

Ryunosuke Amo

Fralin Biomedical Research Institute at VTC

Assistant Professor

e-mail : ramo@vt.edu

Academic Employment

2025.7-Current	Assistant Professor Fralin Biomedical Research Institute at VTC, Virginia Polytechnic Institute and State University (Virginia Tech)
2020.11-2025.6	Research Associate Dr. Naoshige Uchida and Dr. Mitsuko Watabe-Uchida's Lab Department of Molecular and Cellular Biology, Center for Brain Science, Harvard University
2015.11-2020.11	Postdoctoral Fellow Dr. Naoshige Uchida and Dr. Mitsuko Watabe-Uchida's Lab Department of Molecular and Cellular Biology, Center for Brain Science, Harvard University
2012.10-2015.10	Special Postdoctoral Researcher Dr. Hitoshi Okamoto's Lab RIKEN Brain Science Institute (currently Center for Brain Science)
2012.4-2012.9	Postdoctoral Researcher Dr. Hitoshi Okamoto's Lab RIKEN Brain Science Institute (currently Center for Brain Science)
2007.4-2009.3	Part-time Teacher Waseda University Senior High School

Education

2012.3	Ph.D., Science Graduate School of Advanced Science and Engineering, Waseda University, Japan (Advisor: Dr. Hitoshi Okamoto and Dr. Toshio Ohshima)
2009.3	M.Sc., Science Graduate School of Advanced Science and Engineering, Waseda University, Japan (Advisor: Dr. Hitoshi Okamoto and Dr. Toru Higashinakagawa)

2007.3

B.Sc., Science

School of Education, Waseda University, Japan (Advisor: Dr. Toru Higashinakagawa)

Publications

【Original articles】

(Peer reviewed)

(1) Tsutsui-Kimura I, Tian ZM, **Amo R**, Zhuo Y, Li Y, Campbell MG, Uchida N, Watabe-Uchida M. Dopamine in the tail of the striatum suppresses reward acquisition under threat-reward conflicts.

Nature Neuroscience. 2025 Apr;28(4):795-810.

<https://www.nature.com/articles/s41593-025-01902-9>

(2) Liu D, Rahman, M, Johnson A, **Amo R**, Tsutsui-Kimura I, Sullivan ZA, Pena N, Talay M, Logeman BL, Finkbeiner S, Qian L, Choi S, Capo-Battaglia A, Abdus-Sabor I, Ginty DD, Uchida N, Watabe-Uchida M, Dulac C. A hypothalamic circuit underlying the dynamic control of social homeostasis.

Nature. 2025 Apr;640(8060):1000-1010.

<https://www.nature.com/articles/s41586-025-08617-8>

(3) Cai X†, Liu C†, Tsutsui-Kimura I, Lee J, Guo C, Banerjee A, Lee J, **Amo R**, Xie Y, Patriarichi, Li Y, Watabe-Uchida M, Uchida N, Kaeser PS. (†equal contribution)

Dopamine dynamics are dispensable for movement but promote reward responses.

Nature. 2024 Nov;635(8038):406-414.

<https://www.nature.com/articles/s41586-024-08038-z>

(4) **Amo R**, Uchida N, Watabe-Uchida M.

Glutamate inputs send prediction error of reward but not negative value of aversive stimuli to dopamine neurons.

Neuron. 2024 Mar 20;112(6):1001-1019.

[https://www.cell.com/neuron/fulltext/S0896-6273\(23\)00979-0](https://www.cell.com/neuron/fulltext/S0896-6273(23)00979-0)

(5) **Amo R**, Matias S, Yamanaka A, Tanaka KF, Uchida N and Watabe-Uchida M.

A gradual temporal shift of dopamine responses mirrors the progression of temporal difference error in machine learning.

Nature Neuroscience. 2022 Aug;25(8):1082-1092.

<https://www.nature.com/articles/s41593-022-01109-2>

(6) Okumura K, Kakinuma H, **Amo R**, Okamoto H, Yamasu K, Tsuda S.

Optical measurement of neuronal activity in the developing cerebellum of zebrafish using voltage-sensitive dye imaging.

Neuroreport. 2018 Nov 7;29(16):1349-1354.

https://journals.lww.com/neuroreport/abstract/2018/11010/optical_measurement_of_neuronal_activity_in_the.2.aspx

(7) Menegas W, Akiti K, **Amo R**, Uchida N, Watabe-Uchida M.

