Shai Sabbah, Ph.D.

shai_sabbah@brown.edu

Curriculum Vitae

Updated June. 5, 2017

Department of Neuroscience, Brown University, Providence, RI, USA

Bourses postdoctorales Banting Postdoctoral Fellowships

Education

2012-present **Postdoctoral Research Associate**
Department of Neuroscience, Division of Biology and Medicine, Brown University
Providence, RI, USA
Mentor: David Berson

Research Focus 1: Tuning of direction selective cells in the retina and brain, and its role in image stabilization on the retina.

Research Focus 2: Mechanisms of irradiance coding by intrinsically photosensitive retinal ganglion cells.

Techniques used: Calcium and glutamate imaging, multiphoton microscopy, *in-vitro* whole-cell patch clamp physiology, *in vivo* field potentials recording, serial electron microscopy, brain projections characterization, neuroanatomical tracing, immunohistochemistry, spectrophotometry, and modelling.

2007-2012 **Ph.D.**
Department of Biology, Queen's University, Kingston, ON, Canada
Thesis: Functional diversity in the color vision of fish
Supervisor: Craig W. Hawryshyn

2001-2005 **M.Sc.**
Department of Evolution, Systematics, and Ecology
The Hebrew University of Jerusalem, Israel
Thesis: Physical and biological factors affecting the underwater polarized light and the behavior of polarization-sensitive animals
Supervisor: Nadav Shashar

1998-2001 **B.A.** CUM LAUDE
Department of Biology
The Technion - Israel Institute of Technology, Haifa, Israel

Academic and Professional Experience

Academic Service

2010-2012 Delegated on the Diving Safety Committee, Queen's University
2010 Coordinated the Neuroethology and Sensory Biology seminar, Queen's University

Review Activities

Grant proposals referee

1. *Committee:* Experimental Marine Biology: Aquaculture, Pathogens and Pollution
   Organization: Israeli-French High Council for Scientific and Technological Research
2. *Committee:* MIT Sea Grant Marine Research Program
   Organization: Massachusetts Institute of Technology.

Research papers referee

Journal of Vision, Current Zoology, PLOS One (2 instances), Marine Ecology Progress Series.

Supervision Experience

2013-present Supervised Undergraduate Senior Thesis, Brown University
Gabriel Castro
Min Tae Kim
Ananya Bhatia-Lin
Gabrielle Manoff
Elizabeth Koplas
Carin Papendorp

2013-present Supervised Undergraduate students, Brown University
Cameron Etebari
Jesse Siegel
Pu-Ning Chiang
Marjo Beltoja
Ali Noel Gunesch
Luis Carrete
Tiffany Zhao
Vanessa Cushing
Daniel Schreck

2011-2012 Served as a Research Director in the lab of Craig Hawryshyn at Queen's University (in his absence) and supervised Graduate and Undergraduate students

Mark Hornsby	Graduate
Shyh-Chi Chen	Graduate
Manisha Bhardwaj	Undergraduate
Changhai Zhu	Undergraduate
Stephanie Zahradnik	Undergraduate
Mike Sutton	Undergraduate Senior Thesis
Maheen Habib-Nayany	Undergraduate Senior Thesis
Zahra Dargaei	

2010-2011 Supervised Undergraduate Senior Thesis, Queen's University
Frances Hauser
Jonathan Hui

2010, 2011 Supervised three Summer Work Experience Program (SWEP) students, Queen's University

Teaching Experience

Invited lecturer

2011	Animal Behavior	Queen's University
2014	Topics in visual neuroscience	Brown University

Teaching assistant

2009	Comparative Animal Physiology	Queen's University
2009	Introductory Biology of Organisms	Queen's University
2008	Comparative Animal Physiology	Queen's University
2008	Introductory Biology of Organisms	Queen's University
2007	Introductory Biology of Organisms	Queen's University
2004	Behavior of Marine Animals	The Hebrew University
2003	The Ecological System of the Gulf of Aqaba	The Hebrew University
2003	Behavior of Marine Animals	The Hebrew University
2002	The Ecological System of the Gulf of Aqaba	The Hebrew University
2002	Behavior of Marine Animals	The Hebrew University

Professional Development in Teaching

2016 Effective performance: improvisation and performance techniques
A workshop series introducing performance values, drawn from improvisational and theatrical techniques, Brown University

