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PERSONAL STATEMENT

I am an experimental neuroscientist and work in my lab focuses on understanding how the specific wiring of neuronal circuits in the visual system leads to complex visually responsive neurons and ultimately leads to perception. The lab studies visual circuits in healthy, vision-impaired and vision-rehabilitated animals. The lab merges multiple disciplines, including physiology, animal behaviour, virology, genetics, disease models and optogenetics. Techniques in the lab include monitoring brain activity, at cellular resolution, using in vivo 2-photon calcium imaging, utilizing virus-mediated neuronal circuit tracing strategies, and implementing optogenetic vision restoration strategies.

RESEARCH EXPERIENCE AND EDUCATION

04/2013 – 07/2017: Postdoctoral Fellow (Roska Lab) - Friedrich Miescher Institute - Basel, Switzerland
- Research areas: Functional connectivity of cortical circuits; Linking neuronal circuits to behavior; Disease models; Development of viral circuit-tracing techniques

09/2009 – 03/2013: PhD Student (Awatramani Lab) - Dalhousie University - Halifax, Canada
- Research areas: Retinal neurophysiology; Functional roles for gap junctions; Retinal degeneration

09/2007 – 08/2009: MSc Student (Baldridge Lab) - Dalhousie University - Halifax, Canada

09/2002 – 04/2007: BSc Student (Honours) - University of Victoria - Victoria, Canada

CURRENT FUNDING

- Human Frontier Science Program Career Development Award: 2018-2021
  - 300,000 USD – to study the neuronal circuits underlying face-selective visual responses
- Alfred P. Sloan Research Fellowship
  - 65,000 USD – unrestricted funds to help boost early-career researchers
- Canada Research Chair: 2017-2022
  - 500,000 CAD – funds for salary support and to support research that strives to understand how visual circuits are functionally wired
- Canadian Foundation for Innovation – John R. Evans Leaders Fund: 2017
  - 500,000 CAD – lab infrastructure fund to buy large pieces of equipment to set up the lab

COMPLETED FUNDING

- Swiss National Science Foundation Ambizione Fellowship (200,000 Swiss Francs): 09/2016 – 08/2017
- Human Frontier Science Program Long-Term Postdoctoral Fellowship (260,00 Swiss Francs): 04/2013 – 03/2016
- Nova Scotia Health Research Foundation Student Research Award (10,000 CAD): 09/2008 – 08/2009

AWARDS

- Human Frontier Science Program Career Development Award: 2018-2021
- Alfred P. Sloan Research Fellow in Neuroscience: 2018
- Canada Research Chair (Tier 2): 2017-2022
- Brain Star Award - Canadian Institutes of Health Research: 2014
- Brain Star Award - Canadian Institutes of Health Research: 2013

- Excellence in Research Award - Dalhousie University: 2013
- McNee Prize for Excellence in Research - Dalhousie University: 2011

CONFERENCE PRESENTATIONS

- Society for Neuroscience 2011, 2012, 2015, 2017
- Keystone Conference: State of the Brain 2016
- Human Frontier Science Program Awardees Conference 2016
- Canadian Association for Neuroscience 2008, 2009, 2012, 2015, 2017
- Association for Research in Vision and Ophthalmology 2008-2011
- FASEB Retinal Neurobiology 2008, 2012

INVITED TALKS

- Dalhousie University – 04/2018
- McGill University - Physiology Department – 03/2018
- Hospital for Sick Children, Toronto – 02/2018
- University of Ottawa – 12/2017
- Foundation Fighting Blindness Vision Quest 2017 (Montreal) – 10/2017
- McGill University - Montreal Neurological Institute – 03/2016
- University of Geneva – 03/2016
- Albert Einstein Medical College – 01/2016
- Dalhousie University – 05/2014

SUPERVISORY EXPERIENCE

- Dr. Peter Chipman – Postdoctoral Fellow – 01/2017 – Present
- Kadjita Asumbisa – PhD Student – 01/2017 – Present
- Nicole Arnold – Master's Student – 09/2017 – Present
- Aude Villemain – Research Technician – 02/2017 – Present

RESEARCH ARTICLES (19 papers in total; Citations – 519; h-index – 13; source – Google Scholar)

First Author (9 articles)

Schubert R*, **Trenholm S***, Balint K*, Kosche G, Cowan C, Mohr MA, Munz M, Martinez-Martin D, Flaeschner G, Newton R, Krol J, Gross Scherf B, Yonehara K, Wertz A, Ponti A, Ghanem A, Hillier D, Conzelmann KK, Müller DJ and Roska B (2018) Virus stamping for targeted single cell infection in vivo and in vitro. Nature Biotechnology. 36:81-88. *indicates equal contribution. *Highlighted in a 'News and Views' article.*

Wertz A*, **Trenholm S***, Yonehara K, Hillier D, Raics Z, Leinwieber M, Szalay G, Keller G, Rozsa B, Conzellman KK, Roska B (2015) Single-cell-initiated monosynaptic tracing reveals layer-specific cortical network modules. Science. 349:70-4. *indicates equal contribution. *Recommended by the Faculty of 1000*.