Dopamine neurons projecting to the posterior striatum reinforce avoidance of threatening stimuli.

Nature Neuroscience. 2018 Oct;21(10):1421-1430.

<https://www.nature.com/articles/s41593-018-0222-1>

(8) Miyazawa H, Okumura K, Hiyoshi K, Maruyama K, Kakinuma H, **Amo R**, Okamoto H, Yamasu K, Tsuda S.

Optical interrogation of neuronal circuitry in zebrafish using genetically encoded voltage indicators.

Scientific Reports. 2018 Apr 16;8(1):6048.

<https://www.nature.com/articles/s41598-018-23906-1>

- (9) Chou MY, **Amo R**, Kinoshita M, Chong BW, Shimazaki H, Agetsuma M, Shiraki T, Aoki T, Takahoko M, Yamazaki M, Higashijima S, Okamoto H.
Social conflict resolution regulated by two dorsal habenular subregions in zebrafish.
Science. 2016 Apr 1;352(6281):87-90.
<https://www.science.org/doi/abs/10.1126/science.aac9508>
- (10) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Fukai T, Okamoto H.
The habenulo-raphe serotonergic circuit encodes an aversive expectation value essential for adaptive active avoidance of danger.
Neuron. 2014 Dec 3;84(5):1034-48.
[https://www.cell.com/neuron/fulltext/S0896-6273\(14\)00955-6](https://www.cell.com/neuron/fulltext/S0896-6273(14)00955-6)
- (11) Aoki T, Kinoshita M, Aoki R, Agetsuma M, Aizawa H, Yamazaki M, Takahoko M, **Amo R**, Arata A, Higashijima S, Tsuboi T, Okamoto H.
Imaging of neural ensemble for the retrieval of a learned behavioral program.
Neuron. 2013 Jun 5;78(5):881-94.
[https://www.cell.com/fulltext/S0896-6273\(13\)00311-5](https://www.cell.com/fulltext/S0896-6273(13)00311-5)
- (12) Agetsuma M, Aizawa H, Aoki T, Nakayama R, Takahoko M, Goto M, Sassa T, **Amo R**, Shiraki T, Kawakami K, Hosoya T, Higashijima S, Okamoto H.
The habenula is crucial for experience-dependent modification of fear responses in zebrafish.
Nature Neuroscience. 2010 Nov;13(11):1354-6.
<https://www.nature.com/articles/nn.2654>
- (13) **Amo R**[†], Aizawa H[†], Takahoko M, Kobayashi M, Takahashi R, Aoki T, Okamoto H. (†equal contribution)
Identification of the zebrafish ventral habenula as a homolog of the mammalian lateral habenula.
Journal of Neuroscience. 2010 Jan 27;30(4):1566-74.
<https://www.jneurosci.org/content/30/4/1566.short>
- (14) Razzaque MA, Nishizawa T, Komoike Y, Yagi H, Furutani M, **Amo R**, Kamisago M, Momma K, Katayama H, Nakagawa M, Fujiwara Y, Matsushima M, Mizuno K, Tokuyama M, Hirota H, Muneuchi J, Higashinakagawa T, Matsuoka R.
Germline gain-of-function mutations in RAF1 cause Noonan syndrome.
Nature Genetics. 2007 Aug;39(8):1013-7.
<https://www.nature.com/articles/ng2078>

【Review articles】

[in English]

(Peer reviewed)

- (1) Green I, **Amo R**, Watabe-Uchida M.
Shifting attention to orient or avoid: a unifying account of the tail of the striatum and its dopaminergic inputs.
Current Opinion in Behavioral Sciences. 2024 Oct;59:101441.
<https://www.sciencedirect.com/science/article/pii/S2352154624000925>
- (2) **Amo R**.
Prediction error in dopamine neurons during associative learning.
Neuroscience Research. 2024 Feb;199: 12-20.
<https://www.sciencedirect.com/science/article/pii/S0168010223001384>
- (3) Aizawa H, **Amo R**, Okamoto H.

Phylogeny and ontogeny of the habenular structure.

Frontiers in Neuroscience. 2011 Dec 21;5:138.

<https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2011.00138/full>

[in Japanese]

(Not peer-reviewed)

(1) **Amo R**, Okamoto H.

ゼブラフィッシュの神経活動操作.