2013 Teaching Certificate I, The Sheridan center for teaching and learning, Brown University
An internationally recognized certificate program that focuses on providing the skills and perspectives necessary to develop a reflective teaching practice, and developing teaching and assessment strategies.
http://brown.edu/Administration/Sheridan_Center/certificateprograms/sts.html

Invited Oral Presentations

1. **Sabbah S.** Image stabilization and the tuning of direction-selective cells in the retina and the accessory optic system. The Department of Neuroscience, Brown University, Providence, RI, USA, February 2015.
2. **Sabbah S.** Functional diversity in color vision of fish. The Department of Zoology, The Faculty of Life Sciences, Tel-Aviv University, Israel, March 2012.
3. **Sabbah S.** Functional diversity in color vision of fish. The Department of Marine Biology, School of Marine Sciences, University of Haifa, Israel, March 2012.
4. **Sabbah S.** Functional diversity in color vision, Department of Biology, Queen's University, Kingston, ON, Canada, October 2011.
5. **Sabbah S.** The visual performance of Lake Malawi cichlid fishes, Neuroethology and Sensory Biology seminar, Queen's University, Kingston, ON, Canada, January 2011.

Work Experience

2008-2010 Designed and built the prototype of a hyperspectral transmissometer for the ultraviolet-visible spectrum, along with calibration and measurement protocols.
Queen's University
http://aslo.org/lomethods/free/2010/0527.html

2006-2007 Designed a hyperspectral imaging system for the detection of hazardous bacteria
Project manager
R&D department
Green Vision Systems Ltd., Tel-Aviv, Israel

2001-2005 Performed underwater experimental and technical work
The InterUniversity Institute of Marine Sciences in Eilat, Israel

Membership in Professional Societies

2012-present Association for Research in Vision and Ophthalmology (ARVO)
2012-present Society for Neuroscience (SFN)
2008-2011 International Society for Neuroethology (ISN)

Awards, Fellowships and Scholarships

		Value ($)
2015	Ramon Dacheux, II Memorial Travel Grant. Association for Research in Vision and Ophthalmology (ARVO)	750
2013-2015	Banting Postdoctoral Fellowship Natural Sciences and Engineering Research Council of Canada (NSERC) *The most prestigious Canadian postdoctoral fellowship* *Application ranked 7 out of 180 reviewed* http://banting.fellowships-bourses.gc.ca/en/home-accueil.html Title: A vestibulocentric visual channel for image stabilization Description: Proposal to study how the accessory optic system assembles signals from direction-selective cells to allow their efficient comparison with inner-ear head rotation signals. Comparison of these signals drives reflex eye movements that serve to stabilize the image of the outside world on the retina.	140,000
2013-2015	NSERC Postdoctoral Fellowship (declined)	80,000
2012-2013	Sidney A. Fox and Dorothea Doctors Fox Postdoctoral Fellowship in Ophthalmology and Visual Sciences Brown University, Providence, RI	38,000
2010-2012	Vanier Canada Graduate Scholarship, NSERC *The most prestigious Canadian postgraduate scholarship* http://www.vanier.gc.ca/en/home-accueil.html	150,000
2010	Heiligenberg Student Travel Award International Society for Neuroethology	700
2009-2010	International Tuition Award (ITA), Queen's University, Canada	5,000
2009-2010	Ontario Graduate Scholarship (OGS), Canada (declined)	15,000
2008-2009	International Tuition Award (ITA), Queen's University, Canada	5,000
2008-2009	Ontario Graduate Scholarship (OGS), Canada	15,000
2007-2008	Queen's Graduate Award (QGA), Queen's University, Canada	7,210
2007-2008	International Tuition Award (ITA), Queen's University, Canada	5,000
2007-2008	Graduate Entrance Tuition Award (GETA), Queen's University, Canada	5,160
2000-2001	The President's List of Distinction (3 semesters) The Technion - Israel Institute of Technology, Israel	

Scientific Publications

Doctoral Dissertation

Functional diversity in colour vision of fish. Supervisor: Craig W. Hawryshyn. Date: 2012. Department of Biology, Queen's University, Kingston, Ontario, Canada. Dissertation was deposited in QSpace – Queen's Research and Learning repository http://qspace.library.queensu.ca/. The dissertation led to publications # 8, 9, and 14.

