobiology, computation, clinical and technology domains. Specifically, the <u>intrinsic activity</u> and <u>predictive coding</u> Teams revealed inner dynamics underlying Diverse intelligence, including perception, creativity, autism and psychosis. The <u>social</u>

<u>learning</u> and <u>critical period</u> Teams explored the foundations of social communication and collective intelligence, and the <u>neuromodulation</u> Team unmasked cellular and circuit bases of presynaptic plasticity in model systems. All Teams incorporated a developmental lens that also sheds light on mental illness when these fundamental processes go awry. Notably in 2022-23, our efforts seeded an A.I. incubator with specific principles from the developmental origins of H.I., including mechanisms of presynaptic plasticity, pruning of long-range projections, oscillatory biomarkers, untangling co-morbid cognitive disorders, top-down processing of prediction errors, computational roles for stochastic activity and reservoir computing.

**Internationality:** In FY2023, IRCN maintained scientist diversity with initially three out of fifteen PIs (20%), eleven of sixty-three (17%) Affiliated Faculty (AF), six of nineteen (32%) Associate Research Fellows (ARF), and three of sixteen (19%) Research Fellows being non-Japanese. Notably, twenty-one Postdoctoral Fellows out of twenty-eight (75%) were from abroad. IRCN maintained international connections through numerous guest talks from overseas in the weekly Science Salon series, several sabbatical faculty visitors (from Brown Univ, McGill, Univ Geneva, Univ Lucca), Harvard summer interns and others staying at the Center throughout the year. In September 2023, the Boston Children's Hospital IRCN satellite organized the second CDKL5 Asia Forum at UTokyo, including nearly twenty foreign speakers (keynote talk by WPI-IIIS Director Masashi Yanagisawa) and patient family organizations from Europe, USA, Australia and Asia.

**Organizational Reform:** With the retirement of DD Masanobu Kano, PI Kenichi Ohki from the Graduate School of Medicine joined IRCN high-level management as a new DD in the Executive Board (EB). Leadership of the three complementary 'Offices' was reshuffled designed to intersect the Director's top-down leadership, bottom-up proposals from all PIs (Steering Committee, SC), and support from the administration and UTokyo: <u>Sustainability</u> (newly led by DD Kazuo Emoto), <u>Synergy</u> (newly led by DD Ohki) and <u>Community</u> (led by DD Aihara/D Hensch). Daily business continued to be handled by the <u>Director's Office</u> (DO) established in April 2022, consisting of D Hensch, Special Advisor to the Director (SAD) Masamitsu Iino, General Manager (GM) Yasuko Chika and chaired by the Administrative Director (AD) Nobu Toge. Four core facilities continued to provide professional, cost-effective, and rapid access to research services and technologies by expert IRCN staff.



As AD N Toge announced his retirement for March 2024, а new incoming AD Mayumi Kimura (current AD of WPI-IIIS) was recruited D by

Hensch. To further strengthen Diversity, Equity & Inclusion (DEI) amongst IRCN leadership, PI Yukiko Gotoh joined the Community Office in January 2024 (to be named DD in charge as of April 2024). In turn, former DD Kazuyuki Aihara was appointed Executive Director (ED) specifically to boost the A.I. Incubator comprised of several of our most active (top 10%) existing computational AFs. This decision was made after a targeted search for a new PI in the A.I. space in fall/winter 2023-24 failed to yield a suitable single candidate. Finally, with our successful extra federal budget request (概算 要求) for 'Athlete Cognitive Neuroscience (YIPS)' research, a new three-way Alliance bridging IRCN – RIKEN CBS – Teikyo University was created under the guidance of SAD Iino.

**Sustainability:** Impelled by AD Toge and D Hensch, the UTokyo IRCN Taskforce met monthly to actively discuss and determine the following: 1) IRCN will remain under the UTIAS umbrella as an independent Center beyond 2027; 2) a written financial commitment (signed by EVPs and D) to go beyond the original 10 FTE equivalents is to be phased in starting FY2024; 3) formal graduate student access to Project PIs via the Graduate School of Medicine; 4) tenure path to be established by IRCN criteria. Unfortunately, three of our diverse PIs were lost to global competition in January 2024, as UTokyo 'D&I' policy still lacks adequate 'E'. Their promotion at CNRS (PI Tsuji), U Miami (PI Cai), and OIST (PI Yazaki) validates the high quality of Project PIs initially recruited by D Hensch and opens new gateways for international collaboration. To promote further awareness, DEI training was conducted with an outside company (enjoi Japan KK).

\* 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 2023.

\* 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.

#### Core Intelligence <Neuromodulation Team>

<Mechanical transmission at spine synapses: Short-term potentiation and working memory. *Curr Op Neurobiol.* (2023) 80:102706. Kasai H, Ucar H, Morimoto Y, Eto F, Okazaki H.>

Simultaneous investigation of both dendritic spine and presynaptic terminals has recently revealed a novel feature of spine synapses. Spine enlargement pushes the presynaptic terminals with muscle-like force and augments the evoked glutamate release for up to 20 min. We summarized the evidence that such mechanical transmission shares critical features in common with short-term potentiation (STP) and may represent the cellular basis of short-term and working memory. Thus, dendritic spines, which comprise the postsynaptic component of most excitatory synapses, do not exist only for their structural dynamics, receptor trafficking, and chemical and electrical compartmentation. Spine synapses produce the force of learning to leave structural traces for both short and long-term memories.



<**Presynaptic Ube3a E3 ligase promotes synapse elimination through down-regulation of BMP signaling.** *Science*. 381(6663):1197-1205 (2023). Furusawa K, Ishii K, Tsuji M, Tokumitsu N, Hasegawa E, **Emoto K**.>



Inactivation of the ubiquitin ligase Ube3a causes the developmental disorder Angelman syndrome, whereas increased Ube3a dosage is associated with autism spectrum disorders. Despite the enriched localization of Ube3a in the axon terminals including presynapses, little is known about the presynaptic function of Ube3a and mechanisms underlying its presynaptic localization. We show that developmental synapse elimination requires presynaptic Ube3a activity in Drosophila neurons. We

further identified the domain of Ube3a that is required for its interaction with the kinesin motor. Angelman syndrome-associated missense mutations in the interaction domain attenuate presynaptic targeting of Ube3a and prevent synapse elimination. Conversely, increased Ube3a activity in presynapses leads to precocious synapse elimination and impairs synaptic transmission. Our findings reveal the physiological role of Ube3a and suggest potential pathogenic mechanisms associated with Ube3a dysregulation. <Increased vesicle fusion competence underlies long-term potentiation at hippocampal mossy fiber synapses. *Science Advances*. 9(8):eadd3616 (2023). Fukaya R, Hirai H, Sakamoto H, Hashimotodani Y, **Hirose K**, Sakaba T.>

Presynaptic long-term potentiation (LTP) is thought to play an important role in learning and memory. However, the underlying mechanism remains elusive because of the difficulty of direct recording during LTP. Hippocampal mossy fiber synapses exhibit pronounced LTP of transmitter release after tetanic stimulation and have been used as a model of presynaptic LTP. Here, we induced LTP by optogenetic tools and applied direct presynaptic patch-clamp recordings. The action potential waveform and evoked presynaptic Ca<sup>2+</sup> currents remained unchanged after LTP induction. Membrane capacitance measurements suggested higher release probability of synaptic vesicles without changing the number of release-ready vesicles after LTP induction. Synaptic vesicle replenishment was also enhanced. Furthermore, stimulated emission depletion microscopy suggested an increase in the numbers of Munc13-1 and RIM1 molecules within active zones. We propose that dynamic changes in the active zone components may be relevant for the increased fusion competence and synaptic vesicle replenishment during LTP.

< Distorted neurocomputation by a small number of extra-large spines in psychiatric disorders. *Science Advances.* 9(23):eade5973 (2023). Obi-Nagata K, Suzuki N, Miyake R, MacDonald ML, Fish KN, Ozawa K, Nagahama K, Okimura T, Tanaka S, **Kano M**, Fukazawa Y, Sweet RA, Hayashi-Takagi A.>

Human genetics strongly support the involvement of synaptopathy in psychiatric disorders. However, trans-scale causality linking synapse pathology to behavioral changes is lacking. To address this question, we examined the effects of synaptic inputs on dendrites, cells, and behaviors of mice with knockdown of SETD1A and DISC1, which are validated animal models of schizophrenia. Both models exhibited an overrepresentation of extra-large (XL) synapses, which evoked supralinear dendritic and somatic integration, resulting in increased neuronal firing. The probability of XL spines correlated negatively with working memory, and the optical prevention of XL spine generation restored working memory impairment. Furthermore, XL synapses were more abundant in the postmortem brains of patients with schizophrenia than in those of matched controls. Our findings suggest that working memory performance, a pivotal aspect of psychiatric symptoms, is shaped by distorted dendritic and somatic integration via XL spines.

#### **Social Intelligence** <Social Learning, Critical Period Teams>

<**Transient sensorimotor projections in the developmental song learning period.** *Cell Rep* (2024) 43: 114196. Louder MIM, Kuroda M, Taniguchi D, Komorowska-Müller JA, Morohashi Y, Takahashi M, Sánchez-Valpuesta M, Wada K, **Okada Y**, Hioki H, **Yazaki-Sugiyama Y.**>

Memory recall and guidance are essential for motor skill acquisition. Like humans learning to speak, male zebra finches learn to sing by first memorizing and then matching their vocalization to the tutor's song (TS) during specific developmental periods. Yet, the neuroanatomical substrate supporting auditory-memory-guided sensorimotor learning has remained elusive. Here, using a

whole-brain connectome analysis with activitydependent viral expression, we identified a transient projection into the motor region, HVC, from neuronal ensembles responding to TS in the auditory forebrain, the caudomedial nidopallium (NCM), in juveniles. Virally induced cell death of the juvenile, but not adult, TS-responsive NCM neurons impaired song learning. Moreover, isolation, which delays closure of the



sensory, but not the motor, learning period, did not affect the decrease of projections into the HVC from the NCM TS-responsive neurons after the song learning period. Taken together, our results suggest that dynamic axonal pruning may regulate timely auditory-memory-guided vocal learning during development.

<**CDKL5 sculpts functional callosal connectivity to promote cognitive flexibility.** *Mol Psychiatry.* (2023) doi: 10.1038/s41380-023-01962-y. Awad PN, Zerbi V, Johnson-Venkatesh EM, Damiani F, Pagani M, Markicevic M, Nickles S, Gozzi A, Umemori H, **Fagiolini M**.>

Functional and structural connectivity alterations in short- and long-range projections have been reported across neurodevelopmental disorders (NDD). Interhemispheric callosal projection neurons (CPN) represent one of the major long-range projections in the brain, which are particularly important for higher-order cognitive function and flexibility. However, whether a causal relationship exists between interhemispheric connectivity alterations and cognitive deficits in NDD remains elusive. Here, we focused on CDKL5 Deficiency Disorder (CDD), a severe neurodevelopmental disorder caused by mutations in the X-linked Cyclin-dependent kinase-like 5 (CDKL5) gene. We found an increase in homotopic interhemispheric connectivity and functional hyperconnectivity across higher cognitive areas in adult male and female CDKL5-deficient mice by resting-state functional MRI (rs-fMRI) analysis. This was accompanied by an increase in the number of callosal synaptic inputs but decrease in local synaptic connectivity in the cingulate cortex of juvenile CDKL5-deficient mice, suggesting an impairment in excitatory synapse development and a differential role of CDKL5 across excitatory neuron subtypes. These deficits were associated with significant cognitive impairments in CDKL5 KO mice. Selective deletion of CDKL5 in the largest subtype of CPN likewise resulted in an increase of functional callosal inputs, without however significantly altering intracortical cingulate networks. Notably, such callosal-specific changes were sufficient to cause cognitive deficits. Finally, when CDKL5 was selectively re-expressed only in this CPN subtype, in



otherwise CDKL5-deficient mice, it was sufficient to prevent the cognitive impairments of CDKL5 mutants. Together, these results reveal a novel role of CDKL5 by demonstrating that it is both necessary and sufficient for proper CPN connectivity and cognitive function and flexibility, and further validates a causal relationship between CPN dysfunction and cognitive impairment in a model of NDD.

<Sleep-sensitive dopamine receptors mediate attention deficits after early adversity in males. *Science Translational Medicine* (in press). 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**.>

Early life stress (ELS) yields cognitive impairments of unknown molecular and physiological origin. We found that fragmented maternal care of mice during a neonatal critical period from postnatal days P2-9 elevated dopamine receptor D2R and suppressed D4R expression specifically within anterior cingulate cortex (ACC) of only the male offspring. This was associated with poor performance on a two-choice visual attention task, which was acutely rescued in adulthood by local or systemic pharmacological rebalancing of D2R/D4R activity. Further, ELS males demonstrated heightened hypothalamic orexin and persistently disrupted sleep. Since acute sleep deprivation in normally reared males mimicked the ACC dopamine receptor subtype modulation and disrupted

attention, sleep loss likely underlies vulnerability to ELS. Likewise, sleep impairment mediated the attention deficits associated with early adversity in human children. Deeper understanding of the sex-specific cognitive consequences of ELS, thus, reveals novel strategies for overcoming them.

#### <Rapid synaptic and gamma rhythm signature of mouse critical period plasticity. *Proc Natl Acad Sci USA.* (2023) 120(2):e2123182120. Quast KB, Reh RK, Caiati MD, Kopell N, McCarthy MM, Hensch TK.>

Early-life experience enduringly sculpts thalamocortical (TC) axons and sensory processing. Here, we identify the very first synaptic targets that initiate critical period plasticity, heralded by altered cortical oscillations. Monocular deprivation (MD) acutely induced a transient (<3 h) peak in EEG ypower (~40 Hz) specifically within the visual cortex, but only when the critical period was open (juvenile mice or adults after dark-rearing, Lynx1-deletion, or diazepam-rescued GAD65-deficiency). Rapid TC input loss onto parvalbumin-expressing (PV) inhibitory interneurons (but not onto nearby pyramidal cells) was observed within hours of MD in a TC slice preserving the visual pathway - again once critical periods opened. Computational TC modeling of the emergent y-rhythm in response to MD delineated a cortical interneuronal gamma (ING) rhythm in networks of PV-cells bearing gap junctions at the start of the critical period. The ING rhythm effectively dissociated thalamic input from cortical spiking, leading to rapid loss of previously strong TC-to-PV connections through standard spike-timing-dependent plasticity rules. As a consequence, previously silent TC-to-PV connections could strengthen on a slower timescale, capturing the gradually increasing y-frequency and eventual fade-out over time. Thus, ING enables cortical dynamics to transition from being dominated by the strongest TC input to one that senses the statistics of population TC input after MD. Taken together, our findings reveal the initial synaptic events underlying critical period plasticity and suggest that the fleeting ING accompanying a brief sensory perturbation may serve as a robust readout of TC network state with which to probe developmental trajectories.