(Manipulation of neural activity in zebrafish)

Clinical Neuroscience. 2018;36(8):907-909

(2) Okamoto H, **Amo R**.

手綱核による危険予知と絶望.

(Hopelessness and prediction of danger by the habenula)

実験医学 (Experimental Medicine). 2018;36(12):2050-2056

(3) **Amo R**, Okamoto H.

行動下ゼブラフィッシュにおける光遺伝学による神経活動操作.

(Optogenetic manipulation of neural activity in free-moving zebrafish)

生体の科学 (Medical Science). 2017;68(5):480-481

(4) Okamoto H, Aoki T, **Amo R**.

適応的危険回避プログラムは、脳でどのように書き込まれるのか？—ゼブラフィッシュを用いた研究—.

(How is program for adaptive avoidance of danger written in the brain? -The research approaches using zebrafish-)

分子精神医学 (Japanese journal of molecular psychiatry). 2016;16(2):74-83

(5) **Amo R**, Agetsuma M, Aizawa H, Okamoto H.

ゼブラフィッシュを用いた遺伝的神経回路操作による情動行動研究-手綱核による恐怖行動制御

(Emotion research using genetic manipulation of the neural circuit in zebrafish – Control of fear behavior with the habenula).

実験医学 (Experimental Medicine). 2012;30(2):274-280,

【Book Chapters】

(1) Watabe-Uchida M*, **Amo R***. (*Corresponding author)

DA neuron connectomes: Inputs and outputs.

Handbook of Behavioral Neuroscience Series; The Handbook of Dopamine (Elsevier), Editors: Stephanie J Cragg & Mark E Walton. *In editorial processing*

Presentations

【Invited conference presentations】

(1) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Okamoto H.

手綱核-正中縫線核回路による適応的回避行動の制御

(Regulation of adaptive avoidance by the habenulo-median raphe circuit).

The 36th annual meeting of the Japanese Society of Biological Psychiatry/ The 57th annual meeting of Japanese Society for Neurochemistry (Joint meeting), Symposium, Nara, (Sep 2014)

【Conference presentations】

Presentations at international conferences

[Oral presentations]

(1) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Okamoto H. Habenulo-Raphe Circuit Transmits a Danger Avoidance Signal.

11th International Conference on Zebrafish Development and Genetics, Madison, USA, (Jun 2014).

[Poster presentations]

(2) **Amo R**, Uchida N, Watabe-Uchida M.

Glutamate inputs send prediction error of reward but not negative value of aversive stimuli to dopamine neurons
Neuroscience 2023 (Annual meeting of Society for Neuroscience). Washington, D.C., USA, (Nov 2023)

(3) **Amo R**, Tanaka KF, Uchida N, Watabe-Uchida M.

Characterization of glutamate inputs to midbrain dopamine neurons

Neuroscience 2022 (Annual meeting of Society for Neuroscience). San Diego, USA, (Nov 2022)

(4) **Amo R**, Matias S, Yamanaka A, Tanaka KF, Uchida N and Watabe-Uchida M.

A gradual backward shift of dopamine response during associative learning.

Neuroscience 2021 (Annual meeting of Society for Neuroscience). Virtual (Nov 2021).

(5) **Amo R**, Matias S, Yamanaka A, Tanaka KF, Uchida N and Watabe-Uchida M.

A gradual backward shift of dopamine response during associative learning.

ViDA 2021 (Virtual Dopamine Conference 2021). Virtual (June 2021).

(6) **Amo R**, Matias S, Yamanaka A, Tanaka KF, Uchida N and Watabe-Uchida M.

A gradual backward shift of dopamine response during associative learning.

SfN (Society for Neuroscience) Global Connectome. Virtual (Jan 2021).

(7) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Fukai T, Okamoto H.

Habenulo-raphe serotonergic circuit encodes an aversive expectation value essential for adaptive avoidance.

Vision, Memory, Thought: How Cognition Emerges from Neural Network, Tokyo, JAPAN, (Dec 2014).

(8) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Okamoto H. Habenulo-raphe circuit controls Adaptive Avoidance Behavior.

Neuroscience 2014 (Annual meeting of Society for Neuroscience), Washington, D.C., USA, (Nov 2014).

(9) **Amo R**, Agetsuma M, Kinoshita M, Fredes F, Shiraki T, Aoki T, Aoki R, Yamazaki M, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Serotonin regulation by the habenula is essential for adaptive problem solving in zebrafish.

