FY 2018 WPI Project Progress Report

Host Institution	The University of Tokyo	Host Institution Head	Makoto Gonokami
Research Center	International Research Center for Neurointelligence (IRCN)	Center Director	Takao Kurt Hensch

Common instructions:
* Unless otherwise specified, prepare this report based on the current (31 March 2019) 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**)

Overview

In FY2017, the World Premier Initiative program selected the International Research Center for Neurointelligence (IRCN) at The University of Tokyo (UTokyo) to conduct interdisciplinary scientific studies at the interface of human and machine intelligence. This FY2018 Report describes how IRCN has successfully completed the construction phase of its scientific plan. With an innovative research ecosystem in place, the center is poised for fast scientific progress via project-based team science.

Highest Global Level Research

IRCN laboratories performed at a world-class level in FY2018 based on the number of papers in high quality journals and conferences (Appendix 1). However, IRCN's goal is not to focus on individually-oriented lab-based projects, but rather to build fused disciplines by collaboration across the basic life sciences, computational, human, clinical, and social sciences. The first stage in FY2017 and FY2018 involved maintaining the existing world class level of research in its constituent PI labs while, in parallel, building the center's capacity for conducting interdisciplinary fusion in an environment that is historically not built for collaborative fusion. Here, it is important to understand that high impact life science research at universities typically has long (e.g. 4-8 year) publication timelines. Therefore, recruiting well-established PIs into *de novo* fusion projects is a challenge and far more difficult than progress in theoretical or technical fields. Despite this intrinsic handicap, in FY2018, IRCN was able to make exceptional progress in constructing an innovative system for interdisciplinary fusion research. IRCN divided its PIs and AFs into four Units – Development, Computation, Technology, and Human/Clinical – in order to organize the necessary hiring and resourcing and reach an appropriate field balance for fusion across Units. Considering the time needed for publication of new projects in life science fields even if fused with faster moving fields, a realistic timeline for the first publications on fused disciplines at the highest global level would be expected in FY2020.

Generating Fused Disciplines

IRCN used strategic hiring to rebalance PI composition across the Four Units, with a focus on international hires in the Computation and Human/Clinical Units. These new PIs were selected in large part for their potential for collaboration across fields and fusing disciplines. Notably, female PI hiring in FY2018 allowed IRCN (now almost 30%) to lead UTokyo in gender diversification. In infrastructure development, IRCN built and fully staffed five Core Research Facilities – Imaging, ES Mouse/Virus, Data Science, Human fMRI, and Science Writing – to create a comprehensive set of technical platforms necessary to support fusion research. Each Core is tasked with stimulating collaboration across fields while providing services to all IRCN researchers. IRCN's signature internal seminar called the Science Salon was launched as an unprecedented innovation in stimulating bottom-up collaboration, where young researchers from different fields (IRCN Units) present back-to-back talks showcasing a research question that solves an important problem in IRCN's field of Neurointelligence. In FY2018, nine salons were held with great success and the best transdisciplinary proposals were awarded seed funding from the Director. Further, IRCN constructed two "collaboration ecosystems" on the first and third floors of Medical Building 1 by remodeling the labs and offices, adding lounges and scientific interaction spaces for facilitating Team Science.

International Research Environment

IRCN is led by an international Director and Executive Director with extensive global experience and networks, which enabled IRCN to launch ambitious initiatives (12 signed MOUs) to internationalize and integrate the center with the starting lineup of UTokyo PIs. PI and postdoc hiring targeted international faculty and young researchers to greatly increase the percentage of researchers from abroad. Frequent international symposia/workshops brought many foreign researchers to the center to form collaborations. The IRCN flagship program in FY2018 was the Neuro-Inspired Computation Course in March 2019 where 15 faculty and 30 students from abroad convened at IRCN along with over 100 UTokyo students and researchers for 4 days after a highly selective process (>230 applicants) to teach and learn topics in brain computation and AI, as the first course of its kind in Japan. Many students expressed interest in coming back to IRCN in the near future to join a lab or participate in a research project as a collaborator to further internationalize the center. The most promising international development in FY2018 was the addition of six new partnerships, for a total of nine foreign partners, expected to build broad global networks for collaboration across fields, career trajectories for trainees and as sources of visitors to internationalize the center's environment. Finally, the Science Writing Core provided English support and coaching in manuscripts, grants, oral presentations, and press release/web articles for the global public to use communication at IRCN to accelerate the growth of an international research culture.

Making Organizational Reforms

A major organizational reform in FY2018 was the formation of the Office for Research Strategy (ORS) and creation of the IRCN Executive Director (ED) position to head the ORS (and writing core). ED Yokoyama brought broad scientific breadth and management expertise from *Cell* Press and RIKEN, a global research network, and a scientific communications/publishing background. The ORS executes the vision of the Director to implement plans and strategies in areas of collaboration (e.g. Science Salons), grant application support, research field fusion, scientific planning and programs, and operates the Science Writing Core, and they designed the research ecosystem concept and its execution of the 3F computation collaboration space and Team Science, an innovative multi-lab fusion-directed collaboration strategy that will be launched in FY2019. The Science Writing Core is further being considered for expansion of its academic communication services to all of UTokyo. On the academic side, IRCN faculty are joining the innovative UTokyo WINGS programs to participate in graduate education for strong integration of IRCN into the university's educational mission. IRCN programs for student exchange with Harvard University were also launched in FY2018 and similar programs are expected in FY2019 with other partners. IRCN also contributed to excellence initiatives to allow flexible employment in the center and affiliation with UTokyo faculties, such as the Excellent Researcher Faculty and Co-PI systems.

Securing Long Term Development

While still in the construction phase, IRCN took measures to ensure its mid and long-term development and sustainability. The leadership organization chart became stable for fast and effective decision-making with an Executive Board of the Director, two Deputy Directors, Executive Director, and Administrative Director, supported and advised by a transdisciplinary PI Steering Committee and Administrative Office. The total number of PIs including new hires became 19 (by FY2019) and is well balanced across diverse fields. Likewise, the AF group has stabilized with new additions filling gaps particularly in the computation and human/clinical areas. In building toward Team Science, the PI and AF composition is currently under review with an emphasis on faculty invested in collective research goals. The core facilities and international partners are also in ongoing evaluation for contributions to fused disciplines. In FY2018 and onward, large efforts were being made to expand the center's funding portfolio to multiple industry and private sources/philanthropy, and progress is expected in FY2019. In addition to the individual PIs grants, the ORS worked with groups of PIs to seek larger grants and this trend will accelerate with the formation of multi-lab research teams. Last but not least, UTokyo invested large funding outlays to IRCN in FY2018 for a wide range of activities including fMRI purchase, infrastructure renovations, computational course, Harvard internship program, and faculty salaries. In summary, IRCN continues on an upward growth trajectory that will accelerate once interdisciplinary team science projects shape center identity over the next few years.

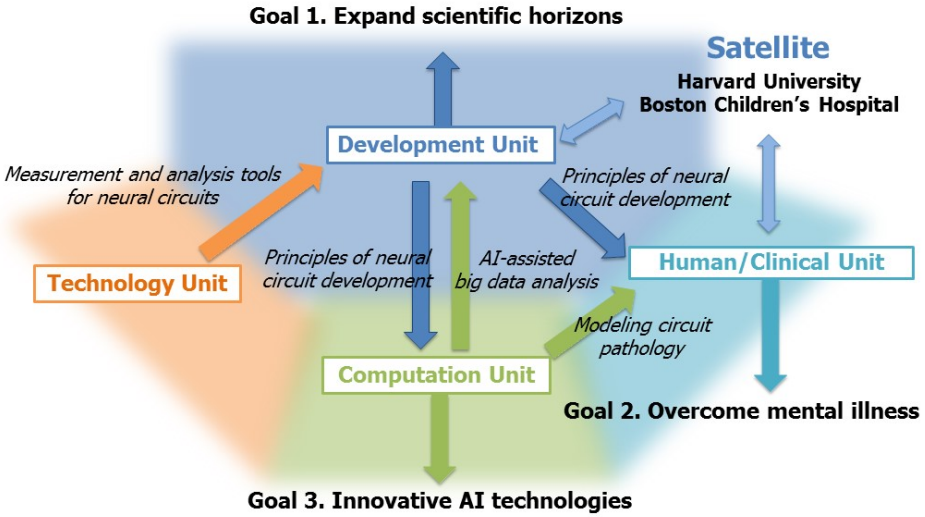
* Describe clearly and concisely the progress being made by the WPI center project from the viewpoints below.
- In addressing the below-listed 1-6 viewpoints, place emphasis on the following:
  (1) Whether research is being carried out at a top world-level (including whether research advances are being made by fusing fields).
  (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 2018.
* 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.

The research mission of the International Research Center for Neurointelligence (IRCN) is to advance a scientific understanding of human intelligence (HI) and its relationship to machine intelligence (MI). The Center will establish parallel research programs for the investigation of fundamental principles of brain development and, conversely, the origins and mechanisms of neurological, neurodevelopmental, neurodegenerative, and psychiatric disorders linked to aberrant development. These two programs will, in turn, motivate the design of novel interventions and innovative artificial intelligence (AI) to understand and enhance normal intelligence and mitigate brain disorders for a healthy human society well integrated with machine technologies.

Interaction among Research Units towards Goals



The IRCN established four Research Units to represent complementary research fields that are used to facilitate transdisciplinary research fusion. The four research units organized in IRCN have respective goals to (1) discover fundamental principles of neural circuit and brain development and function, (2) understand the mechanisms of brain disorders involving impaired intelligence, (3) develop novel experimental research technologies to support goals (1) and (2), and (4) to use the brain principles in (1) to accelerate the development of next-generation computation and AI.

At a foundational level, the global standing of the IRCN depends on the performance of individual laboratories. To evaluate the center's global standing in FY2018, research performance was assessed by the research quality and impact of papers published in journals and conference proceedings. In FY2018, IRCN published 109 original papers (65 WPI papers and 44 WPI-related papers). One fourth of these papers were reported in high quality journals including the Nature/Cell Press/Science families. In bioscience fields, PIs and AFs generated outstanding outcomes reported in visible international journals identified by both their Impact Factor and scientific reputation for quality and rigor among researchers publishing in those fields. Likewise, PIs and AFs in computation/ mathematical fields reported outstanding outcomes in journals and conferences with expert endorsed scientific quality and rigor. While the outstanding performance of individual researchers is one feature of the IRCN, interdisciplinary research has begun in FY2018 as described in the Report.

The Center is advancing world class research in two distinct phases. In Phase 1, approximately years 0-2, individual labs will maintain or increase their individual research output while participating in structured learning about each other's research and begin small scale collaborations to build a critical mass of research capital for more extensive and deeper collaborations in the following stages. In this report on Year 2 of IRCN, we describe the successful completion of Phase 1, by highlighting recent individual lab contributions to world class research capacity across the four Research Units.

Phase 2 will be described in further detail in Section 2 below on "Generating Fused Disciplines".

- **Development Unit:** Five PIs are addressing the central question of how human intelligence is formulated during brain development with a variety of model system. Investigations range from genetic programming in the prenatal embryonic and fetal stages to the postnatal impact of life experience on neural circuits and brain activity in successive critical developmental periods.

Yukiko Gotoh studies the regulation of neural stem/progenitor cell programming and cell fate**.**

The Gotoh lab recently identified an epigenetic control mechanism explaining how neural stem cells lose the potential to produce neurons. In this study, the Polycomb repressive complex (PRC) 1 maintains developmental genes in a poised state through monoubiquitination (Ub) of histone H2A. Although Ub-independent functions of PRC1 have been suggested, whether Ub-dependent and -independent functions of PRC1 operate differentially in a developmental context has been unclear. The group showed that the E3 ubiquitin ligase activity of Ring1B, a core component of PRC1, is necessary for the temporary repression of key neuronal genes in neurogenic (early-stage) neural stem or progenitor cells (NPCs) but is dispensable for the persistent repression of these genes associated with the loss of neurogenic potential in astrogliogenic (late-stage) NPCs. Their findings suggest that an Ub-independent mode of repression by PRC1 plays a role in mammalian development during cell fate restriction expanding our understanding of cell fate (Tsuboi et al., *Dev Cell* 2018).

Masanobu Kano is an expert on synapse elimination in the developing cerebellum.

The Kano lab discovered the involvement of mammalian target of rapamycin (mTOR), a central regulator of cellular metabolism, in synaptic pruning in the developing cerebellum. Previously, the importance of mTORC1 signaling in neuronal development and function was known, and hyperactivation of mTORC1 in the forebrain can lead to neurodegenerative disease. However, the relationship between these neurological manifestations and mTOR signaling in other brain regions remained unclear. To address this question and understand its clinical relevance, the Kano lab collaborated with Prof. Aiba's lab to generate transgenic (Tg) mice in which mTORC1 signaling is directly activated in Purkinje cells with hyperactive mTOR mutation. Surprisingly, they did not find abnormalities in social behavior in the Tg mice, suggesting that activation of mTORC1 in Purkinje cells is insufficient for the onset of autism-like symptoms. On the other hand, these Tg mice exhibited motor discoordination accompanied with pronounced apoptosis and impaired synapse elimination of Purkinje cells. Furthermore, hyperactivated mTORC1 signaling induced increased cell size, a pseudohypoxic state and abnormal mitochondrial dynamics. Their findings suggest that mTORC1 signaling in Purkinje cells is important for cell homeostasis (Sakai et al., *Sci Rep* 2019).

Kazuo Emoto conducts research on neuronal morphogenesis in development and disease.

In FY2017, the Emoto lab screened genes involved in synapse/neurite remodeling using Drosophila sensory neurons as a model system, and identified a novel microRNA required for triggering the regeneration of injured neurites (Kitatani et al., in revision).

Kenichi Ohki examines properties of visual cortical processing by cellular scale in vivo imaging.

The Ohki Lab found that specific cell types of thalamo-cortical inputs constrain formation of direction map in the visual cortex (Nishiyama et al., *Cell Rep* 2019). The relationship between cognitive functions and cell-type-specific neuronal circuits is a central topic in neuroscience. In cats, the lateral geniculate nucleus (LGN) contains several cell types carrying precise visual information. Whereas

LGN cell types lack selectivity for motion direction, neurons in the primary visual cortex (area 17) exhibit sharp direction selectivity. Whether and how such de novo formation of direction selectivity depends on LGN cell types remains unknown. The group addressed this question applying in vivo two-photon calcium imaging in cat area 17, which consists of two compartments receiving different combinations of inputs from the LGN cell types. The direction map in area 17 showed unique fragmented organization and was present only in small and distributed cortical domains. Moreover, direction-selective domains preferentially localized in specific compartments receiving Y and W inputs carrying low spatial frequency visual information, indicating that cell-type-specific thalamo-cortical projections constrain the formation of direction selectivity.

Yoko Yazaki-Sugiyama examines neuronal circuits that control learning behaviors in songbirds.

The Yazaki-Sugiyama lab uses bird song learning as a model of vocal communication to understand how brain circuits are shaped depending on sensory environments during an early developmental period and how the social behavior of animals are affected by early life experience. While songbirds have served as a model for investigating the neuronal mechanisms of sensory-motor learning, progress has been hampered by a lack of genetic tools. The lab has developed and implemented adeno-associated virus vectors (AAVs) for behavioral experiments in songbirds leading the international songbird field in applying cutting-edge techniques such as Tet On/Off system, neuronal activity-dependent gene expression (c-fos promotors) and fluorescent sensors for neuromodulators, combined with sophisticated behavioral paradigms. Exploring those techniques, her lab already initiated several projects for understanding early environmental effects on social communication.

- **Technology Unit:** Five PIs are developing technologies and tools for understanding principles of brain development and function. Driving the fundamental research performed by the other Units, the Technology Unit invents and optimizes innovative, cutting-edge technologies to track, measure and analyze neural structure and activity from individual cells to entire brains.

Yasushi Okada develops new microscopic imaging methods for biological studies.

The Okada lab has applied single-molecule imaging and super-resolution microscopy techniques along with the high-resolution cryo-EM to examine the mechanisms underlying the polarization of a neuron during its early development (Shima et al., *J Cell Biol* 2018). The binding of kinesin to a microtubule triggers cooperative conformational changes in the microtubule, which increase the binding affinity of the next kinesin. This positive feedback mechanism can explain how a neuron extends only a single axon among multiple neurites. In a second study, non-invasive force measurements in the living axon were applied to the analyses of the axonal transport of endosomes (Hayashi et al., *Mol Biol Cell* 2018). The results suggested that a single endosome is transported by a few kinesin or dynein molecules with a pair of dynein dimers as a unit for the force production in the transport. The Okada lab also developed several probes for imaging. A bright luminescent protein probe, Nano-Lantern, was applied to the BRET-FRET hybrid biosensors for optogenetics, chemical screening and in vivo imaging (Komatsu et al., *Sci Rep* 2018). Their novel photostable fluorescent dyes enabled long-term single molecule imaging (Gzrybowski et al., *Ang Chem* 2018), and live-cell STED super-resolution imaging (submitted). Super-resolution microscope techniques were also extended to light-sheet illumination optics. With Bi-Chang Chen, live cell STORM imaging with light-sheet optics was reported (*Commun Biol*, in press), plus new algorithms for molecular localization (Takeshima et al., *J Microsc* 2018) and cell tracking (Yu et al., *IPTA* 2018).

Haruo Kasai studies single synapse manipulation and measurement technologies.

The Kasai lab has achieved a new strategy for targeting of AS-type probes to spines for second generation synaptic labeling. Applying a new method for labeling presynaptic boutons (BS), they could label recently enlarged boutons making synaptic contacts with enlarged spines (unpublished). For the BS probe, sparse labeling occurs even in dissociated cultures, and soon the mechanisms for the specific labeling of the probe to enlarged boutons will be clarified. In collaboration with Shin Ishii (AF, Kyoto U), the lab has been developing 3-direction 2P imaging with AI based analysis, aimed at delineating the local learning circuits at the level of single synapses. The lab has also developed

a behavioral task for the quantitative evaluation of classical conditioning in head-fixed mice. Surprisingly, reward conditioning of mice with a pure tone readily generalized to tones with other pitches, becoming selective if discrimination tasks were subsequently applied. Such discrimination learning was dependent on the pause of dopamine neurons in the VTA, and D2R in the nucleus accumbens.

Arthur Konnerth aims to investigate the role of the cerebellum for brain function and cognition.

Recently, the Konnerth lab focused on information processing in the dendrites of Purkinje neurons, the principal cells of the cerebellar cortex. In order to achieve their goal, they developed a new form of in vivo two photon imaging different from conventional imaging in that the movement of the galvo mirror defining the y-axis of the image is synchronized with a change in focal distance (z-axis), thereby generating a tilted focal plane. The tilted focal plane makes it possible to image Ca^{2+} signals in large dendritic fields of a Purkinje cell. Such measurements cannot be achieved with conventional two photon Ca^{2+} imaging because the dendrites of Purkinje neurons are aligned perpendicularly to the cortical surface. They further improved the technique incorporating single cell-targeted DNA electroporation or the expression of genetically encoded calcium indicators (GECI), such as GCaMPs, in single cells. Owing to the stable long-lasting expression and a high signal-to-noise ratio of the GECIs, it became possible to image Ca^{2+} signals in a small dendritic segment chronically for several weeks from the same dendritic field. Using these techniques, they succeeded in observing spontaneous local dendritic Ca^{2+} transients in awake mice. With the Kano lab, they also investigated the molecular mechanism underlying the spontaneous local dendritic Ca^{2+} transients, and found evidence for the involvement of mGluR1 in spontaneous local dendritic Ca^{2+} transients. Furthermore, they obtained strong experimental evidence for local dendritic inhibition regulating the strength of climbing fiber-activation in specific dendritic subfields in a behavior-dependent manner.

Hiroki Ueda investigates organism-level systems biology and its applications in mammalian brain.

The Ueda lab and collaborators have further proceeded with single-cell resolution whole-organ cell profiling by a tissue-clearing method ‘CUBIC’ (clear, unobstructed, brain/body imaging cocktails and computational analysis) and light-sheet microscopy. Especially regarding the CUBIC method, they developed hydrophilic chemical cocktails applying for better delipidating, decoloring, refractive index matching, and decalcification. Using high-throughput evaluation systems suitable for chemical processes, they screened more than 1,600 chemicals and reached optimal chemical cocktails for rational clearing protocols, which enables large-tissue clearing and expands a possibility into whole-body imaging (including bones) and large primate or even human brains. The tissue-clearing step is very crucial for the quality of the subsequent acquired image and the feasibility of image processing. By providing such an advanced technology, Ueda’s team has updated CUBIC protocols, largely contributing to rapid, integrated, multiscale phenotyping of neuronal circuits (Taninaka et al., *Cell Rep* 2018).

Shoji Takeuchi develops biohybrid robots composed of cultured tissues and flexible substrates.

Although biohybrid robots have been useful to understand the design strategy of living organisms and to engineer their dynamic systems, they do not work well due to spontaneous shrinkage of the muscle tissues caused by their intrinsic traction force that increases through the course of culturing. However, biological systems overcome these issues by using antagonistic pairs of skeletal muscles and balancing tension. The group developed a biohybrid robot which used an antagonistic pair of skeletal muscle tissues for the first time as shown in Figure 1. The skeleton and electrodes of the biohybrid robot were fabricated by stereolithography and parylene-based standard photolithography, respectively. Next, myoblast-laden hydrogel sheets were prepared using polydimethylsiloxane stamps and stacked onto the anchors immobilized on the skeleton to form three-dimensional muscle tissues. The biohybrid robot was actuated by controlling the contractions of the skeletal muscle tissues with applying electrical fields between the pair of the electrodes for a week. They also succeeded in picking up a ring and placing it with a finger-like motion. Although these results are primitive for a machine, the biohybrid robot is expected to evolve into an intelligent machine, by fusing with machine learning research to learn more efficient and strong motions in future versions.