Trenholm S*, McLaughlin AJ*, Schwab DJ, Turner MH, Smith RG, Rieke F, Awatramani GB (2014) Non-linear dendritic integration of electrical and chemical synaptic inputs drives fine-scale correlations. Nature Neuroscience. 17:1759-66. *indicates equal contribution. *Highlighted in a 'News and Views' article.*

Trenholm S, McLaughlin AJ, Schwab DJ, Awatramani GB (2013) Dynamic tuning of electrical and chemical synaptic transmission in a network of motion coding retinal neurons. The Journal of Neuroscience. 33:14927-38.

Trenholm S, Schwab DJ, Balasubramanian VB, Awatramani GB (2013) Lag normalization in an electrically-coupled neural network. Nature Neuroscience. 16:154-6. *Recommended by the Faculty of 1000*.

Trenholm S, Borowska J, Zhang JC, Hoggarth A, Johnson K, Barnes S, Lewis TJ, Awatramani GB (2012) Intrinsic oscillatory activity arising within the electrically-coupled AII amacrine/ON cone bipolar cell network is driven by voltage-gated Na^+ channels. The Journal of Physiology. 590:2501-17.

Shi Z, **Trenholm S***, Zhu M, Buddingh S, Star EN, Awatramani GB, Chow RL (2011) Vsx1 regulates terminal differentiation of type 7 ON bipolar cells. The Journal of Neuroscience. 31:13118-27. *indicates equal contribution.

Trenholm S, Johnson K, Li X, Smith RG, Awatramani GB (2011) Parallel mechanisms encode direction in the retina. Neuron. 71:683-94.

Trenholm S & Baldridge WH (2010) The effect of aminosulfonate buffers on the light responses and intracellular pH of goldfish retinal horizontal cells. The Journal of Neurochemistry. 115:102-11.

Non-first author (6 articles)

Hillier D, Fiscella M, Drinnenberg A, **Trenholm S**, Rompani SB, Raics Z, Katona G, Juttner J, Hierlemann A, Rozsa B, Roska B (2017) Causal evidence for retina-dependent and –independent visual motion computation in mouse cortex. Nature Neuroscience. 20: 960-68.

Yonehara K*, Fiscella M*, Drinnenberg A*, Esposti F, **Trenholm S**, Krol J, Franke F, Gross Scherf B, Kusnyerik A, Muller J, Szabo A, Juttner J, Cordoba F, Police Reddy A, Nemeth J, Nagy ZZ, Munier F, Hierlemann A, Roska B (2016) Congenital nystagmus gene FRMD7 is necessary for establishing a neuronal circuit asymmetry for direction selectivity. Neuron. 89:177-93. *indicates equal contribution.

Hoggarth A, McLaughlin AJ, Ronellenfitch K, **Trenholm S**, Vasandi R, Schwab DJ, Briggman KL, Awatramani GB (2015) Specific wiring of distinct amacrine cells in the directionally selective retinal circuit permits independent coding of direction and size. Neuron. 86:276-91.

Szikra T, **Trenholm S**, Drinnenberg A, Juettner J, Raics Z, Farrow K, Biel M, Awatramani GB, Clark DA, Sahel JA, da Silveira RA, Roska B (2014) Rods in daylight act as relay cells for cone-driven horizontal cell-mediated surround inhibition. Nature Neuroscience. 17:1728-35.

Chau J, Nivison-Smith L, Fletcher EL, **Trenholm S**, Awatramani GB, Kalloniatis M (2013) Early remodeling of Müller cells in the rd/rd mouse model of retinal dystrophy. The Journal of Comparative Neurology. 521:2439-53.

Borowska J, **Trenholm S**, Awatramani GB (2011) An intrinsic neural oscillator in the degenerating mouse retina. The Journal of Neuroscience. 31:5000-12.

REVIEW ARTICLES

Trenholm S & Awatramani GB (2017) Dynamic properties of electrically coupled retinal networks. Chapter in: Network Functions and Plasticity: Perspectives from studying neuronal electrical coupling in microcircuits. Editor: Jian Jing. Publisher: Elsevier. Pages: 183-208.

Trenholm S & Awatramani GB (2015) Origins of spontaneous activity in the degenerating retina. Frontiers in Cellular Neuroscience. 9:277. doi: 10.3389.

Trenholm S & Roska B (2014) Cell-type-specific electric stimulation for vision restoration. Preview in Neuron. 83:1-2.