< Alterations of auditory-evoked gamma oscillations are more pronounced than alterations of spontaneous power of gamma oscillation in early stages of schizophrenia. *Transl Psychiatry.* (2023) 13(1):218. Tada M, Kirihara K, Koshiyama D, Nagai T, Fujiouka M, Usui K, Satomura Y, **Koike S**, Sawada K, Matsuoka J, Morita K, Araki T, **Kasai K**.>

Several animal models of schizophrenia and patients with chronic schizophrenia have shown increased spontaneous power of gamma oscillations. However, the most robust alterations of gamma oscillations in patients with schizophrenia are reduced auditory-oscillatory responses. We hypothesized that patients with early-stage schizophrenia would have increased spontaneous power of gamma oscillations and reduced auditory-oscillatory responses. This study included 77 participants, including 27 ultra-high-risk (UHR) individuals, 19 patients with recent-onset schizophrenia (ROS), and 31 healthy controls (HCs). The auditory steady-state response (ASSR) and spontaneous power of gamma oscillations measured as induced power during the ASSR period were calculated using electroencephalography during 40-Hz auditory click-trains. The ASSRs were lower in the UHR and ROS groups than in the HC group, whereas the spontaneous power of gamma oscillations in the UHR and ROS groups did not significantly differ from power in the HC group. Both early-latency (0-100 ms) and late-latency (300-400 ms) ASSRs were significantly reduced and negatively correlated with the spontaneous power of gamma oscillations in the ROS group. In contrast, UHR individuals exhibited reduced late-latency ASSR and a correlation between the unchanged early-latency ASSR and the spontaneous power of gamma oscillations. ASSR was positively correlated with the hallucinatory behavior score in the ROS group. Correlation patterns between the ASSR and spontaneous power of gamma oscillations differed between the UHR and ROS groups, suggesting that the neural dynamics involved in non-stimulus-locked/task modulation change with disease progression and may be disrupted after psychosis onset.

#### **Diverse Intelligence** < Intrinsic Activity, Predictive Coding Teams>

# < Distinct Frontoparietal Brain Dynamics Underlying the Co-Occurrence of Autism and ADHD. *eNeuro* (2023) 10(7): ENEURO.0146-23. Watanabe D, Watanabe T.>

Previous diagnostic systems precluded the co-existence of autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) in one person; but, after many clinical reports, the diagnostic criteria were updated to allow their co-occurrence. Despite such a clinical change, the neurobiological bases underpinning the comorbidity remain poorly understood, and whether the ASD+ADHD condition is a simple overlap of the two disorders is unknown. Here, to answer this question, we compared the brain dynamics of high-functioning ASD+ADHD children with age-/sex-/IQ-matched pure ASD, pure ADHD, and typically developing (TD) children. Regarding autistic traits, the socio-communicational symptom of the ASD+ADHD children was explained by the same overstable brain dynamics as seen in pure ASD. In contrast, their ADHD-like traits were grounded on a unique neural mechanism that was unseen in pure ADHD: the core symptoms of pure ADHD were associated with the overly flexible whole-brain dynamics that were triggered by the unstable activity of the dorsal-attention network and the left parietal cortex; by contrast, the ADHD-like cognitive instability of the ASD+ADHD condition was correlated with the atypically frequent neural transition along a specific brain state pathway, which was induced by the atypically unstable activity of the frontoparietal control network and the left prefrontal cortex. These observations need to be validated in future studies using more direct and comprehensive behavioral indices, but the current findings suggest that the ASD+ADHD comorbidity is not a mere overlap of the two disorders. Particularly, its ADHD-like traits could represent a unique condition that would need a specific diagnosis and bespoke treatments.



<Cerebral cortical structural alteration patterns across four major psychiatric disorders in 5549 individuals. *Mol Psychiatry.* (2023) 28(11):4915-4923. Matsumoto J, Fukunaga M, Miura K, Nemoto K, **Okada N**, Hashimoto N, Morita K, Koshiyama D, Ohi K, Takahashi T, Koeda M, Yamamori H, Fujimoto M, Yasuda Y, Ito S, Yamazaki R, Hasegawa N, Narita H, Yokoyama S, Mishima R, Miyata J, Kobayashi Y, Sasabayashi D, Harada K, Yamamoto M, Hirano Y, Itahashi T, Nakataki M, Hashimoto RI, Tha KK, **Koike S**, Matsubara T, Okada G, Yoshimura R, Abe O, van Erp TGM, Turner JA, Jahanshad N, Thompson PM, Onitsuka T, Watanabe Y, Matsuo K, Yamasue H, Okamoto Y, Suzuki M, Ozaki N, **Kasai K**, Hashimoto R.> According to the operational diagnostic criteria, psychiatric disorders such as schizophrenia (SZ), bipolar disorder (BD), major depressive disorder (MDD), and autism spectrum disorder (ASD) are classified based on symptoms. While its cluster of symptoms defines each of these psychiatric disorders, there is also an overlap in symptoms between the disorders. We hypothesized that there are also similarities and differences in cortical structural neuroimaging features among these psychiatric disorders. T1-weighted magnetic resonance imaging scans were performed for 5,549 subjects recruited from 14 sites. Effect sizes were determined using a linear regression model within each protocol, and these effect sizes were meta-analyzed. The similarity of the differences in cortical thickness and surface area of each disorder group was calculated using cosine similarity, which was calculated from the effect sizes of each cortical regions. The <u>thinnest</u> cortex was found in SZ, followed by BD and MDD. The cosine similarity values between disorders were 0.943 for SZ and BD, 0.959 for SZ and MDD, and 0.943 for BD and MDD, which indicated that a common pattern of cortical thickness alterations was found among SZ, BD, and MDD. Additionally, a generally <u>smaller cortical surface area</u> was found in SZ and MDD than in BD, and the effect was larger in SZ. The cosine similarity values between disorders were 0.945

for SZ and MDD, 0.867 for SZ and ASD, and 0.811 for MDD and ASD, which indicated a common pattern of cortical surface area alterations among SZ, MDD, and ASD. Patterns of alterations in cortical thickness and surface area were revealed in the four major psychiatric disorders. To our knowledge, this is the first report of a cross-disorder analysis conducted on four major psychiatric disorders. Cross-disorder brain imaging research can help to advance our understanding pathogenesis of the of psychiatric disorders and common symptoms.



< Change detection in the primate auditory cortex through feedback of prediction error signals. *Nat Commun.* (2023) 14(1):6981. Obara K, Ebina T, Terada SI, Uka T, Komatsu M, Takaji M, Watakabe A, Kobayashi K, Masamizu Y, Mizukami H, Yamamori T, Kasai K, Matsuzaki M.>

Although cortical feedback signals are essential for modulating feedforward processing, no feedback error signal across hierarchical cortical areas has been reported. Here, we observed such a signal in the auditory cortex of awake common marmoset during an oddball paradigm to induce auditory duration mismatch negativity. Prediction errors to a deviant tone presentation were generated as offset calcium responses of layer 2/3 neurons in the rostral parabelt (RPB) of higher-order auditory cortex, while responses to non-deviant tones were strongly suppressed. Within several hundred milliseconds, the error signals propagated broadly into layer 1 of the primary auditory cortex (A1) and accumulated locally on top of incoming auditory signals. Blockade of RPB activity prevented deviance detection in A1. Optogenetic activation of RPB following tone presentation nonlinearly enhanced A1 tone response. Thus, the feedback error signal is critical for automatic detection of unpredicted stimuli in physiological auditory processing and may serve as backpropagation-like learning.

# <Short-term neuronal and synaptic plasticity act in synergy for deviance detection in spiking networks. *PLoS Comput Biol.* (2023) 19(10):e1011554. Kern FB, Chao ZC.>

Sensory areas of cortex respond more strongly to infrequent stimuli when these violate previously established regularities, a phenomenon known as deviance detection (DD). Previous modeling work has mainly attempted to explain DD on the basis of synaptic plasticity. However, a large fraction of

cortical neurons also exhibits firing rate adaptation, an underexplored potential mechanism. Here, we investigate DD in a spiking neuronal network model with two types of short-term plasticity, fast synaptic short-term depression (STD) and slower threshold adaptation (TA). We probe the model with an oddball stimulation paradigm and assess DD by evaluating the network responses. We find that TA is sufficient to elicit DD. It achieves this by habituating neurons near the stimulation site that respond earliest to the frequently presented standard stimulus (local fatigue), which diminishes the response and promotes the recovery (global fatigue) of the wider network. Further, we find a synergy effect between STD and TA, where they interact with each other to achieve greater DD than the sum of their individual effects. We show that this synergy is caused by the local fatigue added by STD, which inhibits the global response to the frequently presented stimulus, allowing greater recovery of TA-mediated global fatigue and making the network more responsive to the deviant stimulus. Finally, we show that the magnitude of DD strongly depends on the timescale of stimulation. We conclude that highly predictable information can be encoded in strong local fatigue, which allows greater global recovery and subsequent heightened sensitivity for DD.

#### A.I. Incubator

#### <Maximal Memory Capacity Near the Edge of Chaos in Balanced Cortical E-I Networks. *Neural Comput.* (2023) 20:1-33. Kanamaru T, Hensch TK, Aihara K>

We examined the efficiency of information processing in a balanced excitatory and inhibitory (E-I) network during the developmental critical period, when network plasticity is heightened. A multimodule network composed of E-I neurons was defined, and its dynamics were examined by regulating the balance between their activities. When adjusting E-I activity, both transitive chaotic synchronization with a high Lyapunov dimension and conventional chaos with a low Lyapunov dimension were found. In between, the edge of high-dimensional chaos was observed. To quantify the efficiency of information processing, we applied a short-term memory task in reservoir computing to the dynamics of our network. We found that memory capacity (MC) was maximized when optimal E-I balance was realized,



underscoring both its vital role and vulnerability during critical periods of brain development.

# <Noise and spike-time-dependent plasticity drive self-organized criticality in spiking neural network: towards neuromorphic computing. *Appl. Phys. Lett.* (2023) 123, 023701. Ikeda N, Akita D, Takahashi H.>

Self-organized criticality (SoC) may optimize information transmission, encoding, and storage in the brain. Therefore, the underlying mechanism of the SoC provides significant insight for largescale neuromorphic computing. We hypothesized that noise and stochastic spiking plays an essential role in SoC development in spiking neural networks (SNNs). We demonstrated that under appropriate noise levels and spike-time-dependent plasticity (STDP) parameters, an SNN evolves a SoC-like state characterized by a power-law distribution of neuronal avalanche size in a self-organized manner. Consistent with the physiological findings, the development of SNN was characterized by a transition from a subcritical state to a supercritical state and then to a critical state. Excitatory STDP with an asymmetric time window dominated the early phase of development; however, it destabilized the network and transitioned to the supercritical state. Synchronized bursts in the supercritical state enable inhibitory STDP with a symmetric time window, induce the development of inhibitory synapses, and stabilize the network toward the critical state. This sequence of transitions was observed when the appropriate noise level and STDP parameters were set to the initial conditions. Our results suggest that noise or stochastic spiking plays an essential role in SoC development and self-optimizes SNN for computation. Such neural mechanisms of noise harnessing would offer insight into the development of energy-efficient neuromorphic computing.

# <Adversarial attacks and defenses using feature-space stochasticity. *Neural Networks*. (2023) 167:875-889. Ukita J, Ohki K.>

Recent studies in deep neural networks have shown that injecting random noise in the input layer of the networks contributes towards *l*p-norm-bounded adversarial perturbations. However, to defend against unrestricted adversarial examples, most of which are not *l*p-norm-bounded in the input layer, such input-layer random noise may not be sufficient. In the first part of this study, we generated a novel class of unrestricted adversarial examples termed feature-space adversarial examples. These examples are far from the original data in the input space but adjacent to the original data in a



hidden-layer feature space and far again in the output layer. In the second part of this study, we empirically showed that while injecting random noise in the input layer was unable to defend these feature-space adversarial examples, they were defended by injecting random noise in the hidden layer. These results highlight the novel benefit of stochasticity in higher layers, in that it is useful for defending against these feature-space adversarial examples, a class of unrestricted adversarial examples.

#### 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."

The International Research Center for Neurointelligence (IRCN) seeks new principles of brain development to better understand brain disorders and innovate novel artificial intelligence (A.I.). The dramatic rise in generative A.I. over the past 18 months challenges us to reassess the role for our small academic Center in a landscape dominated by heavily resourced big tech companies. Our mission remains to elucidate basic neuroscience principles, especially in the developing brain, to <u>seed</u> next generation A.I. long into the future. We are inspired by the seminal example of UTokyo Professor *Emeritus* Shun-ichi Amari, whose mathematical insights on stochastic gradient descent in the 1960s became the cornerstone for modern Deep Neural Networks (DNNs) decades later.

While present-day computers are impressive, they require high power, have limited scalability, have limited parallelism and suffer "catastrophic forgetting" (teaching them new things, tends to forgetting old things). Neuromorophic computing promises several appealing features: 1) parallel computing like the brain to perform multiple tasks simultaneously; 2) low power consumption like the brain; 3) adaptability (learning) that enhances efficiency and flexibility (e.g. classification, pattern recognition); 4) fault-tolerance due to distributed / decentralized architecture, such that failure in one portion of the system will not affect the system's overall functioning.