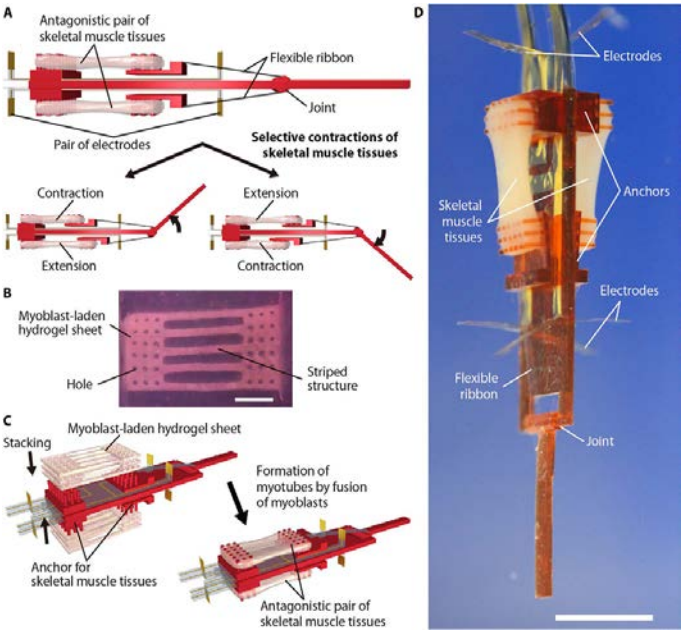


Fig. 1. Biohybrid robot with skeletal muscle cell tissues. [*Science Robotics*, 3(18), eaat4440, 2018]

- **Human/Clinical Unit:** this unit investigates human brain development and its disorders, based on principles discovered by the Development Unit. The Human/ Clinical Unit additionally works with the Computation Unit to develop frameworks for computational psychiatry based on the analysis of large patient cohorts with brain disorders. The Unit will strive to advance research that will allow access to fundamental questions of human intelligence and how this knowledge can help to build healthier human societies in harmony with technology.

Kiyoto Kasai conducts neuroimaging and clinical neurophysiology of psychiatric disorders.

The Kasai Lab aims to elucidate the pathology of autism spectrum disorders (ASD), schizophrenia, and depression in patients using multi-modality neuroimaging and clinical neurophysiology. Using auditory steady state gamma-band response (ASSR) and mismatch negativity (MMN) event-related potential as auditory cortical functions, Koshiyama et al. showed that ASSRs and MMNs were associated with each other in the early stage of schizophrenia (*Transl Psychiatry*, 2018). Okada et al. found that abnormal asymmetries in subcortical brain volume were evident in early adolescents with subclinical psychotic experiences (*Transl Psychiatry*, 2018).

Takao Hensch investigates novel therapies based on developmental critical period biology.

The Hensch lab and affiliated faculty members at Boston Children's Hospital have proceeded with bench-to-bedside collaborative research for neuro-developmental disorders. In particular, they have identified potential circuit-based treatments for cognitive disorders using model animals of autism spectrum disorders (ASD) and schizophrenia reflecting manipulation of critical period timing. They translate these insights into a deeper understanding of the biological basis of critical periods for brain development into the clinic, transcending traditional departmental and field boundaries. Projects include: cognitive consequences of repeated pediatric anesthetic exposure (with Dr. Charles Berde, Anesthesiology & Emery Brown, MGH), longitudinal electrographic biomarkers to track excitatory-inhibitory imbalance in ASD (with Dr. Charles Nelson, Developmental Medicine), and the reopening of juvenile brain plasticity to correct amblyopia ("lazy eye") after the age of 10 (with Dr. David Hunter, Ophthalmology). With IRCN scientists and collaborators (e.g. Nancy Kopell, Boston University), all teams will apply sophisticated computational modeling and machine learning/AI approaches to characterize the circuit dynamics and processes to devise innovative new therapies.

For example, the Hensch and Fagiolini labs identified inhibitory interneurons that mediate developmental critical period plasticity in the neocortex. In FY2018 his team solved the neural

mechanism of how ketamine, an NMDA receptor antagonist, quickly exerts its antidepressant effects. They revealed that NMDA receptors containing the 2A subunit (GluN2A) on parvalbumin (PV)-expressing inhibitory interneurons as a pivotal target of low-dose ketamine. Genetically deleting GluN2A receptors globally or selectively from PV interneurons in mice abolished the rapid enhancement of visual cortical responses and gamma-band oscillations by ketamine. Therefore, GluN2A receptors on PV interneurons are key elements that mediate the fast action of low-dose ketamine treatment. Moreover, female mice responded less consistently to ketamine, depending on the stage of the estrus cycle suggesting gender-specific treatment options regarding NMDA drugs for psychiatric disorders (Picard et al., *Mol Psychiatry* 2019). New studies on critical periods are described under another section.

Kuniyoshi Sakai studies the brain mechanism of human language processing.

The Sakai lab previously reported both anatomical and functional correlates of second language (L2) acquisition in specific cerebral regions. Their research has been further extended in FY2018 to early acquisition phases in L2, including learning Japanese for visitors in Japan, as well as Kazakh for multilinguals or bilinguals. The Sakai lab has been exploring the impact of such short intensive exposure to languages that are new to individual participants. Research details are described in the FY2017 report, and further analyses on this project toward publication are in progress.

- **Computation Unit:** this Unit builds computational brain models and neuro-inspired artificial intelligence (AI) based on principles of neural circuit development in cooperation with the Development Unit, and analyses big data utilizing methods based on mathematical science and AI. The research addressed by the Computation Unit will contribute to a deeper quantitative understanding of human intelligence that will ultimately help to improve machine intelligence.

Kazuyuki Aihara studies computational and mathematical methods for brain modeling/theory.

The Aihara lab aims at understanding not only higher brain functions but also brain pathology by modeling psychiatric and neurological disorders according to the dysregulation of neural circuit development. They developed a new mathematical methodology for prediction by short-term but high-dimensional data (Ma et al., *PNAS* 2018). Since such high-dimensional data are observed in the brain, this method can be widely used for the analysis of neural data. They also proposed an analog neural network model that can destabilize local minima in combinatorial optimization problems by the correction of amplitude heterogeneity among neurons (Leleu et al., *PRL* 2019). Further, in collaboration within IRCN, he is working with Masanobu Kano, Kazuo Emoto and Kantaro Fujiwara in modeling synaptic elimination, with Kenichi Ohki for modeling spatio-temporal transitive dynamics in visual cortex, with Kiyoto Kasai for finding early warning signals of schizophrenia, and with Yoko Yazaki-Sugiyama for modeling attention of song birds. He also studied hardware implementation of biomimetic neural networks with NEC through Social Cooperation Programs between UTokyo and NEC on Brain-Morphic AI to Resolve Social Issues (Levi et al., *IEEE Trans CASII* 2018).

Masashi Sugiyama seeks to create next-generation machine learning AI technologies.

Among its goals, the Sugiyama lab aims to advance current machine learning technologies based on neuroscientific findings. To do so, they need to put together two completely different topics into the same framework: the limitations of current machine learning technologies described in a mathematical form and neuroscientific findings coming from physiological experiments. To achieve this challenging goal, the incorporation of human assistance into the current machine learning algorithms was attempted. This year, the group developed several novel machine learning algorithms following this line of thinking, including a classification framework that can incorporate human knowledge on noise transition, matrix completion frameworks that take the ceiling effect into account and can accommodate active feature acquisition, a hint-guided approach to crowdsourcing, and estimation of individual treatment effects based on separate labels. They have also conducted theoretical analyses to gain insight on how human assistance can be incorporated mathematically.

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."

Progress in FY2018:

Collaborative research across different disciplines is the only solution to accelerate understanding of the complex developmental sequences that contribute to higher brain functions and their disease states to generate new computational models and AI. For IRCN to achieve this outcome, effective technological support bridging across fields is of the highest priority. In FY2018 IRCN focused on founding state-of-the-art "Core Facilities"; i.e., 1) ES-Mouse/Virus Core (generation of transgenic mouse models and production of virus vectors for studies with genetically modified mice), 2) Imaging Core (cutting edge optical equipment), 3) Data Science Core (data storing and analytical mathematical modelling), and the 4) Science Writing Core (consulting and training for global standard communication). In FY2019, a new facility, the 5) Human fMRI core will be launched. The core system enables IRCN PIs, researchers, and collaborators (AFs) to have inexpensive and rapid access to materials and technologies operated by expert IRCN staff, as well as provides a welcoming ecosystem for foreign collaborators and trainees. Altogether, the core system provides advanced technological platforms to drive IRCN researchers' scientific project fusions.

In another effort to promote fusion research, IRCN has held its signature "Science Salon" events on an average of once a month. This activity was inspired from the last retreat held at the end of the previous fiscal year. Initially, this seminar-type event was set up to feature a pair of speakers from 2 individual PIs' laboratories in different fields in which a joint research project was being or might be been conducted. In FY2018, Salons were held nine times since May, and each collaborative pairing is listed below. The Director has used this opportunity to effectively promote transdisciplinary fusion by providing a "Start-up" fund for the best collaboration research seeds. These 2-6 M yen grants were awarded to 3 Salon pairs in FY2018, and the progress of their fused projects will be reported at the next retreat, scheduled on June 8-9, 2019.

Salon 1 (May 23): by the 4 Technology Core managers
Salon 2 (May 30): by the Ohki and Aihara labs (Development vs. Computation)
Salon 3 (June 1): by the Hirata and Gotoh labs (Computation vs. Development)
Salon 4 (June 18): by the Ohki and Sugiyama labs (Development vs. Computation)
Salon 5 (July 23): by the Aihara and K. Kasai labs (Computation vs. Human/Clinical)
Salon 6 (Sept. 19): by Yazaki-Sugiyama and Takeuchi labs (Development vs Technology)
Salon 7 (Nov. 21): by the H. Kasai and Ishii labs (Technology vs. Computation)
Salon 8 (Feb. 20): by the Aihara and Ohki labs (Computation vs. Development)
Salon 9 (March 27): by the Koike and Morishima labs (Human/Clinical vs. Computation)

Even more importantly, to create fusion research IRCN targeted recruitment of new PIs. IRCN advertised several positions globally to attract international researchers focused to fill unbalanced research fields, i.e. computation and human/clinical, and to bridge the gap from biology towards the development of neuro-inspired AI. Two candidates have already been recruited (starting from April 2019), and further screening is completed for the next fiscal year. The first two new faculty members are Drs. Nagai (developmental robotics) and Tsuji (infant language acquisition), and they will play a key role in the IRCN Research Ecosystem where interdisciplinary/trans-species labs are located physically next door to each other on the same floor with Development (Hensch, Yazaki-Sugiyama) and Technology (Takeuchi) labs.

Phase 2 Fusion Activity will be started in FY2019 to further strengthen the link between the computation and neuroscience fields. In preparation, IRCN launched a "Computation Ecosystem" where the newly furnished third floor in the Faculty of Medicine Building 1 was remodeled to house affiliated computational scientists from other campuses of UTokyo and internationally for collaboration with neuroscientists. This new environment will be used for various fusion seminar series and hosting research planning meetings across different fields.

Major Progress in FY2018:

Substantive progress in each study unit for generating fused disciplines are specified as below.

(i) **Technology Unit** | The Unit successively developed state-of-the-art advanced materials and technologies to support neural circuit studies for the Development Unit. Newly developed or improved methods in FY2018 include single cell-targeted DNA electroporation, a tilted focal plane that allows the detection of Ca^{2+} signals by 2 photon imaging in large dendritic fields of a Purkinje cell, new optic probes for super-resolution live-cell imaging, and a fiber photometry sensor for in vivo real-time neurotransmitter monitoring.

(ii) **Development Unit** | The Unit seeks new principles of the brain's developmental programs for building neuro-inspired next generation AI. In FY2018 the research activity of this unit relied on fusion of the advanced technologies supplied by the Technology Unit and advanced mathematical analysis supported by Computation Unit. For example, the Kano lab clarified the molecular mechanism of spontaneous local dendritic Ca^{2+} transients, using a technology provided by Konnerth lab. H. Kasai lab established a collaboration with Shin Ishii (AF, Kyoto U.) to delineate learning circuits labelled by novel synaptic probes using modern AI based imaging analysis (Mu-Net). The Yazaki-Sugiyama lab got a large technical advance from the Takeuchi lab to monitor the spontaneous activity of neuromodulators in songbirds. The Ohki group fused systems neuroscience and deep learning, and developed a novel method to copy the behavior of real neurons into deep artificial neural networks in silico.

(iii) **Computation Unit** | This Unit began to create next-generation AI based on the principles of neural circuit development in the brain in cooperation with the Development Unit, and systematically analyzed a large amount of data obtained from the Imaging core facility in animals models and human fMRI studies, utilizing methods based on mathematical algorithms and machine or deep learning methods. The Aihara and Sugiyama lab members were frequently consulted for collaboration and/or advice on many biomedical-oriented projects.

(iv) **Human/Clinical Unit** | Working together with the Computation Unit, the H/C Unit aims at understanding brain disorders by modeling based on the distorted rules of neural circuit development. This approach included the quantitative analysis of brain images and physiological data from patients with mental disorders aiming at establishing objective criteria for diagnosis. Kiyoto Kasai lab has continued collaborative research with the Aihara and Hirata groups on the detection of early warning EEG signals in the transition from UHR (Ultra-High Risk for psychosis) to FES (First-Episode Schizophrenia) on the basis of bifurcation theory. In addition, the Hensch lab in Boston has been conducting collaborative studies with AF members at Boston Children's Hospital IRCN Satellite. Their data will also be applied to computer modeling with the aid of machine learning/AI techniques to facilitate translational therapies.

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)

In addition to his group's outstanding research, the IRCN Director has exceptionally strong global connections as well as proven successful experience in leading the internationalization of RIKEN BSI from its establishment in 1996. Here, the initiative of the Director has rapidly advanced the formation of an international research environment in IRCN in FY2018 from a baseline level. The following measures outline concrete steps taken to build the center's globalized outlook.

Major investment in international collaboration: To enhance the international collaborations of IRCN, the Director accelerated the establishment of global pipelines with prestigious research organizations abroad by contracting a series of Memorandum of Understanding (MOU). While the MOU partners in FY2017 included the following institutes:

- Max Planck Florida Institute for Neuroscience, USA
- Boston Children's Hospital, USA

- Edwin O. Reischauer Institute of Japanese Studies, Harvard University, USA

Six additional MOU signed in FY2018 were added for a total of 9 partners:

- A*Star, The Agency for Science, Technology & Research, Singapore
- NCCR “Synapsy” –The synaptic bases of mental diseases, Switzerland
- Fondazione Instituto Italiano di Tecnologia (IIT), Italy
- The University of British Columbia, Canada
- The Hong Kong University of Science and Technology, (HKUST) Hong Kong
- The College de France, France

The following regional clinical imaging consortium was also connected to IRCN:

- Asian Consortium on MRI studies in Psychosis

Frequent international seminars / symposia: In FY2018, a total of 33 world-leading scientists from abroad, including 10 researchers from the above partner organizations, visited IRCN to provide lectures/talks at seminars and symposia, which resulted in the stimulation of research activities at IRCN in a global context. Thus, as one of the mechanisms for creating an international environment at IRCN via research exchange, 16 international scientific events were held in FY2018; 11 invited seminars, 2 international workshops, 2 international symposia, and an international lecture course.

Lecture course in Neuro-Inspired Computation to attract excellent young global researchers: Among the international events held, an international lecture course in March 2018 entitled “IRCN Neuro-inspired Computation Course” was prominent as a major driving force toward the globalization of IRCN by a bottom-up training strategy. The course involved 12 lecturers who are leading world-class computational or robotics scientists. There were >230 applicants from the EU-UK, Asia and the United states, competing for 30 seats allocated for post-docs and graduate students. Only the most excellent young researchers were successfully chosen to attend the lecture. The course resulted in major global attention for IRCN and interest in further visits. There were also 69 participants from the Univ. of Tokyo, which enabled international social interactions with the foreign students to establish an international research environment by building the next-generation.

Science Writing Core (SWC) to support international research performance: IRCN established a SWC to support manuscript and grant writing, oral presentation, and public-minded writing toward the IRCN-unique mission of global interdisciplinary research requiring strong communication across diverse fields. IRCN Executive Director, Charles Yokoyama (SWC Core Manager), is a former Senior Editor at Cell Press who has extensive experience in teaching and coaching written and oral communication for highly visible publications and talks in preeminent international journals and conferences. For example, all 18 Science Salon participants received coaching and editing services by the SWC before their talk resulting in marked improvement in presentation. Thus, IRCN researchers are being supported in international level communication.

International strategy for foreign PI and researcher recruitment: The Director has been putting the highest priority on the recruitment of young foreign researchers with high motivation and ability, and the personnel hiring at IRCN in FY2018 reflected this focus on internationalization; Among 90 IRCN researchers, 31 are from overseas, for a 34% global composition. After recruitment, the Director will help the recruited scientists realize outstanding achievements during their term at IRCN and become a strong candidate for faculty or post-doctoral positions at other globally leading research institutions. Attractive job conditions are offered for foreign researchers with an annual salary system based on their competence and performance at internationally competitive salaries.

Improvement of gender balance of PIs: IRCN hired a new female PI who is young and internationally active, Dr. Yazaki-Sugiyama from FY2018. She is a neurobiologist but proactively has started to collaborate with IRCN computation and technology units. Towards the end of 2018, the Director posted a call to recruit other PIs in computation and human behavioral fields and selected two females PIs (Dr. Nagai, computation/robotics; Dr. Tsuji, Human/Clinical unit), who will join IRCN from April 2019. Thus, the ratio of female PI has increased from 6.7% to 23.5% at the beginning of

FY2019.

4. Making Organizational Reforms

* 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.

Supporting Graduate Student Education:
Education of graduate students is an indispensable aspect of IRCN's mission. UTokyo reinforces education at the graduate level to produce qualified professionals through initiatives including the establishment of World-leading Innovative Graduate Study (WINGS), a novel framework for graduate schools of international excellence. Director Hensch and several faculty members are included in a new WINGS proposal submitted in FY2019, and several faculty are already included in an existing WINGS program. UTokyo also supported student education to build IRCN's international research environment via a new student exchange program between UTokyo and Harvard University led by IRCN. The IRCN neuro-inspired computational course also contributed to this mission.

UTokyo Excellent Researcher Faculty System:
UTokyo started a new employment system for faculty level staff named the Excellent Researcher System to support outstanding young researchers who will lead the next generation of academic research. This program stabilizes a large group of new posts for young faculty members. In particular from FY2018, UTokyo recruited the young researchers from all research areas for the first time, and selected 9 outstanding young researchers from 153 applicants. IRCN participated in this program and has successfully hired two female tenure-track junior faculty (out of nine winners), whom IRCN recruited from abroad. Their salaries and start-up funds will be supported by this UTokyo program from April of FY2019.

Planning of Academic Communication Center:
Communication in English is an essential skill for research success in all academic fields and can improve high quality publication output, accelerate the internationalization of Japan's university system, and enable a higher communication capacity of young researchers to make their excellence visible. IRCN has a mission of interdisciplinary research requiring strong communication across diverse fields and therefore launched a Science Writing Core (SWC) that supports manuscript and grant writing, oral presentation, and public-facing writing (See Section 3). IRCN proposed to UTokyo that the experience of SWC management and programs, such as coursework, individual coaching, and performance output to develop long-lasting proficiency, is appropriate to scale up in the university via establishment of a new Academic Communication Center that serves the entire university across career stages including two WINGS graduate programs and three UTokyo Schools.

Executive Director and Office of Research Strategy
IRCN has newly created the Executive Director (ED) position, which is a global trend at research centers but is likely the first case in Japan. The ED, in cooperation with AD, executes and creates strategic plans for the Director. IRCN hired Dr. Charles Yokoyama, a former Senior Editor at Cell Press and Director for Research Administration at RIKEN BSI, as ED based on broad international scientific expertise, and skills in communications and strategic planning, global networking and critical evaluation. He heads the Office of Research Strategy (ORS) and the Science Writing Core, which were launched at IRCN in FY2018. The ORS is itself an innovative research support office unlike any other in Japan, supporting the strategy and implementation of new interdisciplinary research strategies for IRCN PIs and AFs, and support for grant seeking from domestic and foreign funding agencies and foundations, strategic and scientific communications, and collaboration management.

Deputy PI system
IRCN introduced the deputy PI system to enable PIs outside Hongo Campus including overseas PIs to more actively participate in IRCN's collaborative research projects within the Faculty of Medicine Building 1. This system enables young researchers to visit and conduct their research in IRCN, and accelerate interdisciplinary fusion for IRCN. Using this system, Director Hensch hired a Project

Lecturer as his deputy PI, who is full-time in his laboratory at IRCN. Shoji Takeuchi's deputy PI, a full-time project assistant professor, has lab space in the same building. Arthur Konnerth's and Kazuyuki Aihara's deputies are also working in the IRCN building to carry out fusion collaboration.

Infrastructure Renovations for Fusion Research:
IRCN extensively renovated pre-existing research space, equipment, and related resources in the Faculty of Medicine Building 1, and UTokyo supported these space upgrades. IRCN renovated new experimental rooms and offices for new PIs and researchers and several seminar rooms for common use to facilitate interdisciplinary collaboration. IRCN further built common research spaces with advanced instruments and core laboratories providing cutting-edge technologies along with fee-for-services provided by skilled operators and data analysts. IRCN launched five major Core Facilities in FY2018. The ES-mouse/Virus Core provides a service for the generation of genetically-modified mice, and viruses for studies with genetically-modified mice. The Imaging Core enables data acquisition on brain structure and function at different spatial and temporal resolutions using advanced optical imaging equipment. The Data Science Core processes and stores data on brain structure and function and uses statistical analyses and mathematical modelling to derive fundamental properties of neurons and networks. The Science Writing Core provides scientific communication tools, services, training, and resources for funding and publishing world-class international and interdisciplinary research. Finally, the new human fMRI core serves as a hub research facility for scientists from diverse fields to conduct studies for the IRCN mission to create a transdisciplinary field of Neurointelligence. These common research spaces facilitate collaboration of PIs and AFs across the different research units. UTokyo supported the renovation of the entrance hall and hallways providing a modern research environment specifically for fusion research.

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 the 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.

Organization: The startup period for IRCN is operationally defined as FY 2017 to FY 2019 to allow the establishment of the management organization and all research units. The leadership team was established consisting of five Executive Board (EB) members, two Deputy Directors and one Executive Director to support the Director for smooth operation and decision making, while the Administrative Director provides administrative services necessary for the execution of IRCN. In addition to the EB, a Steering Committee (SC) was established to help with center decision-making.