MOST SIGNFICANT PUBLICATIONS

1. Wertz A*, **Trenholm S***, Yonehara K, Hillier D, Raics Z, Leinwieber M, Szalay G, Keller G, Rozsa B, Conzellman KK, Roska B (2015) Single-cell-initiated monosynaptic tracing reveals layer-specific cortical network modules. Science. 349:70-4. *indicates equal contribution. *Cited 48 times.*

Understanding the functional connectivity of cortical circuits: To gain an understanding of how the brain works it is useful to study how diverse inputs to a single neuron get converted into an output. I helped develop a novel strategy to link neuronal input and output, by performing single-cell infection with modified rabies viruses to trace synaptically-connected networks with a calcium indicator dye, followed by in vivo 2-photon calcium imaging. This work revealed novel functional cortical wiring strategies and was recommended by the Faculty of 1000. An image from this work is currently on display in New York in an art exhibit focusing on the intersection between art and neuroscience, with a focus on the work of Ramon y Cajal, and is included in a related book that was recently published (Beautiful Brains: The Drawings of Ramon y Cajal, 2017). A follow up study revealed that cortical circuits can multitask by switching computational modes depending on the stimulus being processed (Trenholm et al., *In preparation*). I have helped researchers from several labs that were interested in learning this technique (including labs situated in London, Seattle, Zurich and Aarhus).

2. **Trenholm S***, McLaughlin AJ*, Schwab DJ, Turner MH, Smith RG, Rieke F, Awatramani GB (2014) Non-linear dendritic integration of electrical and chemical synaptic inputs drives fine-scale correlations. Nature Neuroscience. 17:1759-66. *indicates equal contribution. *Cited 27 times.*

Dynamic interactions between electrical and chemical synapses: Neuronal signals are passed between neurons via electrical or chemical synapses. However, very little is known about how these types of synapses interact to modulate neuronal output. Using mouse retina as a model system, I examined electrical-chemical synaptic interactions within a genetically identified ganglion cell type. I found that interactions between these two forms of synaptic inputs endow this cell type with unique physiological properties, such as being able to compute a fine-scale correlated spiking code. This paper was highlighted in a 'News and Views' article in Nature Neuroscience and awarded the Canadian Institutes for Health Research Brain Star Award in 2015. Related work on the dynamic interactions between electrical and chemical synapses was published in Nature Neuroscience (Trenholm et al., 2013) and the Journal of Neuroscience (Trenholm et al., 2013), and reviewed in a book chapter (Trenholm and Awatramani, 2017).

3. **Trenholm S**, Borowska J, Zhang JC, Hoggarth A, Johnson K, Barnes S, Lewis TJ, Awatramani GB (2012) Intrinsic oscillatory activity arising within the electrically-coupled AII amacrine/ON cone bipolar cell network is driven by voltage-gated Na^+ channels. The Journal of Physiology. 590:2501-17. *Cited 58 times*.

Circuit analysis of the degenerating retina: In rodent models of retinal degenerative diseases, the blind retina becomes spontaneously active. I identified subcellular substrates – namely gap junctions and voltage-gated Na^+ channels in specific retinal cell types – that could be targeted in future vision restoration strategies in order to reduce spontaneous noise in the degenerate retina. A related article was published in the Journal of Neuroscience (Borowska, Trenholm et al., 2011) and this work was reviewed in Frontiers in Cellular Neuroscience (Trenholm and Awatramani, 2015). This work has influenced subsequent studies to modify retinal gap junctional coupling when performing vision rehabilitation experiments.

4. Schubert R*, **Trenholm S***, Balint K*, Kosche G, Cowan C, Mohr MA, Munz M, Martinez-Martin D, Flaeschner G, Newton R, Krol J, Gross Scherf B, Yonehara K, Wertz A, Ponti A, Ghanem A, Hillier D, Conzelmann KK, Müller DJ and Roska B (2018) Virus stamping for targeted single cell infection in vivo and in vitro. Nature Biotechnology. 36:81-88. *indicates equal contribution.

Development of a novel strategy for single-cell virus infection: Recombinant viruses are widely used to genetically engineer cells. Targeted viral infection of single cells can be particularly advantageous for studying complex systems such as the brain. I helped develop a strategy called 'virus stamping' for simple and versatile single cell virus infection in vitro and in vivo. This work was highlighted in a 'News and Views' article in Nature Biotechnology and featured in the 'Research Highlights' article in Nature Methods.

5. **Trenholm S**, Johnson K, Li X, Smith RG, Awatramani GB (2011) Parallel mechanisms encode direction in the retina. Neuron. 71:683-94. *Cited 81 times*.

Analysis of the directionally selective retinal circuit: The directionally selective circuit in the retina is a model system for understanding how a microcircuit performs a complex computation. I described a mouse line in which a single type of retinal ganglion cell is fluorescently labeled, identified this cell type as a directionally selective ganglion cell possessing an asymmetric dendritic tree, and found that this morphological specialization generates directionally selective responses. This was a robust demonstration of form driving functional in a neuronal computation. This mouse line is now used by many labs throughout the world (including labs at Harvard, Berkeley, the Friedrich Miescher Institute, and Virginia Tech) to study the direction selective circuit and to examine how retinal ganglion cells connect to different visual brain centers. In a related study, I examined how retinal bipolar cell development affects development of the directionally selective circuitry (Shi*, Trenholm* et al., 2011, Journal of Neuroscience; * indicates equal contribution).