Original Articles

* Graduate and undergraduate students I supervised

1. **Sabbah S**, Gemmer JA, Bhatia-Lin A*, Manoff G*, Castro G*, Siegel JK*, Jeffery N and Berson DM. (2017). A retinal code for motion along the gravitational and body axes. ***Nature*** (full-length article) doi:10.1038/nature22818. **(IF 41.45; 1/63 Multidisciplinary sciences)**

2. **Sabbah S**, Berg D, Papendorp C*, Briggman KL and Berson DM. (2017). A Cre mouse line for probing irradiance- and direction-encoding retinal networks. *eNeuro* doi:*10.1523/eneuro.0065-17.2017*. **(IF NA; NA/NA Neurosciences)**

3. Fine M, **Sabbah S**, Shashar N. and Hoegh-Guldberg O. (2013). Light from Down Under. *Journal of Experimental Biology* 216, 4341-4346. **(IF 3.20; 17/86 Biology; 3 citations)**

4. **Sabbah S** and Hawryshyn CW. (2013). What has driven the evolution of multiple cone classes in visual systems - object contrast enhancement or light flicker elimination? *BMC Biology* 11, doi:10.1186/1741-7007-1111-1177 **(IF 7.10; 5/86 Biology; 4 citations)**

5. **Sabbah S,** Zhu C*, Hornsby MAW*, Kamermans M and Hawryshyn CW. (2013). Feedback from horizontal cells to cones mediates color induction and may facilitate color constancy in rainbow trout. *PLOS One*. 8, doi:10.1371/journal.pone.0066216 **(IF 3.53; 11/63 Multidisciplinary sciences; 3 citations)**

6. Hornsby MAW[#], **Sabbah S[#],** Robertson RM, and Hawryshyn CW. (2013). Modulation of environmental light alters reception and production of visual signals in Nile tilapia. *Journal of Experimental Biology* 216, 3110-3122. [#]equal contribution **(IF 3.20; 17/86 Biology; 10 citations)**

7. **Sabbah S,** Habib-Nayany MF*, Dargaei Z*, Hauser FE*, Kamermans M and Hawryshyn CW. (2013). Retinal region of polarization sensitivity switches during ontogeny of rainbow trout. *Journal of Neuroscience* 33, 7428-7438. **(IF 6.78; 26/265 Neurosciences; 4 citations)**

8. **Sabbah S,** Troje NF, Gray SM and Hawryshyn CW. (2013). High complexity of aquatic irradiance may have driven the evolution of four-dimensional colour vision in shallow-water fish. *Journal of Experimental Biology* 216, 1670-1682. **(IF 3.20; 17/86 Biology; 4 citations)**

9. **Sabbah S,** Hui J*, Hauser FE*, Nelson WA and Hawryshyn CW. (2012). Ontogeny in the visual system of Nile tilapia. *Journal of Experimental Biology* 215, 2684-2695. **(IF 3.20; 17/86 Biology; 11 citations)**

10. **Sabbah S,** Gray SM and Hawryshyn CW. (2012). Radiance fluctuations induced by surface waves can enhance the appearance of underwater objects. *Limnology & Oceanography* 57, 1025–1041. **(IF 4.28; 2/20 Limnology; 3 citations)**

11. Gray SM, **Sabbah S** and Hawryshyn CW. (2011). Experimentally increased turbidity causes behavioural shifts in Lake Malawi cichlids. *Ecology of Freshwater Fish* 20, 529-536. **(IF 2.03; 11/52 Fisheries; 14 citations)**

12. Lerner A, **Sabbah S,** Erlick C and Shashar N. (2011). Navigation by light polarization in clear and turbid ocean. *Philosophical Transactions of the Royal Society B* 366, 671-679. **(IF 7.22; 6/86 Biology; 27 citations)**

13. Shashar N, Johnsen S, Lerner A, **Sabbah S,** Chiao CC, Mathger LM and Hanlon RT. (2011). Underwater linear polarization - physical limitations to biological functions. *Philosophical Transactions of the Royal Society B* 366, 649-654. **(IF 7.22; 6/86 Biology; 21 citations)**

14. **Sabbah S,** Lamela Laria R, Gray SM and Hawryshyn CW. (2010). Functional diversity in the color vision of cichlid fishes. *BMC Biology* 8, doi: 10.1186/1741-7007-1188-1133 (Highly accessed status). **(IF 7.10; 5/86 Biology; 37 citations)**

