

Updated 06/03/2020

AKIRA SAKURAI

Neuroscience Institute

Georgia State University

P.O. Box 5030

Atlanta, GA 30302-5030

Tel: 404-663-3087

Fax: 404-413-5446

E-mail: akira@gsu.edu

EDUCATION:

Ph.D., 1998 Doctoral Program in Biological Sciences, University of Tsukuba, Japan

Thesis title: "Electrophysiological studies in acceleratory nervous regulation in the isopod crustacean *Ligia exotica*." Advisor: Dr. H. Yamagishi

B.Sc., 1993 College of Biological Sciences, University of Tsukuba, Japan

PROFESSIONAL EXPERIENCES:

Dec 2011-present

Research Scientist II, Neuroscience Institute, Georgia State University, Atlanta, Georgia

Jan 2019-May 2019

Adjunct Lecturer, Neuroscience Institute, Georgia State University, Atlanta, Georgia

July 2008-Nov 2011

Research Scientist I, Neuroscience Institute, Georgia State University, Atlanta, Georgia

June 2004-June 2008

Research Scientist I, Department of Biology, Georgia State University, Atlanta, Georgia

July 2001-May 2004

Research Associate, Department of Biology, Georgia State University, Atlanta, Georgia

July 2000-May 2001

Research Assistant Professor, Section of Molecular Neurobiology, Graduate School, Tokyo Medical and Dental University, Tokyo, Japan

April 2000-July 2000

Research Fellow of the Japan Society for the Promotion of Science (JSPS), Department of Biology, Tokyo Metropolitan University, Tokyo, Japan

May 1998-March 2000

Postdoctoral Fellow, Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada

RESEARCH EXPERIENCES:

2001-present Research Associate, Research Scientist I-II, Georgia State University.

1) *Neuronal processing of noxious cold stimuli in Drosophila somatosensory neurons.*

In collaboration with Dr. Dan Cox (Georgia State University) and Dr. Gennady Cymbalyuk (Georgia State University), I study the physiological responses of the peripheral sensory neurons in *Drosophila* larvae with various genetic manipulations by means of electrophysiology and calcium imaging.

2) *Studies on the mechanisms of resilience and adaptability in emergent oscillatory network.*

In collaboration with Dr. Andrey Shilnikov (Georgia State University), I investigate the dynamical principles underlying homeostasis, resilience, and adaptability in motor control circuits.

3) *Comparison of gene expression between identified homologous neurons.*

In collaboration with Dr. Paul Katz (University of Massachusetts Amherst), I perform single-cell RNA-seq to analyze gene expression in homologous interneurons across different species.

4) *Studies on species-specific differences in locomotor neural circuits.*

To gain insight into general principles of central pattern generators and likely scenarios for their evolutionary paths, I study the neural circuit mechanisms underlying swimming behaviors in closely-related molluscan species.

5) *Studies on functional recovery after a lesion to the central nervous system.*

I have been studying how neural circuits can optimize themselves to face changing internal environments with synaptic plasticity. More specifically, I examine how a neural circuit recovers its function after a brain lesion by using a molluscan preparation. I have found that a cryptic difference in synaptic transmission causes individual variability in behavioral performances after the brain lesion.

6) *Studies on serotonergic neuromodulation of synaptic strength in a locomotor neural circuit.*

I investigated serotonin-induced spike timing- and activity-dependent neuromodulation of synaptic strength within the central pattern generator circuit.

2000-2001 Research Assistant Professor, Tokyo Medical and Dental University, Japan.

By *in vivo* recording of single unit activities in the midbrain of anesthetized guinea pigs, I found that changes in blood sugar level affect the threshold of the central rhythm generator activity involved in cortically-induced rhythmic jaw movements.

2000 JSPS Research Fellow, Tokyo Metropolitan University, Japan.

Working in the laboratory of Dr. K. Kuwasawa, I studied the development of axonal projection

of the cardioregulatory neurons from the central nervous system to the heart during the embryonic development of crustaceans using basic histological techniques combined with the immunohistochemical labeling of neuronal processes.

1998-2000 Postdoctoral Fellow, University of Calgary, Canada.