Interdisciplinary research at IRCN has seeded new insights based on developmental principles. For example, reservoir computing offers an efficient way to process temporal data, requiring very small datasets compared to traditional recurrent neural networks. Unlike traditional networks that use backpropagation to adjust all weights iteratively, reservoir computing avoids this computationally expensive process by keeping the reservoir weights fixed and only training the readout layer through

simple linear regression. In FY2023, Critical Period Team collaboration between Dr T Kanamaru, D Hensch and ED Aihara showed that optimal E-I balance characteristic of critical periods optimizes memory capacity of reservoirs. This suggests a new view why critical periods exist in biology, as they are staggered sequentially across brain regions. By maintaining a reservoir state that integrates past inputs, they are well-suited for tasks like time series prediction and speech recognition.



Near-term understanding and potential treatment of mental illness must rely on <u>translating</u> their biological origins to the clinic aided by the power of A.I. Collaboration between the Intrinsic Activity (PI Watanabe) and Critical Period Teams (D Hensch, PI Gotoh) has applied novel Energy Landscape Analysis to the whole-brain resting-state dynamics of mouse models of autism and actual patients. This captured the cognitive rigidity typical of this disorder spectrum, which were found to be reversible by gene restoration (*Shank3*) or targeted perturbation of the network dynamics (human). Similar Energy Landscape Analysis can now be applied to understand the inner workings of artificial DNNs (PI Watanabe, ED Aihara).

While new A.I. tools now make gathering consensus information and *existing* data more efficient, the role of H.I. that disregards conventional wisdom in pursuit of originality will become *increasingly* important over the long-term. Whereas A.I. now excels in efficiency and computational power, even infant humans benefit from the freedom to embrace randomness, serendipity and flexibility that often leads to breakthrough insights and innovation. With support from Daikin, the Predictive Coding Team (PI Chao) is exploring neural correlates of creativity and how to enhance it. Previous work from the Neuromodulation Team (PI H Kasai, AF Ishii) has inspired novel architectures for A.I. including separable pathways for generalization (dopamine D1) and segregation (D2) in reinforcement learning and decision making. Breakthrough discoveries from the Intrinsic Activity Team (DD Ohki) have revealed a crucial role for spontaneous activity before sensory responsiveness begins, that sculpt higher-order visual cortical processing in parallel modular fashion even before bottom-up feedforward pathways are complete. All such results will have a profound impact on artificial DNN design.

Finally, as we learn to co-exist with A.I., the problem of <u>alignment</u> between man and machine will depend upon the accurate and ethical implementation of H.I. principles. For example, A.I.enabled systems lack the capacity to interpret complex social dynamics, while human intuition (e.g. compassion, emotional intelligence, cross-cultural sensitivity, strategic thinking) plays a critical role in understanding the deeper context of a situation. The most sensitive parts of the healthcare system depend on human, in-person relationships with a nuanced understanding of emotions enabling experienced medical professionals to provide patients and families with comfort and establish trust. While A.I. will allow non-technical people to accomplish a lot more (and begin to perform what were formerly believed to be technical tasks), human happiness is more generally linked to the ability to generate new ideas and increase creativity.

#### 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)

The international composition of IRCN Principal Investigators (PI) in 2023 was initially three out of fifteen (20%), with Takao Hensch (USA), Zenas Chao (TWN) and Mingbo Cai (CHN). Eleven out of sixty-three (17%) Affiliated Faculty (AF) were foreign. Associate Research Fellows (ARF) consisted of six international members out of nineteen (32%). IRCN employed sixteen Research Fellows of whom three (19%) were foreign. Finally, twenty-one Postdoctoral Fellows were from abroad out of twenty-eight (75%). An analysis of IRCN international faculty and researcher composition suggests that the Center meets the standard for internationalization. To strength the research capability with institutional diversity, IRCN started to recruit new tenure-track PIs, supported by a financial commitment from the University Headquarters.

The global foundation was maintained through the establishment of a formal research network of fifteen overseas and four domestic partner institutions, which continued through 2023. As the COVID-19 situation gradually eased, IRCN expanded more opportunities to host intensive face-to-face research gatherings in FY2023, such as the IRCN Retreat 2023 and the CDKL5 Asia Workshop.



In FY2023, the Center made efforts to build and maintain an international research environment through hybrid (combination of in-person and online) events in English with distinguished international speakers and participants. In FY2023, IRCN held thirty-three International Science Salons. Some of these were held in a hybrid format. These discussion seminars were popular, typically attracting 35-55 participants. Twenty-four of these speakers (73%) were international or speaking from abroad. In addition, the IRCN Postdoctoral Advisory Committee (I-PAC) held four international seminars to support the professional career development of junior researchers.

IRCN hosted eighteen guest researchers from abroad, including several professors on sabbatical from Brown Univ, McGill Univ, Univ Geneva, Univ Lucca, to name a few. Seminars and lively discussions took place surrounding this vibrant group of prominent visitors.

#### 4. Making Organizational Reforms

\* Describe the system reforms made to the center's research operation and administrative organization, along with their background and results.

\* 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.

The high-level management of scientific activities and personnel recruitment of IRCN continues to be overseen by a structure consisting of three complementary 'Offices': Sustainability Office, Synergy Office and Community Office. Each office, led by a Deputy Director (DD), is designed to intersect the top-down leadership from the Director, bottom-up proposals from PIs, and support from the administration and UTokyo.

- <u>Sustainability Office</u>, led by DD Kazuo Emoto, catalyzes support, infrastructure and personnel, including fundraising, building renovations for an 'under-one-roof' ecosystem, strategic recruitment with an emphasis on diversity, WPI budget, evaluation and related tasks. Under the leadership of the Director and the Sustainability Office, IRCN continues to attract talented researchers from around the world, by providing flexibility in salary setting, including salary increases with rigorous evaluation.
- <u>Synergy Office</u>, led by DD Kenichi Ohki, promotes research fusion and Team Science. It manages Salons proposed by the IRCN Program Committee to foster Team Science.
- <u>Community Office</u>, led by D Takao Hensch, coordinates education and outreach activities. It offers academic courses for trainees, public events, international workshops and various learning opportunities within IRCN, and ensures logistical support for international visitors. The joining of incoming DD Yukiko Gotoh as of January 2024 has significantly strengthened the Community Office in terms of leadership and diversity empowerment, as she sits on the all-UTokyo D&I committee. She is expected to become a new DD in FY2024 to take over the Community Office.

The <u>Director's Office</u> (DO) continues to provide agile oversight of day-to-day issues spanning academic, technical, and administrative matters. The DO is chaired by Administrative Director (AD) Dr. Nobukazu Toge and consists of Director Hensch, Special Advisor to the Director (SAD) Dr. Masamitsu Iino and General Manager (GM) Ms. Yasuko Chika of the Administrative Office.

The IRCN Steering Committee (SC) includes all PIs as full voting members, together with managers of the IRCN core facilities as observers. This ensures that all important decisions and the exchange of ideas behind them are communicated in a timely, efficient and transparent manner. 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.

The four IRCN Core Facilities (ES-Mouse/Virus Core, Imaging Core, Data Science Core, Human fMRI Core) continued to provide professional, cost-effective, and rapid access to research services and technologies by expert IRCN staff. IRCN Core Director, PI Haruo Kasai, is the key driver of formulating the future of the core facilities through a planned expansion of their services to IRCN researchers, AF, ARF and other collaborators. Team Science and internationalization efforts are also expected to benefit from these measures.

Located in the Faculty of Medicine Building No.1 and the adjacent Experimental Research Building in a quasi-under-one-roof arrangement, IRCN maintained an extensive domestic and global research network by enlisting sixty-three AF members and nineteen ARF members in 2023. They represent an international and diverse mix of established senior and emerging junior researchers in the research areas related to the IRCN mission and participate in the weekly Salon seminars and collaborative research programs. When the COVID-19 situation finally eased, IRCN restarted internship programs to host three students from Harvard University and fourteen graduate or undergraduate students hosted by individual PIs.

Indeed, IRCN continues to support the teaching and training of graduate students. About half of the IRCN PIs (6 out of 12) are based in regular Faculties of UTokyo and carry out standard duties of

supervising graduate students. Of the PIs, Core Managers and Research Fellows that are hired primarily at IRCN, one has been invited to participate in graduate training programs at regular UTokyo Faculties. At the same time, IRCN continued its membership in the MEXT WISE Graduate Program "Forefront of Physics and Mathematics Program to Drive Transformation" (FoPM) based in the Graduate School of Science. Several non-tenured IRCN PIs organized and taught FoPM courses. Through these programs, six PIs, namely, Dr. Takao Hensch, Dr. Yukie Nagai, Dr. Yasushi Okada, Dr. Zenas Chao, Dr. Yoko Yazaki-Sugiyama, and Dr. Mingbo Cai, are eligible to teach courses in the Graduate Schools of UTokyo. Moreover, as of April 2024, the Graduate School of Medicine of UTokyo has agreed to offer teaching appointments to three IRCN project PIs hired with the WPI fund (PIs Chao, Watanabe, Nagai).

Finally, Diversity, Equity and Inclusion (DEI) training was held near the end of FY2023 to raise awareness and further introspection with the aid of an external company (enjoi Japan KK). This is a valuable first step toward improving the UTokyo ecosystem to not only "include" diversity but rather to truly "welcome" it with a potential for career growth. Unfortunately, three key Team PIs were recruited away from IRCN in January 2024, reflecting the high level of our junior faculty who moved on to prestigious positions elsewhere: PI Cai (Univ Miami, Psychology), PI Tsuji (CNRS tenure, Ecole Normale Superieure), PI Yazaki (OIST, Full Professorship). We are proud of their success and will be actively maintaining close connections with them to broaden our international network for teaching and collaboration.

#### 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 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.

Essential ingredients for the long-term sustainability of IRCN include: (1) establishing its unique research fusion brand and societal values for global excellence and leadership in Neurointelligence, (2) successful integration into the host university and large data-driven global scientific academic ecosystems, and (3) securing long-term financial support from governmental and non-governmental funds.

Prospective research planning for the next three years is one of the main objectives of the Director's reorganization of the IRCN management. The three-office structure and involvement of all PIs in organizational management and planning allows a suitable division of labor for the future development of the Center. The Synergy Office will manage Team Science projects and propose changes in Team composition and mission as needed. This plan will include efforts to strengthen A.I. design and development capabilities by hiring A.I. researchers or working with them as AF, ARF or collaborators. Notably, former DD Kazuyuki Aihara has been named Executive Director (ED) with the specific mission to boost the A.I. incubator activity within IRCN, including a select group of the top 10% most active existing computational AFs, their students and new postdoctoral support. Space is being allocated specifically under-one-roof for these newly named "affiliated PIs" (UTokyo internal) and "visiting PIs" (from outside UTokyo) and their lab members.

As stated in its 4th Mid-Term Goals and Planning submitted to the Ministry of Education, UTokyo's policy is to establish and maintain IRCN as a permanent institute. The long-term future of IRCN by the top management of UTokyo has been under discussion within a working-group led by Executive Vice President (EVP), Prof. Nobuhito Saito. With the valuable input of the WPI Committee in 2023, UTokyo now has an established policy to keep IRCN as a research center within the UTokyo Institutes for Advanced Study (UTIAS), as has been the case since its establishment in 2017.

UTokyo will continue to maintain IRCN in this manner after the expiration of the WPI Center period in the spring of 2027. For this purpose EVPs Hiroaki Aihara, Nobuhito Saito and D Hensch came to a written and signed agreement in March 2024 on the magnitude and basic nature of UTokyo budget to be allocated to IRCN in a permanent fashion. Appointment evaluations of tenure-track or tenured members within the IRCN beginning in FY2024 will be initiated under this premise.

Regarding mid- to long-term financial planning, the Sustainability Office continues discussions with a wide range of candidate sponsors, partners, and stakeholders. Within UTokyo, IRCN will strengthen ongoing ties with existing partners, including the UTokyo A.I. ecosystem led by the Beyond AI Joint Project with Softbank, UTokyo-Daikin partnership, the Graduate School of Medicine, and the Technology Licensing Office (TLO) to design a startup engine based on anticipated IRCN intellectual properties and ventures. Entrepreneurship is one major avenue for sustainability. The Director has been interacting closely with the Council on Science, Technology and Innovation (CSTI) under the Prime Minister's initiative to stimulate startup activities in Japan. Regarding prospects with partners outside of UTokyo, IRCN is building long-term relationships with several promising corporate (NTT, Nikon) and NPO sponsors as our mutual interests evolve. Securing philanthropic donations and industrial-academic partnerships is also ongoing. Foreign foundations have been approached, which have scrutinized our DEI efforts. We have initiated training and rebalancing of the governance structure accordingly.

An essential component of sustainability planning is how to instantiate graduate student education of the Center's unique constellation of values, research foci, interdisciplinary fusion ethos, and translational development for society. IRCN has been successfully involving its fixed-term PIs in graduate teaching in various schools and programs. This, in the past has been done in a somewhat limited way, however. After a series of discussions, including those under EVP Saito's working-group, the Graduate School of Medicine of UTokyo has agreed to offer teaching appointments, starting in FY2024, to three IRCN PIs who had been hired with the WPI fund (i.e. all project PIs except D Hensch). This is expected to open the window for both the Graduate School of Medicine and the IRCN to more actively look across organizational boundaries to the other side, together with the traffic of graduate students who will bring fresh air into the center.

#### 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 the second half of FY2022, after the COVID-19 situation subsided, IRCN resumed outreach activities through in-person and hybrid science events. IRCN intensified these activities in FY2023, and hosted or co-hosted international symposia, retreat, public lectures, and special events for high school students, to increase the Center's global visibility and to communicate the joy and importance of science to society.

In September 2023, Boston Children's Hospital satellite organized the second CDKL5 Asia Workshop at UTokyo, "For the Advancement of Understanding and Treatment of CDKL5



Deficiency Disorder". This in-person workshop brought together scientists, clinicians, and pharmaceutical companies from around the world working on CDKL5 Deficiency Disorder (CDD), as well as representatives from patient organizations and CDD families to meet and discuss the latest developments in the field and to advance towards treatments and cures. Participants were highly international. Of the 84 participants, more than 40% were from overseas institutions, including sixteen speakers from abroad.

The "IRCN Retreat 2023" was held in October. This was the third in-person retreat since it was last held in June 2019 after a long break due to COVID-19. 72 people attended the retreat. In addition to PIs and their lab members, IRCN invited Affiliated Faculty members, Associate Research Fellows, foreign Visiting Researchers, graduate students, and internship students from overseas institutions. Speakers from Caltech and MIT were also invited to stimulate discussions on the future of neuro-inspired AI. The retreat contributed greatly to sharing the vision of IRCN within and outside IRCN, promoting interdisciplinary collaboration among the IRCN community and developing future research strategies for neuro-inspired AI, including nurturing the next generation of talent.