Neuroscience 2013 (Annual meeting of Society for Neuroscience), San Diego, USA, (Nov 2013).

(10) **Amo R**, Agetsuma M, Kinoshita M, Fredes F, Shiraki T, Aoki T, Aoki R, Yamazaki M, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Serotonin regulation by the habenula is essential for adaptive problem solving in zebrafish.

International Symposium on Prediction and Decision Making 2013, Kyoto, JAPAN, (Oct 2013).

(11) **Amo R**, Agetsuma M, Kinoshita M, Fredes F, Shiraki T, Aoki T, Aoki R, Yamazaki M, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Involvement of the lateral habenula homolog in the active avoidance learning in zebrafish.

10th International Conference on Zebrafish Development and Genetics, Madison, USA, (Jun 2012).

(12) **Amo R**, Aizawa H., Takahoko M., Kobayashi M., Takahashi R., Aoki T., and Okamoto H.

Identification of the zebrafish ventral habenula as a homologue of the mammalian lateral habenula.

2010 Cold Spring Harbor Meeting on Neuronal Circuits, Cold Spring Harbor, USA, (Mar 2010).

Presentations at Japanese conferences (mostly in English)

[Oral Presentations]

(1) **Amo R**, Uchida N, Watabe-Uchida M.

Glutamate inputs send prediction error of reward but not negative value of aversive stimuli to dopamine neurons
47th Annual Meeting of the Japan Neuroscience Society, Hakata, (Jul 2024).

(2) **Amo R**, Tanaka KF, Uchida N, Watabe-Uchida M.

Characterization of glutamate inputs to midbrain dopamine neurons

46th Annual Meeting of the Japan Neuroscience Society, Sendai, (Aug 2023).

(3) **Amo R**, Fredes F, Kinoshita M, Aoki R, Aizawa H, Agetsuma M, Aoki T, Shiraki T, Kakinuma H, Matsuda M, Yamazaki M, Takahoko M, Tsuboi T, Higashijima S, Miyasaka N, Koide T, Yabuki Y, Yoshihara Y, Okamoto H.
Habenulo-raphé pathway underlies fear-motivated active avoidance behavior

37th Annual Meeting of the Japan Neuroscience Society, Yokohama, (Sep 2014).

(4) **Amo R**, Agetsuma M, Kinoshita M, Fredes F, Shiraki T, Aoki T, Aoki R, Yamazaki M, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Serotonin regulation by the habenula is essential for adaptive problem solving in zebrafish.

19th Japanese Medaka and Zebrafish Meeting, Sendai, (Sep 2013).

(5) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Yamazaki M, Aoki T, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Involvement of the lateral habenula homolog in the active avoidance learning in zebrafish

35th Annual Meeting of the Japan Neuroscience Society, Nagoya, (Sep 2012).

(6) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Functional analysis of the habenulo-raphé pathway using genetic manipulation.

17th Japanese Medaka and Zebrafish Meeting, Mishima, (Sep 2011).

(7) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

ゼブラフィッシュにおける哺乳類外側手綱核相同領域の同定：手綱核の機能の理解に向けて

(Identification of the zebrafish homolog of the mammalian lateral habenula: Toward understanding the function of the habenula.)

16th Japanese Medaka and Zebrafish Meeting, Saitama, (Sep 2010).

[Poster presentations]

(8) **Amo R**, Matias S, Yamanaka A, Tanaka KF, Uchida N and Watabe-Uchida M.

A gradual backward shift of dopamine responses during associative learning.

44th Annual Meeting of the Japan Neuroscience Society, Kobe, (Jul 2021).

(9) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Aoki T, Yamazaki M, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

The Habenulo-Raphé pathway Regulates Active Avoidance Learning in Zebrafish

36th Annual Meeting of the Japan Neuroscience Society • 56th Annual Meeting of Japanese Society for Neurochemistry • 23rd Annual Meeting of Japanese Neural Network Society Joint meeting (Neuro2013) , Nagoya, (Jun 2013).

(10) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

Genetic manipulation of mammalian lateral and medial habenula homolog in zebrafish: Toward functional analysis of the habenula

34th Annual Meeting of the Japan Neuroscience Society, Yokohama, (Sep 2011).