Working in the laboratory of Dr. J. L. Wilkens, I investigated the diversity in electrophysiological and mechanical properties of muscle fibers in crustacean heart. I also investigated the effects of muscle tension on heart pacemaker neurons and discovered that these neurons form "single-neuron reflex arc" inside the heart.

1992-1998 Undergraduate Research and Thesis Research, University of Tsukuba, Japan.

My doctoral thesis, entitled, "Electrophysiological studies in acceleratory nervous regulation in the isopod crustacean *Ligia exotica*," was completed in the laboratory of Dr. H. Yamagishi. I identified two pairs of the cardioacceleratory neurons in the central nervous system of the isopod crustacean and determined their actions onto the heart pacemaker neurons and the heart muscle. I also found that the heart pacemaker neurons use glutamate as the neurotransmitter and that they exhibit both spike-mediated and graded synaptic transmission to the heart muscle.

TEACHING EXPERIENCES:

Class

2019 Adjunct Lecturer, Georgia State University (**Principle of Neuroscience II**, Neur3001, 4 credit hours).

Laboratory mentor and teaching assistant

2016, 2017 Held workshops on general electrophysiological techniques for graduate students.

2001- Mentor for graduate students.

1993-1997 Teaching Assistant in Animal Physiology Lab, Institute of Biological Sciences, University of Tsukuba, Japan.

2000-2001 Molecular Neurobiology Lab, Tokyo Medical and Dental University, Japan.

PUBLICATIONS (*corresponding author):

- 1) Himmel NJ, Letcher JM, **Sakurai A**, Gray TR, Benson MN, Donaldson KJ, and Cox DN* (2021) The evolution of cold nociception in drosophilid larvae and identification of a neural basis for cold acclimation. bioRxiv doi: <https://doi.org/10.1101/2021.01.04.425280>
- 2) Maksymchuk N, **Sakurai A**, Letcher JM, Cox DN, Cymbalyuk G* (2020) Temperature coding mechanisms in the cold-sensitive *Drosophila* neurons. BMC Neuroscience 21 (Suppl 1): P33. doi: [10.1186/s12868-020-00593-1](https://doi.org/10.1186/s12868-020-00593-1)