IRCN co-hosted a number of public outreach events to share the joy of science and to promote public understanding of science. In November, IRCN co-hosted a hybrid public event "Questions of Origins" with WPI Kavli-IPMU and WPI ELSI. PI Yukiko Gotoh participated as a speaker and a panelist, discussing the fundamental question of "What is an origin and what does it mean to think about it" with researchers from the field of mathematics, biotechnology and philosophy. The event was attended by more than 800 people.

In February, Director Hensch gave an online lecture at the "S&TDC-WPI 4-week Special Online Seminars Series" and shared the vision and the recent achievements of IRCN. The event was organized by the Science & Technology Diplomatic Circle and the WPI Center for the leading members of the embassies around the world. The event was attended by twenty-five people.

IRCN considers communication with the younger generation, especially high school students as an essential approach to broadening the society's support for science. In FY2023, IRCN hosted the following events specially tailored for high school students and their teachers: UTokyo Open Campus online event "Meet the Young Scientist: Fusion of Neuroscience, Psychiatry and AI" (co-hosted with the Tokyo Metropolitan Board of Education), online seminar for female high school students "Frontiers of Science 2023: Mysterious and Interesting Brain Mechanisms", and an online seminar for high school teachers "Frontiers of WPI Research 2023: Mathematical Approaches to Life Phenomena" (co-hosted with WPI-iFReC, WPI-I<sup>2</sup>CNER, WPI-ITbM, WPI-ICReDD, WPI-PRiMe). As a strategy to strengthen the connection with the local community, IRCN collaborated with local high schools to conduct on-site lab tours and give a small lecture at a high school.



#### 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) Placing IRCN within the Graduate School of Medicine runs completely counter to the WPI Program's requirement that UTokyo should establish IRCN as an independent and autonomous institute within its organization. The open and interdisciplinary structure of IRCN's faculty, which embodies the system reform intended by the WPI program, will be forced to bend back to a traditional hierarchical structure. UTokyo should seriously reconsider its future plans for IRCN. If nothing else, it should keep IRCN within the University of Tokyo Institutes for Advanced Study (UTIAS) and secure the positions, budget and building sufficient for its sustainable operation, as in the case of Kavli IPMU. It is agreeable that UTokyo has reconsidered a future plan for keeping IRCN within UTIAS. UTokyo should clarify its fundamental policy as to how it intends WPI centers to transform the university.

As stated in its 4th Mid-Term Goals and Planning submitted to the Ministry of Education, UTokyo's policy is to establish and maintain IRCN as a permanent institute. With the valued input of the WPI Program Committee in 2023, UTokyo now intends to keep IRCN as a research Center under the UTokyo Institutes for Advanced Study (UTIAS) umbrella even beyond 2027, as has been the case since its establishment in 2017. For this purpose, EVP Hiroaki Aihara, EVP Nobuhito Saito and Director Hensch came to an agreement in March 2024 on the magnitude and basic nature of UTokyo budget to be allocated to IRCN in a permanent fashion. Appointment evaluations of tenure-track or tenured members within the IRCN beginning in FY2024 will be initiated under this premise.

With regard to management of the WPI Center under UTIAS, except for the appointment of the heads of each organization under it, the WPI is not bound by the conventional rules of departmental management at UTokyo, and a considerable portion is left to the discretion of each organization. For example, salary settings are not bound by the conventional stipend system for faculty members, making it easier to invite internationally competent personnel. In addition, the administrative organization is equipped with strong international capabilities, which are indispensable for the future development of UTokyo to enhance its international visibility and is a major feature that sets it apart from other departments within the university.

The new management methods of UTIAS have been developed and experienced by WPI or WPIequivalent organizations such as Kavli-IPMU, IRCN, and the Center for New Generation Infectious Diseases (UTOPIA). In the future, the new university management know-how accumulated here will be further horizontally deployed to grow into a powerful tool for university transformation. On the other hand, the flexibility of the salary system and the internationalization of the administrative organization, as examples, cannot be developed in one fell swoop, and it is thought that the most excellent parts of each department will be gathered and expanded here, centering on UTIAS, to influence the next generation of the University of Tokyo. In particular, the establishment of the College of Design and the School of Design, which are currently being planned, are major reforms that will strengthen UTokyo's international response as one of their pillars, and it is conceivable that they will be utilized in this context.

2) Strategies must be implemented that will enable young PIs to accept graduate students. IRCN and UTokyo should take stronger initiatives for obtaining crossappointments of junior PIs in appropriate departments so as to allow them to effectively supervise graduate students and deliver lectures in interdisciplinary fields. It will also be valuable for IRCN to develop more

#### aggressive promotion strategies for younger and female scientists.

The Graduate School of Medicine of UTokyo has agreed to offer teaching appointments, starting in FY2024, to three IRCN PIs who had been hired with the WPI fund (i.e. *all project PIs* except Director Hensch). This is expected to open the window for both the Graduate School of Medicine and the IRCN to more actively look across the organizational boundaries to the other side, together with the traffic of graduate students who will bring fresh air into the center.

In FY2024 Prof Yukiko Gotoh will be appointed DD, replacing DD Kazuyuki Aihara (see the point 4 below). Also in FY2024, Project Professor Mayumi Kimura will be newly appointed and take over the role of AD, replacing outgoing AD Nobukazu Toge. They are expected to restore gender balance in the management layer of IRCN and to present a daily center operation with improved accessibility as seen by diverse members within IRCN.

*3) IRCN should clearly describe its progress and overall strategy toward understanding the origin of human intelligence. IRCN's milestones for coming years are not sufficiently articulated. It will need to provide more specific goals for treating mental disorders and innovating neuro-inspired AI.* 

Progress and overall strategy toward understanding the origins of H.I. are being assembled in a perspective article by the Director. To stimulate A.I. related Team Science, an initial call for PIs was made in September 2023. After interviewing several candidates, it was determined that no one person could adequately fill this role. Renewed effort to establish an A.I. Incubator under one roof with experimentalists and clinicians was made. The basic idea is to have orthogonal interactions that leverage biological insights from the five Teams to inspire novel A.I. as schematized here:



4) The impact of IRCN on UTokyo reform should be addressed. The presented list of researchers intended to enhance the center's computational aspects seems somewhat inflated and lacks clear focus. Given the rapid advancements in AI technologies such as generative AI, a vision for neuroscience research that aligns with these advancements is desired. Understanding the brain through the lens of modern AI technologies can provide profound insights and novel directions in the field. To shape IRCN strategy toward novel A.I., DD Kazuyuki Aihara has been appointed ED which had been vacant to play a mentoring role in organizing IRCN's A.I. Incubator effort. This is a matrix organization which will integrate the Team Science effort that has been active in IRCN with the expertise of the most active (top 10%) of AF and ARF members who possess background in computational research and current A.I. (e.g. LLMs). Some of these contributing AF/ARFs are overseas or in other Japanese institutes. Leading candidates will be offered "visiting PI" status (or "affiliated PI" if internal to UTokyo). The A.I. Incubator engine should also increase visibility on campus and sustainability opportunities for entrepreneurship or corporate sponsorship. It should, however, be emphasized that the focus of IRCN is on basic research, where its fundamental impact needs to be measured on the timescale of decades.

5) Considering explosive development of AI and its impacts on society, economy and science, IRCN should clarify its vision on neuro-inspired AI including ethical and social issues. Within the context of a need for milestones and alignment of neuroscience research with recent advances in AI, IRCN may consider writing a forward-looking position paper which presents, from its perspective, views on important progress/discoveries and next steps for neuroscience and AI.

IRCN is initiating studies on the Athlete Cognitive Neuroscience (YIPS phenomenon) with MEXT budget allocated starting FY2024. The work will be organized in collaboration with Advanced Comprehensive Research Organization (ACRO) of Teikyo University and RIKEN Center for Brain Science (CBS). While this might have little immediate connection to A.I., the sizeable cohort study envisaged therein will have a bearing on planning of A.I. Incubator initiative from the standpoint of ethical and social issues. Another research subject which is close in this vein is research by the Social Learning team, particularly as it relates to infant – caregiver interactions. Finally, through the planned Neuro-inspired Computation Course in July 2024, IRCN will lead a special Research Topic volume on this area, including perspective pieces and a wide range of relevant themes for the field of Neurointelligence.

# Appendix 1 FY 2023 List of Center's Research Results and Main Awards

#### **1. Refereed Papers**

- List only the Center's papers published in 2023. (Note: The list should be for the calendar year, not the fiscal year.)

Divide the papers into two categories, A and B. (1)Α.

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.)

в 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
- WPI papers A.
  - 1. Original articles
  - 2. Review articles
  - Proceedings
     Other English articles
- WPI-related papers B.
  - 1. Original articles
  - 2. Review articles

  - Proceedings
     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.

#### **WPI** papers Α.

- **Original** articles (1)
  - Sunagawa, J; Park, H; Kim, KS; Komorizono, R; Choi, S; Torres, LR; Woo, J; Jeong, YD; Hart, WS; Thompson, RN; Aihara, K; Iwami, S; Yamaguchi, R, 2023, NATURE COMMUNICATIONS, 14(1), 7395, https://doi.org/10.1038/s41467-023-43043-2, WOS:001116498500023, Isolation may select for earlier and higher peak viral load but shorter duration in SARS-CoV-2 evolution 1.
  - Yamashita, H; Suzuki, H; Aihara, K, 2023, STATISTICS AND COMPUTING, 33, 31, https://doi.org/10.1007/s11222-022-10199-8, WOS:000908678000003, Entropic herding 2.
  - Yasukata, H; Shen, X; Sasahara, H; Imura, J; Oku, M; Aihara, K, 2023, INTERNATIONAL JOURNAL OF ROBUST AND NONLINEAR CONTROL, 33(12), 6734-6753, https://doi.org/10.1002/rnc.6720, WOS:000975877100001, Design of input assignment and feedback gain for re-stabilizing undirected networks with High-Dimension Low-Sample-Size data 3.
  - Shen, X; Sasahara, H; Morishita, M; Imura, J; Oku, M; Aihara, K, 2023, IEEE ACCESS, 11, 45572-45585, https://doi.org/10.1109/ACCESS.2023.3274530, WOS:000991585200001, Model-Free Dominant Pole Placement for Restabilizing 4. High-Dimensional Network Systems via Small-Sample-Size Data
  - Makinwa, T; Inaba, K; Inagaki, T; Yamada, Y; Leleu, T; Honjo, T; Ikuta, T; Enbutsu, K; Umeki, T; Kasahara, R; Aihara, K; Takesue, H, 2023, COMMUNICATIONS PHYSICS, 6, 121, https://doi.org/10.1038/s42005-023-01240-x, WOS:000995765100001, Experimental observation of chimera states in spiking neural networks based on degenerate optical parametric oscillators 5.
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#### 2. Invited Lectures, Plenary Addresses (etc.) at International Conferences and International **Research Meetings**

List up to 10 main presentations during FY 2023 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<br>name | Presentation title  | Conference name   |
|------------|------------------------------|---|---|
| 2024/3/29  | Yukiko Gotoh                 | Regulation of cell fate choices<br>(Special Lecture)  | The 101st Annual Meeting of The Physiological Society of Japan  |
| 2024/2/1   | Yukie Nagai                  | Predictive Brain in Humans<br>and Robots  | IEEE Robotics and Automation<br>Society Distinguished Lecturer  |
| 2023/11/25 | Yukiko Gotoh                 | Molecular mechanisms for cell<br>fate regulation<br>(Plenary lecture)   | The 30th Federation of Asian and<br>Oceanian Biochemists and<br>Molecular Biologists (FAOBMB)<br>/ 8th BMB Conference               |
| 2023/8/1   | Kenichi Ohki                 | Development of 2-photon<br>functional imaging and study<br>of functional architecture of<br>visual cortex   | Nakaakira Tsukahara Memorial<br>Award Lecture<br>The 46th Annual Meeting of Japan<br>Neuroscience Society                           |
| 2023/7/29  | Yukiko Gotoh                 | Regulation of neural stem cell<br>fate<br>(Plenary lecture)   | The 16th Annual Meeting of Chinese<br>Neuroscience Society & The second<br>China-Japan-Korea International<br>Meeting (The CJK-2nd) |
| 2023/7/24  | Kazuyuki Aihara              | Analysis of High-Dimensional<br>Data and Its Possible<br>Applications (Plenary Talk)  | The 9th Shanghai International<br>Symposium on Nonlinear Sciences<br>and Applications (Shanghai NSA'23)                             |
| 2023/7/11  | Kazuyuki Aihara              | Dynamical Network<br>Biomarkers: Data Analysis on<br>Early Warning Signals in<br>Complex Systems and its<br>Application to Early Precision<br>Medicine (Plenary Talk) | The 22nd World Congress of the<br>International Federation of Automatic<br>Control (IFAC World Congress 2023)                       |
| 2023/7/5   | Yasushi Okada                | Tackling the mystery of velocity of fast axonal transport   | The 49th Naito Conference   |
| 2023/6/16  | Yukiko Gotoh                 | Chromatin-level regulation of<br>neural stem cell fate during<br>mouse neocortical<br>development<br>(Plenary lecture)  | International Society for Stem Cell<br>Research (ISSCR) 2023 Annual<br>Meeting  |
| 2023/4/30  | Yukiko Gotoh                 | Regulation of neocortical<br>neural stem cell fate at the<br>chromatin level<br>(Plenary lecture)   | 3rd Neuroepigenetics &<br>Neuroepitranscriptomics Conference  |