Fifteen world-class principal investigators (PIs) from UTokyo and research institutes overseas were organized into four research units: Development, Technology, Human/Clinical and Computation. Through their deep synergy the production of new studies and their outcomes have been generated as described in Item 2 of this progress report. Due to the new hiring and core facilities the total number of researchers has reached the final target number set for March, 2022.

In addition, IRCN successfully recruited two female PIs, Drs. Yukie Nagai and Sho Tsuji, starting from April 2019, as a Project Professor and a Project Assistant Professor, respectively. They will be collaborating with Director Hensch to investigate developmental mechanisms including 'critical periods' in human babies and human-inspired robots. The critical period research is an inroad to understanding neural circuit plasticity and synaptic development, which are lacking in current artificial intelligence. Thus, their work will open new paths to create next-generation AI.

Core Facilities: In order to develop shared facilities and services in the research center, the IRCN newly established two new cores in FY2018, the Science Writing Core (SWC), composed of the ED, a project associate professor and project lecturer, and an fMRI Core for functional neuroimaging adding to existing core facilities: the ES-mouse/virus Core, Imaging Core and Data Science Core Facilities. The fMRI Core recruited a core manager to start in FY2019, who is an expert to maintain fMRI equipment as a physician-researcher. Additional core facility support is under consideration.

Institutional Collaborations: In addition to the extensive portfolio of international collaborations described in Item 3 above, IRCN also partnered with key domestic institutions. IRCN made an MOU with the RIKEN Center for Advanced Intelligence Project (AIP Center), in order to enhance interdisciplinary research bridging neuroscience and AI. The AIP Center Director is Masashi Sugiyama in the Computation Unit. An MOU with RIKEN Biodynamical Systems Research BDR is also approved. The RIKEN Center for Brain Science (RIKEN CBS), which was established nearly concurrently with IRCN, has yet to respond to the IRCN Director's repeated requests for formal collaboration.

External Funds: IRCN PIs received competitive grants from government sources, including Grants-in-Aid for Scientific Research, AMED, and JST. Examples include Specially Promoted Research (Kano), Scientific Research on Innovative Areas (Emoto, K. Kasai), Scientific Research (S) (Gotoh, H. Kasai, Ueda, Ohki, Aihara, Takeuchi), Scientific Research (A) (Emoto, Sugiyama), Brain Mapping by Integrated Neurotechnologies for Disease Studies (Ohki, Ueda, K. Kasai, H. Kasai, Aihara), and Strategic Basic Research Project–CREST (H. Kasai, Okada, Sugiyama, Takeuchi), ImPACT (Aihara), JST START(Takeuchi), JST Mirai program (Takeuchi) . Industrial collaborations such as Sugiyama and Toyota, Sugiyama and NIKON, and Aihara and NEC also brought large budgets into IRCN research activities. In total, 698 million-yen of external budget and 268 million-yen funded by the host university were used for IRCN activities in FY2018. In addition, the Office for Research Strategy (ORS), consisting of three research support staff, supports domestic and foreign grant applications to facilitate IRCN research, and started services to support the making of proposals of both large and small sized grants by providing individual counseling. Regarding private and non-profit foundation donations, IRCN has been in discussions with various entities. These fund raising activities will support the future sustainable operation of the center and its unique research objectives.

Contribution of the host university: The University of Tokyo strongly supports a successful and sustainable IRCN. In "The University of Tokyo: Vision 2020", President Gonokami defines "expansion and establishment of internationally renowned bases for research" as one of the important action plans. Moreover, the third mid-term objectives/plans of the University state that the University will form "research centers that can contribute to solving issues in both academic and social domains, with pioneering, prompt, agile, and practical approaches". This plan also states that "research centers objectively recognized for their excellence, such as those in UTIAS, a "special district" where IRCN is a member, are prioritized for support from the University." The President regards IRCN as one of the most important units in the University and has promised to provide full- fledged support for IRCN to help the University pioneer its organizational reforms. As examples of concrete contributions of UTokyo to IRCN, the following financial support has been provided in FY2018; expenses for renovation of the IRCN building (31 million-yen), full salaries of 9 IRCN staff (three URAs and six tenured administrative officers, (96 million-yen)), PIs' salaries (114 million-yen), and expenses for purchasing the fMRI machine, etc. (27 million-yen). Furthermore, the limited space of the current building is preferentially reserved for IRCN in spite of a competitive situation with other departments. UTokyo has thus contributed consistently to the sustainable development of IRCN.

6. Others

* Describe what was accomplished in the center's outreach activities in FY 2018 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.

To advertise IRCN's activities more globally, IRCN renewed its Web site, https://ircn.jp/ and https://ircn.jp/en/, and started to use SNS (Facebook and Twitter). Through these web sites, we have posted people, core facilities, collaboration and research activities, outreach, recruitment and evens including International Symposia, Workshops, Computation Course, Opening Ceremony and monthly Science Salons. To emphasis IRCN's presence, we prepared a leaflet (English and Japanese versions), pamphlet (English and Japanese versions) and novelty goods. To intensively collaborate with the other WPI institutes, we co-sponsored IPMU/ELSI/IRCN joint seminar and IPMU/IRCN joint seminar, and participated in a Super Science High School Event and the WPI science symposium. We also cosponsored the UTokyo IIS/Riken AIP/IRCN joint symposium. We also contributed to a symposium and IRCN Core Facility Tour at The University of Tokyo Homecoming day and Festival.

We hosted a special experiments program for high school students and contributed a talk session in Miraikan. We posted 11 Press releases in FY2018. The Summer Student Internship Program and International Neuro-inspired Computational Course greatly raised the global visibility of WPI-IRCN.

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 "Actions required and recommendations" in the Follow-up report, then note how the center has responded to them.
* For the center launched in FY 2018, describe the status of response to the pointed items in "Major points that need to be improved" of "The screening result for WPI centers launched in FY 2018."
* However, if you have already provided this information, indicate where in the report.

FY2018 Site Visit Report

Q1: Research focus, vision, goal, and milestones of IRCN
The current research projects appear disparate and are not well integrated. To establish a globally visible research center and make breakthroughs and paradigm shifts, the following will be important: (i) The research focus of IRCN should be made more clear and unique; (ii) Personnel and resources should be directed more strategically to advancing the focused activity of IRCN, rather than simply moving forward with the starting lineup of researchers; and (iii) It would be worthwhile to hold a discussion with the PIs about their collective and individual goals, visions, milestones, and ways to contribute to the establishment of neurointelligence.
A1: To elucidate the foundations of human intelligence, the research focus of IRCN is to establish bottom-up principles of neural development and innovate AI technologies based on these principles. At the same time, this understanding will allow greater access to the mechanisms of brain disorders including ASD, schizophrenia, and depression. The IRCN strategy will bridge the "gene-cognition" gap by understanding the local circuit development in the brain, as the key for understanding how mature brain functions arise. The bridging component is computational perspective involving large neuroscience datasets across synaptic, circuit and system levels to create our unique neuro-inspired computational approach to this issue. To do this, we are implementing a team science ecosystem, including targeted recruitment of new PIs to bridge the gap between biology and neuro-inspired AI starting their labs in FY2019 (hiring from April). Housed under one roof, these interdisciplinary/trans-species labs will collaborate in the Faculty of Medicine Building 1, which IRCN renovated to be used for fusion seminar series, reciprocal field learning, and hosting simultaneous brainstorming meetings across the various fields (see also below). Thus, we hope to achieve in the coming years great advances across multiple scales.

Q2: Facilitation of fusion
To improve interaction among the component wet-lab projects and to articulate a common vision for them, IRCN research should be more intensively and strongly interactive. To facilitate fusion studies and open the venue of new fields, the ideas derived from young scientists are important. For such purpose, daily discussion and communication among the different labs and fields is necessary. However, the PIs and young scientists of IRCN are scattered among the Hongo, Komaba and Kashiwa campuses. To overcome the present situation, in addition to the "Science Salon," the director should consider systems useful for promoting the sharing of research activities that bring the members closer together as a team.
A2: We created a representative research ecosystem and research fusion on the first floor in the Faculty of Medicine Building 1: Yazaki (song bird), Takeuchi (technology) who moved to Hongo, Hensch (mouse), Tsuji (human infant), and Nagai (robotics) to engage in daily active interaction to span topics of critical periods, vocal communication, social interaction, neuromodulation, attention, predictive coding, and language development from birds to humans. To create this PI cluster, new hiring was focused to fill in unbalanced IRCN research units, i.e. computation and human/clinical, and to bridge the gap from biology toward the development of neuro-inspired AI. Tsuji and Nagai have already been recruited (starting April 2019), and two additional human/computational scientists have accepted offers to join IRCN in September and

December 2019. In addition, on the third floor newly renovated office and collaboration lounge space are available, welcoming computer scientists and students from the Komaba and Kashiwa campuses, and from abroad. Prof. Aihara, who is a key player in our computational projects will also move to the third floor upon retirement in FY2019, to help mentor young talented PIs. Creating an ecosystem of neuroscience/computation research fusion on every floor and filling in the new spaces with key people to allow their interaction is a major part of our strategy to facilitate interdisciplinary research.

In addition to the Science Salon, we have held regular fusion events: Retreats, PI Chalk Talks, Focus Group meetings, International Workshops and Symposia. The Director has used this opportunity to effectively promote transdisciplinary approaches by providing a "Start-up" fund for the best collaboration research seeds presented at the "Science Salon". The grants were awarded to 3 pairs in FY2018, and their progress in fused projects will be followed up at the second annual retreat, scheduled on June 8-9, 2019 along with the awarding of additional Science Salon collaborations in 2019.

To increase technological support across fields, we launched a unique state-of-the-art "Core Facilities" system for hypothesis testing, data generation, analysis and science writing (see also Chapter 2). These cores enable PIs and collaborators (AFs) to access inexpensive and rapidly available materials and technologies, and are operated by specialized IRCN staff. Altogether, these cores provide advanced technological platforms to support IRCN fusion of scientific projects.

Q3: Construction of IRCN building

Creating a new field of neurointelligence via the integration of experimenter PIs with AI PIs is a major goal of IRCN. However, the PIs of the developmental neuroscience and clinical neuroscience are spread across several departments of the Hongo campus while the AI scientists are located on the Komaba and Kashiwa campuses. We emphasize the importance for further effort to secure research space that will enable housing all of IRCN researchers under one roof.

A3: IRCN extensively rearranged pre-existing research spaces, equipment, and related resources in the Faculty of Medicine Building 1, and UTokyo helped to support renovation of the spaces. IRCN prepared new experimental rooms and offices for new PIs and researchers and several seminar rooms for common use to facilitate collaborations ideal for computational researchers/students from Komaba and Kashiwa campuses. IRCN further built common research spaces with advanced instruments, named core laboratories, providing cutting-edge instruments, along with fee-for-service provided by skilled operators and data analysts. These common research spaces are facilitating collaboration of PIs and AFs in the different research fields and from different campuses. UTokyo further supported renovation of the entrance hall and hallways providing a clean and modern environment for IRCN researchers. Regarding potential new buildings, UTokyo is negotiating with Bunkyo City and Tokyo Prefecture to change their rules governing Hongo campus construction.

Q4: Approach to next-generation AI

The current structure of IRCN reflects a strong emphasis on basic/clinical neuroscience research. It would be nice if a subsidiary laboratory for ML/AI PIs (Drs. Aihara and Sugiyama) could be prepared in the vicinity of neuroscientists in order to facilitate an interdisciplinary fusion research environment, and if these PIs could be asked to be more engaged in IRCN by giving them more opportunities for leadership in IRCN. A second option would be to recruit excellent young AI scientists into IRCN for permanent tenured positions.

A4: Notable actions this year for creating computation fusion research included the recruitment of new PIs. IRCN advertised several positions globally to attract international researchers. New hiring focused to mitigate unbalanced research fields, i.e. computation and human/clinical, and to bridge the gap from biology towards the development of neuro-inspired AI. Two candidates have already been recruited (starting April 2019), and two additional human/computational scientists have been selected to join September and December in the next fiscal year. They will be playing a key role in the IRCN Research Ecosystem where interdisciplinary/trans-species labs will collaborate in the Faculty of Medicine Building 1.

IRCN renovated an entire floor in the Medical School Building 1 to attract

computational scientists who are assigned on other campuses of UTokyo for gathering freely in Hongo with wet biologists, namely, the "Computation Ecosystem". Specifically, there is now lab and office space for Profs. Aihara and Sugiyama and their lab members to work. This new environment will be used for fusion seminar series, reciprocal field learning, and hosting simultaneous brainstorming meetings across the various fields.

Q5: Director's leadership
Fusing neuroscience and AI to create neurointelligence constitutes a bold vision, for which enthusiasm must be shared among all the PIs. As this will require strong leadership by Director Hensch, the request for his effort devoted to the center by the WPI Program Committee (50% presence at Hongo campus) should be realized, step by step but not too prolonged. Continued patience would seem to be appropriate at this point, but the matter will need to be reconsidered in later reviews.

A5: Director Hensch has focused on building the center starting with infrastructure renovation, hiring new PIs and researchers strategically for a diversified, balanced and team science-oriented composition, creating our global network of partner institutions (12 MOUs) to attract many foreign students, and positioning the Executive Director to help with local management. The management structure was slightly reshuffled for tight communication every day 24 hours/day via emails, and weekly Zoom meetings with management and steering committee members. Director Hensch's main scientific contributions to IRCN are projects running at our satellite center, Boston Children's Hospital, where 5 affiliated faculty are implementing true translational studies. There is currently no other place in the world where we can pursue such bench-to-bedside research in human infants. In addition to the satellite, the Director has set up a lab in Hongo and recruited a deputy lab head, new postdoc, technician (shared) and computational intern (UToronto) into the common lab space on 1F in Faculty of Medicine Building 1. To secure his physical presence on Hongo campus, Director Hensch will take a sabbatical leave from Harvard teaching duties after May 2019.

Q6: Recruitment of new PIs and young researchers
(i) Currently there are only two PIs from abroad out of a total of 14 PIs. Strategic recruitment of new PIs from abroad is urgently needed to satisfy the minimum 20% requirement. In particular, recruitment of talented young non-Japanese PIs, with an emphasis on increasing female recruitment, will be important for the IRCN's development and for enhancing its international environment.
(ii) Concerning the recruiting of foreign postdocs, students and female researchers, more aggressive recruitment from the international pool of talent is needed.

A6: We recruited new PIs and researchers to address demographics; 10 foreign researchers were hired (60 % female, 40 % foreign), including the Executive Director and 2 research administrator members. We have been successful in attracting those new members from prominent places outside the UTokyo environment.

Among the international events, our Summer Student Internship Program and International Neuro-inspired Computational Course were prominently noteworthy as driving forces toward the globalization of WPI-IRCN by a bottom-up strategy. Only excellent young researchers were successfully chosen to attend the lecture course. Thus, that event served as a trigger to bring global talent to WPI-IRCN. We hope that many of those talented young minds come back to IRCN to work in the near future.

Q7: Affiliation of PIs, Effort of PIs, and Management of external funding
Currently, the positions of all PIs in IRCN are adjunct. They have substantial duties in their home departments and work at the WPI center as "part timers." This suggests that the current effort level dedicated to IRCN by most PIs is low. Nonetheless, most PIs have declared 80% effort for IRCN.
In order for IRCN to achieve scientific breakthroughs and realize its vision toward neurointelligence, more PIs must work at IRCN in primary positions while keeping their commitment of 80% effort.
A related issue is the securing of external funding for IRCN. Currently, PIs must go through their home faculties to apply for external funding, which makes it difficult to acquire external funding within IRCN. Thus, nearly all of the research in IRCN is supported by grants obtained by PIs in their home departments before and even after IRCN was launched.

The following three issues should be solved systematically with strong support from the UTokyo top management: (i) researchers' duties/obligations to their home departments, (ii) securing the promised effort of 80% at IRCN, and (iii) management of external funding.
The Working Group emphasizes the importance of solving these issues, while acknowledging that doing so will not be easy.
Breaking down barriers between departments and faculties is as an important goal of this WPI/IRCN project. This task should be seriously undertaken if IRCN is to become a sustainable institute within UTokyo.

A7: IRCN PIs are working on building a new field of Neurointelligence by pursuing interdisciplinary research in their laboratories in each department and keeping their minimum commitment of 80% effort for IRCN. To physically stimulate collaborative fusion research, IRCN newly established a Learning Center and Collaboration Lounges for research exchange in the Faculty of Medicine Building 1, which IRCN Researchers and students from the Hongo, Komaba, and Kashiwa campuses can freely access for communication with each other. Team-science members hold weekly group meetings/seminars there. In addition, a Computational Collaboration Laboratory was opened on the same floor for computational researchers to be able to visit there and conduct research anytime. To financially support such collaboration activities, PIs, with IRCN-exclusive PIs as the principal investigators in most cases, are applying for large external grants to bring new research funding directly into IRCN laboratories.

The University Tokyo is planning to create 30 new research posts in the next 3 years, especially for excellent young researchers, who can lead the next generation of scientists in the world. This is also the best way to increase the proportion of female researchers. IRCN is encouraged to actively participate in these university programs.

<u>FY 2018 Follow-up of WPI Program</u>

Q1: Program committee has still concerns about Director Hensch's effort and stay at IRCN. He has been making serious efforts to exert leadership and increase his stay at the UTokyo, but the effort and physical presence at IRCN are not yet at an adequate level. The program committee encourages him to keep the promised effort and to work towards the adequate level step by step.
A1: This question is the same as Q5 in the site visit report. Please refer to our answer following Q5.

Q2: With regard to the devotion to the IRCN project, IRCN has a big problem since all PIs and majority of researchers have substantial responsibilities to their host faculties and work at the WPI center only "part time". IRCN is strongly encouraged to devote all PIs/research staffs to the IRCN project. System change is not easy to realize and cannot be done by IRCN alone without the support of the UTokyo headquarter. Breaking down the barriers between departments/faculties is one of the important goals of the WPI project and should be seriously considered.
A2: This question is similar to Q7 in the site visit report, so please refer to our answer following Q7. In addition, we are already seeing that the team science ecosystem that we have planned is exciting to PIs and researchers and they will see a path to do it. Since the last site visit, we are in the stage of proliferation and reshuffling to achieve a more balanced group, thus we are determining the best faculty combination in Year 3 and 4. There should be no problem to discuss with the PIs what the best way forward is to work together; and discussion with UTokyo Headquarters is ongoing on this matter.

Q3: The composition of the PIs in terms of their area of expertise may not be well proportioned. This may need to be adjusted. The recruitment of young PIs and researchers is needed, particularly from the fields of psychiatric disorders and information science, to align the interests among researchers with the aim of the center.
A3: At the beginning of FY2018, IRCN hired a new female PI who is young and internationally active, Dr. Yazaki-Sugiyama. She is a neurobiologist but proactively has started to collaborate with IRCN computation and technology units. Towards the end of 2018, Director Hensch posted a call to recruit other PIs in computation and human behavioral fields. Two females PIs (Dr. Nagai, computation/robotics; Dr. Tsuji

Human/Clinical unit) were hired and will join IRCN from April 2019. Two more computation/human behavior candidates have been hired, and Director Hensch intends for them to join in fall 2019 to reduce the imbalance of computation and human studies within IRCN. This issue directly targeted in our search for all of these new hires, and in FY2019 each study unit will have a balanced composition of five PIs equally.

Q4: IRCN seems to have made a good start. IRCN will be only successful if all researchers will be located at one site and the majority of PIs will work exclusively for IRCN. The program committee will carefully monitor on the scientific goals and strategy as well as the leadership and progress as a WPI program.

A4: To achieve this, IRCN designed and renovated interdisciplinary "research ecosystems" and Core facilities in the 1st Medical Building. As explained above, by the end of FY2018 IRCN offered several PIs positions to work in the UTokyo Hongo campus. The 1st floor will accommodate Dr. Nagai's robotics lab, Dr. Tsuji's baby lab, and the fMRI core facility, which are adjacent to the Yazaki-Sugiyama/songbird and Hensch/mouse Labs, to focus on social interaction, auditory/vocal communication, and neuromodulation. In addition, Asst. Prof. Shimizu (Takeuchi/engineering Lab) will join IRCN on this floor in April to further integrate his contribution under one roof. Whereas the 3rd floor is already set for the other core facilities, i.e., Imaging, Data Science and ES mouse/Virus, and Science Writing cores, newly hired computation faculty, together with Dr. Aihara (computation unit) will have their offices in the same building. In addition, the Office for Research Strategy, which shares personnel with Science Writing Core, will newly locate on the 3rd floor together with future visiting overseas faculties as well as an interactive lounge space. This newly renovated space will function well to create a mutual collaboration environment building up the "research ecosystem" and facilitate the generation of multidisciplinary team science research projects.

Appendix 1 FY 2018 List of Center's Research Results and Main Awards

1. Refereed Papers

- List only the Center's papers published in 2018. (Note: The list should be for the calendar year, not the fiscal year.)

A. WPI papers

1. Original articles

1. Okazaki H, Hayashi-Takagi A, Nagaoka A, Negishi M, Ucar H, Yagishita S, Ishii K, Toyoizumi T, Fox K, Kasai H. Calcineurin knockout mice show a selective loss of small spines, Neurosci Lett 671:99-102, 2018. DOI: 10.1016/j.neulet.2018.02.006

2. Ishii K, Nagaoka A, Kishida K, Okazaki H, Yagishita S, Ucar H, Saito N. Kasai H. Volume dynamics of dendritic spines in the neocortex of wild type and Fmr1 KO mice in vivo. eNeuro 5, e0282-18.2018, 1-13. DOI: 10.1523/ENEURO.0282-18.2018

3. Tse A, Lee AK, Takahashi N, Gong A, Kasai H. Tse, FW. Strong stimulation triggers full-collapse fusion exocytosis and very slow endocytosis of the small dense core granules in carotid glomus cells, J. Neurogenetics, 32:267-278, 2018. DOI: 10.1080/01677063.2018.1497629

4. Utashiro N, Williams CR, Parrish JZ, Emoto K Prior activity of olfactory receptor neurons is required for proper sensory processing and behavior. Scientific Reports 8: 8580, 2018. doi: 10.1038/s41598-018-26825-3.