- 3) Himmel NJ, Letcher JM, **Sakurai A**, Gray TR, Benson MN, Cox DN* (2019) Drosophila menthol sensitivity and the Precambrian origins of TRP-dependent chemosensation. *Phil Trans R Soc B* **374**: 20190369. doi: [10.1098/rstb.2019.0369](https://doi.org/10.1098/rstb.2019.0369)
- 4) **Sakurai A***, Katz PS (2019) Command or obey? Homologous neurons differ in hierarchical position for the generation of homologous behaviors. *J Neurosci* **39**(33): 6460-6471. doi: [10.1523/JNEUROSCI.3229-18.2019](https://doi.org/10.1523/JNEUROSCI.3229-18.2019)
- 5) **Sakurai A*** (2018) Homology and variation in neural control of swimming in nudipleura mollusks. *Jpn Soc Comp Physiol Biochem* **35**: 85-92. doi: [10.3330/hikakuseiriseika.35.85](https://doi.org/10.3330/hikakuseiriseika.35.85)
- 6) **Sakurai A***, Katz PS (2017) Artificial synaptic rewiring demonstrates that distinct neural circuit configurations underlie homologous behaviors. *Curr Biol* **27**(12): 1721-1734. doi: [10.1016/j.cub.2017.05.016](https://doi.org/10.1016/j.cub.2017.05.016)
- 7) Gunaratne CA, **Sakurai A**, Katz PS* (2017) Variations on a theme: Species differences in synaptic connectivity that do not predict roles in central pattern generators. *J Neurophysiol* **118**(2): 1123-1132. doi: [10.1152/jn.00203.2017](https://doi.org/10.1152/jn.00203.2017)
- 8) **Sakurai A***, Tamvacakis AN, Katz PS (2016) Recruitment of polysynaptic connections underlies functional recovery of a neural circuit after lesion. *eNeuro* **3**(4). pii: ENEURO.0056-16.2016. doi: [10.1523/ENEURO.0056-16.2016](https://doi.org/10.1523/ENEURO.0056-16.2016)
- 9) **Sakurai A***, Katz PS (2016) The central pattern generator underlying swimming in *Dendronotus iris*: a simple half-center network oscillator with a twist. *J Neurophysiol* **116**(4): 1728-1742. doi: [10.1152/jn.00150.2016](https://doi.org/10.1152/jn.00150.2016)
- 10) **Sakurai A**, Katz PS* (2015) Phylogenetic and individual variation in gastropod central pattern generators. *J Comp Physiol A* **201**(9): 829-839. doi: [10.1007/s00359-015-1007-6](https://doi.org/10.1007/s00359-015-1007-6)
Review.
- 11) **Sakurai A***, Gunaratne CA, and Katz PS (2014) Two interconnected kernels of reciprocally inhibitory interneurons underlie alternating left-right swim motor pattern generation in the mollusk *Melibe leonina*. *J Neurophysiol* **112**(6): 1317-1328. doi: [10.1152/jn.00261.2014](https://doi.org/10.1152/jn.00261.2014)
- 12) **Sakurai A***, Tamvacakis AN, and Katz PS (2014) Hidden synaptic differences in a neural circuit underlie differential behavioral susceptibility to a neural injury. *eLife* **3**, 202598. doi: <http://dx.doi.org/10.7554/eLife.02598>
This paper was reviewed by Faculty of 1000 Biology (F1000 Factor 3). "... This exceptional study adds to the ongoing debate about how variability affects neural circuits; here a particular variation may serve to enhance the survivability of the animal. Such 'hidden' variability may help to explain why prediction of impairments to brain circuits due to stroke or other traumatic brain injury is so difficult: individual differences in the makeup of such circuits are not revealed until the circuit is damaged." by Ronald Calabrese (30 Jun 2014).
<https://f1000.com/prime/718447133>
- 13) Gunaratne CA, **Sakurai A**, and Katz PS* (2014) Comparative mapping of GABA-immunoreactive neurons in the central nervous systems of nudibranch molluscs. *J Comp Neurol* **522**(4): 794-810. doi: [10.1002/cne.23446](https://doi.org/10.1002/cne.23446).
- 14) Newcomb JM, **Sakurai A**, Lillvis JL, Gunaratne CA, and Katz PS* (2012) Homology and homoplasy of swimming behaviors and neural circuits in the Nudipleura (Mollusca, Gastropoda, Opisthobranchia). *PNAS* **109** Supplement **1**: 10669-10676.