**3. Major Awards** - List up to 10 main awards received during FY 2023 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  |
|------------|------------------------------------|--|
| 2024/2/2   | Yasushi Okada                      | The 16th Nakatani Foundation Award Grand Prize   |
| 2023/11/13 | Yukiko Gotoh                       | The Samuro Kakiuchi Memorial Award   |
| 2023/11/6  | Michela Fagiolini and Takao Hensch | CDKL5 Forum Award for Excellence - Champions<br>of Progress 2023                       |
| 2023/11/2  | Ayuko Hoshino                      | The AMED President's Award at the 6th Japan<br>Medical Research and Development Awards |
| 2023/11/1  | Kazuyuki Aihara                    | Achievement Award, IEICE   |
| 2023/10/24 | Kenichi Ohki                       | Nakaakira Tsukahara Memorial Award   |
| 2023/8/1   | Yukiko Gotoh                       | The Takeda Prize for Medical Science   |
| 2023/6/20  | Haruo Kasai                        | Elected as an IUPS (International Union of<br>Physiological Sciences) Academy member   |
| 2023/6/16  | Shigeo Okabe                       | Japan Medical Association Medical Award (Nihon<br>Ishikai Igaku sho)                   |
| 2023/6/8   | Noboru Mizushima                   | Highly Cited Researchers 2023 (Clarivate)  |

# Appendix 2 FY 2023 List of Principal Investigators

NOTE:

 $\ensuremath{^*\text{Underline}}$  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="" end="" fy<="" of="" th="" the=""><th>2023&gt;</th><th></th><th></th><th>Princij</th><th>oal Investigators Total: 12</th></results>   | 2023>   |             |  | Princij  | oal Investigators Total: 12                              |
|---|-----|---|---|-------------|--|--|--|
| Name  | Age | Affiliation<br>(Position title, department,<br>organization)  | Academic<br>degree,<br>specialty              | Effort (%)* | Starting date of project participation | Status of project participation (Describe in concrete terms)   | Contributions by PIs from overseas research institutions |
| Center Director<br><u>Takao Kurt</u><br><u>Hensch</u> | 57  | Director, Project Professor,<br>International Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study<br>Professor, Molecular and<br>Cellular Biology, Center for Brain<br>Science, Harvard University<br>Professor, Neurology, Kirby Center,<br>Boston Children's Hospital | Ph.D.<br>Neurophysiolo<br>gy                  | 80          | 2017/10/1                              | Often stays at the Boston Children's<br>Hospital. Stays at UTokyo six times<br>(each >1 week) in FY2023.<br>Communicates often by >20 emails<br>daily, and almost nightly video<br>conferences to promote<br>IRCN's sustainability, synergy,<br>community and global visibility. | Manages and directs Center<br>operations                 |
| Kazuo Emoto   | 55  | Deputy Director, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study<br>Professor, Department of Biological<br>Sciences, Graduate School of<br>Science, the University of Tokyo  | Ph.D.<br>Neural<br>Network                    | 80          | 2017/10/1                              | Stays at the Graduate School of<br>Science next to the Center building,<br>and participates in the Center's<br>activities as Deputy Director and an<br>Executive Board member  |  |
| Kazuyuki Aihara                                       | 69  | Deputy Director, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study<br>University Professor, the University<br>of Tokyo   | Ph.D.<br>Biological<br>Information<br>Systems | 80          | 2017/10/1                              | Stays at the Center and participates<br>in the Center's activities as Deputy<br>Director and an Executive Board<br>member  |  |

| Haruo Kasai    | 67 | Project Professor, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study   | M.D. & Ph.D.<br>Neurophysiolo<br>gy   | 100 | 2017/10/1 | Stays at the Center and participates<br>in the Center's activities  |  |
|----------------|----|---|---|-----|-----------|---|--|
| Yasushi Okada  | 55 | Professor, International Research<br>Center for Neurointelligence, the<br>University of Tokyo Institutes for<br>Advanced Study<br>Professor, Cell Biology, Cell Biology<br>and Anatomy, Department of<br>Molecular Cell Biology, Graduate<br>School of Medicine, the University<br>of Tokyo | M.D. & Ph.D.<br>Bioimaging  | 32  | 2017/10/1 | Usually stays at the Graduate<br>School of Science and participates<br>in the Center's activities                       |  |
| Kiyoto Kasai   | 53 | Professor, International Research<br>Center for Neurointelligence, the<br>University of Tokyo Institutes for<br>Advanced Study<br>Professor, Neuropsychiatry, Clinical<br>Neuroscience, Department of<br>Neuroscience, Graduate School of<br>Medicine, the University of Tokyo              | M.D. & Ph.D.<br>Neuroimaging<br>and Early<br>Intervention<br>for<br>Schizophrenia | 80  | 2017/10/1 | Stays at the University of Tokyo<br>Hospital and participates in the<br>Center's activities                             |  |
| Kenichi Ohki   | 52 | Professor, International Research<br>Center for Neurointelligence, the<br>University of Tokyo Institutes for<br>Advanced Study<br>Professor, Integrative Physiology,<br>Physiology, Department of<br>Functional Biology, Graduate<br>School of Medicine, the University<br>of Tokyo         | M.D. & Ph.D.<br>Neuroscience  | 80  | 2017/10/1 | Stays at the Center and participates<br>in the Center's activities  |  |
| Shoji Takeuchi | 51 | Professor, International Research<br>Center for Neurointelligence, the<br>University of Tokyo Institutes for<br>Advanced Study<br>Professor, Department of<br>Mechano-Informatics, Graduate<br>School of Information Science and<br>Technology, the University of<br>Tokyo                  | Ph.D.<br>Biohybrid<br>Systems   | 80  | 2017/10/1 | Stays at the Graduate School of<br>Information Science and<br>Technology and participates in the<br>Center's activities |  |

| Yukiko Gotoh          | 59 | Professor, International Research<br>Center for Neurointelligence, the<br>University of Tokyo Institutes for<br>Advanced Study<br>Professor, Molecular Biology,<br>Department of Pharmaceutical<br>Sciences, Graduate School of<br>Pharmaceutical Sciences, the<br>University of Tokyo | Ph.D.<br>Neural Stem<br>Cells             | 80  | 2017/10/1 | Stays at the Graduate School of<br>Pharmaceutical Sciences and<br>participates in the Center's activities |  |
|-----------------------|----|--|---|-----|-----------|---|--|
| Yukie Nagai           | 49 | Project Professor, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study  | Ph.D.<br>Engineering                      | 100 | 2019/4/1  | Stays at the Center and participates in the Center's activities   |  |
| Zenas C. Chao         | 48 | Associate Professor, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study  | Ph.D.<br>Biomedical<br>Engineering        | 100 | 2019/9/1  | Stays at the Center and participates in the Center's activities   |  |
| Takamitsu<br>Watanabe | 42 | Associate Professor, International<br>Research Center for<br>Neurointelligence, the University of<br>Tokyo Institutes for Advanced<br>Study  | M.D. & Ph.D.<br>Cognitive<br>Neuroscience | 100 | 2020/4/1  | Stays at the Center and participates<br>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 2023

| Name                 | Affiliation<br>(Position title, department,<br>organization)   | Starting date of project participation | Reasons  | Measures taken   |
|----------------------|--|--|----------|--|
| Yoko Yazaki-Sugiyama | Professor, Neuronal Mechanism for<br>Critical Period Unit, Okinawa<br>Institute of Science and<br>Technology | 2018/4/1                               | Promoted | Continues to collaborate with IRCN as Affiliated Faculty Member    |
| <u>Sho Tsuji</u>     | Chargé de recherche, Département<br>d'études cognitives, CNRS, École<br>normale supérieure                   | 2019/4/1                               | Promoted | Continues to collaborate with IRCN as Affiliated Faculty Member    |
| <u>Mingbo Cai</u>    | Assistant Professor, Department of<br>Psychology, The University of<br>Miami                                 | 2019/12/1                              | Promoted | Continues to collaborate with IRCN<br>as Associate Research Fellow |

# Appendix 2a Biographical Sketch of a New Principal Investigator

(within 3 pages per person)

Name (Age)

Affiliation and position (Position title, department, organization, etc.)

#### Academic degree and specialty

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

**Research and education history** 

#### Achievements and highlights of past research activities

#### Achievements

- (1) International influence \* Describe the kind of attributes listed below.
  - a) Recipient of international awards
  - b) Member of a scholarly academy in a major country
  - c) Guest speaker or chair of related international conference and/or director or honorary member of a major international academic society in the subject field
  - d) Editor of an international academic journal
  - e) Peer reviewer for an overseas competitive research program (etc.)

#### (2) Receipt of major large-scale competitive funds (over the past 5 years)

(3) Major publications (Titles of major publications, year of publication, journal name, number of citations)

(4) Others (Other achievements indicative of the PI's qualification as a top-world researcher, if any.)

# Appendix 3-1 FY 2023 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 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.

IRCN has continued to expand Team Science trainees with domestic candidates, where a unique fusion research experience, as each of them must be co-mentored by two PI / AFs in different fields (e.g. clinical and computational) of exercised. In FY2023, we resumed exchanges of researchers to and from abroad after the long break due to COVID-19.

#### **1-2.** Satellites and partner institutions - List the satellite and partner institutions in the table below. 1-2.

- 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<br>(IIT) |                                   |       |
| RIKEN Center for Advanced                |                                   |       |
| Intelligence Project (AIP),              |                                   |       |
| RIKEN Center for Biosystems              | Yasushi Okada                     |       |
| Dynamics Research (BDR)                  |                                   |       |
| (CBS)                                    |                                   |       |
| National Centre Competence in            |                                   |       |
| Research (NCCR) Synapsy                  |                                   |       |
| Edwin O. Reischauer Institute of         | Takao Hensch                      |       |
| Japanese Studies at Harvard              |                                   |       |
| Acies Concertives on MDI                 | Viveta Kazai                      |       |
| Asian Consortium on MRI                  | Kiyoto Kasai                      |       |
| Okinawa Institute of Science             |                                   |       |
| and Technology Graduate                  |                                   |       |
| University                               |                                   |       |
| The University of British                |                                   |       |
| ,<br>Columbia                            |                                   |       |
| The Hong Kong University of              |                                   |       |
| Science and Technology                   |                                   |       |
| Collège de France                        |                                   |       |

| CIFAR, The Canadian Institute<br>for Advanced Research   | Takao Hensch |  |
|--|--------------|--|
| Institute of Neuroscience (ION),<br>Center for Excellence in Brain<br>Science and Intelligence<br>Technology, Chinese Academy<br>of Sciences |              |  |
| Stockholm University   |              |  |
| KTH Royal Institute of<br>Technology   |              |  |
| Karolinska Institutet  |              |  |
| Tsinghua University  |              |  |
| Bielefeld University   |              |  |
| École normale supérieure   |              |  |

## 2. Holding international research meetings

- Indicate the number of international research conferences or symposiums held in FY2023 and give up to three examples of the most representative ones using the table below.

| FY 2023: 2 meetings   |  |
|---|--|
| Major examples (meeting titles and places held)   | Number of participants   |
| CDKL5 Asia "For the Advancement of Understanding and<br>Treatment of CDKL5 Deficiency Disorder" | From domestic institutions: 47<br>From overseas institutions: 37 |
| 3rd IRCN Retreat  | From domestic institutions: 65<br>From overseas institutions: 7  |

- **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 FY2023

Total:923,471,369 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 A: 60,592,000 yen Grant-in-Aid for Scientific Research on Innovative Areas: 14,176,654 yen Grant-in-Aid for Specially Promoted Research: 7,350,000 yen Grant-in-Aid for Scientific Research S: 89,360,000 yen Grant-in-Aid for Scientific Research A: 7,320,000 yen Grant-in-Aid for Scientific Research B: 4,736,000 yen
- JST Moonshot Research and Development Program: 107,601,600 yen CREST: 132,272,000 yen ACT-X: 3,521,026 yen JST-Mirai Program: 52,670,400 yen SIP: 640,000 yen
- AMED Brain/MINDS: 35,002,720 yen Brain/MINDS Beyond: 40,000,000 yen SRPBS: 89,600,000 yen AMED-CREST: 98,716,000 yen SICORP: 4,109,095 yen
- HFSPO HFSP Research Grants: 41,891,890 yen

Beyond AI (collaborative research with Softbank): 44,368,000 yen

Collaborative research with Daikin: 60,695,000 yen

Collaborative research with Toyota Central R&D Labs.: 15,200,000 yen

Others: 13,648,984 yen

## Appendix 3-1a FY 2023 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<br>project | At the end of FY 2023 | Final goal<br>(Date: March 31, 2027) |
| Researchers from within the<br>host institution         | 12                             | 11                    | 10                                   |
| Researchers invited from<br>overseas                    | 2                              | 1                     | 1                                    |
| Researchers invited from<br>other Japanese institutions | 0                              | 0                     | 0                                    |
| Total principal investigators                           | 14                             | 12                    | 11                                   |

#### b) Total members

|             |   | At the beginning<br>project | of  | At the end of FY 2 | 2023 | Final goal<br>(Date: March 31, 2 | 027) |
|-------------|---|-----------------------------|-----|--------------------|------|----------------------------------|------|
|             |   | Number of persons           | %   | Number of persons  | %    | Number of persons                | %    |
| R           | lesearchers   | 27                          |     | 134                |      | 65                               |      |
|             | Overseas<br>researchers                               | 5                           | 19  | 41                 | 31   | 23                               | 35   |
|             | Female<br>researchers                                 | 5                           | 19  | 22                 | 16   | 13                               | 20   |
| Pri         | incipal investigators                                 | 14                          |     | 12                 |      | 11                               |      |
|             | Overseas PIs  | 3                           | 21  | 2                  | 17   | 3                                | 27   |
|             | Female PIs  | 4                           | 29  | 2                  | 17   | 3                                | 27   |
| (           | Other researchers                                     | 13                          |     | 97                 |      | 40                               |      |
|             | Overseas<br>researchers                               | 2                           | 15  | 20                 | 21   | 10                               | 25   |
|             | Female<br>researchers                                 | 1                           | 8   | 15                 | 15   | 5                                | 13   |
|             | Postdocs  | 0                           |     | 25                 |      | 14                               |      |
|             | Overseas<br>postdocs                                  | 0                           | ### | 19                 | 76   | 10                               | 71   |
|             | Female<br>postdocs                                    | 0                           | ### | 5                  | 20   | 5                                | 36   |
| Resear      | ch support staffs                                     | 0                           |     | 30                 |      | 20                               |      |
| Admi        | nistrative staffs                                     | 3                           |     | 21                 |      | 10                               |      |
| form the "o | nber of people who<br>core" of the research<br>center | 30                          |     | 185                |      | 95                               |      |

|                   | At the beginning of project |   | At the end of FY 2023 |      | Final goal<br>(Date: March 31, 2027) |      |
|-------------------|-----------------------------|---|-----------------------|------|--------------------------------------|------|
|                   | Number of persons % N       |   | Number of persons     | %    | Number of persons                    | %    |
| Doctoral students | 0                           | / | 10                    |      | 13                                   |      |
| Employed          | 0                           |   | 3                     | 30.0 | 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" culumn may be changed to coincide with the project's actual content.