5. Uesaka N, Abe M, Konno K, Yamazaki M, Sakoori K, Watanabe T, Kao T-H, Mikuni T, Watanabe M, Sakimura K, Kano M: Retrograde signaling from progranulin to Sort1 counteracts synapse elimination in the developing cerebellum. Neuron 97: 796-805, 2018 (DOI: https://doi.org/10.1016/j.neuron.2018.01.018)

6. Chen S, Weitemier AZ, Zeng X, He L, Wang X, Tao Y, Huang AJY, Hashimotodani Y, Kano M, Iwasaki H, Parajuli LK, Okabe S, Tsutsui-Kimura I, Tanaka KF, Liu X, McHugh TJ: Near-infrared deep brain stimulation via upconversion nanoparticle- mediated optogenetics. Science 359: 679-684, 2018 (DOI: 10.1126/science.aaq1144)

7. Kikuchihara S, Sugio S, Tanaka KF, Watanabe T, Kano M, Yamazaki Y, Watanabe M, Ikenaka K: Ectopic positioning of Bergmann glia and impaired cerebellar wiring in Mlc1-overexpressing mice. J Neurochem 147: 344-360, 2018 (doi: 10.1111/jnc.14486)

8. Hashimotodani Y, Karube F, Yanagawa Y, Fujiyama F, Kano M: Supramammillary nucleus afferents to the dentate gyrus co- release glutamate and GABA and potentiate granule cell output. Cell Rep 25: 2704–2715, 2018 (DOI: 10.1016/j.celrep.2018.11.016)

9. Nakamura M, Takahashi T, Takayanagi Y, Sasabayashi D, Katagiri N, Sakuma A, Obara C, Koike S, Yamasue H, Furuichi A, Kido M, Nishikawa Y, Noguchi K, Matsumoto K, Mizuno M, Kasai K, Suzuki M: Surface morphology of the orbitofrontal cortex in individuals at risk of psychosis: a multicenter study. Eur Arch Psychiatry Clin Neurosci. 2018 Mar 23. doi: 10.1007/s00406-018-0890-6. [Epub ahead of print] PMID: 29572660

10. Yamasaki S, Ando S, Richards M, Hatch SL, Koike S, Fujikawa S, Kanata S, Endo K, Morimoto Y, Arai M, Okado H, Usami S, Furukawa TA, Hiraiwa-Hasegawa M, Kasai K, Nishida A: Maternal diabetes in early pregnancy, and psychotic experiences and depressive symptoms in 10-year-old offspring: A population- based birth cohort study. Schizophr Res. 2018 Dec 26. pii: S0920-9964(18)30704-7. doi: 10.1016/j.schres.2018.12.016. [Epub ahead of print] PMID: 30594455

11. Okada N, Ando S, Sanada M, Hirata-Mogi S, Iijima Y, Sugiyama H, Shirakawa T, Yamagishi M, Kanehara A, Morita M, Yagi T, Hayashi N, Koshiyama D, Morita K, Sawada K, Ikegame T, Sugimoto N, Toriyama R, Masaoka M, Fujikawa S, Kanata S, Tada M, Kirihara K, Yahata N, Araki T, Jinde S, Kano Y, Koike S, Endo K, Yamasaki S, Nishida A, Hiraiwa-Hasegawa M, Bundo M, Iwamoto K, Tanaka SC, Kasai K: The population-neuroscience study of the Tokyo TEEN Cohort (pn-TTC): a cohort longitudinal study to explore the neurobiological substrates of adolescent psychological and behavioral development. Psychiatry Clin Neurosci. 2018 Dec 27. doi: 10.1111/pcn.12814. [Epub ahead of print] PMID: 30588712

12. Todokoro A, Tanaka SC, Kawakubo Y, Yahata N, Ishii-Takahashi A, Nishimura Y, Kano Y, Ohtake F, Kasai K: Deficient neural activity subserving decision-making during reward waiting time in intertemporal choice in adult attention-deficit hyperactivity disorder. Psychiatry Clin Neurosci. 2018 Apr 24. doi: 10.1111/pcn.12668. [Epub ahead of print] PMID: 29687930

13. Yamashita M, Yoshihara Y, Hashimoto R, Yahata N, Ichikawa N, Sakai Y, Yamada T, Matsukawa N, Okada G, Tanaka SC, Kasai K, Kato N, Okamoto Y, Seymour B, Takahashi H, Kawato M, Imamizu H: A prediction model of working memory across health and psychiatric disease using whole-brain functional connectivity. Elife. 2018 Dec 10;7. pii: e38844. doi: 10.7554/eLife.38844. [Epub ahead of print] PMID: 30526859

14. Iijima Y, Okumura Y, Yamasaki S, Ando S, Nakanishi M, Koike S, Endo K, Morimoto Y, Kanata S, Fujikawa S, Yamamoto Y, Furukawa TA, Hiraiwa-Hasegawa M, Kasai K, Nishida A: Response inhibition and anxiety in adolescents: Results from a population-based community sample. J Affect Disord. 2018 Dec 10;246:89-95. doi: 10.1016/j.jad.2018.12.010.PMID: 30578951

15. Morita K, Miura K, Fujimoto M, Shishido E, Shiino T, Takahashi J, Yamamori H, Yasuda Y, Kudo N, Hirano Y, Koshiyama D, Okada N, Ikeda M, Onitsuka T, Ozaki N, Kasai K, Hashimoto R: Abnormalities of eye movement are associated with work hours in schizophrenia. Schizophr Res. 2018 Dec;202:420-422. doi: 10.1016/j.schres.2018.06.064. Epub 2018 Jul 13. PMID: 30017461

16. Koshiyama D, Fukunaga M, Okada N, Morita K, Nemoto K, Yamashita F, Yamamori H, Yasuda Y, Fujimoto M, Kelly S, Jahanshad N, Kudo N, Azechi H, Watanabe Y, Donohoe G, Thompson PM, Kasai K, Hashimoto R: Role of frontal white matter and corpus callosum on social function in schizophrenia. Schizophr Res. 2018 Dec;202:180-187. doi: 10.1016/j.schres.2018.07.009. Epub 2018 Jul 10. PMID: 30005932

17. Kushima I, Aleksic B, Nakatochi M, Shimamura T, Okada T, Uno Y, Morikawa M, Ishizuka K, Shiino T, Kimura H, Arioka Y, Yoshimi A, Takasaki Y, Yu Y, Nakamura Y, Yamamoto M, Iidaka T, Iritani S, Inada T, Ogawa N, Shishido E, Torii Y, Kawano N, Omura Y, Yoshikawa T, Uchiyama T, Yamamoto T, Ikeda M, Hashimoto R, Yamamori H, Yasuda Y, Someya T, Watanabe Y, Egawa J, Nunokawa A, Itokawa M, Arai M, Miyashita M, Kobori A, Suzuki M, Takahashi T, Usami M, Kodaira M, Watanabe K, Sasaki T, Kuwabara H, Tochigi M, Nishimura F,

Yamasue H, Eriguchi Y, Benner S, Kojima M, Yassin W, Munesue T, Yokoyama S, Kimura R, Funabiki Y, Kosaka H, Ishitobi M, Ohmori T, Numata S, Yoshikawa T, Toyota T, Yamakawa K, Suzuki T, Inoue Y, Nakaoka K, Goto YI, Inagaki M, Hashimoto N, Kusumi I, Son S, Murai T, Ikegame T, Okada N, Kasai K, Kunimoto S, Mori D, Iwata N, Ozaki N: Comparative analyses of copy-number variation in autism spectrum disorder and schizophrenia reveal etiological overlap and biological insights. Cell Rep. 2018 Sep 11;24(11):2838-2856. doi: 10.1016/j.celrep.2018.08.022. PMID: 30208311

18. Koshiyama D, Kirihara K, Tada M, Nagai T, Fujioka M, Ichikawa E, Ohta K, Tani M, Tsuchiya M, Kanehara A, 275. Morita K, Sawada K, Matsuoka J, Satomura Y, Koike S, Suga M, Araki T, Kasai K: Auditory gamma oscillations predict global symptomatic outcome in the early stages of psychosis: A longitudinal investigation. Clin Neurophysiol. 2018 Nov;129(11):2268-2275. doi: 10.1016/j.clinph.2018.08.007. Epub 2018 Aug 30. PMID: 30216911

19. Okada N, Yahata N, Koshiyama D, Morita K, Sawada K, Kanata S, Fujikawa S, Sugimoto N, Toriyama R, Masaoka M, Koike S, Araki T, Kano Y, Endo K, Yamasaki S, Ando S, Nishida A, Hiraiwa-Hasegawa M, Kasai K: Abnormal asymmetries in subcortical brain volume in early adolescents with subclinical psychotic experiences. Transl Psychiatry. 2018 Nov 28;8(1):254. doi: 10.1038/s41398-018-0312-6. PMID: 30487578

20. Fujikawa S, Ando S, Nishida A, Usami S, Koike S, Yamasaki S, Morimoto Y, Toriyama R, Kanata S, Sugimoto N, Sasaki T, Furukawa TA, Hiraiwa-Hasegawa M, Kasai K: Disciplinary slapping is associated with bullying involvement regardless of warm parenting in early adolescence. J Adolesc. 2018 Oct;68:207-216. doi: 10.1016/j.adolescence.2018.07.018. Epub 2018 Aug 18.

21. Koshiyama D, Kirihara K, Tada M, Nagai T, Fujioka M, Ichikawa E, Ohta K, Tani M, Tsuchiya M, Kanehara A, Morita K, Sawada K, Matsuoka J, Satomura Y, Koike S, Suga M, Araki T, Kasai K: Electrophysiological evidence for abnormal glutamate-GABA association following psychosis onset. Transl Psychiatry. 2018 Oct 8;8(1):211. doi: 10.1038/s41398-018-0261-0. PMID: 30297786

22. Nakamura Y, Okada N, Kunimatsu A, Kasai K, Koike S: Anatomical templates of the midbrain ventral tegmental area and substantia nigra for Asian populations. Front Psychiatry. 2018 Aug 28;9:383. doi: 10.3389/fpsyt.2018.00383. eCollection 2018. PMID: 30210369

23. Suga M, Kawakubo Y, Nishimura Y, Hashimoto K, Yumoto M, Kasai K: Lack of correlation between phonetic magnetic mismatch field and plasma d-serine levels in humans. Clin Neurophysiol. 2018 Jul;129(7):1444-1448. doi: 10.1016/j.clinph.2018.04.603. Epub 2018 Apr 24. PMID: 29735418

24. Ando S, Nishida A, Usami S, Koike S, Yamasaki S, Kanata S, Fujikawa S, Furukawa TA, Fukuda M, Sawyer SM, Hiraiwa-Hasegawa M, Kasai K: Help-seeking intention for depression in early adolescents: Associated factors and sex differences. J Affect Disord 238: 359-365, 2018. [Jun 7, 2018; doi: 10.1016/j.jad.2018.05.077]

25. Sakakibara E, Takizawa R, Kawakubo Y, Kuwabara H, Kono T, Hamada K, Okuhata S, Eguchi S, Ishii-Takahashi A, Kasai K: Genetic influences on prefrontal activation during a verbal fluency task in children: A twin study using near-infrared spectroscopy. Brain Behav. 2018 Jun;8(6):e00980. doi: 10.1002/brb3.980. Epub 2018 Apr 24. PMID: 30106245

26. Koshiyama D, Kirihara K, Tada M, Nagai T, Fujioka M, Koike S, Suga M, Araki T, Kasai K: Association between mismatch negativity and global functioning is specific to duration deviance in early stages of psychosis. Schizophr Res 2018;195:378-384. [May 2018]

27. Tanaka SC, Yahata N, Todokoro A, Kawakubo Y, Kano Y, Nishimura Y, Ishii-Takahashi A, Ohtake F, Kasai K: Preliminary evidence of altered neural response during intertemporal choice of losses in adult attention-deficit hyperactivity disorder. Sci Rep. 2018 Apr 30;8(1):6703. doi: 10.1038/s41598-018- 24944-5. PMID: 29712945

28. Morimoto Y, Yamasaki S, Ando S, Koike S, Fujikawa S, Kanata S, Endo K, Nakanishi M, Hatch SL, Richards M, Kasai K, Hiraiwa-Hasegawa M, Nishida A. Purpose in life and tobacco use among community- dwelling mothers of early adolescents. BMJ Open. 2018;8(4):e020586. [Apr 20, 2018]

29. Sugawara H, Murata Y, Ikegame T, Sawamura R, Shimanaga S, Takeoka Y, Saito T, Ikeda M, Yoshikawa A, Nishimura F, Kawamura Y, Kakiuchi C, Sasaki T, Iwata N, Hashimoto M, Kasai K, Kato T, Bundo M, Iwamoto K: DNA methylation analyses of the candidate genes identified by a methylome-wide association study revealed common epigenetic alterations in schizophrenia and bipolar disorder. Psychiatry Clin Neurosci. 2018;72(4):245-254. [Apr, 2018]

30. Nishioka M, Bundo M, Ueda J, Katsuoka F, Sato Y, Kuroki Y, Ishii T, Ukai W, Murayama S10, Hashimoto E, Nagasaki M, Yasuda J, Kasai K, Kato T, Iwamoto K. Identification of somatic mutations in postmortem human brains by whole genome sequencing and their implications for psychiatric disorders. Psychiatry Clin Neurosci. 2018;72(4):280-294. [Apr, 2018]

31. Nishioka M, Bundo M, Ueda J, Yoshikawa A, Nishimura F, Sasaki T, Kakiuchi C, Kasai K, Kato T, Iwamoto K. Identification of somatic mutations in monozygotic twins discordant for psychiatric disorders. NPJ Schizophr 2018;4(1):7. [Apr 13, 2018]

32. Shima T, Morikawa M, Kaneshiro J, Kambara T, Kamimura S, Yagi T, Iwamoto H, Uemura S, Shigematsu H, Shirouzu M, Ichimura T, Watanabe TM, Nitta R, Okada Y, Hirokawa N. Kinesin-binding-triggered conformation switching of microtubules contributes to polarized transport. J Cell Biol. 217:4164-4183, 2018 Oct 8. doi: 10.1083/jcb.201711178.

33. Hayashi K, Tsuchizawa Y, Iwaki M, Okada Y. Application of the fluctuation theorem for non-invasive force measurement in living neuronal axons. Mol Biol Cell, 29:3017-3025, 2018 Oct 3 doi: 10.1091/mbc.E18-01-0022.

34. Gzrybowski M, Taki M, Senda K, Sato Y, Ariyoshi T, Okada Y, Kawakami R, Imamura T, Yamaguchi S. A highly photostable near-infrared labeling agent based on a phospha-rhodamine for long-term and deep imaging. Angew. Chem. 57:10137-10141, 2018. doi:10.1002/anie.201804731

35. Takeshima T, Takahashi T, Yamashita J, Okada Y, Watanabe S. A multi-emitter fitting algorithm for potential live cell super-resolution imaging over a wide range of molecular densities. Journal of Microscopy. 271: 266-281, 2018. doi:10.1111/jmi.12714

36. Yoshida S. Kato-Negishi M. Takeuchi, S. Assembly and Connection of Micropatterned Single Neurons for Neuronal Network Formation. MICROMACHINES, 9(5), 235, MAY 2018 DOI: 10.3390/mi9050235

37. Morimoto Y. Onoe H. Takeuchi, S. Biohybrid robot powered by an antagonistic pair of skeletal muscle tissues. SCIENCE ROBOTICS, 3(18), eaat4440, MAY 2018 DOI: 10.1126/scirobotics.aat4440

38. Yoshida S. Morimoto Y. Zheng L. Onoe H. Takeuchi, S. Multipoint bending and shape retention of a pneumatic bending actuator by a

variable stiffness endoskeleton. SOFT ROBOTICS, 5(6), pp.718-725, DEC 2018 DOI: 10.1089/soro.2017.0145

39. Shima A. Morimoto Y. Sweeney HL. Takeuchi, S. Three-dimensional contractile muscle tissue consisting of human skeletal myocyte cell line. EXPERIMENTAL CELL RESEARCH, 370(1), pp.168-173, SEP 2018 DOI: 10.1016/j.yexcr.2018.06.015

40. Morimoto Y. Kiyosawa M. Takeuchi S. Three-dimensional Printed Microfluidic Modules for Design Changeable Coaxial Microfluidic Devices. SENSORS AND ACTUATORS B: CHEMICAL, 274(20), pp.491-500, NOV 2018 DOI: 10.1016/j.snb.2018.07.151

41. Yoshida K, Shi S, Ukai-Tadenuma M, Fujishima H, Ohno R, Ueda HR. Leak potassium channels regulate sleep duration. Proc. Natl. Acad. Sci. USA 115, 2018. E9459-E9468

42. Niwa Y, Kanda GN, Yamada RG, Shi S, Sunagawa GA, Ukai-Tadenuma M, Fujishima H, Matsumoto N, Masumoto K, Nagano M, Kasukawa T, Galloway J, Perrin D, Shigeyoshi Y, Ukai H, Kiyonari H, Sumiyama K, Ueda HR. Muscarinic Acetylcholine Receptors Chrm1 and Chrm3 Are Essential for REM Sleep. Cell Rep. 24, 2231-2247, 2018

43. Tainaka K, Murakami TC, Susaki EA, Shimizu C, Saito R, Takahashi K, Hayashi-Takagi A, Sekiya H, Arima Y, Nojima S, Ikemura M, Ushiku T, Shimizu Y, Murakami M, Tanaka KF, Iino M, Kasai H, Sasaoka T, Kobayashi K, Miyazono K, Morii E, Isa T, Fukayama M, Kakita A, Ueda HR. Chemical Landscape for Tissue Clearing Based on Hydrophilic Reagents. Cell Rep. 24, 2196-2210, 2018

44. Murakami TC, Mano T, Saikawa S, Horiguchi SA, Shigeta D, Baba K, Sekiya H, Shimizu Y, Tanaka KF, Kiyonari H, Iino M, Mochizuki H, Tainaka K, Ueda HR. A three-dimensional single-cell-resolution whole-brain atlas using CUBIC-X expansion microscopy and tissue clearing. Nat. Neurosci. 21, 625-637, 2018

45. Levi T. Nanami, T. Tange, A. Aihara, K. and Kohno, T. Development and applications of biomimetic neuronal networks toward Brain Morphic Artificial Intelligence. IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS－II: EXPRESS BRIEFS, 65(5), pp.577-581, MAY 2018 DOI: 10.1109/TCSII.2018.2824827

46. Tanaka G. Dominguez-Huttinger E. Christodoulides P. Aihara K. Tanaka RJ. Bifurcation analysis of a mathematical model of atopic dermatitis to determine patient-specific effects of treatments on dynamic phenotypes. JOURNAL OF THEORETICAL BIOLOGY, 448, pp.66-79, JUL 2018 DOI: 10.1016/j.jtbi.2018.04.002

47. Ma H. Leng S. Aihara K. Lin W. Chen L. Randomly distributed embedding making short-term high-dimensional data predictable. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 115(43), pp.E9994- E10002, OCT 2018 DOI: 10.1073/pnas.1802987115

48. Miyahara H. Aihara K. Work relations with measurement and feedback control on nonuniform temperature systems. PHYSICAL REVIEW E, 98(4), pp.042138-1-6, OCT DOI: 10.1103/PhysRevE.98.042138

49. Morino K. Tanaka G. Aihara K. Bifurcation mechanism for emergence of spontaneous oscillations in coupled heterogeneous excitable units. PHYSICAL REVIEW E, 98(5), pp.052210, NOV 2018 DOI: 10.1103/PhysRevE.98.052210

50. Tsuboi M, Kishi Y, Yokozeki W, Koseki H, Hirabayashi Y, Gotoh Y. Ubiquitination-Independent Repression of PRC1 Targets during Neuronal Fate Restriction in the Developing Mouse Neocortex. Developmental Cell 47(6) 758-772.e5 DEC 2018 https://doi.org/10.1016/j.devcel.2018.11.018

51. Lanjakornsiripan D, Pior BJ, Kawaguchi D, Furutachi S, Tahara T, Katsuyama Y, Suzuki Y, Fukazawa Y, Gotoh Y. Layer-specific morphological and molecular differences in neocortical astrocytes and their dependence on neuronal layers. Nature Communications 9(1) 1623 April 2018 DOI:10.1038/s41467-018-03940-3
s

52. Kamijo S, Ishii Y, Horigane SI, Suzuki K, Ohkura M, Nakai J, Fujii H, Takemoto-Kimura S, Bito H. A Critical Neurodevelopmental Role for L-Type Voltage-Gated Calcium Channels in Neurite Extension and Radial Migration. J Neurosci. 38: 5551-5566, 2018. doi: 10.1523/JNEUROSCI.2357-17.2018.

53. Ebina T, Masamizu Y, Tanaka YR, Watakabe A, Hirakawa R, Hirayama Y, Hira R, Terada S, Koketsu D, Hikosaka K, Mizukami H, Nambu A, Sasaki E, Yamamori T, and Matsuzaki M. Two-photon imaging of neuronal activity in motor cortex of marmosets during upper-limb movement tasks. NATURE COMMUNICATIONS 9, 1879, 2018. Doi: 10.1038/s41467-018-04286-6.

54. Yoshida E, Terada S, Tanaka YH, Kobayashi K, Ohkura M, Nakai J, and Matsuzaki M. Wide-field calcium imaging of mouse thalamocortical synapses with an 8 K ultra-high-definition camera. SCEINTIFIC REPORTS 8, 8324, 2018. Doi: 10.1038/s41598-018-26566-3.

55. Tanaka YH, Tanaka YR, Kondo M, Terada S, Kawaguchi Y, and Matsuzaki M. Thalamocortical axonal activity in motor cortex exhibits layer-specific dynamics during motor learning. NEURON 100, 244-258, 2018. Doi: 10.1016/j.neuron.2018.08.016.

56. Terada S, Kobayashi K, Ohkura M, Nakai J, and Matsuzaki M. Super-wide-field two-photon imaging with a micro-optical device moving in post-objective space. NATURE COMMUNICATIONS 9, 3550, 2018. Doi: 10.1038/s41467-018-06058-8.

57. Iida T, Tanaka S, Okabe S. Spatial impact of microglial distribution on dynamics of dendritic spines. Eur J Neurosci. 2018 Dec 26. doi:10.1111/ejn.14325. [Epub ahead of print] PubMed PMID: 30585660.