<http://www.pnas.org/content/109/suppl.1/10669>

- 15) Sakurai A, Newcomb JM, Lillvis JL, and Katz PS* (2011) Different roles for homologous interneurons in species exhibiting similar rhythmic behaviors. *Curr Biol* **21**: 1036-1043. <http://www.cell.com/current-biology/retrieve/pii/S0960982211004829>
- 16) Sakurai A* and Katz PS (2009) Functional recovery after lesion of a central pattern generator. *J Neurosci* **29**: 13115-13125. <http://www.jneurosci.org/cgi/content/abstract/29/42/13115>
This paper was reviewed by Faculty of 1000 Biology (F1000 Factor 10). "Functional recovery of a structure such as the spinal cord after a lesion of the nervous system may depend on the re-establishment of axonal connections through regeneration/sprouting of descending pathways or else on plastic mechanisms within the spinal cord itself. Unfortunately, the cellular bases for the latter are lacking. This remarkable paper by Sakurai and Katz is a clear example of how simpler animal preparations (*Tritonia diomedea*) may shed light on mechanisms of the functional recovery of the swim escape behaviour that depends on plastic changes within such intrinsic circuitry after a central lesion." by Serge Rossignol (8 Jan 2010). <http://f1000biology.com/article/id/1383968/evaluation>
- 17) Sakurai A* and Katz PS (2009) State-, timing-, and pattern-dependent neuromodulation of synaptic strength by a serotonergic interneuron. *J Neurosci* **29**: 268-279. <http://www.jneurosci.org/cgi/content/abstract/29/1/268>
- 18) Hill ES, Sakurai A, and Katz PS*. (2008) Transient enhancement of spike-evoked calcium signaling by a serotonergic interneuron. *J Neurophysiol* **100**: 2919-2928. <http://jn.physiology.org/cgi/content/abstract/100/5/2919>
- 19) Clemens S, Calin-Jageman RJ, Sakurai A, and Katz PS* (2007) Altering cAMP levels within a central pattern generator modifies or disrupts rhythmic motor output. *J Comp Physiol A* **193**: 1265-1271. <http://link.springer.com/article/10.1007/s00359-007-0280-4>
- 20) Sakurai A*, Calin-Jageman R, and Katz PS (2007) Potentiation phase of spike timing dependent neuromodulation by a serotonergic interneuron involves an increase in the fraction of transmitter release. *J Neurophysiol* **98**: 1975-1987. <http://jn.physiology.org/cgi/content/short/98/4/1975>
This paper was reviewed by Faculty of 1000 Biology (F1000 Factor 6). "This careful study provides evidence that the 5HT-induced potentiation phase of spike-timing-dependent neuromodulation of the synaptic output of ventral swim interneuron B in the mollusk *Tritonia diomedea* is caused by an increase in the fraction of transmitter release." by John Hildebrand (27 Nov 2007) <http://www.f1000biology.com/article/id/1096014/evaluation>
- 21) Sakurai A* (2007) Spike timing-dependent neuromodulation in the *Tritonia* swim central pattern generator. *Jpn Soc Comp Physiol Biochem* **24**: 18-26. doi: 10.3330/hikakuseiriseika.24.18
- 22) Sakurai A*, Darghouth NR., Butera RJ., and Katz PS (2006) Serotonergic enhancement of a 4-AP-sensitive current mediates the synaptic depression phase of spike timing-dependent neuromodulation. *J Neurosci* **26**: 2010-2021. <http://www.jneurosci.org/cgi/content/full/26/7/2010>
- 23) Yamagishi H*, Miyamoto H, and Sakurai A (2004) Developmental changes in dopamine modulation of the heart in the isopod crustacean *Ligia exotica*: Reversal of chronotropic

effect. *Zool Sci* **21**: 917-922. <http://dx.doi.org/10.2108/zsj.21.917>

- 24) Katz PS*, **Sakurai A**, Clemens S, and Davis D (2004) The cycle period of a network oscillator is independent of membrane potential and spiking activity in individual central pattern generator neurons. *J Neurophysiol* **92**: 1904-1917. <http://jn.physiology.org/cgi/content/abstract/92/3/1904>
 - 25) **Sakurai A** and Katz PS* (2003) Spike timing-dependent serotonergic neuromodulation of synaptic strength intrinsic to a central pattern generator circuit. *J Neurosci* **23**: 10745-10755. <http://www.jneurosci.org/cgi/content/abstract/23/34/10745>
This paper was reviewed by Faculty of 1000 Biology (F1000 Factor 8). "This paper shows that neuromodulation can be used to shape each oscillatory cycle of a pattern-generating circuit." by William Kristan (15 Dec 2003) <http://www.f1000biology.com/article/id/1016612/evaluation>
 - 26) **Sakurai A*** and Wilkens JL (2003) Tension sensitivity of the heart pacemaker neurons in the isopod crustacean *Ligia pallasii*. *J Exp Biol* **206**: 105-115. <http://jeb.biologists.org/cgi/content/abstract/206/1/105>
 - 27) **Sakurai A** (2001) Neuromuscular transmission in the heart of crustacean *Ligia exotica*. *Jpn Soc Comp Physiol Biochem* **18**: 36-42. doi: [10.3330/hikakuseiriseika.18.36](https://doi.org/10.3330/hikakuseiriseika.18.36)
 - 28) **Sakurai A** and Yamagishi H* (2000) Graded neuromuscular transmission in the heart of the isopod crustacean *Ligia exotica*. *J Exp Biol* **203**: 1447-1457. <http://jeb.biologists.org/cgi/content/abstract/203/9/1447>
 - 29) **Sakurai A**, Mori A, and Yamagishi H* (1999) Acceleratory nervous regulation of juvenile myogenic hearts in the isopod crustacean *Ligia exotica*. *Comp Biochem Physiol* **124A**: 575-580. [http://dx.doi.org/10.1016/S1095-6433\(99\)00152-X](http://dx.doi.org/10.1016/S1095-6433(99)00152-X)
 - 30) **Sakurai A**, Mori A, and Yamagishi H* (1999) Cardioinhibitory neurons in the isopod crustacean *Ligia exotica*. *Zool Sci* **16**: 401-406. <http://dx.doi.org/10.2108/zsj.16.401>
 - 31) **Sakurai A** (1998) Electrophysiological studies in acceleratory nervous regulation of the heart in the isopod crustacean, *Ligia exotica*. Doctoral Thesis, University of Tsukuba.
 - 32) Yamagishi H*, **Sakurai A**, and Mori A (1998) Isolation of neurogenic and myogenic activities by Joro spider toxin in the adult heart of the isopod crustacean *Ligia exotica*. *Zool Sci* **15**: 673-676. <http://dx.doi.org/10.2108/zsj.15.673>
 - 33) **Sakurai A**, Mori A, and Yamagishi H* (1998) Glutamatergic neuromuscular transmission in the heart of the isopod crustacean *Ligia exotica*. *J Exp Biol* **201**: 2833-2842. <http://jeb.biologists.org/cgi/content/abstract/201/20/2833>
 - 34) **Sakurai A** and Yamagishi H* (1998) Cardioacceleratory neurons in the isopod crustacean, *Ligia exotica*: Visualization of peripheral projection onto the heart muscle. *Zool Sci* **15**: 19-25. <http://dx.doi.org/10.2108/zsj.15.19>
 - 35) **Sakurai A** and Yamagishi H* (1998) Identification of cardioacceleratory neurons in the isopod crustacean, *Ligia exotica* and their effects on cardiac ganglion cells. *J Comp Physiol A* **182**: 145-152. <http://link.springer.com/article/10.1007/s003590050165>
-