15. **Sabbah S,** Gray SM, Boss ES, Fraser JM, Zatha R and Hawryshyn CW. (2011). The underwater photic environment of Cape Maclear, Lake Malawi: Comparison between rock- and sand-bottom habitats and implications for cichlid fish vision. *Journal of Experimental Biology* 214, 487-500. **(IF 3.20; 17/86 Biology, 17 citations)**

16. **Sabbah S,** Fraser JM, Boss ES, Blum I and Hawryshyn CW. (2010). Hyperspectral portable beam transmissometer for the ultraviolet - visible spectrum. *Limnology & Oceanography: Methods* 8, 527-538. **(IF 2.98; 5/20 Limnology; 2 citation)**

17. Hawryshyn CW, Ramsden SD, Betke KM and **Sabbah S.** (2010). Spectral and polarization sensitivity of juvenile Atlantic salmon (*Salmo salar*): phylogenetic considerations. *Journal of Experimental Biology* 213, 3187-3197. **(IF 3.20; 17/86 Biology; 11 citations)**

18. Anderson LG, **Sabbah S** and Hawryshyn CW. (2010). Spectral sensitivity of single cones in rainbow trout (*Oncorhynchus mykiss*): A whole-cell voltage clamp study. *Vision Research* 50, 2055-2061. **(IF 2.31; 190/256 Neurosciences; 7 citations)**

19. **Sabbah S** and Shashar N (2007).The polarization of light under water near sunrise. *Journal of the Optical Society of America A* 24, 2049-2056. **(IF 1.41; 51/90 Optics; 16 citations)**

20. **Sabbah S** and Shashar N (2006). Underwater light polarization and radiance fluctuations induced by surface waves. *Applied Optics* 45, 4726-4739. **(IF 1.61; 49/90 Optics; 16 citations)**

21. **Sabbah S** and Shashar N (2006). Polarization contrast of zooplankton: A model for polarization-based sighting distance. *Vision Research* 46, 444-456. **(IF 2.31; 190/256 Neurosciences; 21 citations)**

22. **Sabbah S,** Barta A, Gál J, Horváth G and Shashar N. (2006). Experimental and theoretical study of skylight polarization transmitted through Snell's window of a flat water surface. *Journal of the Optical Society of America A* 23, 1978-1988. **(IF 1.41; 51/90 Optics; 27 citations)**

23. Shashar N, **Sabbah S** and Aharoni N. (2005). Migrating locusts can detect polarized reflections to avoid flying over seas. *Biology Letters*. 1, 472-475. Featured in 'Research Highlights' in ***Nature*** 436, 306-307 (2005). **(IF 3.38; 19/86 Biology; 36 citations)**

24. Shashar N, **Sabbah S** and Cronin TW. (2004). Transmission of linearly polarized light in sea water: implications for polarization signaling. *Journal of Experimental Biology* 207, 3619-3628. **(IF 3.20; 17/86 Biology; 61 citations)**

Chapters in Books

1. **Sabbah S,** Lerner A^{S}, Erlick C^{C} and Shashar N^{PI}. Under water polarization vision- a physical examination. In *Recent Research Developments in Experimental & Theoretical Biology.* (Transworld Research Network, Trivandrum, 2005), pp. 123-177. **(42 citations)**

Invited Papers in Scientific Meetings

1. **Sabbah S**, Papendorp C, Koplas E, Beltoja M, Etebari C, Gunesch AN, Carrete L, Kim MT, Manoff G, Bhatia-Lin A, Dowling H, Briggman K, Berson DM. All bipolar cells encode irradiance in their output. Association for Research in Vision and Ophthalmology (ARVO) 2017 Annual Meeting, ARVO, Baltimore, MD, USA, May 2017 **(International)**.

2. **Sabbah S**, Gemmer JA, Lin AB, Manoff G, Castro G, Siegel JK, Jeffery N, and Berson DM. Retinal direction selectivity uses vestibular logic to encode self-motion. Retinal Neurobiology and Visual Processing, Federation of American Societies for Experimental Biology (FASEB), Keystone, Colorado, USA, July 2016 **(International)**.

3. **Sabbah S**, Kim M, Manoff G, Bhatia-Lin A, Papendorp C, Briggman K, and Berson DM. Connectomics of irradiance-encoding ON bipolar-cell inputs to ipRGCs. Association for Research in Vision and Ophthalmology (ARVO) 2016 Annual Meeting, ARVO, Seattle, WA, USA, May 2016 **(International)**.