|                       |   |             | (Million yens)                   |
|-----------------------|---|-------------|----------------------------------|
| Cost items            | Details<br>(For Personnel - Equipment please fill in the breakdown of fiscal expenditure, and<br>the income breakdown for Research projects.) | Total costs | Amount covered<br>by WPI funding |
|                       | Center Director and Administrative Director   | 36          | 36                               |
|                       | Principal Investigators and Special Advisor to President (no. of persons: 15)   | 173         | 55                               |
| Perconnel             | Other researchers (no. of persons: 19)  | 108         | 108                              |
| reisonnei             | Research support staff (no. of persons: 8)  | 19          | 19                               |
|                       | Administrative staff (no. of persons: 23)   | 151         | 66                               |
|                       | Subtotal  | 487         | 284                              |
|                       | Gratuities and honoraria paid to invited principal investigators  | 0           | 0                                |
|                       | (no. of persons):OO   | 0           | 0                                |
|                       | Core Facilities' operation cost   | 76          | 76                               |
|                       | Research startup cost (no. of persons: 2)   | 1           | 1                                |
|                       | Cost of satellite organizations (no. of satellite organizations: 1)   | 79          | 79                               |
| Project activities    | Outreach activities   | 2           | 2                                |
|                       | Rental fees for facilities  | 80          | 73                               |
|                       | Cost of consumables   | 7           | 3                                |
|                       | Cost of utilities   | 9           | 9                                |
|                       | Other costs   | 54          | 48                               |
|                       | Subtotal  | 308         | 291                              |
| Travel                | Travel expenses (domestic and international)  | 23          | 23                               |
|                       | Subtotal  | 23          | 23                               |
|                       | Depreciation of buildings   | 0           | 0                                |
| Equipment             | Depreciation of equipment   | 103         | 102                              |
|                       | Subtotal  | 103         | 102                              |
|                       | KAKENHI   | 184         |                                  |
| Research projects     | Commissioned research projects, etc.  | 608         |                                  |
| (Detail items must be | Joint research projects   | 120         |                                  |
| incu)                 | Ohers (donations, etc.)   | 11          |                                  |
|                       | Subtotal  | 923         | 0                                |
|                       | Total   | 1844        | 700                              |

| WPI grant in FY 2023  | 700 |
|---|-----|
| Costs of establishing and maintaining                         |     |
| facilities  | 0   |
| Establishing new facilities                                   | 0   |
| (Number of facilities: , OO m <sup>2</sup> )                  |     |
| Repairing facilities  | 0   |
| (Number of facilities: , OO m <sup>2</sup> )                  |     |
| Others  | 0   |
|   |     |
| Costs of equipment procured                                   | 103 |
| Unagi -benchtop buffer exchange solution- (Unchained<br>Labs) | 15  |
| (Number of units:1)   |     |
| ROI Multipoint Optical Stimulation Unit for A1R<br>(NIKON)    | 14  |
| (Number of units:1)   |     |
| Others  | 74  |

\*1. Management Expenses Grants (including Management Enhancements Promotion Expenses (機能強化経費)), subsidies including National university reform reinforcement promotion subsidy (国立大学改革強化推進補助金) 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)、国立大学改革強化推進補助金等の補助金、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

Costs (Million yens)

### 2) Costs of satellites

|                    |   |            | (Million yens)                     |
|--------------------|---|------------|------------------------------------|
| Cost items         | Details                                     | Total cost | s Amount covered<br>by WPI funding |
|                    | Principal investigators (no. of persons):00 |            | $\land$                            |
|                    | Other researchers (no. of persons):00       |            |                                    |
| Personnel          | Research support staff (no. of persons):OO  |            |                                    |
|                    | Administrative staff (no. of persons):OO    |            |                                    |
|                    | Subtotal                                    |            | 0 0                                |
| Project activities | Subtotal                                    |            | 78 78                              |
| Travel             | Subtotal                                    |            |                                    |
| Equipment          | Subtotal                                    |            |                                    |
| Research projects  | Subtotal                                    |            |                                    |
|                    | Total                                       |            | 78 78                              |

The University of Tokyo -2

WPI-IRCN

# Appendix 4 FY 2023 Status of Collaboration with Overseas Satellites

#### **1.** Coauthored Papers

- List the refereed papers published in FY 2023 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. 2024 and not described in Appendix 1.

#### **Overseas Satellite 1 Boston Children's Hospital** (Total: 3 papers)

- [App1 list #7] Kanamaru, T; Hensch, TK; Aihara, K, 2023, NEURAL COMPUTATION, 35(8), 1430-1462, 1) https://doi.org/10.1162/neco\_a\_01596, WOS:001069683700003, Maximal Memory Capacity Near the Edge of Chaos in Balanced Cortical E-I Networks
- 2) [App1 list #22] Quast, KB; Reh, RK; Caiati, MD; Kopell, N; McCarthy, MM; Hensch, TK, 2023, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 120(2), e2123182120, https://doi.org/10.1073/pnas.2123182120, WOS:001045272300003, Rapid synaptic and gamma rhythm signature of mouse critical period plasticity
- [App1 list #23] Wu, C; Gaier, ED; Nihalani, BR; Whitecross, S; Hensch, TK; Hunter, DG, 2023, SCIENTIFIC 3) REPORTS, 13(1), 10161, https://doi.org/10.1038/s41598-023-34891-5, WOS:001018507300035, Durable recovery from amblyopia with donepezil

2. Status of Researcher Exchanges - Using the below tables, indicate the number and length of researcher exchanges in FY 2023. Enter by institution and length of

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<br>to 1 month | From 1 month<br>to 3 months | 3 months<br>or longer | Total |
|--------|--------------|---------------------------|-----------------------------|-----------------------|-------|
| EV2022 | 0            | 0                         | 0                           | 0                     | 0     |
| F12023 | 0            | 0                         | 0                           | 0                     | 0     |

#### <From satellite>

|        | Under 1 week | From 1 week<br>to 1 month | From 1 month<br>to 3 months | 3 months<br>or longer | Total |
|--------|--------------|---------------------------|-----------------------------|-----------------------|-------|
| EV2022 | 3            | 6                         | 0                           | 0                     | 9     |
| F12023 | 0            | 0                         | 0                           | 0                     | 0     |

#### **Overseas Satellite 2:**

#### <To satellite>

|        | Under 1 week | From 1 week<br>to 1 month | From 1 month<br>to 3 months | 3 months<br>or longer | Total |
|--------|--------------|---------------------------|-----------------------------|-----------------------|-------|
| FY2023 |              |                           |                             |                       |       |

#### <From satellite>

|        | Under week | From 1 week<br>to 1 month | From 1 month<br>to 3 months | 3 months<br>or longer | Total |
|--------|------------|---------------------------|-----------------------------|-----------------------|-------|
| FY2023 |            |                           |                             |                       |       |

#### Appendix 5 FY 2023 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: 18

|   | Name Age                  |     | Affiliation   |             | Academic  | Record of research activities   | Time, duration          | Summary of activities<br>during stay at center   |
|---|---------------------------|-----|---|-------------|---|---|-------------------------|--|
|   |                           |     | Position title, department,<br>organization                                 | Country     | legice, specially                                     | ( marco record, etc.)   |                         | (e.g., participation as principal investigator; short-term<br>stay for joint research; participation in symposium)   |
| 1 | Jerome Sanes              | 71  | Professor, Brown University   | USA         | Ph.D.,<br>Neuroscience                                | 2015-2016 Fulbright Scholar Award, Franco-American<br>Commission<br>2018 President's Award for Excellence in Faculty Governance,<br>Brown University, and more.                             | 26 Jan – 19 Aug<br>2023 | Conduct human neuroimaging research on<br>brain mechanisms underlying voluntary<br>movement, motor skill learning and<br>cognitive flexibility. Also, helped accelerate<br>collaborations between IRCN and<br>international research institutes. |
| 2 | Jeroen Lamb               | N/A | Professor, Imperial College<br>London                                       | UK          | Ph.D., Theoretical<br>Physics                         | 1998 NWO Talent Research Fellowship at the University of<br>Houston<br>2001-2006 EPSRC Advanced Research Fellowship at Imperial<br>College London   | 3 Apr – 14 Apr<br>2023  | Collaborate with PI Aihara on mathematical study of random dynamical systems.  |
| 3 | Nathaniel Daw             | 49  | Professor, Princeton<br>University  | USA         | Ph.D., Computer<br>Science, Cognitive<br>Neuroscience | 2022 NEURIPS Outstanding Paper Award<br>2019 BPS Cognitive Psychology Section Award   | 28 Mar – 10 Apr<br>2023 | Collaborate with PI Cai on a deep learning project on computational psychiatry.  |
| 4 | Yael Niv                  | 50  | Professor, Princeton<br>University  | USA         | Ph.D., Neural<br>Computation                          | 2019 Nirit and Michael Shaoul Fellow, The Mortimer and<br>Raymond Sackler Institute of Advanced Studies, Tel Aviv<br>University<br>2015 National Academy of Sciences Troland Research Award | 28 Mar – 10 Apr<br>2023 | Collaborate with PI Cai on a deep learning project on computational psychiatry.  |
| 5 | Alex Pouget               | 57  | Professor, Geneva University  | Switzerland | Ph.D., Biology  | 2016 Carnegie Prize in Brain and Mind Sciences<br>2016 Co-founder of the International Brain Laboratory (With<br>Zach Mainen and Mike Hausser)  | 5 May – 25 Jun<br>2023  | Interdiciplinary collaboration on predictive coding.   |
| 6 | Daphne Bavelier           | 57  | Professor, Geneva University  | Switzerland | Ph.D., Brain and<br>Cognitive Sciences                | 2019 Recipient of the 2019 Klaus J. Jacobs Research Prize,<br>endowed with CHF 1 million<br>2018 Selected as an APS Fellow by the Association for<br>Psychological Sciences                 | 5 May – 25 Jun<br>2023  | Interdiciplinary collaboration on how the brain adapts to changes in experience, either by nature - for example, deafness - or by training - for example, playing video games.   |
| 7 | Sarah Woolley             | 49  | Associate Professor, McGill<br>University                                   | Canada      | Ph.D., Zoology  | 2021-2024 Human Frontiers in Science Program (HFSP)<br>2004-2006 Postdoctoral Individual National Research Service<br>Award   | 17 May – 8 Jul<br>2023  | Collaborate with PI Yazaki to perform the researches to understand the effect of domapine and noreepinepherine on auditory processing in female zebra finches.   |
| 8 | Alberto Nogales<br>Moyano | 42  | Postdoctoral Researcher and<br>Lecturer, University Francisco<br>de Vitoria | Spain       | Ph.D., Computer<br>Science                            | Patent application award by Universidad Francisco de Vitoria:<br>ARQGAN project, April 2022.  | 14 May – 31 Aug<br>2023 | Collaborate with PI Cai on analyzing infant eye-tracking data.   |

|    | Name Ag            |    | Affiliation   |         | Academic<br>degree, specialty  | Record of research activities<br>(Awards record, etc.)  | Time, duration               | Summary of activities during stay at center  |
|----|--------------------|----|---|---------|--|---|------------------------------|--|
|    |                    | -  | Position title, department,<br>organization                           | Country |  |   |                              | (e.g., participation as principal investigator; short-term<br>stay for joint research; participation in symposium)   |
| 9  | Emre Ugur          | 43 | Associate Professor, Bogazici<br>University                           | Turkey  | Ph.D., Computer<br>Engineering                                       | 2021 The Young Scientist Award of the Science Academy<br>(BAGEP),<br>2021 The Excellence in Teaching Award by the Faculty of<br>Engineering   | 17 Jul – 26 Aug<br>2023      | Collaborate with PI Nagai on learning<br>mechanisms in cognitive developmental<br>robotics.  |
| 10 | Oded Bein          | 39 | Postdoctoral Research Fellow,<br>Princeton University                 | USA     | Ph.D., Cognition<br>and Perception                                   | 2022- Fellow, National Institute of Mental Health T32 grant,<br>Princeton University<br>2020 Grinker award, New York University   | 3 Sep – 19 Sep<br>2023       | Learning analysis methods for fMRI data<br>and collaborate with PI Cai on decoding<br>representation of task states from fMRI<br>data.   |
| 11 | Stephen Keeley     | 33 | Assistant Professor, Fordham<br>University                            | USA     | Ph.D.,<br>Computational<br>Neuroscience.,                            | 2021 NERSC AY 2021 DOE Mission Science Allocation Award.<br>2017 BRAIN Initiative Fellow: NRSA Individual Postdoctoral<br>Fellowship (F32)  | 25 Sept – 15 Dec<br>2023     | Conduct collaboration with Cai Lab on<br>interpretable deep latent variable models<br>for neural data and behaviour.   |
| 12 | Linda Polka        | 64 | Professor, McGill University  | Canada  | Ph.D.,<br>Experimental<br>Psychology &<br>Communication<br>Disorders | 2021-22 Telemachus Scholar, McGill University<br>2019 Fellow of the Acoustical Society of America   | 15 Oct – 13 Dec<br>2023      | Contribute to Team Science fusion<br>research by exploring with IRCN members<br>novel ways to link infant social<br>development work with AI methods.                                    |
| 13 | Lorijn Zaadnordijk | 35 | Research Fellow, Trinity<br>College Dublin                            | Ireland | MSc, Cognitive<br>Neuroscience                                       | 2022 Best Postdoc Publication Award School of Psychology<br>Trinity College Dublin<br>2020 Best dissertation award by the Dutch Society for<br>Developmental Psychology   | 30 Oct – 10 Nov<br>2023      | Collaboration with PI Tsuji on develpmental<br>cognitive science using artificial<br>intelligence.   |
| 14 | Davide Bottari     | 47 | Sr. Research Collaborator,<br>IMT School for Advanced<br>Study, Lucca | Italy   | Ph.D., Cognitive<br>Neuroscience and<br>Education                    | 2009 Best PhD Thesis award in Cognitive Science – Italian<br>association of PhD schools in Cognitive Sciences<br>2008 Best PhD Thesis University of Trento award – University<br>of Trento  | 19 Nov 2023 – 16<br>Jan 2024 | Collaboration on advanced Studies in<br>various researches especially on distinct<br>yet highly complementary perspectives on<br>critical and sensitive periods in brain<br>development. |
| 15 | Hanako Yoshida     | 52 | Associate Professor,<br>University of Houston                         | USA     | Ph.D.,<br>Developmental<br>Psychology                                | 2019 University of Houston Faculty Excellence Award:<br>Undergraduate Research Mentor Award<br>2006 The Irving Saltzman Award, the recognition of<br>outstanding graduate career given by Department of<br>Brain and Psychological Sciences, Indiana University | 4 Jan – 31 Mar<br>2024       | Collaboration with PI Tsuji on early social interaction between parent and child.  |
| 16 | Pawel Herman       | 44 | Associate Professor, KTH<br>Royal Institute of Technology             | Sweden  | Ph.D., Computer<br>Science   | Member of the Board of Stockholm University Brain Imaging<br>Centre (SUBIC)<br>Member of the Board of Inno-Brain AB, Sweden<br>Co-founder and member of the Board of Cortechs AB,<br>Sweden   | 25 Mar – Apr 26<br>2024      | Collaboration with PI Aihara on<br>computational study of working memory<br>and brain-like computing approaches to AI  |