BOOK CHAPTERS:

- 1) Katz PS and **Sakurai A** (2017) Neural control of swimming in Nudipleura. In: *The Oxford Handbook of Invertebrate Neurobiology* (Ed. John H. Byrne). doi: [10.1093/oxfordhb/9780190456757.013.21](https://doi.org/10.1093/oxfordhb/9780190456757.013.21)
 - 2) Newcomb JM, **Sakurai A**, Lillvis JL, Gunaratne CA, and Katz PS* (2012) Homology and homoplasy of swimming behaviors and neural circuits in the Nudipleura (Mollusca, Gastropoda, Opisthobranchia). In the Light of Evolution: Volume VI: Brain and Behavior, pp153-174.
-

INVITED TALKS:

- 2018(Apr) Invited speaker, "Diverse dimensions of evolution: Behavior, culture and consciousness" in the 1st AsiaEvo Conference, Shenzhen, China.
- 2018(Apr) Invited speaker, School of Life Sciences Seminar, Nanjing University, Nanjing, Jiangsu, China.
- 2016 (Jul) Workshop organizer and speaker, Organization of Computational Neuroscience meeting, Jeju, Korea.
- 2015 (July) Speaker, Society of Mathematical Biology Conference, Atlanta, Georgia.
- 2015 (Jan) Speaker, Winter Conference in Brain Research at Big Sky, Montana.
- 2014 (Sep) Invited speaker, Neurobiology: Diverse Species & Conserved Principles, Cold Spring Harbor Asia, Suzhou, China.
- 2013 (Nov) Invited speaker, Biology Department Seminar, College of Charleston.
- 2013 (Mar) Speaker, the South East Neuroscience Conference: Young Investigator Platform Presentations.
- 2012 (Aug) Symposium speaker, the 10th International Congress of Neuroethology, Invited Symposium 4: Variability in intrinsic properties of neurons and their synaptic connections: Consequences for the functional output of neuronal networks.
- 2012 (Jul) Invited speaker, the 21st Annual Meeting of Computational Neurosciences, Workshop: Principles of motor pattern generation: experiments and modeling.
- 2012 (Jul) Invited speaker, the 21st annual meeting of Computational Neurosciences, Workshop: Dynamics of rhythm generation.
- 2010 (Jul) Invited Lecture, Biology (8700) Graduate Seminar, Georgia State University.
- 2010 (Feb) Invited Lecture, Institute of Neurobiology, University of Puerto Rico.
- 2009 (Nov) Invited Lecture, Biology (4970) Seminar Series, Georgia State University.
- 2006 (Oct) Invited Lecture, Hybrid Neural Microsystem, Georgia Institute of Technology.
- 2000 (July) Invited Speaker, Yoshida Prize for Young Researchers Symposium, Japanese Society for Comparative Physiology and Biochemistry.
-