(11) **Amo R**, Agetsuma M, Kinoshita M, Shiraki T, Higashijima S, Matsuda M, Suster ML, Kawakami K, Ohshima T, Aizawa H, Okamoto H.

ゼブラフィッシュ手綱核各領域の遺伝学的操作による機能解析

(Functional analysis of Zebrafish habenula subregions using genetic manipulation)

Comprehensive Brain Network, Summer Workshop 2011, Kobe, (Aug 2011).

(12) **Amo R.**, Aizawa H., Takahashi R., Kobayashi M., Takahoko M., Aoki T., and Okamoto H.

Identification of the zebrafish ventral habenula as a homologue of the mammalian lateral habenula

32nd Annual Meeting of the Japan Neuroscience Society, Nagoya, (Sep 2009).

[Other Presentations]

(1) **Amo R**

Mechanism of reward prediction error coding in dopamine neurons

CBS (Center for Brain Science at Harvard University) Neurolunch, Cambridge, (Mar 2024)

(2) **Amo R**

Mechanism of reward prediction error coding in dopamine neurons

Harvard Medical School Systems Club, Boston, (Jan 2024)

(3) **Amo R**

Dopamine activity during learning mirrors temporal difference errors in machine learning.

MCB (Department of Molecular and Cellular Biology) Friday Talk, Cambridge, (Apr 2023)

(4) **Amo R**

A gradual temporal shift of dopamine responses mirrors the progression of temporal difference error in machine learning.

JSPS Boston Forum, Cambridge, (Nov 2022).

(5) **Amo R**

A gradual backward temporal shift of dopamine responses during associative learning.

RIKEN CBS Forum, Saitama, (Aug 2022).

(6) **Amo R**

A gradual temporal shift of dopamine responses mirrors the progression of temporal difference error in machine learning.

基盤医学特論 TOKURON (Nagoya University Graduate School of Medicine), Nagoya, (Aug 2022).

(7) **Amo R**

A gradual backward shift of dopamine responses during associative learning

Harvard Medical School Systems Club, Boston, (Oct 2021)

(8) **Amo R**

Dual cell-type-specific labeling of monosynaptic inputs to dopamine neurons for anatomical and functional analysis.

Harvard Brain Institute (HBI) Behavior Meeting, Boston, (Feb 2020).

(9) **Amo R**

手綱核-縫線核神経回路は危険の予測価値をコードする事で能動的回避行動を可能とする

(Habenulo-raphé circuit encodes an aversive expectation value essential for adaptive avoidance)

Society for Young Researcher on Neuroscience, 15th Colloquium, Tokyo, (Jan 2015)

Awards, fellowships, and Grants

【Awards】

(1) Amo R

Society for Neuroscience, Trainee Professional Development Award (2023)

(2) Amo R

Japan Neuroscience Society, Young Investigator Award (2023)

(3) Amo R

Comprehensive Brain Network, Summer Workshop 2011, Best Presentation Award (2011)

【Fellowships】

(1) Amo R

JSPS, Overseas Research Fellowships (2016-2018)

(2) Amo R

RIKEN, Special Postdoctoral Researcher Program (2012-2015)

(3) Amo R

JSPS, Doctoral Course Research Fellow (DC1) (2009-2012)

【Grants】

(1) Amo R

Harvard Brain Science Initiative, Postdoc Pioneers Grant. (2023-2025), 50,000 USD

(2) Amo R

MEXT Grants-in-Aid for Early-Career Scientists (B) (2015-2016, Discontinued at the middle to study in U.S.) , 4,290,000 JPY (approximately 30,000 USD)

(3) Amo R

RIKEN Grant for Special Postdoctoral Researcher (2012-2015), 3,000,000 JPY (approximately 21,000 USD)

(4) Amo R

JSPS, Grant for Doctoral Course Research Fellow (2009-2012), 2,100,000 JPY (approximately 15,000 USD)

【Manuscript Review】

iScience

【Mentoring】

Undergraduate students

Vanessa Roser

Research Assistants

Zhiyu Tian

Rotation graduate students

Shuhan Huang

Patrick Gainey

Kaiwen Shi

Intern graduate students

Aditi Maduskar

Intern undergraduate students

Sakura Ikeda

Aya Yoshii

Midori Maeda

Intern high school students

Kotone Yoshihara

Michael Brunelli

【Others】

RIKEN Brain Science Institute, the 1st Brain Science Training Program, Completed (2010-2011)