|    | Name          |     | Affiliation  | 1         | Academic<br>degree, specialty                       | Record of research activities<br>(Awards record, etc.)   | Time, duration          | Summary of activities<br>during stay at center<br>(e.g., participation as principal investigator; short-term   |
|----|---------------|-----|--|-----------|---|--|-------------------------|--|
|    |               |     | organization   | Country   |   |  |                         | stay for joint research; participation in symposium)   |
| 17 | Ham Gao Xiang | 23  | Research Fellow, NTU School<br>of Social Sciences, Nanyang<br>Technological University | Singapore | Ph.D., claustrum<br>neural circuits and<br>function | 2017 – 2021 NTU Graduate Research Officer Scholarship<br>LKCM PhD Award<br>2012 – 2016 A*STAR Undergraduate Scholarship  | 18 Mar - 21 Mar<br>2024 | Collaborative research on understanding<br>the neural mechanisms and circuits<br>involved in higher cognition and social<br>learning. Using rodent models and a<br>variety of techniques (such as wholebrain<br>connectome mapping, functional circuit<br>dissection, wireless optogenetics, and<br>various behavioral tasks). |
| 18 | Jing Cai      | N/A | Instructor, Mass General<br>Research Institute / Harvard<br>Medical School             | USA       | Ph.D., Physics                                      | 2018 Herbert Callen Memorial Prize – Made significant<br>contribution to statistical physics<br>2016 Chase Risk Management Teamwork Award -<br>Outstanding performance in teamwork | 21-Mar-24               | Collaborative research on natural human<br>communication, utilizing single<br>neuronal recordings and intracranial EEG<br>recordings to gain insights into these<br>intricate neural processes.  |

## Appendix 6 FY2023 State of Outreach Activities

\* Fill in the numbers of activities and times held during FY2023 by each activity.

\* Describe the outreach activities in the "6. Others" of Progress Report, including those stated below that warrant special mention.

| Activities   | FY2023 (number of activities, times held) |
|--|---|
| Lectures, seminars for general public  | 45  |
| Teaching, experiments, training for<br>elementary, secondary and high school<br>students | 18  |
| Participating, exhibiting in events  | 2   |
| Press releases   | 18  |
| Publications of the popular science books  | 6   |
| Others (Organizing workshops and symposia)   | 7   |

\*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 2023 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) A new finding about Autism+ADHD co-occurrence was well received by the public.

On July 14, IRCN issued a press release with Dr. Takamitsu Watnabe (Principal Investigator) based on his new paper published in eNeuro, "Watanabe, D. & Watanabe, T. Distinct frontoparietal brain dynamics underlying the co-occurrence of autism and ADHD. eNeuro (2023) doi:10.1523/ENEURO.0146-23.2023". Dr. Watanabe discovered that although ASD+ADHD condition are often reported to co-exist in one person, it is actually not equivalent to a merger of pure ASD and pure ADHD but rather a subtype of ASD with unique brain dynamics that underpin its ADHD-like cognitive overflexibility. This work was an international collaboration with Mr. Daichi Watanabe, an undergraduate student at the University of California Berkeley and then an intern student at IRCN. The press release titled "Autism+ADHD co-occurrence  $\neq$  Autism + ADHD —The ADHD traits in autism+ADHD comorbid condition are governed by unique neural mechanisms unseen in pure ADHD—", was not only a successful display of marvelous scientific findings by Dr. Watanabe, but it was also very well received by the public. As of March 2023, it reached 86,294 Facebook viwers and 247,644 X(Twitter) impressions. There were 24,000 visits to the IRCN website, which was about 10 times more than normal press releases.

#### 2) Getting high school students engaged

Communication with the younger generation, especially high school students is an essential approach to broadening the society's support for science. In FY2023, IRCN hosted the following events specially tailored for high school students and their teachers:

- 272 people attended the UTokyo Open Campus online event "Meet the Young Scientist: Fusion of Neuroscience, Psychiatry and AI". The event was co-hosted with the Tokyo Metropolitan Board of Education.
- (2) 201 people attended the online seminar for female high school students "Frontiers of Science 2023: Mysterious and Interesting Brain Mechanisms". Of which, 139 were female high school or middle school students.
- (3) 100 people attended the online seminar for high school teachers "Frontiers of WPI Research 2023: Mathematical Approaches to Life Phenomena". This was a collaborative public event with WPI colleague institutes; WPI-iFReC, WPI-I2CNER, WPI-ITbM, WPI-ICReDD and WPI-PRiMe.

- (4) 9 and 30 students attended respectively the on-site lab tour for Gyosei High School and Tokyo Gakugei University Senior High School.
- (5) Dr. Hideki Ukai gave a special lecture on biology at Tokyo Gakugei University Senior High School to about 30 students.

#### 3) Books and articles targeted to public audiences

「ニュートン別冊 こんなにすごい! ふしぎな動物超図鑑 - Topics おどろきのメカニズム 昆虫のフェロモン」("Surprising Mechanisms of Insect Pheromones" In: Newton extra issue "So Amazing! The Mysterious Animals Super Book") Touhara, K. (Affiliated Faculty member) 科学雑誌Newton (Graphic Science Magazine Newton) ISBN978-4-315-52712-4 Published on June 30, 2023

「子ども白書2023 - いま、なぜ『紙』の教科書なのか」("Why we need 'Paper' textbooks now" In: "A White Book on Children") Yamaguchi, T. & Sakai, K (Affiliated Faculty member) かもがわ出版 (Kamogawa Publishers, Kyoto) ISBN 978-4-7803-1281-2) pp. 172-173. Published on July 19, 2023

「高校生と考える 21世紀の突破口 - 脳から見る言葉の力 なぜ紙の本が人にとって必要なのか」("Power of language observing from the brain" In: "Thinking with High-School Students about Breakthrough of the 21st Century") Sakai, K. (Affiliated Faculty Member) 左右社 (Sayusha, Tokyo) ISBN 978-4-86528-365-5, pp. 160-174 Published in April 2023.

「『脳とこころ』御巣鷹に逝った科学者 - 解説に代えて(インタビュー記事)」("Commentary" In: "Brain and Mind – A Scientist Lost In Osutaka") Kasai H. (Principal Investigator) 上毛新聞社刊 (Jomo Shinbun) ISBN-10:4863523408 Published in September 2023

### Appendix 7 FY 2023 List of Project's Media Coverage

\* List and describe media coverage (e.g., articles published, programs aired) in FY2023.

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

| Name                | Date       | Type of media (e.g.,<br>newspaper, magazine,<br>television | Title of the article, etc.  |
|---------------------|------------|--|---|
| Shinsuke<br>Koike   | 2024/2/21  | andla<br>(Website)   | [Koike] Adolescent hippocampal changes after the first emergency declaration are evident.   |
| Shinsuke<br>Koike   | 2024/2/16  | Brain/MINDS Beyond<br>(Website)                            | [Koike] Development of a machine learner to identify the onset of psychosis using brain imaging data.   |
| Shinsuke<br>Koike   | 2024/2/9   | NIKKEI SHIMBUN<br>(Website)                                | [Koike] The University of Tokyo, Observed changes in volume and hippocampal microstructural integration of the hippocampus and hippocampal subregions during adolescence after the first declaration of the state of emergency.           |
| Shinsuke<br>Koike   | 2024/2/9   | NIKKEI SHIMBUN<br>(Website)                                | [Koike] University of Tokyo develops machine learner to identify the onset of psychosis using brain image data.   |
| Kiyoto Kasai        | 2024/1/29  | Tech+<br>(Website)   | [K.Kasai] Persistent withdrawal and increased physical illness in adolescence puts adolescents at risk of rarefied thoughts -<br>University of Tokyo and other research.  |
| Kiyoto Kasai        | 2024/1/26  | NIKKEI SHIMBUN<br>(Website)                                | [K.Kasai] The University of Tokyo and the Metropolitan Institute of Medical Science present on the relationship between persistent withdrawal symptoms and increased physical illness and the risk of adolescent suicidal ideation.       |
| Naohiro<br>Okada    | 2024/1/25  | Tech+<br>(Website)   | [N.Okada] Neuroscience Confirms How Bullying Affects Adolescents' Brains and Minds.   |
| Kiyoto Kasai        | 2023/12/14 | NIKKEI SHIMBUN<br>(Website)                                | [K.Kasai] University of Tokyo and the Tokyo Metropolitan Institute of Medical Science use deep learning technology to identify a group of adolescents at high risk of suicide due to their inability to seek help.                        |
| Kiyoto Kasai        | 2023/12/14 | Tii-Seimeikagaku<br>(Website)                              | [K.Kasai] Identification of a group of adolescents at high risk of suicide due to inability to seek help, using deep learning techniques - based on assessments by the children themselves and their caregivers in the Tokyo Teen Cohort. |
| Kiyoto Kasai        | 2023/12/8  | AKAHATA SHIMBUN<br>(Newspaper)                             | [K.Kasai] The publication of "Our psychiatric disorders"  |
| Takuya<br>Takahashi | 2023/12/1  | TBS, NEWS23<br>(Television)                                | [T.Takahashi] The Final Frontier: Exploring the Cutting-Edge of Long-COVID Treatment<br>Electromagnetic Waves Activate the Brain: In-Depth Look at Clinical Research Investigating the Causes of 'Brain Fog'.                             |
| Kiyoto Kasai        | 2023/11/30 | NIHON KEIZAI SHIMBUN<br>(Newspaper)                        | [K.Kasai] The government will start neuroscientific research on dementia and psychiatric disorders.   |
| Kazuyuki Aihara     | 2023/11/25 | CHUBU KEIZAI SHIMBUN<br>(Newspaper)                        | [Aihara] "Coronavirus evolution through behavioural change? Corona strain analysis, Nagoya Univ."<br>(Morning edition, page 3)  |
| Kazuyuki Aihara     | 2023/11/24 | ASAHI SHIMBUN<br>(Newspaper)                               | [Aihara] "Coronavirus infection control measures may have caused viral evolution Research conducted by Nagoya University,<br>Hokkaido University and others." (Evening edition, page 10)  |

| Name            | Date       | Type of media (e.g.,<br>newspaper, magazine,<br>television | Title of the article, etc.  |
|-----------------|------------|--|---|
| Kazuyuki Aihara | 2023/11/24 | GIFU SHIMBUN<br>(Newspaper)                                | [Aihara] "Evolution of the virus through behavioural change? Overcoming "San-Mitsu" control measures and increasing infectivity.<br>Nagoya University team analyses corona strains." (Morning edition, page 20) |
| Kazuyuki Aihara | 2023/11/24 | NIHON KEIZAI SHIMBUN online<br>(Newspaper)                 | [Aihara] "Coronavirus infectivity, changes in human behavioural change? Nagoya University, etc."<br>(Morning edition, page 26)  |
| Kazuyuki Aihara | 2023/11/24 | NIHON KEIZAI SHIMBUN online<br>(Website)                   | [Aihara] "Coronavirus infectivity, changes in human behavioural change? Nagoya University, etc."  |
| Kazuyuki Aihara | 2023/11/22 | ASAHI SHIMBUN DEGITAL<br>(Website)                         | [Aihara] "Avoiding the 'San-Mitsu' and isolation 'evolve' coronavirus? Virus increase and peak earlier"   |
| Kazuyuki Aihara | 2023/11/22 | MAINICHI SHIMBUN<br>(Newspaper)                            | [Aihara] "The variant strain viral load increased Peak of infected person shedding"<br>(Morning edition, page 20)   |
| Kazuyuki Aihara | 2023/11/22 | SCIENCE.ORF.AT<br>(Website)                                | [Aihara] "Wie Verhalten das Coronavirus veränderte" written by SCIENCE.ORF.AT   |
| Kazuyuki Aihara | 2023/11/21 | FUKUI SHIMBUN ONLINE<br>(Website)                          | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | GIFU SHIMBUN WEB<br>(Website)                              | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | HOKKAIDO SHIMBUN<br>(Website)                              | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | HOKKOKU SHIMBUN DEGITAL<br>(Website)                       | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | KAHOKU SHIMPO ONLINE<br>(Website)                          | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | KITANIHON SHIMBUN WEBUN<br>PLUS                            | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | KOBE SHIMBUN NEXT<br>(Website)                             | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | KOCHI SHIMBUN<br>(Website)                                 | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | KYODO TSUSHIN SHA<br>(Website)                             | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | MAINICHI SHIMBUN<br>(Website)                              | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | NEWS MEDICAL<br>(Website)                                  | [Aihara] "Human behavior may drive the evolution of new coronavirus strains"  |
| Kazuyuki Aihara | 2023/11/21 | NEWSWEEK<br>(Website)                                      | [Aihara] "COVID's Evolution May Have Been Driven by Human Behavior, Say Biologists"   |
| Kazuyuki Aihara | 2023/11/21 | NIIGATA NIPPO DEGITAL PLUS<br>(Website)                    | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | NISHINIPPON SHIMBUN ME<br>(Website)                        | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | OITA GODO SHIMBUN GATE<br>(Website)                        | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | OKINAWA TIMES PLUS<br>(Website)                            | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | SAGA SHIMBUN<br>(Website)                                  | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |
| Kazuyuki Aihara | 2023/11/21 | SAITAMA SHIMBUN<br>(Website)                               | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University analyses data from infected individuals."  |