AWARDS:

- 2010 **Faculty of 1000 Biology evaluation** (Sakurai and Katz, 2009b) by Serge Rossignol
- 2009 **Faculty of 1000 Biology evaluation** (Sakurai and Katz, 2009 poster at SfN meeting) by Ronald Calabrese
- 2007 **Faculty of 1000 Biology evaluation** (Sakurai et al., 2007) by John Hildebrand
- 2005 **Society for Neuroscience Chapters Postdoctoral Travel Award**
- 2004 **Best Poster Award**, South East Nerve Net Meeting
- 2003 **Faculty of 1000 Biology evaluation** (Sakurai and Katz, 2003) by William Kristan
- 2000 **Yoshida Prize for Young Researchers**, Japanese Society for Comparative Physiology and Biochemistry
-

FUNDING:

PI/Co-PI

- 2008 Brains & Behavior Seed Grant, Georgia State University (PI: P.S. Katz. Co-PI A. Sakurai) "A model for functional recovery without nerve regeneration."
- 2000-2001 Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists "Development of cardioregulatory neural projection to the embryonic heart in the isopod crustacean, *Ligia exotica*."

Contributed

- 2019-2024 CRCNS grant (PI: D.N. Cox, G. Cymbalyuk) "Molecular and Computational Dissection of Cold Nociception" Role: Co-Investigator
- 2019 Brains & Behavior Seed Grant, Georgia State University (PI: D.N. Cox) "Comparative analysis of neural circuit dynamics" Role: Co-Investigator
- 2015-2019 NSF IOS-1455527 (PI: P.S. Katz) "Neural Mechanisms underlying Evolvability of Behavior." Role: Research scientist
- 2014-2018 March of Dimes Foundation 6-FY14-441 (PI: Paul S. Katz) "A novel animal model for studying individual variability in susceptibility to neural damage and the ability to functionally recover from it." Role: Research scientist
- 2012 Brains & Behavior Seed Grant, Georgia State University (PI: P.S. Katz) "Comparative analysis of neural circuit dynamics" Role: Research scientist
- 2011-2015 NSF-IOS-1120950 (PI: P.S. Katz) "Evolution of Neural Circuits for Locomotion" Role: Research scientist
- 2008-2012 NSF IOS-0814411 (PI: P.S. Katz) "Evolution of Neural Circuits for Locomotion" Role: Research scientist
- 2008 Brains & Behavior Seed Grant, Georgia State University (PI: R. Clewley) "A data-driven model optimization strategy for synaptic plasticity" Role: Post-doc

2001-2007 NIH/NINDS R01-NS35371 (PI: P.S. Katz) “Intrinsic neuromodulation of a small neuronal network” Role: Research associate

PROFESSIONAL SERVICES:

2015- Georgia State's Scientific Computing Day Conference Committee
2011- Review Editorial Board of Frontiers in Invertebrate Physiology
2010-2012 Councilor, Japanese Society for Comparative Biochemistry and Physiology
2008 South East Nerve Net, Steering committee
2006 South East Nerve Net, Steering committee
2004 South East Nerve Net, Steering committee
2002-2004 Councilor, Japanese Society for Comparative Biochemistry and Physiology
1998-2000 Young researcher association committee, Japanese Society for Comparative Biochemistry and Physiology
1996-1998 Young researcher association organizer, Japanese Society for Comparative Biochemistry and Physiology

AD HOC REFEREE:

Comparative Biochemistry and Physiology
Frontiers in Physiology
Frontiers in Invertebrate Physiology
Journal of Neuroscience
Journal of Neurophysiology
PLOS ONE
PLOS Biology
Scientific Reports
Trends in Neuroscience
Zoological Sciences

COMMUNITY OUTREACH:

Mentor for ION summer research programs for high school students

MEMBERSHIP OF ACADEMIC SOCIETIES:

Society for Neuroscience
Organization of Computational Neuroscience
International Society for Neuroethology
Japanese Society for Comparative Physiology and Biochemistry