58. Ito H, Kawamata Y, Kamiya M, Tsuda-Sakurai K, Tanaka S, Ueno T, Komatsu T, Hanaoka K, Okabe S, Miura M, Urano Y. Red-Shifted Fluorogenic Substrate for Detection of lacZ-Positive Cells in Living Tissue with Single-Cell Resolution. Angew Chem Int Ed Engl. 2018 Nov 26;57(48):15702-15706. doi:10.1002/anie.201808670. Epub 2018 Nov 2. PubMed PMID: 30255610.

59. Sato Y, Okabe S. Nano-scale analysis of synapse morphology in an autism mouse model with 15q11-13 copy number variation using focused ion beam milling and scanning electron microscopy. Microscopy (Oxf). 2018 Oct 29. doi:10.1093/jmicro/dfy128. [Epub ahead of print] PubMed PMID: 30371805.

60. Tzeng TC, Hasegawa Y, Iguchi R, Cheung A, Caffrey DR, Thatcher EJ, Mao W, Germain G, Tamburro ND, Okabe S, Heneka MT, Latz E, Futai K, Golenbock DT. Inflammasome-derived cytokine IL18 suppresses amyloid-induced seizures in Alzheimer-prone mice. Proc Natl Acad Sci U S A. 2018 Sep 4;115(36):9002-9007. doi: 10.1073/pnas.1801802115. Epub 2018 Aug 20. PubMed PMID: 30127003; PubMed Central PMCID: PMC6130368.

61. Nakayama H, Abe M, Morimoto C, Iida T, Okabe S, Sakimura K, Hashimoto K. Microglia permit climbing fiber elimination by promoting

GABAergic inhibition in the developing cerebellum. Nat Commun. 2018 Jul 19;9(1):2830. doi:10.1038/s41467-018-05100-z. PubMed PMID: 30026565; PubMed Central PMCID: PMC6053401.

62. Chen S, Weitemier AZ, Zeng X, He L, Wang X, Tao Y, Huang AJY, Hashimotodani Y, Kano M, Iwasaki H, Parajuli LK, Okabe S, Teh DBL, All AH, Tsutsui-Kimura I, Tanaka KF, Liu X, McHugh TJ. Near- infrared deep brain stimulation via upconversion nanoparticle- mediated optogenetics. Science. 2018 Feb 9;359(6376):679-684. doi: 10.1126/science.aaq1144. PubMed PMID: 29439241.

63. Morimoto MM, Tanaka S, Mizutani S, Urata S, Kobayashi K, Okabe S. In Vivo Observation of Structural Changes in Neocortical Catecholaminergic Projections in Response to Drugs of Abuse. eNeuro. 2018 Feb 6;5(1). pii: ENEURO.0071-17.2018. doi: 10.1523/ENEURO.0071-17.2018. eCollection 2018 Jan-Feb. PubMed PMID:29445765; PubMed Central PMCID: PMC5810039.

64. Higashi T, Tanaka S, Iida T, Okabe S. Synapse Elimination Triggered by BMP4 Exocytosis and Presynaptic BMP Receptor Activation. Cell Rep. 2018 Jan 23;22(4):919-929. doi: 10.1016/j.celrep.2017.12.101. Epub 2018 Jan 28. PubMed PMID: 29386134.

65. Osakada T, Ishii K.K, Mori H, Eguchi R, Ferrero D.M, Yoshihara Y, Liberles S.D, Miyamichi K.*, and Touhara K.* Sexual rejection via a vomeronasal receptor-triggered limbic circuit. Nature Communications 9, 4463, 2018. doi.org/10.1038/s41467-018-07003-5

2. Review articles

66. Uesaka N, Kano M: Presynaptic mechanisms mediating retrograde semaphorin signals for climbing fiber synapse elimination during postnatal cerebellar development. Cerebellum 17: 17-22, 2018 (doi: 10.1007/s12311-017-0888-z)

67. Hirai H, Kano M: Type 1 metabotropic glutamate receptor and its signaling molecules as therapeutic targets for the treatment of cerebellar disorders. Curr Opin Pharmacol 38: 51–58, 2018 (doi: https://doi.org/10.1016/j.coph.2018.02.002)

68. Sugaya Y, Kano M: Control of excessive neural circuit excitability and prevention of epileptic seizures by endocannabinoid signaling. Cell Mol Life Sci 75: 2793-2811, 2018 (doi: https://doi.org/10.1007/s00018-018-2834-8)

69. Kano M, Watanabe T, Uesaka N, Watanabe M: Multiple phases of climbing fiber synapse elimination in the developing cerebellum. Cerebellum 17: 722–734, 2018 (doi: 10.1007/s12311-018-0964-z)

70. Nie M. Takeuchi, S. Bottom-up biofabrication using microfluidic techniques. BIOFABRICATION, 10(4), 044103, SEP 2018 DOI: 10.1088/1758-5090/aadef9

71. Ode K.L, Ueda HR. Lost in clocks: non-canonical circadian oscillation discovered in Drosophila cells. Mol. Syst. Biol. 14, 2018. e8567

72. Ode K.L, Ueda HR. Design Principles of Phosphorylation-Dependent Timekeeping in Eukaryotic Circadian Clocks. Cold Spring Harb. Perspect. Biol. 10, 2018. a028357

73. Kishi Y, Gotoh Y. Regulation of Chromatin Structure During Neural Development. Frontiers in Neuroscience 12 874 2018 https://doi.org/10.3389/fnins.2018.00874

74. Okazaki T, Gotoh Y. An Unexpected Calm: Mfge8 Controls Stem Cell Quiescence and Maintenance. Cell Stem Cell 23(3) 311-312 OCT 2018 DOI: 10.1016/j.stem.2018.08.006

3. Proceedings

75. Kondratiev AY, Yaginuma H, Okada Y. Dmitry V. Sorokin. A Method for Automatic Tracking of Cell Nuclei in 2D Epifluorescence Microscopy Image Sequences. Eighth International Conference on Image Processing Theory, Tools and Applications (IPTA). 2018

76. Nishimura K. Takeuchi S. Multi-Branched Alginate Hydrogel Microfibers Formed by Parallel Microfluidic Spinning. Proceedings of MicroTAS 2018, pp.493-494, NOV 2018

77. Nagata S. Ozawa F. Takeuchi S. Enhancement of iPSC-derived hepatocyte function through 3D culture using cell fiber technique. Proceedings of MicroTAS 2018, pp.1475-1476, NOV 2018

78. Ozawa F. Sawayama J. Takeuchi S. A 3D Perfusable Device to Evaluate Dynamic Islet Functions. Proceedings of MicroTAS 2018, pp.1487-1488, NOV 2018

79. Chen H, Huang Y, Nakayama H. Semantic Aware Attention Based Deep Object Co-segmentation. Proceedings of the 14th Asian Conference on Computer Vision (ACCV) 2018

80. Shu R, Nakayama H. Improving Beam Search by Removing Monotonic Constraint for Neural Machine Translation. Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (ACL) Volume 2, Pages 339-344, 2018 DOI: 10.18653/v1/P18-2054

81. Nishida N, Nakayama H. Coherence Modeling Improves Implicit Discourse Relation Recognition. Proceedings of the 19th Annual SIGdial Meeting on Discourse and Dialogue (SIGDIAL) Pages 344-349, 2018 DOI: 10.18653/v1/W18-5040

82. Yokota M, Nakayama H. Augmenting Image Question Answering Dataset by Exploiting Image Captions. Proceedings of the Eleventh International Conference on Language Resources and Evaluation (LREC) Pages 2753-2757, 2018. ISBN 979-10-95546-00-9

83. Han C, Hayashi H, Rundo L, Araki R, Shimoda W, Muramatsu S, Furukawa Y, Mauri G, Nakayama H. GAN-based synthetic brain MR image generation. 15th IEEE International Symposium on Biomedical Imaging (ISBI) Pages 734-738, 2018 DOI: 10.1109/ISBI.2018.8363678

84. Shu R, Nakayama H. Compressing Word Embeddings via Deep Compositional Code Learning. Proceedings of the 6th International Conference on Learning Representations (ICLR) 2018

4. Other English articles

85. Morita K, Kawaguchi Y. A Dual Role Hypothesis of the Cortico-Basal-Ganglia Pathways: Opponency and Temporal Difference Through Dopamine and Adenosine. Frontiers in Neural Circuits 12:111. Jan 2019 doi: 10.3389/fncir.2018.00111. eCollection 2018.

B. WPI-related papers

1. Original articles

86. Sun H, Takesian AE, Wang TT, Lippman-Bell JJ, Hensch TK, Jensen FE. Early Seizures Prematurely Unsilence Auditory Synapses to Disrupt Thalamocortical Critical Period Plasticity. Cell Reports 23(9): 2533-2540, 2018

87. Ikuo Ogiwara, Hensch TK. I. Nav1.2 haplodeficiency in excitatory neurons causes absence-like seizures in mice. Communications Biology.(96)2018, 2018

88. Takesian AE, Bogart LJ, Lichtman JW, Hensch TK. Inhibitory circuit gating of auditory critical-period plasticity. Nature Neuroscience. 21(2): 218-227 2018

89. Hensch TK and Quinlan EM. Critical periods in amblyopia. Vis Neurosci. Jan; 35, 2018

90. Qin H, Fu L, Hu B, Liao X, Lu J, He W, Liang S, Zhang K, Li R, Yao J, Yan J, Chen H, Jia H, Zott B, Konnerth A and Chen X. A visual cue-dependent memory circuit for place navigation. NEURON 99, pp. 1–9, 2018

91. Okamoto K, Germond A, Fujita H, Furusawa C, Okada Y, Watanabe TM. Single cell analysis reveals a biophysical aspect of collective cell-state transition in embryonic stem cell differentiation. Sci Rep. 8:11965, 2018 Aug 10 doi:10.1038/s41598-018-30461-2.

92. Komatsu N, Terai K, Imanishi A, Kamioka Y, Sumiyama K, Jin T, Okada Y, Nagai T, Matsuda M. A platform of BRET-FRET hybrid biosensors for optogenetics, chemical screening, and in vivo imaging. Scientific Reports 8: 8984, 2018.

93. Ueno A, Omori Y, Sugita Y, Watanabe S, Chaya T, Kozuka T, Kon T, Yoshida S, Matsushita K, Kuwahara R, Kajimura N, Okada Y, Furukawa T. Lrit1, a Retinal Transmembrane Protein, Regulates Selective Synapse Formation in Cone Photoreceptor Cells and Visual Acuity. Cell Rep. 2018 Mar 27;22(13):3548-3561. doi: 10.1016/j.celrep.2018.03.007.

94. Luo J, Frisken S, Machado I, Zhang M, Pieper S, Golland P, Toews M, Unadkat P, Sedghi A, Zhou H, Mehrtash A, Preiswerk F, Cheng C-C, Golby A, Sugiyama M, Wells III W. M. Using the variogram for vector outlier screening: application to feature-based image registration. International Journal of Computer Assisted Radiology and Surgery, vol.13, no.12, pp.1871-1880, 2018.

95. Han B, Yao Q, Pan Y, Tsang I. W, Xiao X, Yang Q, Sugiyama, M. Millionaire: A hint-guided approach for crowdsourcing. Machine Learning, to appear.

96. Gutierrez MG. Yoshida S. Malmstadt N. Takeuchi S. Photolithographic patterned surface forms size-controlled lipid vesicles. APL BIOENGINEERING, 2(1), 016104, JAN 2018 DOI: 10.1063/1.5002604

97. Sakaguchi H. Tamate S. Yamamoto Y. Aihara K. Utsunomiya S. Community detection by laser network dynamics. JOURNAL OF PHYSICS COMMUNICATIONS, 2(1), pp.015005-1-8, JAN 2018 DOI: 10.1088/2399-6528/aa9b6b

98. Schäfer B. Beck C. Aihara K. Witthaut D. Timme M. Non-Gaussian power grid frequency fluctuations characterized by Lévy-stable laws and superstatistics. NATURE ENERGY, 3(2), pp.119-126, FEB 2018 DOI: 10.1088/2399-6528/aa9b6b

99. Hirata Y. Morino K. Akakura K. Higano CS. Aihara K. Personalizing androgen suppression for prostate cancer using mathematical modeling. SCIENTIFIC REPORTS, 8, Article No.2673, pp.1-8, FEB 2018 DOI: 10.1038/s41598-018-20788-1

100. Levi T. Guo Y. Aihara K. Kohno T. Study of real-time biomimetic CPG on FPGA: Behavior and evolution. JOURNAL OF ROBOTICS NETWORKING AND ARTIFICIAL LIFE, 4(4), pp.299-302, MAR 2018 DOI: 10.2991/jrnal.2018.4.4.9

101. Aihara K. (Invited) Recent progress in mathematical modelling of complex systems. NONLINEAR THEORY AND ITS APPLICATIONS, IEICE, 9(2), pp.149-154, APR 2018 DOI: 10.1587/nolta.9.149

102. Oku M. Aihara K. On the covariance matrix of the stationary distribution of a noisy dynamical system. NONLINEAR THEORY AND ITS APPLICATIONS, IEICE, 9(2), pp.166-184, APR 2018 DOI: 10.1587/nolta.9.166

103. Uenohara S. Morie T. Tamukoh H. Aihara K. A pulse-width-modulation mode CMOS integrated circuit implementation of threshold-coupled map. NONLINEAR THEORY AND ITS APPLICATIONS, IEICE, 9(2), pp.268-280, APR 2018 DOI: 10.1587/nolta.9.268

104. Leleu T. Levi T. Kohno T. Aihara K. Network structure reconstruction using packets of spikes in cultured neuronal networks coupled to microelectrode arrays. NONLINEAR THEORY AND ITS APPLICATIONS, IEICE, 9(2), pp.281-294, APR 2018 10.1587/nolta.9.281

105. Ito D. Ueta T. Aihara K. Bifurcation analysis of eight coupled degenerate optical parametric oscillators. PHYSICA D, 372, pp.22-30, JUN 2018. DOI: 10.1016/j.physd.2018.01.010

106. Sviridova N. Zhao T. Aihara K. Nakamura K. Nakano A. Photoplethysmogram at green light: Where does chaos arise from? CHAOS, SOLITONS FRACTALS, 116, pp.157-165, NOV 2018 DOI: 10.1016/j.chaos.2018.09.016

107. Liu X. Chang X. Leng S. Tang H. Aihara K. Chen L. Detection for disease tipping points by landscape dynamic network biomarkers. NATIONAL SCIENCE REVIEW, nwy162, pp.1-23, DEC 2018 DOI: 10.1093/nsr/nwy162

108. Zhou Y, Vo T, Rotstein HG, McCarthy MM, Kopell N. M-Current Expands the Range of Gamma Frequency Inputs to Which a Neuronal Target Entrains. J Math Neurosci 8(1):13, 2018.

109. Pittman-Polletta BR, Quach A, Mohammed AI, Romano M, Kondabolu K, Kopell NJ, Han X, McCarthy MM. Striatal cholinergic receptor activation causes a rapid, selective, state- dependent rise in cortiostriatal β activity. P Eur J Neurosci, 48(8):2857-2868, 2018.

110. Morita K, Hama Y, Izume T, Tamura N, Ueno T, Yamashita Y, Sakamaki Y, Mimura K, Morishita H, Shihoya W, Nureki O, Mano H, Mizushima N. Genome-wide CRISPR screen identifies TMEM41B as a gene required for autophagosome formation. J Cell Biol. 2018 Nov 5;217(11):3817-3828. doi:10.1083/jcb.201804132.

111. Deretic V, Prossnitz E, Burge M, Campen MJ, Cannon J, Liu KJ, Sklar LA, Allers L, Garcia SA, Baehrecke EH, Behrends C, Cecconi F, Codogno P, Chen GC, Elazar Z, Eskelinen EL, Fourie B, Gozuacik D, Hong W, Hotamisligi G, Jäättelä M, Jo EK, Johansen T, Juhász G, Kimchi A, Ktistakis N, Kroemer G, MIzushima N, Münz C, Reggiori F, Rubinsztein D, Ryan K, Schroder K, Simonsen A, Tooze S, Vaccaro MI, Yoshimori T, Yu L, Zhang H, Klionsky DJ. Autophagy, Inflammation, and Metabolism (AIM) Center of Biomedical Research Excellence: supporting the next generation of autophagy researchers and fostering international collaborations. Autophagy. 2018;14(6):925-929. doi: 10.1080/15548627.2018.1465784.

112. Matsui T, Jiang P, Nakano S, Sakamaki Y, Yamamoto H, Mizushima N. Autophagosomal YKT6 is required for fusion with lysosomes independently of syntaxin 17. J Cell Biol. 2018 Aug 6;217(8):2633-2645. doi:10.1083/jcb.201712058.

113. Takahashi S, Kagami Y, Hanaoka K, Terai T, Komatsu T, Ueno T, Uchiyama M, Koyama-Honda I, Mizushima N, Taguchi T, Arai H, Nagano T, Urano Y. Development of a Series of Practical Fluorescent Chemical Tools To Measure pH Values in Living Samples. J Am Chem Soc. 2018 May 9;140(18):5925-5933. doi: 10.1021/jacs.8b00277.

114. Wallot-Hieke N, Verma N, Schlütermann D, Berleth N, Deitersen J, Böhler P, Stuhldreier F, Wu W, Seggewiß S, Peter C, Gohlke H, Mizushima N, Stork B. Systematic analysis of ATG13 domain requirements for autophagy induction. Autophagy. 2018;14(5):743-763. doi: 10.1080/15548627.2017.1387342.

115. Hirata Y, Stemler T, Eroglu D, Marwan N, "Prediction of flow dynamics using point processes," Chaos 28, 011101, 2018. https://doi.org/10.1063/1.5016219

116. Hirata Y, Morino K, Akakura K, Higano CS, and Aihara K, "Personalizing androgen suppression for prostate cancer using mathematical modeling," Scientific Reports 8, 2673, 2018. https://doi.org/10.1038/s41598-018-20788-1

117. Hirata Y, "Reconstructing latent dynamical noise for better forecasting observables," Chaos 28, 033112, 2018. https://doi.org/10.1063/1.4996043

118. Amigó JM, Hirata Y, "Detecting directional couplings from multivariate flows by the joint distance distribution," Chaos 28, 075302, 2018. https://doi.org/10.1063/1.5010779

119. Benner S, Aoki Y, Watanabe T, Endo N, Abe O, Kuroda M, Kuwabara H, Kawakubo Y, Takao H, Kunimatsu A, Kasai K, Bito H, Kakeyama M, Yamasue H. Neurochemical evidence for differential effects of acute and repeated oxytocin administration. Mol Psychiatry. 2018. doi: 10.1038/s41380-018-0249-4.

120. Sonoda K, Matsui T, Bito H, Ohki K. Astrocytes in the mouse visual cortex reliably respond to visual stimulation. Biochem Biophys Res Commun. 505: 1216-1222, 2018. doi: 10.1016/j.bbrc.2018.10.027

121. Nishiguchi KM, Fujita K, Tokashiki N, Komamura H, Takemoto-Kimura S, Okuno H, Bito H, Nakazawa T. Retained Plasticity and Substantial Recovery of Rod-Mediated Visual Acuity at the Visual Cortex in Blind Adult Mice with Retinal Dystrophy. Mol Ther. 26: 2397-2406, 2018. doi: 10.1016/j.ymthe.2018.07.012.

122. Yamazaki H, Sasagawa Y, Yamamoto H, Bito H, Shirao T. CaMKIIβ is localized in dendritic spines as both drebrin-dependent and drebrin-independent pools. J Neurochem. 146: 145- 159, 2018. doi: 10.1111/jnc.14449.

123. Attardo A, Lu J, Kawashima T, Okuno H, Fitzgerald JE, Bito H, Schnitzer MJ. Long-term consolidation of ensemble neural plasticity patterns in hippocampal area CA1. Cell Reports, 25: 640-650, 2018. doi: 10.1016/j.celrep.2018.09.064

124. El-Boustani S, Ip JPK, Breton-Provencher V, Knott GW, Okuno H, Bito H, Sur M. Locally coordinated synaptic plasticity of visual cortex neurons in vivo. Science. 360: 1349-1354, 2018. doi: 10.1126/science.aao0862.

125. Steward O, Matsudaira Yee K, Farris S, Pirbhoy PS, Worley P, Okamura K, Okuno H, Bito H. Delayed degradation and impaired dendritic delivery of intron-lacking EGFP-Arc/Arg3.1 mRNA in EGFP-Arc transgenic mice. Front Mol Neurosci. 10: 435, 2018. doi: 10.3389/fnmol.2017.00435.

126. Tanaka T. Hirose Y. Komaki F. Second-order matching prior family parametrized by sample size and matching probability. STATISTICAL PAPERS 2018(Online First)

127. Komaki F. Biswas A. Bayesian optimal response-adaptive design for binary responses using stopping rule. STATISTICAL METHODS IN MEDICAL RESEARCH, 27(3), pp.891–904, MAR 2018 DOI:10.1177/0962280216647210

128. Fuchigami T, Shikauchi Y, Nakae K, Shikauchi M, Ogawa T, Ishii S. Zero-shot fMRI decoding with three-dimensional registration based on diffusion tensor imaging. Scientific Reports, 2018;8(1):12342, 2018. doi:10.1038/s41598-018-30676-3

129. Liang Z, Hamada Y, Oba S, Ishii S. Characterization of electroencephalography signals for estimating saliency features in videos. Neural Networks,105, 52-64.

130. Qiang Y, Artoni P, Seo KJ, Culaclii S, Hogan V, Zhao XY, Zhong YD, Han X, Wang PM, Lo YK, Li YM, Patel HA, Huang YF, Sambangi A, Chu JSV, Liu WT, Fagiolini M, Fang H. Transparent arrays of bilayer-nanomesh microelectrodes for simultaneous electrophysiology and two-photon imaging in the brain. Science Advances 05 Sep 2018: Vol. 4, no. 9, eaat0626, DOI: 10.1126/sciadv.aat0626

2. Review articles

131. Zott B, Busche MA, Sperling R and Konnerth A. What Happens with the Circuit in Alzheimer Disease in Mice and Humans? ANNUAL REVIEWS NEUROSCIENCE 41, pp. 277-297, 2018

132. Umejima K. Sakai KL: The Brain, the source of multilingualism. Brain and Nerve 70, 633-638, 2018. Kinno, R. & Sakai, K. L.: The language function of the cerebellum. Clin. Neurosci. (Rinsyo-sinkei-kagaku) 36, 622-623, 2018.