| Name                  | Date       | Type of media (e.g.,<br>newspaper, magazine,<br>television | Title of the article, etc.  |
|-----------------------|------------|--|---|
| Kazuyuki Aihara       | 2023/11/21 | SCITECHDAILY<br>(Website)                                  | [Aihara] "How Lockdowns Shaped the Virus: AI Uncovers COVID-19's Evolutionary Secrets"  |
| Kazuyuki Aihara       | 2023/11/21 | TOKYO SHIMBUN TOKYO WEB<br>(Webiste)                       | [Aihara] "Coronavirus evolution in behavioural change? Nagoya University, data analysis of infected individuals"  |
| Kazuyuki Aihara       | 2023/11/21 | Yahoo! NEWS<br>(Website)                                   | [Aihara] "Novel coronavirus, mutation causes a 5-fold increase in viral shedding and a 1.5-fold earlier peak"   |
| Masanori<br>Matsuzaki | 2023/11/13 | NIHON KEIZAI SHIMBUN<br>(Website)                          | [Matsuzaki] The University of Tokyo and RIKEN discover that error signals involved in brain prediction are fed back from higher<br>auditory cortex to primary auditory cortex   |
| Manabu<br>Honda       | 2023/11/10 | JKD Collective<br>(Film)                                   | [Honda]Sound Civilization   |
| Kazushige<br>Touhara  | 2023/11/10 | NHK E-television<br>(Television)                           | [Touhara] "Hanashichao!", Touhara,K., "Pheromones×Animal Behavior"  |
| Takuya<br>Takahashi   | 2023/11/4  | NHK, NEWS<br>(Television)                                  | [T.Takahashi] Unraveling the Mechanism Behind 'Brain Fog' in Long-COVID   |
| Kazuo<br>Emoto        | 2023/11/2  | NIKKEI SHIMBUN<br>(Website)                                | [Emoto] Sugar intake insensitive to pain, University of Tokyo clarifies the mechanism for painkillers.  |
| Kazuo<br>Emoto        | 2023/10/18 | Tii-Seimeikagaku<br>(Website)                              | [Emoto] Elucidation of the mechanism by which eating sugar suppresses the pain response - Tuning of peripheral pain sensation according to the nutritional status of the individual.  |
| Yukiko<br>Gotoh       | 2023/10/16 | NIKKEI SHIMBUN<br>(Website)                                | [Gotoh] University of Tokyo Clarifies that Protein HMGA2 Has Direct Chromatin Aggregation Activity  |
| Yukiko<br>Gotoh       | 2023/10/16 | Tii-Seimeikagaku<br>(Website)                              | [Gotoh] Discovery of Novel Chromatin Aggregation Factor - HMGA2 Contributes to the Maintenance of Neural Stem Cells by Directly Aggregating Chromatin - The University of Tokyo Elucidates that Protein HMGA2 Has Direct Chromatin Aggregation Activity |
| Takuya<br>Takahashi   | 2023/10/13 | KANAGAWA SHIMBUN<br>(Newspaper)                            | [T.Takahashi] Unlocking the Mystery of 'Brain Fog': Cutting-Edge Imaging Technology Aims to Understand Long-COVID   |
| Kiyoto Kasai          | 2023/10/11 | Tech+<br>(Website)   | [K.Kasai] University of Tokyo Finds Adolescent "Psychological Difficulties" Linked to Brain Development   |
| Kiyoto Kasai          | 2023/10/10 | NIKKEI SHIMBUN<br>(Website)                                | [K.Kasai] University of Tokyo Clarifies Link Between Psychological Difficulties and Brain Development in Adolescence  |
| Kenichi<br>Ohki       | 2023/9/21  | MIT Technology Review Japan<br>(Website)                   | [Ohki]Making AI secure by introducing random noise that mimics brain neurons ——Reduces its vulnerability against some adversarial examples by injecting random noise in the hidden layers of deep neural networks——2023                                 |
| Kenichi<br>Ohki       | 2023/9/16  | Academic Gates<br>(Website)                                | [Ohki]Brain inspires more robust AI   |
| Kenichi<br>Ohki       | 2023/9/16  | Andor<br>(Website)   | [Ohki]Making AI secure by introducing random noise that mimics brain neurons ——Reduces its vulnerability against some adversarial examples by injecting random noise in the hidden layers of deep neural networks——2023                                 |
| Kenichi<br>Ohki       | 2023/9/16  | BIOENGINEER<br>(Website)                                   | [Ohki]Brain inspires more robust AI   |
| Kenichi<br>Ohki       | 2023/9/16  | EurekAlert!<br>(Website)                                   | [Ohki]Brain inspires more robust AI   |
| Kenichi<br>Ohki       | 2023/9/16  | News8Plus<br>(Website)                                     | [Ohki]Using the brain as a model inspires a more robust AI  |
| Kenichi<br>Ohki       | 2023/9/16  | NIHON KEIZAI SHIMBUN<br>(Website)                          | [Ohki]Making AI secure by introducing random noise that mimics brain neurons ——Reduces its vulnerability against some adversarial examples by injecting random noise in the hidden layers of deep neural networks——2023                                 |

| Name                  | Date      | Type of media (e.g.,<br>newspaper, magazine,<br>television | Title of the article, etc.  |
|-----------------------|-----------|--|---|
| Kenichi<br>Ohki       | 2023/9/16 | Science Daily<br>(Website)                                 | [Ohki]Brain inspires more robust AI   |
| Kenichi<br>Ohki       | 2023/9/16 | Scienmag<br>(Website)                                      | [Ohki]Brain inspires more robust AI   |
| Kenichi<br>Ohki       | 2023/9/16 | TECH TIMES<br>(Website)                                    | [Ohki]How the Human Brain Is Inspiring AI Systems to Be More Robust   |
| Kenichi<br>Ohki       | 2023/9/16 | Technology Networks<br>(Website)                           | [Ohki]Brain-Inspired Changes Could Make AI More Resilient   |
| Kenichi<br>Ohki       | 2023/9/16 | Techxplore<br>(Website)                                    | [Ohki]Using the brain as a model inspires a more robust AI  |
| Kenichi<br>Ohki       | 2023/9/16 | TS2<br>(Website)   | [Ohki]Improving Neural Networks' Defense Against Adversarial Attacks  |
| Kenichi<br>Ohki       | 2023/9/16 | VERVETIMES<br>(Website)                                    | [Ohki]The Brain Serves As A Catalyst For The Development Of Highly Resilient AI   |
| Kazuo<br>Emoto        | 2023/9/15 | NIKKEI SHIMBUN<br>(Website)                                | [Emoto] Ube3a, a Responsible Factor for Angelman Syndrome, Promotes Synaptic Removal via Degradation of BMP Receptors in<br>the Presynaptic Area. University of Tokyo   |
| Kazuyuki Aihara       | 2023/8/30 | TV Tokyo<br>(Television)                                   | [Aihara] "Science from the living room: 'Predicting the future with one formula'".  |
| Yukie<br>Nagai        | 2023/8/17 | JIJI MEDICAL<br>(Website)                                  | [Nagai] Perceptual experience improves negative feelings toward ASD   |
| Sho                   | 2023/8/14 | TBS, NEWS23<br>(Television)                                | [Tsuji, Ganna Mamonova]The endless war in Ukraine: Haruka Ayase speaks with displaced people living in Japan about the reality of the war   |
| Naohiro<br>Okada      | 2023/8/7  | Qlife Pro<br>(Website)                                     | [N.OKada] New Classification of Four Major Mental Disorders by Brain Volume Proposed in Japanese Multicenter Study - NCNP<br>e.t.c.   |
| Kiyoto Kasai          | 2023/8/6  | YOMIURI SHIMBUN<br>(Newspaper)                             | [K.Kasai]Yomiuri Shimbun: 50 years of MRI for innovation in brain research  |
| Yukie<br>Nagai        | 2023/8/4  | Qlife Pro<br>(Website)                                     | [Nagai] ASD Perceptual Experience Simulator Improves Negative Emotions Held by Typically Developed Individuals - University of Tokyo, etc.  |
| Naohiro<br>Okada      | 2023/8/4  | Tii-Seimeikagaku<br>(Website)                              | [N.Okada] Proposal of a New Classification of Mental Disorders Based on Brain Volumes - Expectations for the Development of New Diagnostic Methods for Mental Disorders Related to Cognitive and Social Functions |
| Kiyoto Kasai          | 2023/8/3  | NATURE<br>(Magazine)                                       | [K.Kasai]Focal Point on Brain Science in Japan  |
| Yukie<br>Nagai        | 2023/8/3  | NIKKEI SHIMBUN<br>(Website)                                | [Nagai] University of Tokyo and LITALICO Reveal that Experiencing Perceptions of Autism Spectrum Disorders Improves Negative  |
| Takamitsu<br>Watanabe | 2023/7/14 | NIKKEI SHIMBUN<br>(Website)                                | [Watanabe]Neural basis of autism spectrum disorder (ASD) and ADHD complications ASD/ADHD complications are not a simple superposition   |
| Takamitsu<br>Watanabe | 2023/7/14 | Tech+<br>(Website)   | [Watanabe]The University of Tokyo discovers that ASD/ADHD complications are not a simple complication of both   |
| Kazuo<br>Emoto        | 2023/7/13 | NIKKEI SHIMBUN<br>(Website)                                | [Emoto] University of Tokyo presents "Neural Mechanisms by which Fear Biases Visual Responses".   |
| Kazuo<br>Emoto        | 2023/7/13 | Tii-Seimeikagaku<br>(Website)                              | [Emoto] Through what neural mechanism does fear bias the organism's visual response?  |
| Kazuyuki Aihara       | 2023/6/20 | NIHON KEIZAI SHIMBUN<br>(Newpaper)                         | [Aihara] "Science fiction perspectives, a source of creation and thought."<br>(Morning edition, page 27)  |

| Name                 | Date      | Type of media (e.g.,<br>newspaper, magazine,<br>television | Title of the article, etc.  |
|----------------------|-----------|--|---|
| Kazuyuki Aihara      | 2023/6/19 | NIHON KEIZAI SHIMBUN<br>(Newpaper)                         | [Aihara] "Science fiction perspectives, a source of creation and thought."<br>(Morning edition, page 26)  |
| Masako<br>Myowa      | 2023/6/4  | NHK<br>(Television)  | [Myowa]NHK Special "After COVID-19": It became difficult to meet others -Science Reveals the Trouble! Anomalies of the Heart~<br>(Broadcasted on June 4, 2023, 21:00~21:50, Supervision and Appearance)   |
| Masako<br>Myowa      | 2023/6/3  | ASAHI SHIMBUN<br>(Television)                              | [Myowa]Asahi Shimbun "COVID Disaster" - Is there any safe content that can be shown in the room? A program for children conceived by employees doing childcare. (June 3, 2023, Evening edition, page 2)   |
| Kazuyuki Aihara      | 2023/6/1  | TELEASA NEWS<br>(Website)                                  | [Aihara] "Financial Services Agency and the University of Tokyo sign collaboration agreement, including research on "prediction" of financial crises".  |
| Kazuyuki Aihara      | 2023/6/1  | TV ASAHI<br>(Television)                                   | [Aihara] "Financial Services Agency and the University of Tokyo sign collaboration agreement, including research on "prediction" of financial crises".  |
| Kazuyuki Aihara      | 2023/5/31 | TELETO BIZ<br>(Website)                                    | [Aihara] "University of Tokyo x Financial Services Agency 'financial research' collaboration agreement".  |
| Kazuyuki Aihara      | 2023/5/31 | TV Tokyo<br>(Television)                                   | [Aihara] "University of Tokyo x Financial Services Agency 'financial research' collaboration agreement".  |
| Masako<br>Myowa      | 2023/5/29 | YOMIURI SHIMBUN<br>(Newspaper)                             | [Myowa] Brain Maturation "Instinct" Precedes - Emotional Brakes Develop Slowly (May 29, 2023, Morning Edition, page 28)   |
| Ayuko<br>Hoshino     | 2023/5/21 | YOMIURI SHIMBUN<br>(website)                               | [Hoshino] [Science Human] The most important thing is not the publication of papers but the contribution to treatment Ayuko Hoshino, Professor, The University of Tokyo 41                                |
| Kazuyuki Aihara      | 2023/5/14 | NIHON KEIZAI SHIMBUN<br>(Newpaper)                         | [Aihara] "Solving the mysteries of life with mathematical formulas: In 2050, predicting disease before it occurs may become possible".<br>(Morning edition, page 26)                                      |
| Kazuyuki Aihara      | 2023/5/13 | NIHON KEIZAI SHIMBUN<br>(Website)                          | [Aihara] "Solving the mysteries of life with mathematical formulas: In 2050, predicting disease before it occurs may become possible".  |
| Masako<br>Myowa      | 2023/5/7  | HOKKAIDO SHIMBUN<br>(Newspaper)                            | [Myowa]Hokkaido Shimbun: Children living in masks, concerns about brain and ego development. How were we and the society during the three years of COVID disaster (May 7, 2023, Morning Edition, page 24) |
| Masako<br>Myowa      | 2023/4/30 | YOMIURI TV<br>(Television)                                 | [Myowa] Yomiuri TV: Supervision of "Iroriro", a TV program encouraging children to take on new challenges. (from April 30, 2023, every Sunday 6:30-7:00 regular,  |
| Masako<br>Myowa      | 2023/4/22 | Mainichi SHIMBUN<br>(Newspaper)                            | [Myowa] Mainichi Shimbun: A TV program "Iroriro" safe for children to watch was created under the supervision of a university professor. (April 22, 2023, Evening Edition)                                |
| Kazushige<br>Touhara | 2023/4/10 | NHK<br>(Television)  | [Touhara] Asaichi: "Update your daily life with the power of flavors and fragrances"  |