4. **Sabbah S**, Gemmer JA, Castro G, Siegel JK, Jeffery N, and Berson DM. ON-DS retinal ganglion cells encode global motion in vestibular coordinates. Association for Research in Vision and Ophthalmology (ARVO) 2015 Annual Meeting, ARVO, Denver, CO, USA, May 2015 **(International)**.

Abstracts - Conference Presentations

1. **Sabbah S**, Gemmer JA, Siegel JK, Castro G, and Berson DM. Topographic variation in directional tuning of ON DS retinal ganglion cells: implications for image stabilization. Retinal Neurobiology and Visual Processing, Federation of American Societies for Experimental Biology (FASEB), Saxtons River, Vermont, USA, June 2014 **(International, poster)**.

2. Hornsby MAW, **Sabbah S**, Robertson RM, and Hawryshyn CW. Age-dependent effect of light environment on visual sensitivity and body colouration in Nile tilapia. The tenth International Congress of Neuroethology, International Society for Neuroethology, University of Maryland, USA, August 2012 **(International, poster)**.

3. Lerner A, **Sabbah S**, Shashar N and Haspel C. The role of hydrosols on underwater polarization as a function of wavelength. The Twenty-fifth Meeting of the Israeli Association for Aerosol Research, Weizmann Institute of Science, Rechovot, Israel, March 2012 **(National, Oral)**.

4. Lerner A, **Sabbah S**, Erlick-Haspel C and Shashar, N. Navigation by light polarization in ocean. The Eighth Meeting of the Israeli Association for Aquatic Sciences, Hadera, Israel, April 2011, **(National, poster)**.

5. **Sabbah S,** Lamela Laria R, Gray SM and Hawryshyn CW. Through the eyes of cichlid fishes: Sex differences and functional diversity in color vision. The Ninth International Congress of Neuroethology, International Society for Neuroethology, Salamanca, Spain, August 2010 **(International, poster)**.

6. Gray SM, **Sabbah S** and Hawryshyn CW. Exploring visual microhabitat usage by three sympatric, congeneric Lake Malawi cichlids. Evolution Annual Meeting, the Society for the Study of Evolution, Moscow, Idaho, USA, June 2009, **(International, oral)**.

7. Gray SM, **Sabbah S** and Hawryshyn CW. A field experiment testing the influence of increased turbidity on cichlid behaviour in Lake Malawi. Canadian Society of Ecology and Evolution Annual Meeting, Halifax, Nova Scotia, Canada, May 2009, **(National, poster)**.

8. Lerner A, **Sabbah S**, Shashar N and Erlick C. Polarization in Turbid Water - Implications for Underwater Navigation. New Directions in Research on Polarization of Light, Heron Island, Australia, June 2008 **(International, poster)**.

9. Lerner A, **Sabbah S**, Shashar N and Erlick C. Polarization – the 3rd quality of light: Can it be used for navigation in the marine environment? The Sixth International Conference on Animal Navigation, The Royal Institute of Navigation, University of Reading, Berkshire, UK, April 2008 **(International, oral)**.

10. Lerner A, Erlick C, Shashar N and **Sabbah S.** On the Quest for the scattering mechanism that determines the polarization field in the ocean. Ocean Optics XVIII Conference, Montreal, Quebec, Canada, October 2006 **(International, oral)**.

11. Lerner A, **Sabbah S**, Shashar N and Erlick C. Underwater polarization field outside of Snell's window. NeuroEthology, Gordon Research Conference, Oxford, UK, Aug. 2005 **(International, poster)**.

12. Lerner A, Erlick C, **Sabbah S** and Shashar N. Particles in the sea and their effect on underwater polarization and marine animal behaviour. The Nineteenth Meeting of the Israeli Association for Aerosol Research, the Israel Institute of Biological Research, Ness-Ziona, Israel, May 2005, **(National, poster)**.

13. Lerner A, **Sabbah S**, Shashar N and Erlick C. The underwater polarization outside of Snell’s window. Visual Function conference, Tel-Aviv, Israel, April 2005, **(International, poster)**.

14. **Sabbah S** and Shashar N. Is the underwater polarization signal stable? The First Meeting of The Israeli Limnology Society, Bar-Ilan University, Tel-Aviv, Israel, May 2004 **(National, poster)**.

15. Shashar N, **Sabbah S**, Zarfati E and Hanlon RT. Submersible polarization sensors. Biological and Chemical Sensors in the Ocean Workshop, Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, USA, June 2003, **(International, poster)**.