133. Kinno R. Sakai KL: Lateralization of the frontal association cortex: Syntax-related networks. Brain and Nerve 70, 1075-1085, 2018.

134. Sakai KL: [Lecture Series] Mastery of second languages from the viewpoint of brain science: An essay on natural methods of language mastery. Acquisition of Japanese as a Second Language 21, 136-148, 2018.

135. Sakai KL, et al.: [Discussion meeting] The art of telling languages (Japanese). In: The Art of Telling the World (Volume 2) - Language and Ethics, Eds. UT-EMP & Nakajima, T, University of Tokyo Press, Tokyo (ISBN 978-4-13-043062-3), pp. 7-108, 2018.

136. Sakai KL: The future of artificial intelligence from the viewpoint of brain science (Japanese). In: The Art of Telling the World (Volume 2) - Language and Ethics, Eds. UT-EMP & Nakajima, T, University of Tokyo Press, Tokyo (ISBN 978-4-13-043062-3), pp. 111-121, 2018.

137. Moroni L. Burdick JA. Highley C. Lee SJ. Morimoto Y. Takeuchi S. Yoo JJ. Biofabrication strategies for 3D in vitro models and regenerative medicine. NATURE REVIEWS MATERIALS, 3, pp.21-37, APR 2018 DOI: 10.1038/s41578-018-0006-y

138. Kamm RD. Bashir R. Arora N. Dar RD. Gillette MU. Griffith LG. Kemp ML. Kinlaw K. Levin M. Martin AC. McDevitt TC Nerem RM Powers MJ. Saif TA. Sharpe J. Takayama S. Takeuchi S. Weiss R. Ye K. Yevick HG. Zaman MH. The promise of multi-cellular engineered living systems. APL BIOENGINEERING, 2(4), 040901, SEP 2018 DOI: 10.1063/1.5038337

139. Mizushima N. A brief history of autophagy from cell biology to physiology and disease. Nat Cell Biol. 20(5):521-527, 2018. doi: 10.1038/s41556-018- 0092-5.

140. Okuno H, Minatohara K, Bito H. Inverse synaptic tagging: An inactive synapse-specific mechanism to capture activity-induced Arc/arg3.1 and to locally regulate spatial distribution of synaptic weights. Semin Cell Dev Biol. 77: 43-50, 2018. doi: 10.1016/j.semcdb.2017.09.025.

3. Proceedings

141. Tanaka K, Kinno R. Sakai KL: The reproducibility and variety of the three syntax-related networks for sentence processing. Neurosci. Res. Suppl, 2O-07m2-3, 2018.

142. Kinno R, Muragaki Y, Maruyama T, Tamura M, Tanaka K, Ono K, Sakai KL: Effects of a left frontal glioma on the cortical structures of both hemispheres. Neurosci. Res. Suppl, 2O-10m1-4, 2018.

143. Oshiba Y, Tada H, Miyamae T, Hayano R, Sakai KL: Commonality between language and music based on the brain activation of violin students. Neurosci. Res. Suppl, 3O-02a1-2, 2018.

144. Umejima K, Yamada A, Chen R, Flynn S, Sakai KL: Syntax-related networks of newly acquiring a language for multilinguals. Neurosci. Res. Suppl, 3O-02a1-3, 2018.

145. Kuwamoto T Sakai KL: Localized brain activation decrease caused by learning a second language abroad. Neurosci. Res. Suppl, 3O-02a1-4, 2018.

146. Huang S-J, Xu M, Xie M.-K, Sugiyama M, Niu G, Chen S. Active feature acquisition with supervised matrix completion. In Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD2018), pp.1571-1579, London, UK, Aug. 19-23, 2018.

147. Luo J, Toews M, Machado I, Frisken S, Zhang M, Preiswerk F, Sedghi A, Ding H, Pieper S, Golland P, Golby A, Sugiyama M, Wells III W. M. A feature-driven active framework for ultrasound-based brain shift compensation. In A. F. Frangi, J. A. Schnabel C. Davatzikos C. Alberola-López and G. Fichtinger (Eds.), Proceedings of the 21st International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI2018), Lecture Notes in Computer Science, vol.11073, pp.30-38, Granada, Spain, 2018.

148. Han B, Yao J, Niu G, Zhou M, Tsang I, Zhang Y, Sugiyama M. Masking: A new perspective of noisy supervision. In S. Bengio and H. Wallach and H. Larochelle and K. Grauman and N. Cesa-Bianchi and R. Garnett (Eds.), Advances in Neural Information Processing Systems 31 (NeurIPS2018), pp.5836-5846, 2018.

149. Yamane I, Yger F, Atif J, Sugiyama M. Uplift modeling from separate labels. In S. Bengio and H. Wallach and H. Larochelle and K. Grauman and N. Cesa-Bianchi and R. Garnett (Eds.), Advances in Neural Information Processing Systems 31 (NeurIPS2018), pp.9927-9937, 2018.

150. Oda H. Shima A. Takeuchi S. Fabrication of Cell-Based Sensor Array for Multichemical Detection. Proceedings of MicroTAS 2018, pp.239-240, NOV 2018

151. Soda R. Nishimura K. Takeuchi S. Freezing Na-Alginate Solution to Form Alginate Hydrogel Microstructure on Glass. Proceedings of MicroTAS 2018, pp.542-543, NOV 2018

152. Nie M. Takeuchi S. Serial Encoding of “Core-Shell” Microfibers Using 3D-Printed Microfluidic Devices. Proceedings of MicroTAS 2018, pp.549-550, NOV 2018

153. Hirata Y. Morimoto Y. Takeuchi S. Cell-Based Odorant Sensor on a Smartphone. Proceedings of MicroTAS 2018, pp.786-787, NOV 2018

154. Sawayama J. Takeuchi S. Urine Glucose Sensor for Detection of Pet Diabetes in Early Stage. Proceedings of MicroTAS 2018, pp.851-852, NOV 2018

155. Sugahara K. Morimoto Y. Takeuchi S. Electrofusion Device for Continuously Observation of Droplets. Proceedings of MicroTAS 2018, pp.1097-1098, NOV 2018

156. Morimoto Y. Kiyosawa M. Kato-Negishi M. Takeuchi S. Formation of Coaxial Hierarchical-Layered Cell-Laden Fiber. Proceedings of MicroTAS 2018, pp.1482-1483, NOV 2018

157. Yokomizo A. Morimoto Y. Takeuchi S. 3D Fat Fiber on a Chip. Proceedings of MicroTAS 2018, pp.1564-1565, NOV 2018

158. Shima A. Nagata S. Takeuchi S. Three-Dimensional Human Blood-Brain Barrier Model for Long-Term Analysis. Proceedings of MicroTAS 2018, pp.1650-1651, NOV 2018

159. Furuya Y. Ozawa F. Yamada T. Takeuchi S. CNT Covered and Shewanella-Laden Hydrogel Microfiber for Miniaturized Microbial Fuel Cell. Proceedings of MicroTAS 2018, pp.2204-2205, NOV 2018

160. Levi T. Aihara K. Kohno T. Study of real-time biomimetic CPG on FPGA: Behavior and evolution. Proceedings of the 2018 International

Conference on Artificial Life and Robotics (ICAROB 2018), OS9-1, pp.461-464, 1-4 FEB 2018, Beppu, Oita, Japan

161. Leleu T. Levi T. Kohno T. Aihara K. New methodology of neural network reconstruction for in vitro culture on MultiElectrode Array (MEA) Proceedings of the 2018 International Conference on Artificial Life and Robotics (ICAROB 2018), OS9-6, pp.481-484, 1-4 FEB 2018, Beppu, Oita, Japan

162. Takeuchi T. Hirata Y. Horai S. Aihara K. Prediction-step-dependent expert advice: application to wind energy ramp forecasting. Proceedings of the Grand Renewable Energy 2018 International Conference, O-We-6-6, 17-22 JUN 2018, Yokohama, Japan

163. Yamashita H. Aihara K. Suzuki H. Algorithmic aspects of a continuous-time dynamical system for solving SAT problems. Proceedings of the 2018 International Symposium on Nonlinear Theory and its Applications (NOLTA2018), pp.495-498, 2-6 SEP 2018, Tarragona, Spain

164. Takeuchi T. Hirata Y. Horai S. Aihara K. Japan's R& D Project of Ramp Forecasting Technology: A forecast integration method. Proceedings of the 17th Wind Integration Workshop, WIW18-145, 17-19 OCT 2018, Stockholm, Sweden

165. Sviridova N. Savchenko V. Savchenko M. Aihara K. Okada K. Zhao T. Reconstructed dynamics of the imaging photoplethysmogram. Proceedings of 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBC 2018, pp.2969-2972, 17-21 JUL 2018, Honolulu, USA DOI: 10.1109/EMBC.2018.8512955

166. Fujita Y, Ishii S. Reproducing the cognitive function with the robustness against the brain structure and with the efficient learning algorithm. CNS2018, Seattle, USA, 2018.7.15

4. Other English articles

Book Chapter:

167. Vijayan S, McCarthy M. Inferring Neuronal Network Mechanisms Underlying Anesthesia-Induced Oscillations Using Mathematical Models. In: Dynamic Neuroscience. Chen Z, Sarma S.V. (eds), Springer, Cham. 2018.

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

- List up to 10 main presentations during FY 2018 in order from most recent.
- For each, write the lecturer/presenter's name, presentation title, conference name and date(s)

Date(s)	Lecturer/Presenter's name	Presentation title	Conference name
1.29	Kenichi Ohki	Multiscale Functional Imaging of Marmoset Visual Cortex	International Symposium of Brain Projects: From Structure to Function
12.1	Masanobu Kano	Mechanisms Underlying Climbing Fiber Synapse Elimination during Postnatal Cerebellar Development	The 75th FUJIHARA Seminar : "The Cerebellum as a CNS hub – from its evolution to therapeutic strategies"
10.31	Masashi Sugiyama	Machine learning from weak supervision---Towards accurate classification with low labeling costs.	Conference on Robot Learning 2018
10.9	Takao K. Hensch	Mechanisms underlying critical periods of brain development: Implications for psychiatric disorders	11th International Conference on Early Intervention in Mental Health (IEPA)
9.26-29	Kazuo Emoto	Molecular and cellular basis for dendrite degeneration and regeneration	Cold Spring Harbor Asia Conference
7.25	Kazuyuki Aihara	Individuality and Personalized Medicine: a DNB (Dynamical Network Biomarkers) Approach	International symposium: Toward Understanding "INDIVIDUALITY"
7.9	Yoko Yazaki-Sugiyama	Neuronal mechanism for bird song learning under innate restrictions	11th FENS Forum in Neuroscience
7.6	Haruo Kasai	Dopamine actions on the dendritic spines for reward and aversive learning in the nucleus accumbens.	World Congress of Pharmacological Science
7.5	Hiroki R. Ueda	Whole-body/organ Imaging with Single-cell Resolution Toward Organism-level Systems Biology	7th Conference on Systems Biology of Mammalian Cells
5.22	Yukiko Gotoh	Regulation of embryonic and adult neural stem cell fate.	International Society for Developmental Neuroscience 2018

3. Major Awards

- List up to 10 main awards received during FY 2018 in order from the most recent.
- For each, write the recipient's name, the name of award, and the date issued.
- In case of multiple recipients, underline those affiliated with the center.

Date	Recipient's name	Name of award
2019.2.20	Shoji Takeuchi	Kyoto SMI Nakatsuji Award
2018.12.18	Kazuo Emoto	Terumo Foundation Prize
2018.11.1	Masanobu Kano	Medical Award of The Japan Medical Association
2018.5.22	Arthur Konnerth	Hertie Senior Professorship
2018.4.17	Haruo Kasai	Medal with Purple Ribbon
2018.4.16	Hiroki Ueda	Ichimura Academic Award

Appendix 2　FY 2018 List of Principal Investigators

NOTE:

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

*In the case of researcher(s) not listed in the latest report or in the proposal for newly selected centers in FY2018, attach a “Biographical Sketch of a New Principal Investigator”(Appendix 2a).

<Results at the end of FY2018> **Principal Investigators Total: 15**

Name	Age	Affiliation (Position title, department, organization)	Academic degree, specialty	Effort (%)*	Starting date of project participation	Status of project participation (Describe in concrete terms)	Contributions by PIs from overseas research institutions
Center Director Takao Kurt Hensch*	52	Director, Project Professor,International Research Center for Neurointelligence,The University of Tokyo Institutes for Advanced Study	Ph.D. Neurophysiology	80	October 2017	stayed at the center 68 days in FY2018,usually stays at Boston Children’s Hospital satellite, and very often communicates by 10 emails per day and once a week videoconference Promote IRCN's interests universities, research institutions, and academic societies around the world	manages and directs center’s operations
Masanobu Kano*	62	Deputy Director, International Research Center for Neurointelligence,The University of Tokyo Institutes for Advanced Study Professor, Department of neurophysiology, Division of Functional Biology, Graduate School of Medicine, The University of Tokyo	M.D. & Ph.D. Neurophysiology	80	October 2017	usually stays at center and participates in the center's activities as Deputy Director and an Executive Board member	
Kazuo Emoto*	50	Deputy Director, International Research Center for Neurointelligence,The University of Tokyo Institutes for Advanced Study Professor, Department of Biological Sciences, Graduate School of Science, the University of Tokyo	Ph.D. Neural Network	80	October 2017	usually stays at Graduate School of Science next to the center building, and participates in the center's activities as Deputy Director and an Executive Board member	
Kazuyuki Aihara*	64	Professor, Department of Informatics and Electronics, Institute of Industrial Science, the University of Tokyo	Ph.D. Biological Information Systems	80	October 2017	usually stays at Institute of Industrial Science and participates in the center's activities as a Steering Comittee member	
Haruo Kasai*	62	Professor, Center for Disease Biology and Integrative Medicine, Graduate School of Medicine, the University of Tokyo	MD & PhD Neurophysiology	80	October 2017	usually stays at center and participates in the center's activities as a Steering Comittee member	
Kiyoto Kasai*	48	Professor, Department of Neuropsychiatry, Graduate School of Medicine, The University of Tokyo	MD & PhD Neuroimaging and Early Intervention for Schizophrenia	80	October 2017	usually stays at The University of Tokyo Hospital and participates in the center's activities as a Steering Comittee member	
Kenichi Ohki*	47	Professor, Department of Integrative Physiology, Division of Functional Biology, Graduate School of Medicine, the University of Tokyo	M.D. & Ph.D. Neuroscience	80	October 2017	usually stays at center and participates in the center's activities as a Steering Comittee member	
Arthur Konnerth*	65	Director, Institute of Neuroscience, Technical University of Munich	M.D. & Ph.D. Neurophysiology	50	October 2017	joins 1st IRCN RETREAT and regularly communicates by emails.	
Yukiko Gotoh*	55	Professor, Department of Pharmaceutical Sciences, Graduate School of Pharmaceutical Sciences, the University of Tokyo	Ph.D. Neural Stem Cells	80	October 2017	usually stays at Graduate School of Pharmaceutical Sciences and participates in the center's activities	
Kuniyoshi Sakai*	54	Professor, Department of Basic Science, Graduate School of Arts and Sciences, the University of Tokyo	Ph.D. Neurobiology of Language	80	October 2017	usually stays at Graduate School of Arts and Sciences and participates in the center's activities	
Yasushi Okada*	50	Professor, Department of Physics, Graduate School of Science, the University of Tokyo	M.D. & Ph.D. Bioimaging	32	October 2017	usually stays at Graduate School of Science and participates in the center's activities	

Shoji Takeuchi*	46	Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science, the University of Tokyo	Ph.D. Biohybrid Systems	80	October 2017	usually stays at Institute of Industrial Science and participates in the center's activities	
Masashi Sugiyama*	44	Professor, Department of Complexity Science and Engineering, Graduate School of Frontier Sciences, the University of Tokyo	Ph.D. Statistical Machine Learning	16	October 2017	usually stays at Graduate School of Frontier Sciences and participates in the center's activities	
Hiroki Ueda*	43	Professor, Department of Systems Pharmacology, Division of Functional Biology, Graduate School of Medicine, the University of Tokyo	M.D. & Ph.D. Systems Biology	80	October 2017	usually stays at center and participates in the center's activities	
Yoko Yazaki-Sugiyama	47	Project Associate Professor, International Research Center for Neurointelligence, The University of Tokyo Institutes for Advanced Study	Ph.D. Biological Science	80	April 2018	usually stays at center and participates in the center's activities	

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

Principal investigators unable to participate in project in FY 2018

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

Appendix 2a Biographical Sketch of a New Principal Investigator

Name (Age) Yoko Yazaki-Sugiyama (47)

Affiliation and position (Position title, department, organization, etc.)
Project Associate Professor (part-time), WPI-IRCN, The University of Tokyo
Associate Professor, OIST Graduate University (tenured)

Academic degree and specialty **Ph. D in Science**

Effort **80 %**
* Percentage of time that the principal investigator will devote to working for the center vis-à-vis his/her total working hours.

Education and Research History

Dr. Yazaki-Sugiyama received her Ph.D. from Sophia University under the supervision of Prof. Kiyoshi Aoki. Her thesis reported a neuroethological study of Japanese quail vocal behavior. She subsequently received postdoctoral training at Duke University with Dr. Richard Mooney where she explored the neurophysiological correlates of early auditory and vocal experience in the zebrafinch. During her second postdoctoral stint at RIKEN Brain Science Institute with Dr. Takao Hensch, she studied neuronal circuit plasticity in the mouse and revealed a novel form of cortical plasticity in a specific inhibitory circuit. She became an independent investigator at Okinawa Institute of Science and Technology in 2011 where she has addressed the question of how brain circuits that are shaped by early sensory experience during developmental critical periods could regulate higher cognitive functions as an adult, using zebrafinch song learning as an experimental model. More recently, she studies how early auditory experience is encoded in neural circuits and their effects on social communication.

Research Achievements and Activities

Dr. Yazaki-Sugiyama works with songbirds, especially with zebra finches, which learn to sing during an early developmental critical period, aiming to understand how a song's auditory information is processed and mapping brain areas where neuronal plasticity occurs during zebra finch song learning. Her lab has recently made two discoveries. 1) Her group identified a brain area in zebrafinch higher auditory cortex where early tutor song experience shapes neuronal circuits to form auditory memories and an underlying mechanism for behavior state-dependent memory formation (Yanagihara & Yazaki-Sugiyama, Nature Commun 2016, Yanagihara & Yazaki-Sugiyama, Behav Proc 2018). Her lab found that neurons in zebrafinch higher auditory cortex exhibited exclusive auditory responsiveness to experienced tutor song playbacks. Those findings advance our understanding of the neuronal basis for sensory memory-driven motor learning and theoretical modeling of learning rules. 2) Identifying innate neuronal mechanisms for detecting species-specific cues in zebrafinch song. (Araki et al, Science 2016). There is a

long-standing “auditory template hypothesis” (Marler, 1976), that juvenile songbirds possess an “innate” auditory specification of species-specific song, while the underlying neuronal mechanism remained unknown. Her lab found that zebra finches do not learn temporal silent gap patterns of songs, but they copy the acoustical structure of song elements. They further found that a subset of neurons in primary auditory area innately detect the temporal silent gap patterns of the song. These findings suggest that the innate temporal coding of inter-syllable silent gaps work as a neuronal barcode for conspecific vocal learning in acoustically-diverse environments.

In addition to the main achievements stated above, her lab has been establishing new techniques such as viral vector techniques in songbirds, succeeding in implementing viral vector techniques to introduce chemogenetic tools (Yazaki-Sugiyama et al, Eur J Neurosci 2015), and has developed cell-type specific gene expression in songbirds. These technical developments, as well as her scientific achievements, have attracted collaborators in worldwide including Profs. Jon Sakata at McGill University, Luke Remage-Healey at the University of Massachusetts, Stephanie White at UCLA and Melissa Coleman at Claremont College.

Achievements

(1) International influence * Describe the kind of attributes listed below.

According to her scientific achievements, Dr. Yazaki-Sugiyama has been invited for talks at distinguished international conferences, such as a symposium at the FENS meeting (meeting for the European Neuroscience Society), Gordon Conference on Auditory Systems, a talk at the Annual Meeting of the Society for Neuroscience, and so on. She also contributed to the International Society of Neuroethology by chairing the symposium at the 2014 Meeting as well as serving as a Capranica Prize Committee Member (2019~) and co-organized an annual international workshop ‘Developing Neural Circuit Course’ (former ‘Developmental Neurobiology Course) at OIST, which attracted junior participants and distinguished lecturers worldwide, for the last several years. She also served as a grant reviewer for the Auckland Medical Research Foundation and Neurological Foundation of New Zealand. These activities indicate that Dr. Yazaki-Sugiyama has in a short time become an internationally recognized member in her field.

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

2019-2020 Grant-in-Aid for Scientific Research on Innovative Areas “Dynamic Regulation of Brain Function by Scrap & Build System”
“Scrap and Build of innate and acquired neuronal circuits for zebra finch song learning.”
PI: Yoko Yazaki-Sugiyama
JSPS, MEXT Japan
¥7,200,000 / 2 years (direct cost)

2018-2020 Grant-in -Aid for Scientific Research (B)
“Neuronal mechanism regulating bird vocal learning, determined by early auditory experience”
PI: Yoko Yazaki-Sugiyama
JSPS, MEXT Japan
¥13,300,000 / 3 years (direct cost)

2017-2018 Grant-in-Aid for Scientific Research on Innovative Areas “Dynamic Regulation of Brain

Function by Scrap & Build System"
"Neuronal mechanism for bird song learning under innate restrictions."
PI: Yoko Yazaki-Sugiyama
JSPS, MEXT Japan
¥8,200,000 / 2 years (direct cost)

2017-2018 Grant-in-Aid for Scientific Research on Innovative Areas "Creation and Promotion of Willdynamics"
"Motivational control of memory formation in zebra finch song learning."
PI: Yoko Yazaki-Sugiyama
JSPS, MEXT Japan
¥7,700,000 / 2 years (direct cost)

2014-2015 Grant-in-Aid for Scientific Research on Innovative Areas "Memory dynamism" #26115526
"Behavioral state control of auditory memory formation in zebra finch song learning."
PI: Yoko Yazaki-Sugiyama
JSPS, MEXT, Japan
¥6,500,000 / 2 years (direct cost)

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

Yanagihara S. and *Yazaki-Sugiyama Y. Social interaction with a tutor modulates responsiveness of specific auditory neurons in juvenile zebra finches. ***Behav Proc***, https://doi.org/10.1016/j.beproc.2018.04.003 (2018)

Araki M., Bandi M. M. and *Yazaki-Sugiyama Y. Mind the Gap: Neural Coding of Species Identity in Birdsong Prosody. ***Science*** 354: 1282-1287(2016) (# of citation: 19)
Featured: ***Science*** 354: 1234-1235

Yanagihara S. and *Yazaki-Sugiyama Y. Auditory experience dependent cortical circuit shaping for memory formation in bird song learning. ***Nat. Commun***, doi: 10.1038/NCOMMS11946. (featured article) (2016) (# of citation: 30)

*Yazaki-Sugiyama Y., Yanagihara S, Fuller P.M. and Lazarus M. Acute inhibition of a cortical motor area impairs vocal control in singing zebra finches. ***Eur J Neuroscience*** 41:97-108 (2015) (# of citation: 4)

Toyoizumi T., Miyamoto H., Yazaki-Sugiyama Y., Atapour, N., *Hensch T.K. and *Miller K.D. A theory of the transition to critical period plasticity: inhibition selectivity suppresses spontaneous activity. ***Neuron*** 80: 51-63 (2013) (# of citation: 73)

Yazaki-Sugiyama Y., Kang S., Câteau H., Fukai T. and *Hensch T.K. Bidirectional plasticity in fast-spiking GABA circuits by visual experience. ***Nature*** 462: 218-221 (2009) (# of citation: 169)

Yazaki-Sugiyama Y. and *Mooney R. Sequential learning from multiple tutors and serial retuning of auditory neurons in a brain area important to birdsong learning. ***J Neurophysiol*** 92: 2771-2788 (2004) (# of citation: 30)

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

Appendix 3-1 FY 2018 Records of Center Activities

1. Researchers and center staffs, satellites, partner institutions

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

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

Special mention

- Enter matters warranting special mention, such as concrete plans for achieving the Center's goals, established schedules for employing main researchers, particularly principal investigators.

Adding to hiring a new female PI, Dr. Yazaki-Sugiyama of OIST, in FY2018, the WPI-IRCN actively recruited 2 more female researchers as PIs starting in FY2019: Dr. Y Nagai of CiNET and Dr. S Tsuji of Ecole Normale Supérieure de Paris. Two more foreign PIs, Dr. Zenas Chao of Kyoto University and Dr. Mingbo Cai of Princeton University, were also recruited in FY2018 to start later in FY2019. These hires were made by a global call for applications specifically in computational and human/clinical neuroscience to balance the disciplines at IRCN. In order to bring the physically-distanced PIs "under one roof" at Hongo campus, space was created to support three laboratories in FY2019 (Drs. Aihara and Takeuchi from Komaba campus). To provide a foundation for global collaboration across disciplines, 5 core facilities for research development at WPI-IRCN were established, including 5 research specialists (core managers) for ES-Mouse/Virus Core, Imaging Core, Data Science Core, Science Writing Core in FY2018, and another for the Human fMRI Core recruited to start FY2019. To increase foreign participation, the IRCN postdoctoral fellows system was newly created, and the monthly Science Salon, driven by trainees to seed collaborations across disciplines of IRCN laboratories, was established. Top Salon pairings are awarded Director's seed funding twice per year.

- 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.

WPI-IRCN aims to globalize UTokyo both at by organizational and individual researcher's circulation. From the organizational aspect, Director Hensch signed 12 MOUs with related universities/institutes both locally and worldwide to strategically complement our efforts in neuroscience, computer science, and human/clinical science, within FY2018. To foster young researchers, WPI-IRCN invited students from Harvard University, Utrecht University, and University of Toronto as interns. To shape the new field of Neurointelligence, an international Neuro-inspired computation course was launched, attracting over 230 applications from around the world. This highly successful effort to attract global attention of promising young graduate students and postdoc researchers is expected to attract returnees to WPI-IRCN. Infrastructure to support sabbatical stays, state-of-the-art core facilities and multiple focused workshops also establish a welcoming ecosystem for globalization at the PI level.

1-2. Satellites and partner institutions

- List the satellite and partner institutions in the table below.
- Indicate newly added and deleted institutions in the "Notes" column.
- If satellite institutions have been established, 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
RIKEN	Hiroki Ueda, Yasushi Okada, Masashi Sugiyama	
Max Planck Florida Institute for		

Neuroscience		
The Agency for Science, Technology & Research, Singapore		
Fondazione Instituto Italiano di Tecnologia		
NCCR “Synapsy-The synaptic bases of mental diseases”		
Edwin O. Reischauer Institute of Japanese Studies, Harvard University		
Asian Consortium on MIR studies in Psychosis		
Okinawa Institute of Science and Technology Graduate University	Yoko Yazaki-Sugiyama	
The University of British Columbia		
The Hong Kong University of Science and Technology		
The Chair of Morphogenetic Processes of the Collège de France		

2. Holding international research meetings

- Indicate the number of international research conferences or symposiums held in FY2018 and give up to three examples of the most representative ones using the table below.

FY 2018: 17 meetings

Major examples (meeting titles and places held)	Number of participants
“Frontiers of Neurointelligence” - Satellite Symposium for The 41st Annual Meeting of the Japan Neuroscience Society (Tetsumon Memorial Hall, Hongo campus, UTokyo)	From domestic institutions: 202 From overseas institutions: 11
IRCN 2nd International Symposium (Fukutake Hall, Hongo campus, UTokyo)	From domestic institutions: 146 From overseas institutions: 8
Neuro-inspired Computation Course (Sanjo Kaikan and IRCN Seminar Room)	From domestic institutions: 76 From overseas institutions: 39

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).

Takao K. Hensch
Director

Executive Board

Masanobu Kano
Deputy Director

Kazuo Emoto
Deputy Director

Charles Yokoyama
Executive Director

Tetsushi Kagawa
Administrative Director

Principal Investigators

Affiliated Faculty

Research Core Facilities

- Data Science Core
- ES Mouse/Virus Core
- Human fMRI Core
- Imaging Core
- Science Writing Core

Satellites/Global Partners

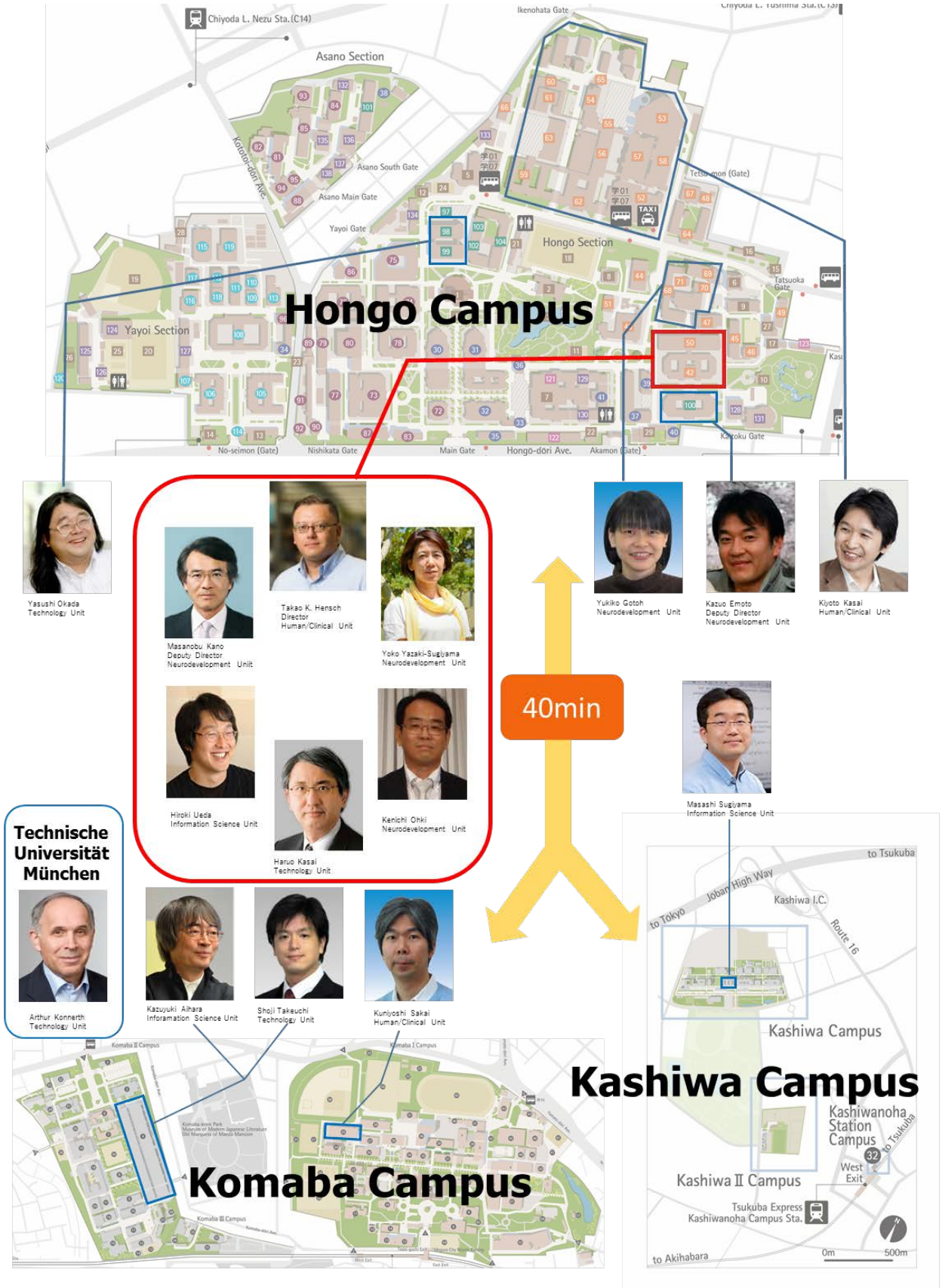
Office for Research Strategy

Administrative Office

- Administrative Manager
  - Financial Section
  - General Section
  - International Section

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 FY2018

Total: 698 million 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,” and for “joint research projects” as listed under “Research projects” in Appendix 3-2, Project Expenditures.

Kakenhi

H. Kasai 大脳の記憶シナプスや回路の２光子顕微鏡と新規光プローブとを用いた研究 25,315,008
K. Emoto スクラップビルド 総括班費 11,300,000
K. Aihara 生命システムの数理モデリングとその個別化医療への応用のための数理的基盤の確立 29,100,000
K. Kasai 思春期からの主体価値の発展過程解明 21,385,380
M. Masanobu シナプスにおける逆行性シグナルが生後発達期の機能的神経回路形成に果たす役割の解明 10,000,000
S. Takeuchi 次世代三次元組織培養を実現する細胞ファイバ工学の創成 31,100,000

Commissioned research projects

H. Kasai "JST CREST 研究費「記憶構造を解明する新しい光操作・画像法の開発」" 22,409,760
H. Kasai "AMED 融合脳 「うつ症状の神経基盤モデルに基づく診断・治療法の開発 – 皮質・側坐核・中脳系への着目」" 19,484,400
K. Aihara "革新的研究開発推進プログラム （ImPACT）『量子人工脳を量子ネットワークでつなぐ高度知識社会基盤の実現』「脳型情報処理」" 42,362,377
K. Aihara NEDO 「電力系統出力変動対応技術研究開発事業」 32,383,840
K. Kasai "AMED革新的技術による脳機能ネットワークの全容解明プロジェクト「臨床研究グループ・臨床研究総括チーム」" 72,096,871
S. Takeuchi "AMED 先端計測分析技術・機器開発プログラム「インスリン投与量を決定可能な連続グルコース計測システムの開発」" 44,200,000
S. Takeuchi "AMED 再生医療技術を応用した創薬支援基盤技術の開発「医薬品の脳内移行性を評価可能な3次元血液脳関門(BBB)デバイスの開発」" 34,015,385
S. Takeuchi "AMED 再生医療実現拠点ネットワークプログラム 拠点B「iPS細胞を基盤とする次世代型膵島移植療法の開発拠点」" 35,000,000
Y. Gotoh "AMED「環境適応・ストレス応答の生体恒常性を司る神経幹細胞の制御と破綻」" 17,058,000
H. Ueda "AMED-CREST「生体恒常性維持・変容・破綻機構のネットワーク的理解」領域「睡眠・覚醒リズムをモデルとした生体の一日の動的恒常性の解明」" 28,700,000
H. Ueda "AMED 革新的技術による脳機能ネットワークの全容解明プロジェクト「マーモセット脳の3次元観察・解析に資する基盤技術開発」" 38,642,000

Others (donations, etc)

K. Aihara 社会課題解決のためのブレインモルフィックAI社会連携研究部門 35,884,603

Appendix 3-1a FY 2018 Records of Center Activities

1. Researchers and other center staffs, satellites, partner institutions

1-1. Number of researchers and other center staffs

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

a) Principal Investigators

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

(number of persons)

	At the beginning of project	At the end of FY 2018	Final goal (Date: March, 2022)
Researchers from within the host institution	12	12	11
Researchers invited from abroad	2	2	4
Researchers invited from other Japanese institutions	0	1	2
Total principal investigators	14	15	17

b) Total members

	At the beginning of project		At the end of FY2018		Final goal (Date: March, 2020)	
	Number of persons	%	Number of persons	%	Number of persons	%
Researchers	27		90		70	
Overseas researchers	3	11.1	31	34.44	19	27.14
Female researchers	4	14.8	23	25.56	17	24.29
Principal investigators	14		15		17	
Overseas PIs	2	14.3	2	13.33	4	23.53
Female PIs	1	7.14	2	13.33	2	11.76
Other researchers	13		75		53	
Overseas researchers	1	7.69	29	38.67	15	28.3
Female researchers	3	23.1	21	28	15	28.3
Research support staffs	0		11		20	
Administrative staffs	3		14		10	
Total number of people who form the "core" of the research center	30		115		100	

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 (For Personnel - Equipment please fill in the breakdown of fiscal expenditure, and the income breakdown for Research projects.)	Total costs	Amount covered by WPI funding
Personnel	Center director and administrative director	38	38
	Principal investigators (no. of persons):13	120	6
	Other researchers (no. of persons):19	128	92
	Research support staffs (no. of persons):7	28	28
	Administrative staffs (no. of persons):14	106	44
	Subtotal	420	208
Project activities	Cost of satellite organizations (no. of satellite organizations):1	74	74
	Cost of international symposiums (no. of symposiums):2	10	3
	Rental fees for facilities	28	28
	Cost of consumables and Fixtures	77	62
	Cost of utilities	3	2
	Cost of public relations	5	5
	Cost of Core Facility established	36	36
	Development of research environment	95	74
	Other costs	17	11
	Subtotal	345	295
Travel	Domestic travel costs	3	2
	Overseas travel costs	8	5
	Travel and accommodations cost for invited scientists (no. of domestic scientists):18 (no. of overseas scientists):54	19	7
	Travel cost for scientists on transfer (no. of domestic scientists):4 (no. of overseas scientists):54	4	4
	Subtotal	34	18
Equipment	Depreciation of buildings	2	
	Depreciation of equipment	63	
	Subtotal	65	0
Research projects (Detail items must be fixed)	Project supported by other government subsidies, etc. *1	6	
	KAKENHI	189	
	Commissioned research projects, etc.	438	
	Joint research projects	18	
	Ohers (donations, etc.)	47	
	Subtotal	698	0
Total		1562	521

Costs (Million yens)

WPI grant in FY 2018	0
Costs of establishing and maintaining facilities	34
Establishing new facilities	0
(Number of facilities: , OO m²)	
Repairing facilities	34
(Number of facilities: , 1284 m²)	
Others	0
Costs of equipment procured	296
・Wide field Multi-Photon Microscope System for animal experiments 1set	149
・Stimulated Emission Depletion Confocal Microscope 1set	32
・Neurimager prototype device 1s(	32
・EEG System 1set	11
・Laser light source for light sheet 1set	9
・fMRI system for brain function measurement 1set	5
Others	58

*1. Funding sources that include government subsidies (including Enhancements promotion expenses (機能強化促進経費), 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.

2) Costs of satellites

(Million yens)

Cost items	Details	Total costs	Amount covered by WPI funding
Personnel	Principal investigators (no. of persons): 0		
	Other researchers (no. of persons): 9		
	Research support staffs (no. of persons): 0		
	Administrative staffs (no. of persons): 0		
	Subtotal	35	35
Project activities	Subtotal	39	39
Travel	Subtotal	0	0
Equipment	Subtotal	42	42
Research projects	Subtotal	0	0
Total		116	116

Appendix 4 FY 2018 Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY 2018 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. 2019 and not described in Appendix 1.

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

1) (86) Sun H, *Takesian AE*, Wang TT, Lippman-Bell JJ, Hensch TK, Jensen FE. Early Seizures Prematurely Unsilence Auditory Synapses to Disrupt Thalamocortical Critical Period Plasticity. Cell Reports 23(9): 2533-2540, 2018
2) (88) *Takesian AE*, Bogart LJ, Lichtman JW, Hensch TK. Inhibitory circuit gating of auditory critical-period plasticity. Nature Neuroscience. 21(2): 218-227 2018
3) (130) Qiang Y, Artoni P, Seo KJ, Culaclii S, Hogan V, Zhao XY, Zhong YD, Han X, Wang PM, Lo YK, Li YM, Patel HA, Huang YF, Sambangi A, Chu JSV, Liu WT, *Fagiolini M*, Fang H. Transparent arrays of bilayer-nanomesh microelectrodes for simultaneous electrophysiology and two-photon imaging in the brain. Science Advances 05 Sep 2018: Vol. 4, no. 9, eaat0626, DOI: 10.1126/sciadv.aat0626
4) *Picard N, Takesian AE, Fagiolini M*, Hensch TK. NMDA 2A receptors in parvalbumin cells mediate sex-specific rapid ketamine response on cortical activity. Molecular Psychiatry 29 January 2019.
5)

2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY 2018. Enter by institution and length of exchange.
- Write the number of principal investigator visits in the top of each space and the number of other researchers in the bottom.

Overseas Satellite 1:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2018	2				
		2	1		

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2018					
	2	2			

Overseas Satellite 2:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2018					

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2018					

Appendix 5　FY 2018 Visit Records of Researchers from Abroad

* If researchers have visited/ stayed at the Center, provide information on them in the below table.

Total: 33

	Name	Age	Affiliation (Position title, department, organization)	Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
1	Stefano Panzeri	51	Istituto Italiano di Technologia(IIT) (Senior Researcher Tenured - Principal Investigator - Center Coordinator, Neural	Ph.D. Computational Neuroscience	Bertarelli Foundation Visiting Scholar, Harvard Medical School, Neurobiology Department Max Planck society Honorary Visiting Scholar – Max Planck Institute for Biological Cybernetics, Tuebingen	2018/5/24-2018/5/29	Participation in workshop and opening ceremony
2	Steve Chien	53	Autonomous Space Systems Technical Group Supervisor, Artificial Intelligence Group@NASA	Ph.D. Computer Science	Awarded the innaugural AIAA Intelligent Systems Award in 2011. Awarded a JPL Magellan Award as well as the NASA Exceptional Achievement Medal for his contributions to automated science scheduling for ESA's Rosetta mission in 2015.	2018/5/25-2018/5/29	Participation in workshop and opening ceremony
3	Michela Fagiolini	50	Associate in Neurology, Boston Children' Hospital Associate Professor, Harvard Medical School	Ph.D. Neurobiology	Is studying experience-dependent brain development in mouse models of autism spectrum disorders (ASDs). Particularly focused on Rett Syndrome, a leading cause of intellectual disability with autistic features.	2018/5/24-2018/5/29	Participation in workshop and opening ceremony
4	Annemie Van Der Linden	62	Professor, Biomedical sciences, University of Antwerp	Ph.D. Biomedical Sciences	Focusses on the imaging of the rodent and avian brain using a combination of in vivo molecular, functional, physiological and anatomic neuro MRI in small animals (mice, rats, fish and songbirds). Explore the possibility for combining optogenetical approaches with imaging of rat brains.	2018/5/25-2018/5/28	Participation in workshop and opening ceremony
5	Pietro Artoni	33	Postdoctoral Fellow, Boston Children's Hospital	Ph.D. Neurology	Interdisciplinary interests: Physics, Developmental disorders, machine learning. HFSP cross-disciplinary fellow in Fall 2015-Fall 2018, studying arousal modulation and cortical gain in Rett Syndrome, (Fagiolini Lab, Boston Children's Hospital, USA).	2018/5/20-2018/5/29	Participation in workshop and opening ceremony
6	Arthur Konnerth	65	Director, Institute of Neuroscience, Technische Universität München	Ph.D., Medical	2015 Brain Prize (shared with Winfried Denk, Karel Svoboda and David Tank)	2018/6/17-2018/6/21	Participation in WPI site visit as a principal investigator
7	Yosuke Morishima	41	Senior Lecturer, University of Bern University Hospital of Psychiatry	MD, Ph.D. (Physiology)	Group leader at Division of Systems Neuroscience Psychopathology, Translational Research Center, University Hospital of Psychiatry	2018/7/15-2018/7/24	Participation in IRCN symposium and conducting joint research as an IRCN affiliated faculty
8	David Cox	40	Assistant Professor of Molecular and Cellular Biology and of Computer Science, Harvard University	Ph.D. Computational Neuroscience	Smith Family Foundation Award for Excellence in Biomedical Research – 2013 Google Research Award – 2010 Rowland Junior Fellowship, Harvard University – 2007-2012 Seeks to understand the computational underpinnings of visual processing through concerted efforts in both reverse- and forward-engineering.	2018/7/21-2018/8/4	Participation in The JNS 41st Annual Meeting and IRCN satellite symposium
9	Rebecca Saxe	43	Professor, MIT, Brain and Cognitive Sciences	Ph.D. in Cognitive Science, Best Thesis Award	2017 BCS Awards for Excellence: in Graduate Mentoring; and in Undergraduate Teaching 2015 Arthur C Smith Award for dedication to student life and learning, MIT 2014 Troland Award, National Academy of Sciences	2018/7/22-2018/7/31	Participation in The JNS 41st Annual Meeting and IRCN satellite symposium

10	Naoshige Uchida	48	Professor of Molecular and Cellular Biology, Harvard University	Ph.D.(Science)	Interested in neuronal processes by which sensory information and memory about previous experiences guide behavior of the animal.	2018/7/22-2018/7/29	Participation in The JNS 41st Annual Meeting and IRCN satellite symposium
11	Daphne Bavelier	59	Professor, Faculty of Psychology and Education Sciences, University of Geneva	Ph.D. Brain and Cognitive Sciences	Her scientific contributions have been recognized by several awards including a John Merck Scholar Awards, a Collaborative Award by The James S. McDonnell Foundation, and a finalist prize in the Blavatnik Awards for Young Scientists in 2008. Her work has been featured in numerous outlets nationally and internationally, including Le Temps, the New York Times, Le Monde, CNN, RTS, the Washington Post, the Economist, or the BBC.	2018/7/22-2018/7/29	Participation in The JNS 41st Annual Meeting and IRCN satellite symposium
12	Lenkei Zsolt	51	Research Director, INSERM Laboratoire de Plasticité du Cerveau, ESPCI-CNRS UMR 8249, ESPCI Paris	Ph.D. Neurosciences	1996 Young Investigator Award de la Société de Neuroendocrinologie-Servier 2008 Jancso Plenary Lecture, IBRO International Workshop on Complex Neural Networks, Debrecen, Hungary 2014 Prix Jean Langlois 2015 Elected co-president for the 2017 'Gordon Research Conference on Cannabinoid Function in the CNS', New Hampshire, USA	2018/9/20-2018/9/22	Participation in IRCN Seminar
13	Ghislaine Dehaene-Lambertz	59	Researcher, CNRS (Directrice de recherche): Cognitive neuroimaging unit, INSERM U992, Neurospin, CEA/SAC/DSV/DRM, Bat145, point courrier 156, 91191 Gif/Yvette, France	Ph.D., Cognitive science	Directing the lab of developmental neuroimaging in Neurospin, a brain-imaging platform dedicated to the human brain in Saclay.The goal is to study the brain functional organization and its development in order to understand how complex cognitive functions, such as language, music, mathematics, etc... emerge in the human brain. My approach is to examine the primitive functions that are accessible to the human brain to process the external word soon after birth, then to study how initial biases in brain organization could be shaped by the human environment to give rise to the mature state.	2018/12/8-2018/12/17	Participation in the 2nd IRCN International Symposium
14	Stanislas Dehaene	53	Professor at the Collège de France, chair of Experimental Cognitive Psychology Director of the INSERM-CEA Cognitive Neuroimaging Unit,	Ph.D., Cognitive science	2015 APA Distinguished Scientific Contribution Award 2014 Thomas Reuters Highly Cited Researcher 2014 Prix LIRE, best science book of 2014 for Le Code de la Conscience (French version of	2018/12/8-2018/12/17	Participation in the 2nd IRCN International Symposium
15	Mamiya Ping Chao	44	Research Scientist, The Institute for Learning & Brain Sciences (I-LABS), University of Washington	Ph.D. Biopsychology and Behavioral Neuroscience	2017 Helmsley Fellowship, Cold Spring Harbor Laboratory 2016 Scholarship to attend Summer Institute, University of Washington, Department of Biostatistics 2016 Scholarship to attend Gila in Health and Disease meeting, Cold Spring Harbor Laboratory	2018/12/13-2018/12/20	Participation in Workshop with A*Star Singapore
16	Charles Nelson	66	Research Director, Division of Developmental Medicine; Richard David Scott Chair in Pediatric Developmental Medicine Research Professor of Pediatrics, Harvard Medical School	Ph.D. Developmental and child psychology	His specific interests are concerned with the effects of early experience on brain and behavioral development, particularly as such experience influences the development of memory and the development of the ability to recognize faces. Nelson studies both typically developing children and children at risk for neurodevelopmental disorders, and he employs behavioral, electrophysiological (ERP), and metabolic (MRI) tools in his research.	2018/12/13-2018/12/20	Participation in the 2nd IRCN International Symposium and Workshop with A*Star Singapore
17	David Fitzpatrick	56	Chief Executive Officer, Research Group Leader, Scientific Director, MaxPlanck Florida Institute for Neuroscience	Ph.D. Psychology/Neuroscience	Played a pivotal role in defining the functional organization of cortical circuits, exploring rules of intracortical connectivity, addressing mechanisms of neural coding, and probing the role of experience in the maturation of cortical circuits. Current research utilizes state-of-the-art in vivo imaging techniques to probe the functional synaptic architecture of circuits in primary visual cortex, defining the circuit mechanisms that build the selective response properties of cortical neurons and the critical role that neural activity plays in the proper maturation of these circuits.	2018/12/14-2018/12/27	Participation in the 2nd IRCN International Symposium
18	Genevieve Konopka	43	Associate Professor, University of Texas, Southwestern Medical Center	Ph.D. Neurobiology	Understanding Human Cognition Scholar Award The James S. McDonnell Foundation (2016) Basil O'Connor Starter Scholar Research Award March of Dimes (2013) Kavli Fellow (2013)	2018/12/15-2018/12/18	Participation in the 2nd IRCN International Symposium
19	David Poeppel	55	Professor of Psychology and Neural Science, New York University Director, Max-Planck-Institute, Frankfurt	Ph.D. Psychology	Fellow, American Association for the Advancement of Science, 2007. DaimlerChrysler Berlin Prize, American Academy Berlin, Fall 2004	2018/12/15-2018/12/18	Participation in the 2nd IRCN International Symposium
20	Michael Meaney	68	Co-Scientific Director, Ludmer Centre for Neuroinformatics and Mental Health Researcher, Douglas Institute Director, Sackler Program for Epigenetics & Psychobiology James McGill Professor, Departments of Psychiatry and Neurology and Neurosurgery, McGill University	Ph.D. Neurobiology	2016 Margolese Brain Disorder Prize 2014 Wilder-Penfield Award 2014 Klaus J. Jacob Research Prize 2012 Member of the Order of Canada	2018/12/17-2018/12/20	Participation in Workshop with A*Star Singapore
21	Sho Tsuji	34	Postdoctoral researcher, University of Pennsylvania, Department of Psychology and Laboratoire de Sciences Cognitives et Psycholinguistique (ENS, EHESS, CNRS)	Ph.D. Psycholinguistics	2017- Appointed Catalyst, Berkeley Initiative for Transparency in the Social Sciences, for promoting reproducible science. 2013 Best Student Oral Presentation Award, International Child Phonology Conference	2018/12/15-2018/12/24	Participation in the 2nd IRCN International Symposium and Workshop with A*Star Singapore
22	Janet Metcalfe	50	Head of Vitae	Ph.D.	Chair of the CROS/PIRLS Steering Group, responsible for developing and managing the Careers in Research Online Survey (CROS) and the Principal Investigator and Research Leaders Survey (PIRLS) and a member of the European Commission's Marie Skłodowska-Curie Actions Advisory Group and the Royal Society Diversity Committee	2019/2/14-2019/2/16	Participation in IRCN Seminar

23	Mingbo Cai	32	Postdoctoral Research Associate Princeton Neuroscience Institute	PhD. Neuroscience	Best student talk, Rush Record Neuroscience Forum, Galveston TX, 2012 Learning a nonlinear generative model of fMRI data with deep neural networks.	2019/3/2- 2019/3/9	Participation in IRCN Seminar
24	Partha Mitra	50	Professor Cold Spring Harbor Laboratory	Ph.D. Theoretical Physics	Fellow, American Physical Society Senior Member, IEEE H N Mahabala Chair Professor (visiting), IIT Madras Senior Visiting Scientist, RIKEN Brain Science Institute George S. Axelby Outstanding Paper Award	2019/3/13- 2019/3/24	Participation in Neuro-inspired Computation Course
25	Graham Taylor	36	Associate Professor and Canada Research Chair in Machine Learning Canada CIFAR AI Chair School of Engineering, University of Guelph and Vector Institute	Ph.D. Computer Science	Leading the Machine Learning Research Group at the University of Guelph. Interested in statistical machine learning and biologically-inspired computer vision, with an emphasis on deep learning and time series analysis.	2019/3/16- 2019/3/24	Participation in Neuro-inspired Computation Course
26	Arvind Kumar	42	Associate Professor Division of Computational Science and Technology, KTH Royal Institute of Technology	Ph.D. Theoretical Physics	Using analytical methods from statistical mechanics, probability theory, graph theory and control systems theory, and combine them with numerical simulations of large-scale neuronal networks of different brain regions. The overall goal of this line of work is to develop mathematical models of brain diseases and create a theoretical framework to understand the mechanisms underlying the emergence of disease related aberrant activity dynamics in diseases (e.g. Parkinson's diseases, epilepsy, anxiety).	2019/3/19- 2019/3/25	Participation in Neuro-inspired Computation Course
27	Stefano Panzeri	51	Senior Researcher Tenured - Principal Investigator - Center Coordinator Director of the Neural Computation Laboratory, Italian Institute of Technology	Ph.D. Computational Neuroscience	2015 and 2016: Bertarelli Foundation Visiting Scholar, Harvard Medical School, Neurobiology Department 2010-2015: Max Planck society Honorary Visiting Scholar – Max Planck Institute for Biological Cybernetics, Tuebingen 2005-2009 Member of the UK's Engineering and Physics Research Council (EPSRC) Grant Review Panel (major funding agency's grant-award panel)	2019/3/19- 2019/3/23	Participation in Neuro-inspired Computation Course
28	Surya Ganguli	41	Assistant Professor of Applied Physics and, By Courtesy, of Neurobiology and of Electrical Engineering, School of Humanities and Sciences, Stanford University	Ph.D. String Theory	Works on theoretical neuroscience, with the fundamental goal of understanding how networks of neurons and synapses cooperate across multiple scales of space and time to mediate important brain functions, like sensory perception, motor control, and memory. To achieve this goal, we employ and extend tools from disciplines like statistical mechanics, dynamical systems theory, machine learning, information theory, control theory, and high-dimensional statistics, as well as collaborate with experimental neuroscience laboratories collecting physiological data from a range of model organisms	2019/3/19- 2019/3/25	Participation in Neuro-inspired Computation Course
29	Markus Diesmann	51	Director of the Institute of Neuroscience and Medicine (INM-6, Computational and Systems Neuroscience), director of the Institute for Advanced Simulation (IAS-6, Theoretical Neuroscience) and director of the JARAInstitute Brain structure-function relationships (INM-10) at Jülich Research Centre, Germany	Ph.D. Physics	2015 Co-opted Professor at Department of Physics, Faculty I, RWTH Aachen University, Aachen, Germany 2010 Offered position of director of Institute of Neuroscience and Medicine (INM-6), Computational and Systems Neuroscience, Research Center Jülich and W3 professorship (tenured) in Computational Neuroscience, RWTH University Aachen, Germany 2009 Evaluated as "world-leading computational neuroscientist in the field of large-scale simulations" by an international review panel (12 experts, chair: Rodney Douglas, reporters for lab: Wolfgang Maass and Peter Latham) in BSI group review	2019/3/19- 2019/3/23	Participation in Neuro-inspired Computation Course
30	Nima Dehghani	43	Senior Postdoc Associate MIT center for brains, minds and machines (CBMM)	PhD. MD.	Aims to use the theoretical perspective of neuronal ensemble dynamics in design of bio-inspired intelligence and to further enhance their usability for clinical purposes.	2019/3/19- 2019/3/28	Participation in Neuro-inspired Computation Course and IRCN seminar
31	Michelle McCarthy	50	Research Assistant, Math and Statistics Boston University	PhD.	Mathematical neuroscience	2019/3/12- 2019/3/24	Participation in Neuro-inspired Computation Course
32	Jonathan Schneider	36	Postdoctoral Fellow, University of Toronto	PhD. Physics	Interested in how computational approaches can provide objective assistance in learning more about the fly, and sociality in general.	2019/3/19- 2019/3/24	Participation in Neuro-inspired Computation Course
33	Daniel Brunner	39	Permanent CR2 position at the French national center of scientific research (CNRS), FEMTO-ST, Besançon, France	PhD.	2015 First listed during national competition of Juan de la Cierva fellowship, Spain, Ministry of Economy and Competetivity. 2010 IoP Roys prize for best submitted thesis in area of semiconductor physics, annual and UK-wide	2019/3/19- 2019/3/24	Participation in Neuro-inspired Computation Course

Appendix 6 FY2018 State of Outreach Activities

* Fill in the numbers of activities and times held during FY2018 by each activity.
* Describe the outreach activities in the "6. Others" of Progress Report, including those stated below that warrant special mention.

Activities	FY2018 (number of activities, times held)
PR brochure, pamphlet	2: IRCN A4 leaflet (English version, Japanese version), IRCN pamphlet (English version, Japanese version)
Lectures, seminars for general public	6: IPMU/ELSI/IRCN joint seminar (Sakai), IPMU/IRCN joint seminar (Charles), WPI science symposium (H. Kasai), UTokyo IIIS/Riken AIP/IRCN joint symposium (Sugiyama, Aihara), The University of Tokyo Homecoming Symposium (Sakai), Talk session in Miraikan (Shimizu)
Teaching, experiments, training for elementary, secondary and high school students	1: Special experiments program for high school students (Gyosei High School)
Science café	N.A.
Open houses	1: IRCN Core Facility Tour (The University of Tokyo Homecoming Event)
Participating, exhibiting in events	3: Super Science High School Event, The University of Tokyo Festival, WPI science symposium
Press releases	11 Press releases (Ohki, Hensch, Fagiolini, K. Kasai, Gotoh, Touhara, Aihara, Ueda, Takeuchi)
Publications of the popular science books	N.A.
Others（ ）	Neuro-inspired Computation Course (March 21-24), IRCN-Harvard Internship Program

*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.

Appendix 7 FY 2018 List of Project's Media Coverage

* List and describe media coverage (e.g., articles published, programs aired) in FY2018 resulting from press releases and getting reported.

	Date	Types of Media (e.g., newspaper, magazine, television)	Description
1	22-May-18	newspaper	Yomiuri shimbun: The launch of Center for Adolescents and Young Adults, UTokyo Hospital [K. Kasai]
2	22-May-18	Web	Techrunch: Researchers recreate a brain, piece by piece [Takeuchi] https://techcrunch.com/2018/05/22/researchers-recreate-a-brain-piece-by-piece/
3	22-May-18	Web	Science Daily: Building a brain, cell by cell: Researchers make a mini neuron network (of two) [Takeuchi] https://www.sciencedaily.com/releases/2018/05/180522114607.htm
4	23-May-18	Web	Phys.org: Researchers make a two-neuron network **[Takeuchi]** https://phys.org/news/2018-05-two-neuron-network.html
5	30-May-18	magazine	National Geographic：New hybrid robot uses living muscles to move **[Takeuchi]** https://news.nationalgeographic.com/2018/05/robotic-living-muscle-tissue-science/
6	31-May-18	news agency	Kyodo News: 培養筋肉で動く指ロボット開発　構造工夫で長持ち **[Takeuchi]**
7	31-May-18	newspaper	Yamanashi Nichi Nichi Shimbun: 培養筋肉で指ロボット(Top news) **[Takeuchi]**
8	31-May-18	newspaper	The Asahi Shimbun: 筋肉の伸縮で動くロボット **[Takeuchi]**
9	31-May-18	newspaper	Nikkei Sangyo Shimbun: 生体素材使う指型ロボ　東大、長時間動作可能に **[Takeuchi]**
10	31-May-18	newspaper	Nikkan Kogyo Shimbun: 東大、筋肉と機械融合　バイオハイブリッドロボ　義手などに応用 **[Takeuchi]**
11	31-May-18	newspaper	The Sankei Shimbun: 筋肉ロボ　人の腕と同じ動き **[Takeuchi]**
12	31-May-18	television	TV Asahi: 世界初　筋肉と機械で構成したロボット　東大が開発 **[Takeuchi]**
13	31-May-18	television	Nippon Television Network: 動物の筋肉と機械組み合わせた指型ロボット **[Takeuchi]**
14	31-May-18	magazine	Futurism: The Cyborgs are here: Researchers put living cells in a robotic finger **[Takeuchi]**

15	31-May-18	magazine	Forbes: Scientists uncover ways to integrate living muscle into machines to create a 'Biohybrid' Robot [Takeuchi] https://www.forbes.com/sites/leebelltech/2018/05/31/scientists-uncover-way-to-integrate-living-muscle-into-machines-to-create-a-biohybrid-robot/#55605b1d659c
16	1-Jun-18	magazine	L'express: Ce mini robot a de vrais muscles **[Takeuchi]** https://www.lexpress.fr/actualite/sciences/ce-mini-robot-a-de-vrais-muscles_2013135.html
17	1-Jun-18	television	Xinhua News Agency: 日本研究人員発明"生物合成机器人 **[Takeuchi]** http://www.xinhuanet.com/2018-06/01/c_1122925312.htm
18	1-Jun-18	Web	Gigazine: 培養した筋肉を搭載したハイブリッドロボットが開発される **[Takeuchi]** https://gigazine.net/news/20180601-robotic-finger-use-muscles/
19	4-Jun-18	Web	Digital Trends: Japanese researchers have made robots with living muscle tissue **[Takeuchi]**
20	4-Jun-18	press release	Early-Life Seizures Disrupt Critical Period Plasticity **[Hensch]** Cell Reports 23, May 29, 2018
21	6-Jun-18	newspaper	Mainichi Shimbun: ラット細胞で指型ロボット　義手や義足開発に道 **[Takeuchi]**
22	11-Jun-18	television	BBC World News: Robotic fingers flex their human muscles **[Takeuchi]** https://www.bbc.com/news/av/technology-44371062/robotic-fingers-flex-their-human-muscles
23	11-Jun-18	Web	Gizmode: より人間らしく。東京大学による、機械と筋肉を融合したバイオハイブリッドロボットの研究 **[Takeuchi]** https://www.gizmodo.jp/2018/06/tokyouni-biohybrid.html
24	25-Jun-18	newspaper	Nippon Keizai shimbun: Strengthening the support for adolescents and young adults with schizophrenia [K. Kasai]
25	27-Aug-18	Web	Yahoo News: Toward integrative care for children with intractable diseases **[K. Kasai]**
26	29-Aug-18	newspaper	Asahi digital:「夢見ないマウス」遺伝子操作で作製　レム睡眠ほぼゼロ **[Ueda]**
27	29-Aug-18	newspaper	Mainichi shimbun:**「レム睡眠」二つの必須遺伝子を特定** [Ueda]
28	29-Aug-18	Newspaper	Nikkan Kogyo shimbun: **レム睡眠の遺伝子、東大が発見　薬剤開発応用に期待** [Ueda]
29	29-Aug-18	Newspaper	Nikkei shimbun: **理研、レム睡眠に必須の遺伝子発見　眠りの仕組み解明へ** [Ueda]
30	7-Sep-18	press release	Transparent EEG Array Allows Visual Access to Brain **[Hensch]** Science Advances 05 Sep 2018: Vol. 4, no. 9, eaat0626 DOI: 10.1126/sciadv.aat0626
31	11-Sep-18	Web	HERO-X: 医療に大きな変革をもたらす培養筋肉の研究は、もうここまで来た！ **[Takeuchi]** http://hero-x.jp/article/4992/

32	13-Sep-18	magazine	第96回　夢見る睡眠をなくしたマウスの誕生から考える **[Ueda]**
33	18-Sep-18	press release	Sleep Duration is Determined by Leak Potassium Channels **[Ueda]** (Yoshida et a., Leak potassium channels regulate sleep duration. Proc. Natl. Acad. Sci. USA 115: E9459-E9468, 2018)
34	19-Sep-18	Web	China Central Television: 聚焦夏季达沃斯论坛 生物混合机器人话题引发热烈 **[Takeuchi]** https://www.youtube.com/watch?v=OPN0Rkc_cXM (2:13~)
35	9-Oct-18	press release	Dividing Time and Space to Predict the Future **[Aihara]** (Announcement on the publication of the article "Randomly distributed embedding making short-term high-dimensional data predictable" in Proceedings of the National Academy of Sciences of the United States of America)
36	18-Dec-18	press release	Growing a brain: Two-step control mechanism identified in mouse stem cells **[Gotoh]** (Tsuboi et al., Ubiquitination-Independent Repression of PRC1 Targets during Neuronal Fate Restriction in the Developing Mouse Neocortex. Developmental Cell 47, 758-772.e5)
37	31-Jan-19	press release	Prosocial Behavior and the Teenage Brain **[K. Kasai]** (Okada et al., Neurometabolic and functional connectivity basis of prosocial behavior in early adolescence. Scientific Reports, 2019)
38	31-Jan-19	press release	New Analog Neural Network to Solve Combinatorial Optimization Problems Effectively **[Aihara]** (Announcement on the publication of the article "Destabilization of local minima in analog spin systems by correction of amplitude heterogeneity" in Physical Review Letters)
39	14-Feb-19	newspaper	News on the publication of the article "Destabilization of local minima in analog spin systems by correction of amplitude heterogeneity" in Physical Review Letters written by NIKKEI SANGYO SHIMBUN (Morning edition, page 5) **[Aihara]**
40	18-Feb-19	press release	How the antidepressant ketamine rapidly awakens the brain, and why its effects vary more in women **[Hensch]** (Picard et al., NMDA 2A receptors in parvalbumin cells mediate sex-specific rapid ketamine response on cortical activity. Molecular Psychiatry. 2019)
41	1-Mar-19	press release	Symposium and Fashion Show on Considering Symbiosis and Future of HI and AI through Fashion **[Aihara & Sugiyama]**
42	7-Mar-19	press release	Teaching AI to Improve Visual Recognition **[Ohki]** (Ukita et al., Characterisation of nonlinear receptive fields of visual neurons by convolutional neural network. Scientific Reports, 2019)
43	8-Mar-19	Web	Research-er.jp **[Ohki]**
44	18-Mar-19	Web	Univ Journal Online **[Ohki]**
45	17-Mar-19	Dempa Newspaper	KDDI Foundation Award **[Sugiyama]**
46	28-Mar-19	newspaper	NIKKEI SANGYO SHIMBUN: Dresses Designed by AI and Human. University of Tokyo and RIKEN unveiled 20 Dresses **[Aihara & Sugiyama]**